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THE IMPLEMENTATION OF NETWORK SERVER SECURITY SYSTEM USING HONEYPOT

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Abstract

Network Server security is an important aspect of ensuring the integrity and availability of information systems. This research aims to implement network Server security at Muhammadiyah University of East Kalimantan using Honeypot technology. Honeypots are used to attract the attention of attacks and monitor suspicious activities on the network. The research method used is NDLC (Network Development Life Cycle), which includes the design and implementation of Honeypots, as well as the collection and analysis of detected attack data. The research results show that by using three attack techniques, namely Slowloris attack with a Honeypot processing time of 2 seconds and Snort processing time of 180 seconds, GoldenEye attack with a Honeypot processing time of 2 seconds and Snort processing time of 180 seconds, and LOIC tools with a Snort processing time of 180 seconds. Honeypots cannot identify DDoS attacks because they focus more on attacks such as penetration attempts or other suspicious activities.

Keywords: Network Security, Honeypot, Slowloris, GoldenEye, LOIC.

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1. INTRODUCTION

With the increasing security threats to server networks from cyberattacks, organizations and government institutions are at risk of significant harm [1]. Servers are crucial for providing efficient and effective storage, management, and processing of data. Despite having robust security systems in place, vulnerabilities still exist that can be exploited by internal and external threats [2]. Therefore, it is essential to implement security measures to protect servers from potential harmful attacks [3].

Network security for servers involves implementing a robust set of measures and protocols to defend against a wide range of cyber threats, including unauthorized access, data breaches, denial-of-service (DoS) attacks, malware infiltration, and more [4]. The goal is to establish multiple layers of protection to create a formidable defense against potential vulnerabilities and cyber risks [5], [6].

Various aspects of network security for servers, including the use of firewalls, intrusion detection systems (IDS), encryption protocols, access controls, and the incorporation of honeypots as deceptive security measures [7], [8]. By comprehensively

addressing these aspects, organizations can bolster their server network security and ensure the confidentiality, integrity, and availability of their critical data and services [9].

One increasingly popular solution for detecting and mitigating attacks on server networks is the use of Honeypot technology [10]. Honeypots are designed to mimic real systems or services within a network and act as attractive targets for attackers [11]. Honeypot is an open-source system designed to attract the attention of attackers [12]. Honeypot systems can be in the form of fake servers or applications that appear active and connected to the internet [13]. When attackers attempt to breach them, the Honeypot system records the attackers' activities, such as the type of attack, tools used, and methods employed to compromise the server network [14]. This information is then sent to the network administrator to prevent similar attacks in the future.

The main objective of implementing honeypots is to divert attackers from the actual target and learn about the attack methods they employ [15]. This helps enhance the understanding of existing threats and improves the security of server networks [16]. This research focuses on the implementation of a server

network security system using honeypots to detect and prevent network attacks [17]. It is expected that this research will make a significant contribution to enhancing server network security [18].

2. RESEARCH METHOD

NDLC (Network Development Life Cycle) is a methodology used in computer network development that encompasses a series of stages or steps to be followed in order to build and develop a secure and efficient network. efektif [19]. The NDLC (Network Development Life Cycle) method is one of the approaches used to identify existing issues in servers. In Figure 1, there is a flow diagram illustrating the NDLC method.

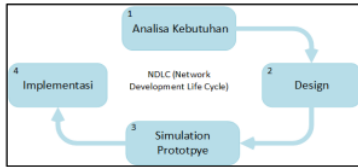


Figure 1. NDLC (Network Development Life Cycle)

1. Requirement Analysis: The requirement analysis phase aims to identify the devices and methods used for implementing Honeypot on the server network. The hardware requirements for creating a Honeypot include a computer with the following specifications: Processor: Intel(R) Core(TM) i5-10400 and RAM: 8.00 GB. The software requirements include the following:
 - a. Oracle VM Virtualbox: This virtual machine software is used to run the server operating system.
 - b. Kali Linux: It is utilized as an attacker system, employing attack methods such as Slowloris and GoldenEye.
 - c. Ubuntu: This operating system is installed with Pentbox, which is used to run the Honeypot.
 - d. PfSense Firewall: It is equipped with Snort for detecting attacks and blocking them.

