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# **Implementation of Bridge Filtering to Prevent DHCP Starvation Attack (Case Study: SD Inpres Papindung)**

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### Abstract

The impact of internet cut off or disrupted at SD Inpres Papindung, the teachers will have difficulty finding teaching materials and may have to return to traditional methods that are less effective. Updating Dapodik data will also be disrupted, which could affect school administration and evaluation. The unavailability of an internet connection does occur due to technical reasons or due to intentional elements, one of which is the use of Yersinia software. Yersinia is a piece of software that is commonly used to attack available networks by sending fake MAC addresses continuously so that the IP address on the DHCP server runs out, so that the client does not get an IP address which causes the client unable to access the internet. This attack are called DHCP Starvation Attack. This can be prevented using Bridge Filtering method. Bridge Filtering can filter only recognized MAC addresses to transmit data or can request an IP address from the DHCP server, while MAC addresses that are not recognized or foreign devices will not be allowed to request from that port or will not receive an IP address from the DHCP server. The aim of implementing Bridge Filtering is to measure the creativity of the Bridge Filtering method in preventing DHCP Starvation Attack attacks so that clients who want to connect to the network can access the internet and improve network quality at SD Inpres Papindung. The results show that the Bridge Filtering method effective in preventing DHCP Starvation Attacks and improves network quality at SD Inpres Papindung which is shown by an increase of throughput, before implementation it was 794.66 Kbps and after implementation it was 1283.70 Kbps, there was a decrease of delay from 6.89 ms before implementation to 4.06 ms after implementation. There was also a decrease in jitter before implementation 10.56 ms and after implementation 6.05 ms, but caused an increase in packet loss which was 0.30% before implementation and after implementation increased to 0.79%. Of the four variables, all of them remain at the same level except for the throughput variable, where there is a change from the fair category to the good category, so that it has an impact on the quality of the internet network at SD Inpres Papindung after implementing Bridge Filtering which is stated to be better than before implementing Bridge Filtering on the internet network at SD Inpres Papindung.

Keywords: MikroTik, DHCP, Yersinia, DHCP Starvation attack, Bridge Filtering.

# 1. Introduction

With advances in technology, the need for computer networks and the internet will become increasingly important, both in education, work and other sectors. The use of internet networks in schools can make it easier for teachers to search for interesting and relevant open materials, such as educational videos, images and additional information that can enrich lesson material [1]. Apart from that, the internet network can support teachers to carry out other work, for example filling in performance, inputting Basic Education Data (Dapodik), monitoring the learning environment and accessing other educational information. Without reliable internet access, teachers face challenges in quickly finding open educational resources and may revert to traditional teaching methods, which tend to be less interactive and engaging. Filling in Dapodik data and learning environment surveys will also be disrupted, which could affect school administration and evaluation. Without internet access, getting the latest educational information and following developments in the world of education becomes more difficult, potentially hampering efforts to improve the quality of teaching and learning in schools [2].

Network security in educational environments is critical to protecting sensitive data, such as personal information of students, staff, and academic data, from growing cyber threats. Educational institutions are often targets of attacks due to the large amount of data they manage and their dependence on digital technology for the learning process. Without a strong security system, the risk of data leaks, hacking, and malware attacks can disrupt teaching and learning activities, damage the institution's reputation, and cause financial losses. In addition, good network security also creates a safe environment for students and teachers to access digital resources freely without worrying about online threats, while supporting the development of technology in education in a responsible way [3].

The Bridge Filtering method is used to solve the problem of filtering data or information flow in a network by connecting two different network segments, thereby enabling more efficient data traffic management. This concept is usually applied in systems that require separation between two types of networks or segments without breaking their connectivity. Bridge Filtering works by filtering data flowing between the two networks, blocking or allowing certain packets based on predetermined criteria, such as IP address, protocol, or data type. Its application in a network context can help reduce traffic loads, increase security, and optimize network performance [4].

Sometimes the unavailability of an internet network does not occur due to technical reasons, sometimes it occurs due to deliberate actions, one of which is the use of Yersinia software. Yersinia is a piece of software that is commonly used to attack available networks by sending fake MAC addresses continuously so that the IP address on the DHCP server runs out, so that the client does not get an IP address which causes the client to be unable to access the internet [5].

SD Inpres Papindung is one of the educational institutions located in Mauliru Village, Kec. Kambera District. East Sumba, which was founded on July 22 1980, has a total of 226 students, with 128 males and 98 females, with 17 teachers. The problem that occurs in schools is the lack of internet network security, one of which is the DHCP Starvation Attack, which will send IP addresses continuously so that the DHCP server will run out of IP addresses, so that clients who want to access the network will not get an IP address or will not have internet access.

Form of DHCP attack Starvation Attack is a form of attack where the attacker tries to exhaust all available IP addresses on the DHCP server, so that legitimate users cannot get an IP address and lose access to the network. Attackers typically use automated tools to send spoofed DHCP requests with a variety of random MAC addresses. As a result, the DHCP server runs out of IP addresses it can provide, blocking other devices from connecting to the network. After that, attackers can take advantage of this condition by building a fake DHCP server (rogue DHCP server) to control and traverse the data network.

