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An Innovative Security Strategy Using DShield honeypot

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List of Acronyms and Abbreviations

| | |
|------|-------------------------------------|
| DDOS | Denial-of-service attacks |
| DHCP | Dynamic Host Configuration Protocol |
| SSH | Secure Shell |
| TCP | Transmission Control Protocol |
| IP | Internet Protocol |

Abstract

Across the globe, security is the top concern in all spheres of life and work. In cyberspace or networks, security remains the primary consideration when considering potential threats that might occur at any time. Thus, security and cyber security are the focus of this initiative where a forensic tool is developed to keep an eye on the network and track down attacker information.

Instead of serving as an antivirus, this device attracts attackers and uses exploits to lead them into a trap. It is a honeypot device that works best when it is connected to a network. This device can also be utilised in forensic investigations at crime scenes to determine whether an attacker is attempting to steal data.

This technology will alert us to potential attacks and keep us informed about them rather than blocking out the attacker and the attack. As long as we are online, attacks will never be prevented. Therefore, identifying the attackers is the suggested remedy here.

Keywords - Raspberry Pi, DShield Honeypot, Advanced IP scanner, Cyber-attack, PUTTY, Nmap scan, Network, Kali Linux,

Introduction and Background

Introduction

Each element of technology now revolves around security, and our jobs are insecure without it. Let's begin with a simple illustration involving money at home, which necessitates a locker for security. We require network and cyber security in the same way. The little network's security is the focus of this project, and the gadget gathers data rather than only safeguarding it.

Any criminal activity involving a computer is referred to as computer crime. The PC may be used to support the misconduct allegation or it could be used as the main goal. Cybercrime is a term used to describe illegal access to the internet. Cybercrimes are a combination of these two elements and are best defined as "Offences that are committed against individuals or groups of individuals to intentionally harm the victim's reputation or make bodily or psychological harm to the target, either directly or through allegations made using current media transmission systems. (Rodney Anthony Raj et.al, August 2017)

The process of obtaining, reviewing, and providing an account of sophisticated data in a legally acceptable way is known as computer forensics. It can be applied in any situation where proof is cautiously stored, as well as in the identification and avoidance of misconduct. PC crime scene investigation follows a process that is similar to other quantifiable courses and deals with related problems.

Any proof stored or communicated in a digitised format that a gathering for a court case may use at trial is referred to as digital evidence, occasionally referred to as electronic evidence. A court will determine whether the evidence is substantial before accepting advanced confirmation, even if it is gossip, and whether a duplicate is sufficient or the original must be shown.

An attacker is someone who plans to obtain sensitive or important data from another person or from a system that contains such data. The entity where the data is located may be an individual or an organisation. These days, the primary source of denial-of-service attacks is a simple little network. Attackers' planted malware is the primary cause of denial-of-service attacks (DDOS), as it takes over millions of machines.

Attackers design scenarios in which victims fall prey, such as receiving a message claiming they have won \$1,000 and a link. Although most victims are aware that the scenario is a hoax, they nevertheless attempt to click on the link to see whether they are indeed victims. Thus, victims are increasingly numerous as a result of our ignorance.

Thus, anyone attempting to commit fraud, theft, or other crimes is referred to as an attacker or a cybercriminal. We need to be aware of it and avoid being taken advantage

of. We must be aware of things to avoid these situations. Even developers and IT professionals could end up being targets of attacks by visiting unsecured websites or clicking links to complete their work.

If and only if we avoid becoming targets and none of the security measures function until and unless we are vulnerable, an attacker can be stopped. Imagine that a system with great security may be breached by a social engineering technique called password leakage. Where the danger is that we fall into.

By routinely updating our computers, doing scans, and even not installing things we are not aware of, we can even prevent the attacks. All of this, though, does not offer a real-time solution, and even if we were to stop the attacker, we would never be aware of their true goals. Whatever happens, even if we gather all the data and determine what the attacker requires. Based on that, this initiative gathers data regarding the attacks.

Background

Web Application Honeypot is a proactive defence mechanism that is intended to identify, trick, and reroute malicious actors who are trying to take advantage of holes in web applications. This approach uses decoy web apps to attract and analyse malicious activity in real time, in contrast with regular security methods that mostly concentrate on reactive actions.

These honeypots provide security experts with important insights into the strategies, methods, and processes used by cyber attackers by mimicking genuine web services. (Lutkevich,B., Clark,C.andCobb, M.(2021))

There are different types of honeypots, each designed for different production and purposes. One of those is pure honeypot which is a full-scale system running on various servers. It completely mimics the production system. With this honeypot data looks confidential, and uses delicate information.