These software and hardware components are essential for setting up the Honeypot system and conducting the necessary attack simulations and security monitoring.

2. Design: After completing the requirement analysis, the next stage is network design and topology. The design phase aims to provide an overview of the implementation to be carried out. Below is the Honeypot network scheme, which can be seen in Figure 2.

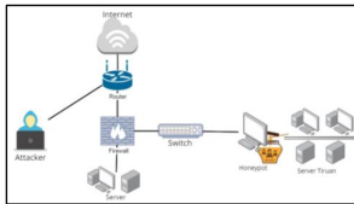


Figure 2. Honeypot network topology design

In Figure 2, it is explained that when an attacker attempts to enter the internet network, the firewall redirects the traffic, causing the attack to enter the Honeypot system, which serves as a location for capturing and recording the attacker's activities. The previous analysis also required a network topology, which can be seen in Figure 3, showing the interconnected devices within the network.

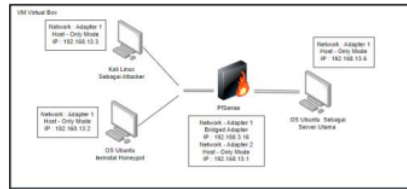


Figure 3. Network topology

In the topology, there are four virtual machines connected to each other using Host-Only and Bridged Adapter. Kali Linux, Ubuntu, and Ubuntu Server can communicate with each other through the Host-Only network. PfSense, which has Snort installed, is used for detecting and preventing attacks. PfSense acts as a gateway with a WAN connection linked to the host network and a LAN connection connected to other virtual machines via the Host-Only adapter.

3. Simulation Prototype: At this stage, a simulation is conducted based on the designed architecture. The simulation can be observed in the image below, depicted in Figure 4.

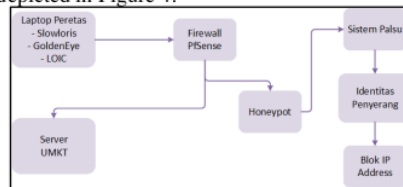


Figure 4. Simulation Prototype

In Figure 4, the simulation process for this research is presented. Based on Figure 4, the testing process begins with launching Slowloris, GoldenEye, and LOIC attacks, aiming to render a legitimate server inaccessible to authorized users. Subsequently, the attacker launches these attacks on the Honeypot system, which is equipped with security measures, and the PfSense firewall, capable of detecting incoming attacks on the server system. If the IP address originates from a legitimate user, it is directed to the genuine server. However, if the IP address is from an unauthorized or invalid user, it is redirected to the Honeypot to trap the attacker using a fake server. The Honeypot records and detects the attacker's identity and activities, and the PfSense firewall can block the attacker's identity

and withhold incoming attack packets aimed at the server system.

4. **Implementation:** The implementation phase involves the actual deployment of all the designed components. This stage includes the installation of equipment, configuration of software and hardware, and integration with existing systems.

3. RESULT AND DISCUSSION

In this stage, we will discuss the implementation process of Honeypot, PfSense Firewall, and TCP, UDP, and HTTP attacks.

3.1 Web Server

The operating system used is Ubuntu Server 22.04.2 LTS. The web server creation is conducted to test the effectiveness of Honeypot as a simulated web server. Below is the image of the web server that has been created, as shown in Figure 5.



Figure 5. Web Server

The web server has the IP address 192.168.13.6 as the main server's address. This IP address has been carefully chosen and is separate from the Honeypot's IP address used for the simulated system. By using different IP addresses, the Honeypot and web server can minimize the risk of attacks from attackers.