The purpose of using Yersinia software is to carry out penetration testing and simulate attacks on data link layer protocols in the network, such as STP (Spanning Tree Protocol), CDP (Cisco Discovery Protocol), DTP (Dynamic Trunking Protocol), and other network protocols. Yersinia helps network administrators and security researchers identify weaknesses or vulnerabilities in the network infrastructure they manage, so that mitigation or repair steps can be taken before these weaknesses can be exploited by irresponsible parties.

By implementing the Bridge Filtering Method at SD Inpres Papindung, you can prevent DHCP Starvation Attacks. Bridge Filtering can filter only MAC addresses that are already recognized for sending data or can request an IP address from the DHCP server, while MAC addresses that are not recognized or foreign devices will not be allowed to request from that port or will not get an IP address from the DHCP server. This research aims to prevent DHCP Starvation attacks by applying the Bridge Filtering Method on the network at SD Inpres Papindung. Then measure the effectiveness and influence of implementing Bridge Filtering on the network at SD Inpres Papindung by conducting analysis before and after implementing Bridge Filtering. It is hoped that the results of this research can improve network security at SD Inpres Papindung. The Bridge Filtering method was chosen to prevent DHCP Starvation Attacks at SD Inpres Papindung because the school only uses a MikroTik Router device without a switch. In these networks, a DHCP Starvation Attack attack can cause an exhaustion of IP addresses, making it impossible for legitimate devices to connect. Therefore, researchers used Bridge Filtering on existing MikroTik Routers to filter and limit Starvation Attack DHCP requests, thereby preventing the attack. Compared to the switch port security method, which is generally applied to switch devices to limit access based on MAC addresses, this method cannot be applied at SD Inpres Papindung because there is no switch in the network. Therefore, Bridge Filtering on the MikroTik Router side is an effective solution for protecting school internet networks from DHCP Starvation Attacks.

The effectiveness of the solution for using Bridge Filtering in dealing with DHCP Starvation Attack attacks, steps that can be taken include attack simulation testing before and after implementing Bridge Filtering. Network administrators can perform a controlled DHCP Starvation Attack attack in a test environment using tools such as Yersinia, then determine whether Bridge Filtering is capable of blocking or limiting incoming fraudulent DHCP packets. In addition, it is also important to pay attention to whether authorized users can still receive IP addresses from the DHCP server after Bridge Filtering is applied. Effectiveness can be measured by the reduction in spurious DHCP requests the server receives and the desire for network service to legitimate users without interruption.

# 2. Research Methodology

There are 5 stages of research that will be carried out by researchers in conducting this research, as shown in the following picture:



#### Fig. 1: Research Flow

The stages carried out are as follows:

- Analysis: At this analysis stage the author carried out an analysis by experimenting with running the Yersinia software before applying the Bridge Filtering method. Data collection was carried out by direct observation and conducting interviews with school operators with questions related to the research carried out. Apart from interviews, observations and mapping of the network topology used at SD Inpres Papindung were also carried out.
- Design: to implement Bridge Filtering by configuring the proxy router to filter invalid or suspicious DHCP packets. This includes checking the origin of packets and ensuring that only packets from legitimate clients are forwarded to the DHCP server at SD Inpres Papindung. Based on initial tests carried out on the Yersenia attack on the internet network at SD Inpres Papindung, it was found that the DHCP Starvation attack attacked the internet network at SD Inpres Papindung by continuously requesting IP addresses so that the DHCP server ran out of IP addresses so that new clients wanted to access the internet network at the elementary school. Inpres Papindung did not get another IP address because the DHCP starvation attack used up the IP provided by the DHCP server.
   an another IP address because the DHCP starvation attack used up the IP provided by the DHCP server.
- 3) Implementation: Implementation is carried out on the MikroTik device at SD Inpres Papindung which is connected to the internet where the device will be implemented using the Bridge Filtering method according to the design that has been built.
- 4) Testing: Testing is carried out by comparing the IP Address obtained by the client when a DHCP Starvation Attack occurs using Yersinia before implementation and after implementation, and also testing network quality which is represented through QOS variables in the form of Throughput, Delay, Jitter and Packet Loss before and after application of Bridge Filtering between initial testing during the Yersinia attack on the internet network at SD Inpres Papindung and testing after implementing the Bridge Filtering method on the internet network at SD Inpres Papindung.
- 5) Final Results: In the analysis section of the final results a comparison will be made between the initial test and the test after applying the Bridge Filtering method. Where an analysis was carried out on the ability of Bridge Filtering to prevent DHCP Starvation Attack attacks, then an analysis was carried out by comparing four QOS variables, namely Trougphut, Delay, Jitter and Packet Loss.

## 3. Results and Discussiona

a)

Bridge

In this research the author has prepared a network topology design for the implementation of Bridge Filtering with the Bakti Kominfo ISP, modem, MikroTik router, and connected access points with the internet. The local network design in this research is as in Figure 2

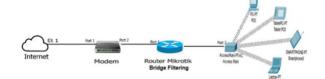


Fig. 2: Network Topology After Implementing The Bridge Filtering Method

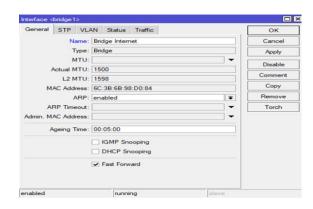


Fig. 3: Internet Bridge Menu

The image above shows the configuration interface for a network bridge in network management software. On the General tab, you can see that this bridge is named Internet Bridge with the bridge type then click apply and ok.