The second one is high interaction honeypot which is designed to get attackers to invest as much time as possible inside the honeypot. From this, the security team can get more chances to witness the target. This honeypot has some extra systems which are databases and processors that attackers will want to try to infiltrate.

The third one is mid interaction honeypot which duplicates the elements of the application layer but this type of honeypot doesn't have an operating system. Their mission is to confuse an attacker and give more time to the organization or the person.

And the last one is a low-interaction honeypot. These are less resource-intensive and gather elementary information regarding the kind of threat and where it came from. These are relatively simple to set up and they make use of Transmission control protocol

(TCP), Internet Protocol (IP) and network services. Though nothing inside the honeypot to hold the attacker's attention for a considerable amount of time.

Those days are long gone when one could get by with just an antivirus program installed on his PC. Vulnerabilities in system architecture, system configuration, application design, implementation configuration, and operations make sensitive data breaches easy to "crack" in the so-called "Internet Friendly" environment we live in today. (www.ncsc.gov.uk. (n.d.).) Now, internet security has become crucial. The following scams will demonstrate this.

CASE 1 - Illicit Cyber Activity in the Banking and Finance Sector

Starting in the autumn of 1996, two credit union employees collaborated for many months to modify credit records in exchange for money. Based on updated information the company received, the employees were allowed to modify credit reports as part of their regular duties.

But in return for payment, the staff members wilfully abused their official access to create fictitious positive credit indications and erase negative credit indicators from specific credit histories. The overall fraud damage resulting from their actions was more than \$215,000. The credit union faced an unquantifiable amount of danger (Marisa Reddy Randazzo, 2004).

CASE 2 - UBS PaineWebber

A "logic bomb" that was detonated in March 2002 erased 10 billion files from the computer systems of UBS PaineWebber, an international financial services business. A logic bomb is a malicious code that is implanted on a target system and programmed to run either on the occurrence of a certain system activity or after a predetermined amount of time. More than 1300 of the company's servers across the US were impacted by this event. About \$3 million was lost by the company; this is the amount needed to fix the damage and recover the erased files. (Finextra Research. (2006))

CASE 3 - Monster job site hacked

Following investigations by computer forensic experts and law enforcement specialists, it was discovered that the logic bomb was planted by a disgruntled worker who had just left the company due to a disagreement over the amount of his yearly bonus. (Team, E. (2006))

A security breach at Monster.com in August 2007 is said to have led to the theft of confidential data belonging to around 1.3 million job searchers. Later, that figure was changed to "millions."

Using credentials stolen from Monster customers, hackers obtained data from the password-protected CV library on the US online job board. They used a botnet and two servers from a Ukrainian web hosting provider to launch the attack. Info stealer is a malicious software program that has infiltrated vulnerable systems. When Monster was informed that it was being attacked by investigators from internet security firm Symantec on August 17, the company became aware of the issue for the first time. (Hackers steal jobseekers' details from Monster Recruitment Website (2009))

This article explores the significance of web application honeypots in strengthening overall cybersecurity posture and explores the nuances of adopting an innovative security strategy using them. Let's go over the fundamental ideas of Web Application Honeypots, how to set them up, and the priceless information they can give businesses. In addition, let's look at successful real-world case studies.

Literature review

Web-based applications are becoming increasingly popular. The critical data of most or all industries is prevalent. Organizations are stored via web apps. Thus, web applications are a much bigger target for numerous cyber-attacks, ranging from database injection to SQL injection, PHP object injection, template injection, XML external entity injection, unsensitized input attacks Scripting, and numerous others. (OWASP (2021))

The most widely used honeypots ever built in the Information security community include the Google Hack Honeypot, The Glastopf, and the HIHAT (Djanali, S. et al. (2015)). The level of interaction with the system and classification of honeypots is based on the following criteria low, medium, and high (Gupta, R., V., M. and K, M (2021). Low-interaction honeypots are impervious to attacks and cannot be used in conjunction with vulnerable mimicked services. Honeypots with medium engagement mimic susceptible services in a less complex manner than those with high interaction, but still more so than those with low interaction. High-interaction honeypots, on the other hand, mimic genuine services and vulnerabilities that attackers may directly access, making them the most advanced in terms of identifying malicious behaviour on the network.