Having separate IP addresses for the Honeypot and the main web server adds an extra layer of security to the network. It helps ensure that attackers targeting the Honeypot won't accidentally impact the real web server, and vice versa. This practice is a common security measure to isolate potentially vulnerable systems from critical production servers, reducing the potential for damage or unauthorized access during the testing and monitoring process [20].

3.2 Honeypot

The operating system used is Ubuntu Server 22.04.2 LTS. The creation of the Honeypot is carried out within Pentbox, which provides a set of integrated computer security tools in one package. One of the features of Pentbox is Honeypot. By using Honeypot, one can learn the methods and techniques used by attackers [10], [21], [22].

Pentbox's Honeypot feature allows users to deploy a simulated system that attracts and traps attackers. By monitoring the activities of the attackers on the Honeypot, network administrators and security experts can gain valuable insights into the types of attacks being used, the attacker's tactics, and potential vulnerabilities in their network defences [23], [24].

This knowledge can be instrumental in improving overall network security and developing better countermeasures to protect against real-world attacks [25].



Figure 6. Honeypot Configuration in Pentbox

After running Pentbox 1.8, several options will be displayed. Since you intend to use Honeypot, select "Network Tools" (Option 2) and then choose "Honeypot" (Option 3) as shown in Figure 6. After setting up Pentbox and directing it to the Honeypot system, the next step is to configure the Honeypot to open port 80 to capture and identify attacks.

Configuring the Honeypot involves setting up a service or application that listens on port 80, which is typically used for web traffic (HTTP). By opening this port on the Honeypot, it creates an attractive target for attackers, making them believe it is a legitimate web server. The Honeypot will record the activities of any attackers who attempt to interact with the open port, providing valuable information on their tactics and techniques.

However, it's essential to implement proper security measures and restrict access to the actual production server to minimize the risk of attackers exploiting the Honeypot or impacting the real network. The data collected from the Honeypot can help strengthen network defenses and improve overall security.

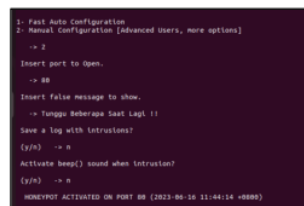


Figure 7. Configure Honeypot Ports

Setting up the Honeypot to open port 80 and inputting the message "tunggu beberapa saat lagi" (which means "please wait a few moments more" in English) on the website provided by Pentbox can be achieved through the configuration of the Honeypot software.

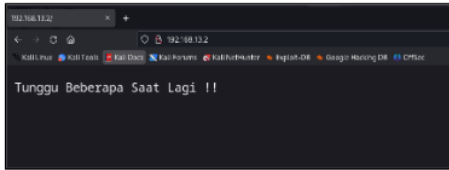


Figure 8. Access IP Honeypot

3.3 Slowloris Testing

Testing using the Slowloris attack with the Denial of Service (DoS) method aims to send numerous HTTP connections or invalid requests to the target network with IP 192.168.13.2, causing it to be unable to process requests from legitimate users and resulting in server downtime. Honeypot and PfSense will detect the attack from the server.

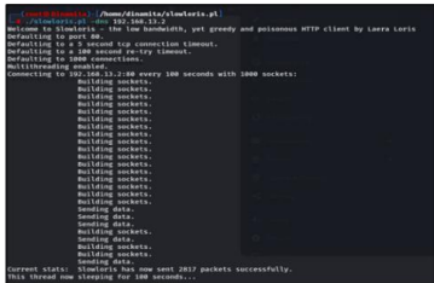


Figure 9. TCP attack testing

Based on Figure 9, the successful attack was executed with the command `#./Slowloris -dns 192.168.13.2`. The meanings of each parameter in the command are as follows:

Table 1. TCP Attack Testing Analysis

No.	Parameter	Description
1.	#	is the symbol or term used to represent the superuser or administrative access in Unix and Linux operating systems.
2.	./Slowloris	This is the name of the Slowloris executable file or script being executed.
3.	-dns	This parameter indicates that the attack is targeting a specific domain or IP address (in this case, 192.168.13.2) to perform the DoS attack.
4.	192.168.13.2	This is the target IP address where the Slowloris attack is being directed.