Interface <	Bridge LA	AN>						
General	STP	VLAN	Status	Traffic	:			ОК
	Nan	ne: Bridg	e LAN					Cancel
	Тур	be: Bridg	e					Apply
	МТ						•	Disable
,	Actual MT	-						Comment
	L2 M1 AC Addre	U: 1598		0.00.05				Сору
IVI.		RP: enab		0.00.00			Ŧ	Remove
A	RP Timeo						•	Torch
Admin. M	AC Addre	ss:					-	
A	geing Tin	ne: 00:0	5:00					
		🗌 IG	MP Sn	ooping				
			HCP S	nooping				
		💌 Fa	st Forv	vard				
enabled			runn	ing		sla	ve	

Fig. 4: LAN Bridge Menu

In the picture above is the Bridge 2 menu with the name bridge LAN with bridge type. Bridge LAN is used to connect several network segments so that it can function as one large network.

b) Bridge ports

lge	Ports VLANs M		rides Fit	ers NAT	l Hosts	Bridge Port <ether1_internet></ether1_internet>	
-	K C       Interface	Bridge		Trusted no	Priority (h.	General STP VLAN Status Interface: ether1_INTERNET	OK Cancel
H	tteher2 tteher3 tteher4	Bridge LAN Bridge LAN Bridge LAN		no no no	1	Bridge: Bridge Internet	1999
H	ttvether5_LAN ttvwlan1			no no	1	Hotzon:	Uisable
						<ul> <li>✓ Unknown Unicast Rood</li> <li>✓ Unknown Multicast Rood</li> <li>✓ Broadcast Rood</li> </ul>	Copy Remove
						Hardware Officiad	
ms (1	selected)						

Fig. 5: Bridge Internet Ports

The figure above illustrates that port 1 is used for an internet bridge by entering the bridge then clicking the port menu, on the general tab in the interface menu selecting ether 2 or internet source then on

the bridge menu selecting internet bridge ok.

General       STP       VLAN       Status       OK         Interface:       ether2       Image: Cancel       Apply         Bridge:       Bridge LAN       Image: Cancel       Apply         Horizon:       Image: Comment       Image: Comment       Copy         Image: Vuknown Multicast Rood       Image: Comment       Comment         Image: Vuknown Multicast Rood       Image: Comment       Comment         Image: Vuknown Multicast Rood       Image: Comment       Image: Comment         Image: Vuknown Multicast Rood       Image: Comment       Image: Comment         Image: Vuknown Multicast Rood       Image: Comment       Image: Comment         Image: Vuknown Mul					
Interface: ether2 Bridge: Bridge LAN Horizon: Learn: no Unknown Unicast Flood V Unknown Multicast Flood Trusted V Hardware Offload	Bridge Port	<ether2></ether2>			
Bridge:       Bridge LAN       Image: Apply         Horizon:       Image: Apply       Disable         Leam:       Image: Apply       Disable         Image: Unknown Unicast Flood       Image: Apply       Disable         Image: Unknown Multicast Flood       Image: Apply       Disable         Image: Image: Apply       Image: Apply       Image: Apply         Image: Image: Apply       Image: Apply       Image: Apply         Image: Apply       Image: Apply </td <td>General</td> <td>STP VLAN</td> <td>Status</td> <td></td> <td>ОК</td>	General	STP VLAN	Status		ОК
Horizon: no Vicast Flood Comment Copy Remove Remove	Interface:	ether2		₹	Cancel
Leam: no Comment Unknown Unicast Flood Unknown Multicast Flood Broadcast Flood Trusted Hardware Offload	Bridge:	Bridge LAN		₹	Apply
Unknown Unicast Flood       Comment         ✓ Unknown Multicast Flood       Copy         ✓ Broadcast Flood       Remove         Trusted       Hardware Offload	Horizon:			<b>—</b>	Disable
✓ Unknown Multicast Flood     Copy       ✓ Broadcast Flood     Remove       ✓ Trusted        ✓ Hardware Offload	Leam:			₹	Comment
Remove     Remove     Remove					Сору
☐ Trusted ☐ Hardware Offload					Remove
I Hardware Offload		<ul> <li>Broadcast Florence</li> </ul>	bod		
		Trusted			
enabled lipactive I Hw Offload		Hardware Of	fload		
anabled linactive law Offload					
enabled linactive Hw Offload					
enabled inactive Hw Offload					
indeave indeave	enabled		inactive	Hw. Offloa	d

Fig. 6: Bridge LAN Ports

In the figure above illustrates that ports 2-5 are used for LAN bridges by entering the bridge then clicking the port menu, on the general tab in the interface menu select ether 2 then on the bridge menu select LAN bridge then uncheck unknown unicast flood then on learn select no click then apply and ok, do the same thing on ether 3,4 and 5.