It has been attempted several times to use deception to improve the effectiveness of honeypots (B. Mphago, O. Bagwasi, B. Phofuetsile, and H. Hlomani 2015). For instance, the Glastopf honeypot is enhanced by incorporating a content management system that enables the generation of dynamic Web pages that mimic real-world Web pages. This resulted in a decrease in the probability of attackers recognizing it as a honeypot. A sporadic delay in response times of a Web portal suggested that the input from the attacker was causing a slowdown of the site (M. D. P. Julian, 2003).

Problem definition

The detailed information on this hypothesis is introduced in this section. First, we discuss the issue's inspiration, how it is articulated about the venture goal, how it conflicts with the current framework, and last, we look at the proposed framework.

Every person's daily life involves numerous situations where forensics is necessary. Whether for business purposes or personal use. Therefore, it is not ideal to approach professionals for assistance each time anything is needed. because it requires a significant investment of time and money, and because trust is crucial to the process. Although a lot of people will know, they don't have the necessary resources.

Therefore, a tool or gadget that satisfies the needs of people with a range of Knowledge is required.

The primary aim of the paper is:

Network Security Inspection: One can monitor network traffic and identify any risks, such as malware, botnets, or other malicious activity targeting the network, by setting up a Raspberry Pi as a DShield honeypot.

Detecting Attack Patterns: By examining the tactics and patterns of attack employed by cybercriminals, the honeypot can shed light on their tactics and strategies.

Compiling Security Intelligence: The honeypot can aid in the development of threat intelligence, which can be utilised to improve network security protocols and create potent defence plans, by gathering information on attempted intrusions and attacks.

Advance Warning System: By informing network administrators of questionable activity or new threats, the honeypot can serve as an early warning system. This enables administrators to take preventative action to lower risks and safeguard the network infrastructure.

Researching and Analysing: Researchers can examine the most recent trends in cyber threats and create remedies to improve overall cybersecurity posture by using a Raspberry Pi to run a DShield honeypot as a platform for cybersecurity research and analysis.

Existing system

Numerous forensic tools, including cyber black boxes or sleuth kits, are employed in the current system to either force an attacker to leave the network or to examine the facts following an attack to determine what evidence is kept. However, they are costly and sophisticated tools that are only available to a select group of experts. Additionally, they employ programmes like Galleta, Pasco, Nessus (a network vulnerability scanner), etc., which need licences to function properly.

Proposed system

A device that can save all network logs and traffic and be accessed to obtain the attacker's information or be used as a forensic tool at the crime scene to determine whether any outside traffic is entering the network to protect data.

Selection of board

The Raspberry Pi 4 Model B with an 8 GB RAM board was chosen. Following are the specifications shown above.

| Specification | |
|----------------------|---|
| Processor: | Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz |
| Memory: | 1GB, 2GB, 4GB or 8GB LPDDR4 (depending on model) with on-die ECC |
| Connectivity: | 2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN, Bluetooth 5.0, BLE Gigabit Ethernet 2 × USB 3.0 ports 2 × USB 2.0 ports. |
| GPIO: | Standard 40-pin GPIO header (fully backwards-compatible with previous boards) |
| Video & sound: | 2 × micro HDMI ports (up to 4Kp60 supported) 2-lane MIPI DSI display port 2-lane MIPI CSI camera port 4-pole stereo audio and composite video port |
| Multimedia: | H.265 (4Kp60 decode); H.264 (1080p60 decode, 1080p30 encode); OpenGL ES, 3.0 graphics |
| SD card support: | Micro SD card slot for loading operating system and data storage |
| Input power: | 5V DC via USB-C connector (minimum 3A) 5V DC via GPIO header (minimum 3A) Power over Ethernet (PoE)-enabled (requires separate PoE HAT) |
| Environment: | Operating temperature 0–50°C |
| Production lifetime: | Raspberry Pi 4 Model B will remain in production until at least January 2031. |
| Compliance: | For a full list of local and regional product approvals, please visit pip.raspberrypi.com |

Figure 1: Raspberry Pi configuration

The Raspberry Pi 4 Model B is equipped with a powerful 64-bit quad-core processor, hardware support for twin displays at up to 4K resolutions via two micro HDMI connections, Up to 8GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (with a separate PoE HAT add-on) are among the features, along with video decoding at up to 4Kp60. The Raspberry Pi 4 Model B offers desktop performance to users that is on par with entry-level x86 PCs.