In Table 1, the parameters for conducting the Slowloris attack are listed. The attack will then commence by sending incomplete HTTP requests to the target server while keeping the connections open. The goal is to fill up all available connections on the server, causing it to become unresponsive and unable to serve requests from legitimate networks.

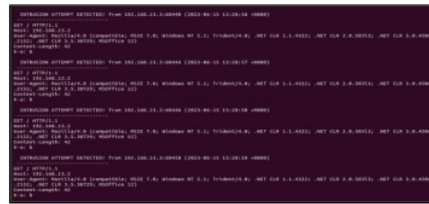


Figure 10. Honeypot log

In Figure 10, the log displays the identified attack captured by the Honeypot. It provides information about the attacker, such as the time of the attack, the attacker's IP address, and the operating system used by the attacker. This information can be crucial for analyzing the attack patterns and understanding the tools and methods utilized by the attacker, which can further assist in enhancing network security and implementing appropriate countermeasures.



Figure 11. Alert TCP on Snort PfSense

In Figure 11, the results of the identified Slowloris attack are displayed in Snort on PfSense. The attack is automatically logged in the Snort Alerts on PfSense, providing information such as the time of the attack, the protocol used, the source IP address, the destination IP address, the port utilized, and a description of the attack. The details of the Snort alerts are available in Table 3.

Having the Snort system in place helps to detect and respond to various types of attacks in real-time, including the Slowloris attack. The information captured by Snort enables network administrators to take appropriate actions to mitigate the effects of the attack and strengthen the overall network security..

3.4 GoldenEye Testing

The next testing involves using GoldenEye with the Distributed Denial of Service (DDoS) attack method. This attack floods the target system with a massive amount of network traffic, aiming to overwhelm the system and render it unable to function normally.

GoldenEye is designed to perform DDoS attacks, and it can utilize various techniques to generate a high volume of network traffic, such as HTTP GET and POST requests. By overwhelming the target system's resources, the DDoS attack disrupts its ability to respond to legitimate user requests, leading to service outages or slowdowns.



Figure 15. TCP attack using LOIC

In Figure 15, the process illustrates the HTPP attack conducted using LOIC against port 80 on IP Address 192.168.13.2. However, in this scenario, the Honeypot was unable to identify the attack. On the other hand, Snort (as shown in Figure 16) was able to successfully detect and identify the attack.

Date	Action	Pri	Proto	Class	Source IP	SPort	Destination IP	DPort	Msg Size	Description
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55276	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55276	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55284	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55222	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55227	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55271	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55220	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55219	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55217	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD
2023-06-29 17:38:02	3	TCP	Unknown Traffic	Q	192.168.13.100	55218	192.168.13.1	80	115:20	[PIDS_injected] UNKNOWN METHOD

Figure 16. Alert LOIC Snort on PfSense

In Figure 16, there is an attack using TCP, and it automatically triggers an alert in Snort on PfSense. The alert contains information such as the time of the attack, the protocol used (TCP), the source IP address, the destination IP address, the port utilized, and a description of the attack. The details of the Snort alerts are available in Table 3.

3.6 Firewall Snort on PfSense

Then, in figures 11, 14, and 16, each parameter of the TCP Snort attack alert on PfSense is explained as follows:

Table 3. Alert Analysis on Snort PfSense

No.	Parameter	Description
1.	Date	Shows the date and time of the attack occurrence.
2.	Pri (Priority)	Indicates the severity level of the threat; the higher the priority value, the more serious the threat.
3.	Protocol	Shows the network protocol type as TCP.
4.	Class	Indicates the detected attack category.
5.	Source IP	Shows the source IP address that triggered the threat alert.
6.	Sport (Source Port)	Port from which the attacker originates the attack towards the target server.