Bridge DHCP clients c)

DHCP Client <bridge internet=""></bridge>	
DHCP Advanced Status	ок
Interface: Bridge Internet	Cancel
Use Peer DNS	Apply
Use Peer NTP	Disable
Add Default Route: yes	Comment
	Сору
	Remove
	Release
	Renew
enabled Status: bound	

Fig. 7: DHCP Clients

The image above shows where the internet bridge is made into a DHCP client by entering the IP menu then entering DHCP client, on the interface tab select internet bridge then on the add default route menu select yes so that the internet bridge becomes a DHCP client, then click apply and ok wait until you get the IP.

d) LAN bridge IP

-	7	Find
	Address <192.168.0.1/24>	
	Address: 192.168.0.1/24	ок
D	Network: 192.168.0.0	Cancel
D	Interface: Bridge LAN	Apply
		Disable
		Comment
		Сору
		Remove
	enabled	

Fig. 8: LAN Bridge IP

The figure above illustrates shows the process of creating an IP address on a LAN bridge, by entering the IP menu section then selecting the address menu, then clicking add in the address column, we enter the IP as in the image above for the network 192.168.0.0 then select the interface. LAN bridge, then click apply and ok.

e) DHCP server

DHCP         Networks         Leases         Options         Options         Options         Aters           Image: Control of the state	of Add AR
+ m 🖉 🙁 🍸 DHCP Config DHCP Setup	
Name / Interface Relay Lease Time Address P	ol Add AR
DHCP server can not run on slave interface!	
I dhcp1 ether5_LAN 00:10:00 dhcp_poo	no li
DHCP server can not run on slave interface!	
1 dhcp2 wlan1 00:10:00 dhcp_poo	l no
dhcp3 Bridge LAN 00:10:00 dhcp_poo	no
3 žens	

The figure above illustrates how to create a DHCP server on a LAN bridge by entering the IP menu then selecting the DHCP server tab then clicking DHCP setup then selecting LAN bridge then clicking next until successful and then a picture will appear like the picture above. f) Bridge Filter

	Switch Rule <2E:65:	9D:6A:24:88/FF:FF:FF:FF:FF:FF>		
	Match Action			ок
	Switch:	switch1	Ŧ	Cancel
witch			• •	Apply
Switch Port Port Isolation Ho		2E:65:9D:6A:24:88 / FF:FF:FF:FF:FF	-	Disable
+ × × 7	Dst. MAC Address:		-	Сору
# Switch Ports	MAC Protocol:		-	Remove
0 switch1 ether2 1 switch1 switch1 cp	VLAN Header:		-	
2 switch1 ether2 3 switch1 ether2	VLAN ID:		-	
4 switch1 switch1 op 5 switch1 streps LA	VLAN Priority:		-	
5 switch I ether5_L4	Sro. Address:		<b>-</b>	
	Dat. Address:		-	
	Protocol:		-	
	Src. Port:		-	
	Det. Port:		-	
	DSCP:		-	
	Src. Address 6:		-	
items (1 selected)	Dat. Address 6:		- I	
	Traffic Class:		-	
	Flow Label:			

Fig. 10: Rules Menu

The figure above illustrates how to make switch 1 by selecting the switch menu then going to the rules tab, click add, then it will appear like the picture above on the switch, select switch 1 then fill in ports with ether5\_LAN then Src. Mac Address: Fill in the MAC address of the laptop or PC that has been registered, then select the action menu as shown in the image below.

ew Switch Rule		
Match Action		ок
	Copy To CPU	Cancel
	Redirect To CPU	Apply
	Mirror	Disable
	Set New Dst. Ports	Сору
New Dst. Ports	÷	Remove
New VLAN ID		
New VLAN Priority	·	

Fig. 11: Actions Tab

The figure above illustrates the devices that can pass through or can connect to the internet network by unchecking set new, etc. Ports.

New Host	
MAC Address: 5E:65:9D:6A:24:88	ОК
VID:	Cancel
On Interface: wlan1	Apply
Age:	Comment
Bridge: Bridge LAN	
	Сору
	Remove
local exte	emal

Fig. 12: Host Menu

he image above explains how to add a MAC address to the host menu by entering the bridge menu, then selecting the host menu, then clicking Add, an image like the one above will appear, then on the MAC Address tab, add the MAC address that has been registered or the interface where the plug is placed. connected then on the bridge menu select LAN bridge then click apply and ok.

ew Switch F	ule	
Match Act	ion	ок
s	witch: switch1	Cancel
	Ports:	Apply
Src. MAC Ad	dress: 2E:65:9D:6A:24:88 / FF:FF:FF:FF:FF	▲ Disable
Det. MAC Ad	dress:	Сору
MAC Pro	tocol:	-
- VLAN		Remove
VLAN H		-
	AN ID:	-
VLAN F	riority:	-
Src. Ad	deser [	_
Dst. Ad		-
	tocol:	-
	Port:	-
	. Port:	<u> </u>
	DSCP:	<u> </u>
- IP 6	Joer.	-
Src. Addr	ess 6:	-
Dst. Addr	ess 6:	-
Traffic	Class:	-
Flow	Label:	-

Fig. 13: Switch Rule Without Purpose

The image above explains the creation of switch 1 without a purpose by selecting the switch menu then entering the rules tab, clicking add, then it will appear like the image above on the switch. We use switch 1 in the port menu and leave it blank then on Src. Mac Address: Fill in the MAC address of the laptop or PC that has been registered. Then select the action menu as shown in the image below.