System Requirements and Specification

Hardware requirements

The following Basic Hardware has to be fulfilled for the project to begin functioning:

1. Raspberry Pi 4 Model B
2. Micro USB Cable
3. Keyboard and mouse (for the configuration)
4. Router

Software Requirements

Kali Linux - The choice of operating system is since it comes with all the fundamental forensic tools pre-installed or readily installable from different sources depending on the user's demands.

For vulnerability investigation, a specially designed honeypot server has been used. It is available for execution via the command line, and both the working copy and the database reside on the server or local host.

Advanced IP scanner - With the use of a powerful IP scanner, we can rapidly manage and scan both our IPv4 and IPv6 addresses.

PuTTY – This is a network file transfer programme, serial console, and terminal emulator that is free and open-source. It is compatible with several network protocols, such as Telnet, SSH, SCP, and raw socket connections. After the implementation of the operating system into the Raspberry Pi we'll get into SSH using this application. Using the particular port and the hostname we can get into the SSH.

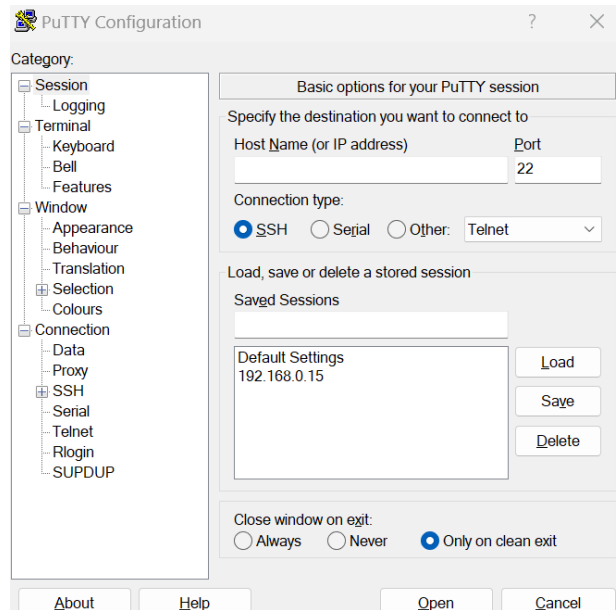


Figure 2: Putty workspace

Raspberry Pi Imager – This is an easy-to-use programme for making bootable discs for Raspberry Pi devices. This is used to Load the operating system on the SD card. After plugging the SD card reader with the SD card into the computer load the operating system.

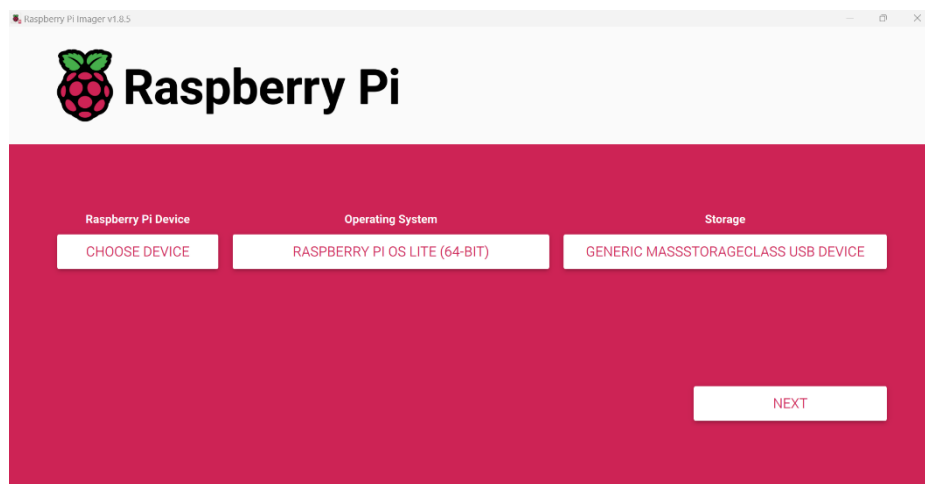


Figure 3: Raspberry Pi imager

Opening the Advanced options panel by selecting CTRL + SHIFT + X, can select the hostname, set the username, and password, and enable SSH