No.	Parameter	Description
7.	Destination IP	IP address indicating the device or server receiving the related network traffic.
8.	DPort (Destination Port)	Port targeted by the attacker to send attack packets.
9.	Description	Information about the ongoing attack.

In Table 3, each parameter is analyzed to provide information about the detected attacks in the PfSense security system. By analyzing the characteristics of the attacks, PfSense can effectively block those attacks to protect the server network.

The analysis of the detected attacks helps PfSense in identifying the attack patterns, sources, and methods used by the attackers. With this knowledge, PfSense can implement appropriate rules, filters, and countermeasures to block and mitigate similar attacks in the future. By actively responding to threats, PfSense enhances the overall security posture of the network and ensures the protection of the server and its resources from potential threats.

3.7 Results of Attack Data

After conducting attack testing to assess the performance of the Honeypot and Snort Firewall on PfSense in identifying, detecting, and blocking attacks, the following data was obtained from the server network:

Table 4. Result on data from attack testing

Slowloris Testing		
Attack type	Slowloris	
Protocol	TCP	
Attack Time	15:20	
Time Notification Received	Honeypot	15:20
	Snort	15:23
Processing Time	Honeypot	2 s
	Snort	180 s
GoldenEye Testing		
Attack type	GoldenEye	
Protocol	TCP	
Attack Time	15:25	
Time Notification Received	Honeypot	15:25
	Snort	15:27
Processing Time	Honeypot	2 s
	Snort	120 s
LOIC Testing		
Attack type	LOIC	
Protocol	TCP	
Attack Time	17:33	
Time Notification Received	Honeypot	-
	Snort	17:36
Processing Time	Honeypot	-
	Snort	180 s

In Table 4, the results of the attack testing conducted on the server are presented. Based on the

performed testing, three types of attacks were identified:

- 1) Slowloris: Detected by Honeypot with a processing time of 2 seconds and by Snort with a processing time of 180 seconds.
- 2) GoldenEye: Detected by Honeypot with a processing time of 2 seconds and by Snort with a processing time of 120 seconds.
- 3) LOIC: Detected by Snort with a processing time of 180 seconds, with a time difference of 60 seconds for Snort to identify the attack.

Honeypot is designed to attract and capture suspicious activities, but it may not detect all types of attacks, such as the LOIC attack. Honeypots are more focused on detecting penetration attempts or other suspicious activities.

Each type of attack may have distinct characteristics, and the choice of defense mechanisms, like Snort in this case, plays a crucial role in identifying and mitigating different attack types. By utilizing both Honeypot and Snort on PfSense, the network's overall security is enhanced, as they complement each other in capturing various types of threats and attacks, thereby fortifying the network's defenses against potential risks.

4. CONCLUSION

After conducting the research, analyzing the data, and discussing the findings, the following conclusions have been drawn:

1. Based on the conducted testing, Honeypot proved to be effective in detecting Slowloris and GoldenEye attacks, but it was not efficient in detecting DDoS attacks executed using specialized software like LOIC.
2. PfSense Firewall was not able to identify DDoS attacks comprehensively, but it provided other relevant information regarding the ongoing attacks.
3. Honeypot performed well in detecting threat packets, and it required only 2 seconds, while Snort took approximately 180 seconds, depending on the internet connection.
4. Honeypot's alerts worked effectively and provided real-time information, whereas Snort alerts took some time to deliver the information.

In summary, the research highlights the strengths and limitations of the Honeypot and Snort Firewall implementations. Honeypot was successful in detecting specific types of attacks but had limitations in identifying DDoS attacks with specialized tools. On the other hand, Snort showed effectiveness in identifying various attacks, including DDoS, but it might have longer processing times compared to Honeypot. Understanding these strengths and weaknesses is essential for designing a comprehensive network security strategy that combines various tools and techniques to protect the network from different types of threats.

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