New Switch Rule		□ ×
Match Action		ок
	Copy To CPU	Cancel
	Redirect To CPU	Apply
	Mirror	Disable
	✓ ISet.New.Dat.Ports	Сору
New Dst. Ports:	÷	Remove
New VLAN ID:		
New VLAN Priority:	▼	
enabled		

#### Fig. 14: Action Block Tab

The image above explains how to block MAC addresses that are not registered by checking set new, etc. Ports then click apply and ok, so only the registered MAC addresses can be connected to the internet network.

g) The following are initial tests before implementing the Bridge Filtering Method:

DH	CP Networks	Leases Options	Option Sets Alerts							
÷	- 🖉 🔛	🗂 🍸 Cheo	:k Status							Find
	Address /	MAC Address	Client ID	Server	Active Address	Active MAC Addre	Active Hos	Expires After	Status	
)	192.168.0.231	50:40:F8:2A:0C:0	F	dhcp2	192.168.0.231	50:40:F8:2A:0C:0F		00:00:26	offered	
0	192.168.0.232	5C:06:59:5B:01:1	8	dhcp2	192.168.0.232	5C:06:59:5B:01:18		00:00:26	offered	
)	192.168.0.233	6C:7F:7A:75:42:3		dhcp2	192.168.0.233	6C:7F:7A:75:42:3F		00:00:26		
)	192.168.0.234	69:E6:9A:32:ED:A	A	dhcp2	192.168.0.234	69:E6:9A:32:ED:AA		00:00:26	offered	
)	192.168.0.235	0B:45:E7:21:1B:B	0	dhcp2	192.168.0.235	0B:45:E7:21:1B:B0		00:00:26	offered	
)	192.168.0.236	05:BD:84:11:B0:9	3	dhcp2	192.168.0.236	05:BD:84:11:B0:93		00:00:26	offered	
)	192.168.0.237	C4:EC:82:2C:28:F	6	dhcp2	192.168.0.237	C4:EC:82:2C:28:F6		00:00:26	offered	
)	192.168.0.238	E5:5B:A7:63:F6:4	5	dhcp2	192.168.0.238	E5:5B:A7:63:F6:45		00:00:26	offered	
)	192.168.0.239	2A:78:CE:38:91:D	F	dhcp2	192.168.0.239	2A:78:CE:38:91:DF		00:00:26	offered	
)	192.168.0.240	4D:57:B6:54:3D:8	D	dhcp2	192.168.0.240	4D:57:B6:54:3D:8D		00:00:26	offered	
)	192.168.0.241	D5:49:08:4E:DA:9	90	dhcp2	192.168.0.241	D5:49:08:4E:DA:90		00:00:26	offered	
)	192.168.0.242	FE:21:BC:62:FC:3	0	dhcp2	192.168.0.242	FE:21:BC:62:FC:30		00:00:26	offered	
)	192.168.0.243	97:16:B6:11:DD:9	8	dhcp2	192.168.0.243	97:16:B6:11:DD:98		00:00:26	offered	
)	192.168.0.244	1D:35:08:10:A7:9	0	dhcp2	192.168.0.244	1D:35:08:10:A7:90		00:00:26	offered	
)	192.168.0.245	A4:1C:27:67:7D:5	2	dhcp2	192.168.0.245	A4:1C:27:67:7D:52		00:00:26	offered	
)	192.168.0.246	D1:3C:49:66:06:2	C	dhcp2	192.168.0.246	D1:3C:49:66:06:2C		00:00:26	offered	
)	192.168.0.247	EA:D2:73:81:14:6	A 1:ea:d2:73:81:14:	dhcp2	192.168.0.247	EA:D2:73:81:14:6A	Redmi-13C	00:08:23	bound	
)	192.168.0.248	08:00:27:D5:F2:9	C 1:8:0:27:d5f2:9c	dhcp2	192.168.0.248	08:00:27:D5:F2:9C	serverubu	00:07:17	bound	
)	192.168.0.249	B4:B5:B6:7C:DA:.	1:b4:b5:b6:7c:da:	dhcp2	192.168.0.249	B4:B5:B6:7C:DA:	DESKTOP	00:07:11	bound	
)	192.168.0.250	A6:8E:7D:41:F1:3	3 1:a6:8e:7d:41f1:33	dhcp2	192.168.0.250	A6:8E:7D:41:F1:33	vivo-2007	00:05:18	bound	
)	192.168.0.251	3A:C7:82:1A:8D:7	74	dhcp2	192.168.0.251	3A:C7:82:1A:8D:74		00:00:27	offered	
•	192.168.0.252	CC:3A:86:4B:29:8	F	dhcp2	192.168.0.252	CC:3A:86:4B:29:8F		00:00:27	offered	
)	192.168.0.253	76:57:C0:7C:2E:B	2	dhcp2	192.168.0.253	76:57:C0:7C:2E:B2		00:00:27	offered	
)	192.168.0.254	D6:C7:CF:05:EE:F	A	dhcp2	192.168.0.254	D6:C7:CF:05:EE:FA		00:00:27	offered	