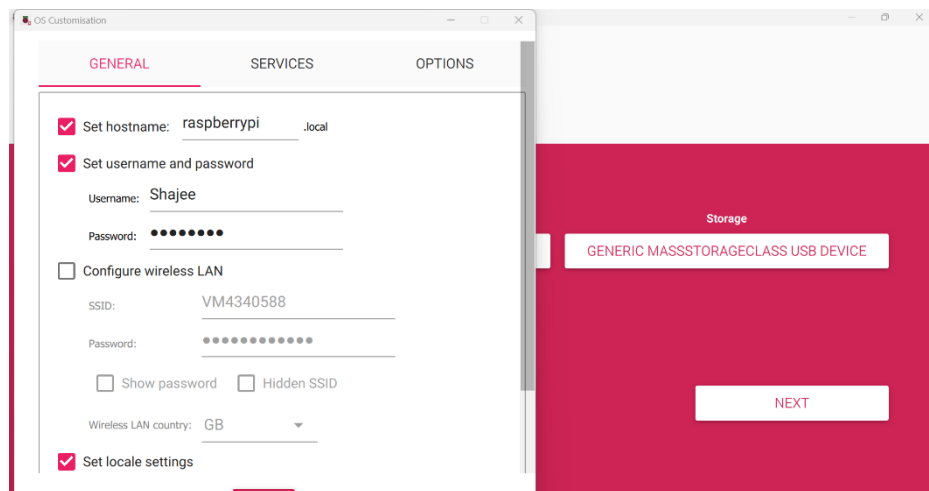


Figure 4: Raspberry Pi imager

Enabling SSH helps configure the system and future to do command line executions.

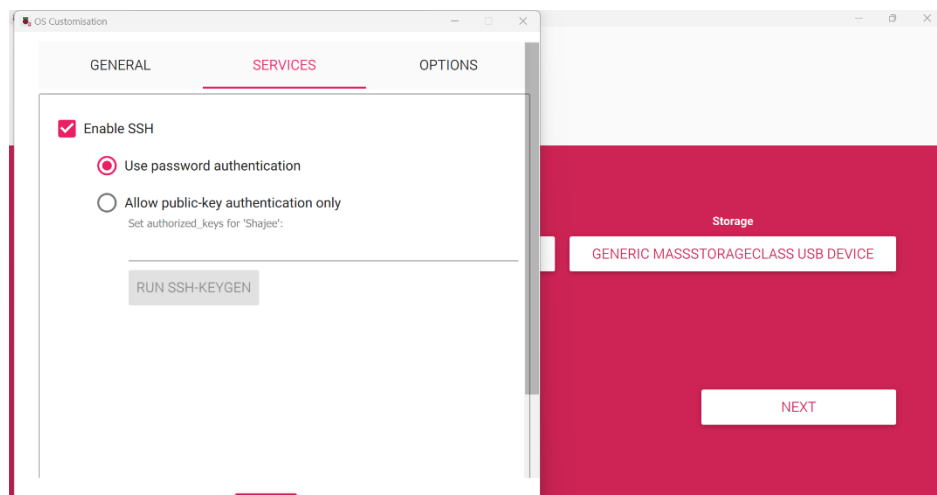


Figure 5: Raspberry Pi imager

After finishing the all configurations write on the SD card.