Fig. 15: Testing Before Implementing Bridge Filtering

Based on initial tests carried out on the Yersenia attack on the internet network at SD Inpres Papindung, it was found that the DHCP Starvation attack attacked the internet network at SD Inpres Papindung by continuously requesting IP addresses so that the DHCP server ran out of IP addresses so that new clients wanted to access the internet network at the elementary school. Inpres Papindung did not get another IP addresses because the DHCP starvation attack used up the IP provided by the DHCP server. The following is the final test after implementing the Bridge Filtering Method:

844

<b>+</b>	P Networks	0 5		Option Sets Alerts Status							Find
Τ.	Address /	MAC Ac		Client ID	Server	Active Address	Active MAC Addre	Active Hos.	Expires After	Status	<u>I III</u>
D	10.10.10.244	00:0B:0	D:16:25:35	1:0:b:d:16:25:35	dhcp1	10.10.10.244	00:0B:0D:16:25:35			bound	
D	192.168.0.245	1C:65:9	D:6A:24:88	1:1c:65:9d:6a:24:	dhcp2	192.168.0.245	1C:65:9D:6A:24:88	DESKTOP	00:06:26	bound	
D	192.168.0.246	EA:D2:	73:81:14:6A	1:ea:d2:73:81:14:	dhcp2	192.168.0.246	EA:D2:73:81:14:6A	Redmi-13C	00:05:06	bound	
D	192.168.0.247	A6:8E:7	D:41:F1:33	1:a6:8e:7d:41f1:33	dhcp2	192.168.0.247	A6:8E:7D:41:F1:33	vivo-2007	00:03:33	bound	
D	192.168.0.249	B4:B5:E	6:7C:DA:	1:b4:b5:b6:7c:da:	dhcp2	192.168.0.249	B4:B5:B6:7C:DA:	DESKTOP	00:07:19	bound	

Fig. 16: Testing After Implementing Bridge Filtering

The picture above shows the final test carried out after implementing Bridge Filtering, where when the Yersenia software attacked the internet network, it was found that the DHCP Starvation attack could no longer attack the availability of internet network access at SD Inpres Papindung, in other words the Bridge Filtering method was able to block DHCP attacks Starvation Attack on the internet network of SD Inpres Papindung.

#### h) QoS (Quality of Service) Analysis

Quality of Service (QoS) is a method for measuring and managing performance and quality in a network. Various services have different requirements in terms of performance such as throughput, packet loss, delay, and jitter. Apart from testing the success of implementing Bridge Filtering, QOS testing was also carried out before and after implementing Bridge Filtering.

No. Time	Source	Destination		Lengt Info		21388 0.05584	292.168.100.253	185-132-12-228	015	83 Standard query BidBe4 A coptoken.ccs.mcafee.com
	74,125.68,198	192.168.10.239			Data, Application Data, Application Data	21389 8.08638	292.168.108.253	183.132.12.228	015	83 Standard query loadic HTPS coptoken.ccs.acafee.com
	192.168.10.239	216.239.38.128	UDP	256 51691 + 443 Lan+224		21318 8 53634	132.168.100.253	34.104.35.123	4779	389 EET /edgedl/diffgen-puffin/laelgle/hene/gingboagddgdfbengep/2288458a334839525e279c3374c8484efe884352ecd5a324fe
	54,234,25,176	192,168,10,239	TCP		53 [ACK] Segel Ackel835 Wine16060 Lenv0			74.125.68.287		
4613 0.000000		192-168-18.239		355 TCP Previous segment not capt	tered] / Continuation Data 2 [ACK] Seg=1 Ack=1725 Min=16859 Cen=1460		1 192.118.109.253		0.00	73 Protected Payload (UPD), 0CID+F5495b15a7c5687N
	192.168.10.239	172.67.73.26			E [ACK] 549-1 ACK-1725 ACK-1 MIN-18059 CHT+1400 443 [ACK] 5eg-1725 ACK-1 MIN-64240 Cen+0 SLE+1401 58E+1782					
	192,168,10,239	172.67.73.26		54 53562 + 443 [857, AOX] Seg-177		21313 0.00000	199.232.210.172	152.168.100.253	102	1254 00 + 54416 [ACC] Seg-2012909 Ack+9439 Min-15600 Len-1200 [TCP segment of a reassembled PDU]
	192,168,10,239	74,125,68,150	TLSv2.3			21314 8.88888	139.232.218.172	192.168.100.253	1(2	1254 80 + 54416 [ACK] Sep-2014189 Ack+9439 Min-15680 Len-1200 [TCF segment of a reassembled PDU]
	142.251.12.95	192,160,10,239	TCP		65235 Ack+351 Wim+15780 Len+301 [TCP segment of a reassembled POU]		74.125.68.387	192.168.108.253	0.00	1292 Protected Payload (GPB)
	142.251.12.95	192.168.10.239	TCP		Ack-351 Win-15700 Lon-1460 [TCP segment of a reassembled PDU]				fear	
	192.168.10.239	142.251.12.95	TCP	54 53469 + 443 [ACK] Seq=351 Ack	1647996 Win+64240 Let+0		199.232.228.172	192.168.100.253	10	1254 00 + 54416 [ACX] Seq-2015309 Ack+9439 Win+15600 Lem-1200 [TCP segment of a reassembled PDU]
	185.125.190.21	192.168.10.239		1514 Ignored Unknown Record		21317 0.00000	199.232.210.172	292.168.100.253	TCP	1254 00 + 54416 [ACX] Seq=2016509 Ack+9439 Win+15000 Lem=1200 [TCP segment of a reassembled PDU]
	192.168.18.239 74.125.68.198	185.125.190.21	TCP	54 53545 + 443 [ACK] Seq=832 Ack		21318 8.888000	199.232.258.172	282,168,100,253	7(2)	1514 00 + 54483 [ACK] Sep-1033741 Ack+9880 Min+15633 Len+1468 [TCP segment of a reassembled PDV]
	74.125.68.198 142.251.12.95	192.168.10.239	TCP	56 443 + 53556 [ACK] Seq=2823 Ack	x3728 Winw15998 Lenv0 x7996 Ack+351 Winw15788 Lenw381 (TCP segment of a reassembled POU)	21119 8.00000	74.125.68.287	192.168.100.253	0.07	1292 Protected Payload (198)
	142.251.12.55	192.168.18.239	TLSv2.2		vaae workaar wrikravee ceikaer (ich bebeeur ol a lienzeentee ido)		74,125.68.287	192.168.100.253	0.00	1292 Protected Payload (109)
	103.132.12.228	192,168,10,239	185		No such name A beacons5.gvt3.com SOA elailai				four	
	142.251.12.95	192,168,10,239	TCP	1514 443 + 53469 [ACK] Sep-1648297	Ack+351 Win+15780 Let+1460 [TCP segment of a reassembled POU]		199.232.254.172	152.168.108.253	10	1254 00 + 54484 [ACK] Seq=1268829 Ack=9818 Min=15680 Les=1200 [TCP segment of a reassembled PDU]
4647 0.000035	192.168.18.239	142.251.12.95	TCP	54 55469 + 443 [ACK] Seg=351 Ack	1649757 Win+64248 Len+0	21322 0.00000	74.125.68.207	292.168.100.253	2010	1252 Protected Payload (090)
	142.251.12.95	192.168,10.239	TCP		18757 Ack+351 Win+15780 Len+381 (TCP segment of a reassembled POU)	21323 0.00000	199.232.210.172	152.168.100.253	10	1254 88 + 54416 [ACK] Sep-2017709 Ack+9439 kin+15680 Len+1200 [10P segrent of a reassembled PD0]
	192.168.10.239	142.258.4.182	TCP		Win+63965 Len+1 [TCP segment of a reassembled POU]		74.125.68.287	192.168.100.253	0.00	1292 Protected Payload (OPH)
	185.125.190.21	192.168.10.239		1514 Ignored Unknown Record 54 53545 n 443 (400) Senul33 4rks						
	192.168.18.239		TYR	38 d7 a1 b4 b5 b6 7c da cd 88 80 4			74.125.68.287	292.168.100.253		1292 Protected Payload (GPB)
	rtes on wire (1968 bi c: ChonggingFug 7c:d		000 C4 ad 34	30 07 al 04 05 06 70 da 00 00 40 40 52 40 00 00 11 04 44 70 11 04 15 75	5.00 48 6	21325 0.00000	216.239.38.128	292-168-188-253	715(1.3	1514 Application Data
	col Version 4. Sect 1		020 04 77 e2	d2 01 bb 00 d4 50 ds 4b e8 ac ec 4	0.4b w	21327 0.00000	216.239.38.128	152.16E.100.253	TLSvL.3	1534 Application Data
	Protocol, Sec Port: 5		020 67 d6 a2	69 29 15 e4 91 57 95 cc 9e b7 55 b	261 g·1)···N···U·a	21128 0.00000	216.239.38.128	192.168.100.253	71541.3	1514 Application Data
~ Data (284 bytes			040 AC 25 AP	4e 6d 2c 55 d3 1d 59 9b fa 37 f5 2	9 38 4 Net, U Y 7 )8	21220 0 00000	216.239.30.120	152,168,100,253		1514 Application Data
Data [trunca	ted]: 4be8scec404b67	66a2692915e4911	100 04 59 90	39 b0 /e ee at 3/ 03 90 9e b3 30 9 3f 22 bl #6 cll d7 cf h2 a6 29 40 a	4 6f 7					
[Length: 204	9			5c d0 6f 67 39 a5 f0 c2 fc f9 80 3			34.135.68.387	183 148 188 751		1592 Bretactad Davload (200)
		-0	1111 c2 f8 d9	38 15 41 1a 2f 2a 4c 3a d7 96 a9 b	8 39 ·····8·A·/ *L:····9	Frane 6: 54 by	tes on wire (432 bis	is), 54 bytes car 0000	<b>秋勤務</b>	98 d0 89 1c 45 9d 6a 24 03 88 00 💆 00 1;k e j5 🚦
			000 47 73 9e	45 b5 13 ca 24 7f ac b3 0f cb 4c a	1 be Os W SL.		rc: LiteonTechno Ga		00 23 49	47 48 98 98 66 cc bd c8 ad 64 fd c7 ed (1 条 · · · · · · · · ·
			10 E3 59 dr	12 98 95 97 C8 96 99 88 1C 83 D5 3 67 17 5e 98 88 57 85 77 18 1d 16 a	d 8b _ CY = ^ H +		col Version 4, Src:		65 at 64	结相 58 时 78 转 da da da da 59 58 ····· 子·····子·
<				34 43 36 at \$6 4a +1 34 +0 48 0+ +		paternet Proto	cou versual 4, pro:	Net: 5436, 0	fa få 1e	Ac 10 00
						Transmission G	entral Protocol, Sn	Part: 54361, 01		

Fig. 17: 1) Capture Results Before Applying Bridge Filtering, 2) Capture Results After Applying Bridge Filtering

From the capture results, throughput, packet loss, delay and jitter are calculated beforehand application of Bridge Filtering and after application of Bridge Filtering.

1. Throughput Before Implementation

1. Throughput Derore implementation
Throughput = (Data Packets Received)/( Observation Time)
Throughput = 65979923/664.232 bytes/second Bps
Throughput = 65979923/664.232
Throughput = 99332,647 byte per second (Bps)
Throughput = 99.33 kBps
Throughput $= 99.33 \times 8 \text{ kbps}$
Throughput = 794.66 kbps
1. Throughput After Implementation
Throughput=(Data Packets Received)/(Lama Pengamatan)
Throughput= 119520922/744.851 bytes/second Bps
Throughput=119520922/744.851
Throughput =160462,860 byte per second (Bps)
Throughput=160.462 kBps
Throughput=160.462 x 8 kbps
Throughput = 1283.70 kbps
2. Packet Loss Before Implementation
Packet Loss = (packet lost)/( Data Packet Sent) x 100%
Packet Loss = $(292)/96410 \times 100\%$
Packet Loss = $(292)/96410 \times 100\%$
Packet Loss = $0.30 \%$
2. Packet Loss After Implementation
Packet Loss = $(packet lost)/(Data Packet Sent) \times 100\%$
Packet Loss = $(1456)/183287 \times 100\%$
Packet Loss = $1456/183287 \times 100\%$
Packet Loss = $0.79 \%$
Delay Before Implementation
Rata-rata Delay = Total Delay/Total Packages Received
Rata-rata Delay = $664.23/96410$
Rata-rata Delay $= 0.0069$ s (seconds)

Rata-rata Delay = 0.0069 s (seconds)Rata-rata Delay = 0.0069 s (1000 ms (milliseconds)) Rata-rata Delay = 6.89 ms (milliseconds)

Jitter Before Implementation 3. Jitter = (Total Delay Variation)/(Total Packets Received-1) 1018.39/(96410-1) Jitter = Jitter = 1018.39/96409 Jitter = 0.01056 s Jitter = 0.01056 x 1000 ms Jitter = 10.56 ms 3. Delay After Implementation Rata-rata Delay = Total Delay/Total Packages Received Rata-rata Delay = 744.85/183287 Rata-rata Delay = 0.0040 s (seconds) Rata-rata Delay  $= 0.0040 \times 1000 \text{ ms}$  (milliseconds) Rata-rata Delay = 4.06 ms (milliseconds) Jitter After Implementation 4 Jitter = (Total Delay Variation)/(Total Packets Received-1) Jitter = 1109.53/(183286-1) Jitter = 1109.53/183285 Jitter = 0.00605 s Jitter = 0.00605 x 1000 ms 6.05 ms Jitter =

QOS measurements have an impact on the quality of the internet network at SD Inpres Papindung where the network quality on the internet network at SD Inpres Papindung remains in good condition before and after the implementation of Bridge Filtering.

# 4. Conclusion

The implementation of Bridge Filtering at SD Inpres Papindung can be implemented and can successfully prevent attacks from DHCP Starvation Attack so that the internet network at SD Inpres Papindung can be used more safely. The implementation of Bridge Filtering also caused an increase in throughput, before implementation it was 794.66 Kbps and after implementation it was 1283.70 Kbps, there was a decrease in delay from before implementation 6.89 ms and after implementation 4.06 ms. There was also a decrease in jitter before implementation 6.05 ms, but caused an increase in packet loss which was 0.30% before implementation and after implementation increased to 0.79%. Of the four variables, all of them remain at the same level except for the throughput variable, where there is a change from the fair category to the good category. The implementation of Bridge Filtering at SD Inpres Papindung is effective in preventing DHCP Starvation Attack attacks and improving network quality, as proven by increasing throughput, reducing delay and jitter. However, despite the improvements, there has been an increase in packet loss that needs to be taken into account. As a recommendation, schools should continue to monitor network performance periodically to identify other potential problems, increase DHCP server capacity to reduce the possibility of network devices and security software is also important to maintain system stability.

For further research, it is recommended to explore various other network security methods that can complement the implementation of bridge filtering in preventing DHCP starvation attacks. Several areas that could be the focus of research include the implementation of intrusion detection systems (IDS) to detect and prevent attacks early, as well as the use of VLAN (Virtual Local Area Network) technology to limit network access and improve segmentation. Additionally, using security protocols such as IPsec to encrypt communications between devices can also provide an additional layer of protection. Further research could also include evaluating the effectiveness of such methods in more dynamic environments, such as in cloud-based networks or IoT systems, where security challenges are more complex. In this way, a more holistic solution can be found to protect the network from various growing threats.

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