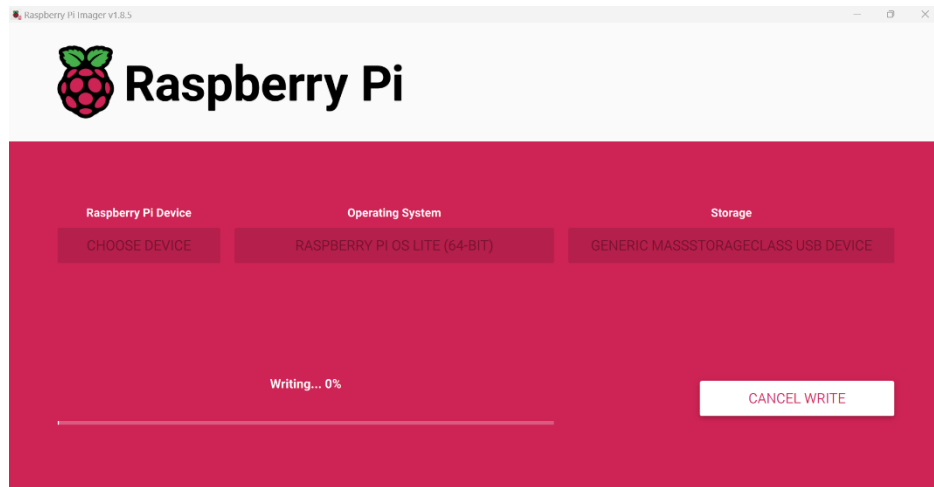


Figure 6: Raspberry Pi imager configuration

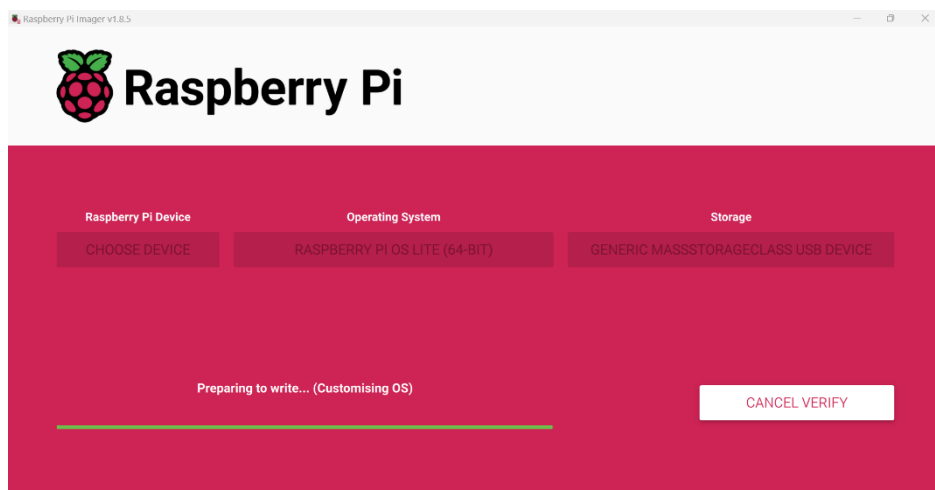


Figure 7: Raspberry Pi imager configuration

System design and features

The project's connection architecture is described as follows:

Network - The network refers to the connection that exists between the investigator performing a live acquisition, the virtual computer, and the device.

Raspberry Pi - A device that is set up and linked to the internet to carry out the required forensic operation.

Investigator - An expert or any person using the machine for testing.

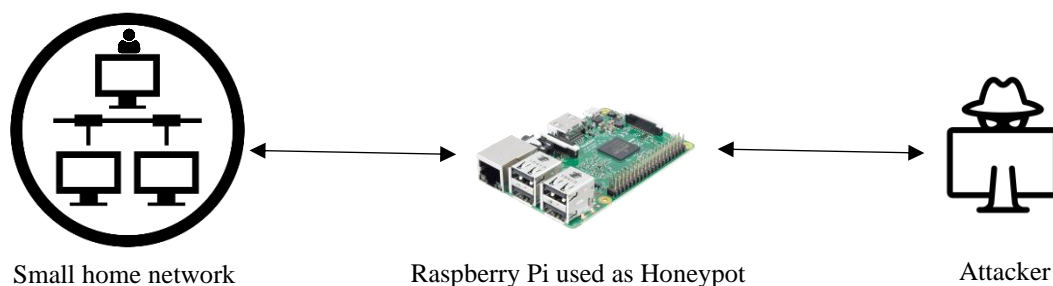


Figure 8: System work pattern

In the small home network, A router is the first component of a network since it acts as a gateway between a local network and the internet. The router controls network traffic flow between connected devices and external networks.

Electronic devices: A variety of devices, including laptops, tablets, smartphones, smart TVs, and more, are a part of the home network. These devices are either wirelessly connected by Wi-Fi or Ethernet cables connected to the router.

Raspberry Pi: A Raspberry Pi set up as a honeypot is one of the network's devices. A decoy system used to attract possible attackers is called a honeypot. In this instance, an attacker might be interested in using the Raspberry Pi to imitate vulnerable services or systems.

Attacker: An intruder is attempting to access devices on the home network without authorization. The attacker might be someone trying to use device or service vulnerabilities for nefarious ends.

Network Traffic: The attacker targets devices on the network with a variety of network traffic types, including port scans, penetrating, and attempted exploits. The Raspberry Pi honeypot reacts as if it were a vulnerable system when the attacker's scans reach it.

Security Measures: Information about possible dangers and attackers is the main goal of setting up a honeypot, such as the Raspberry Pi. By finding weaknesses and creating defences against them, this data can subsequently be utilised to improve the network's overall security.

Isolation: To stop any possible compromise from affecting other devices, it is essential to isolate the honeypot from the rest of the network. This can be accomplished by running the honeypot in a different environment utilising virtualization techniques, or by segmenting the network.

Control flow

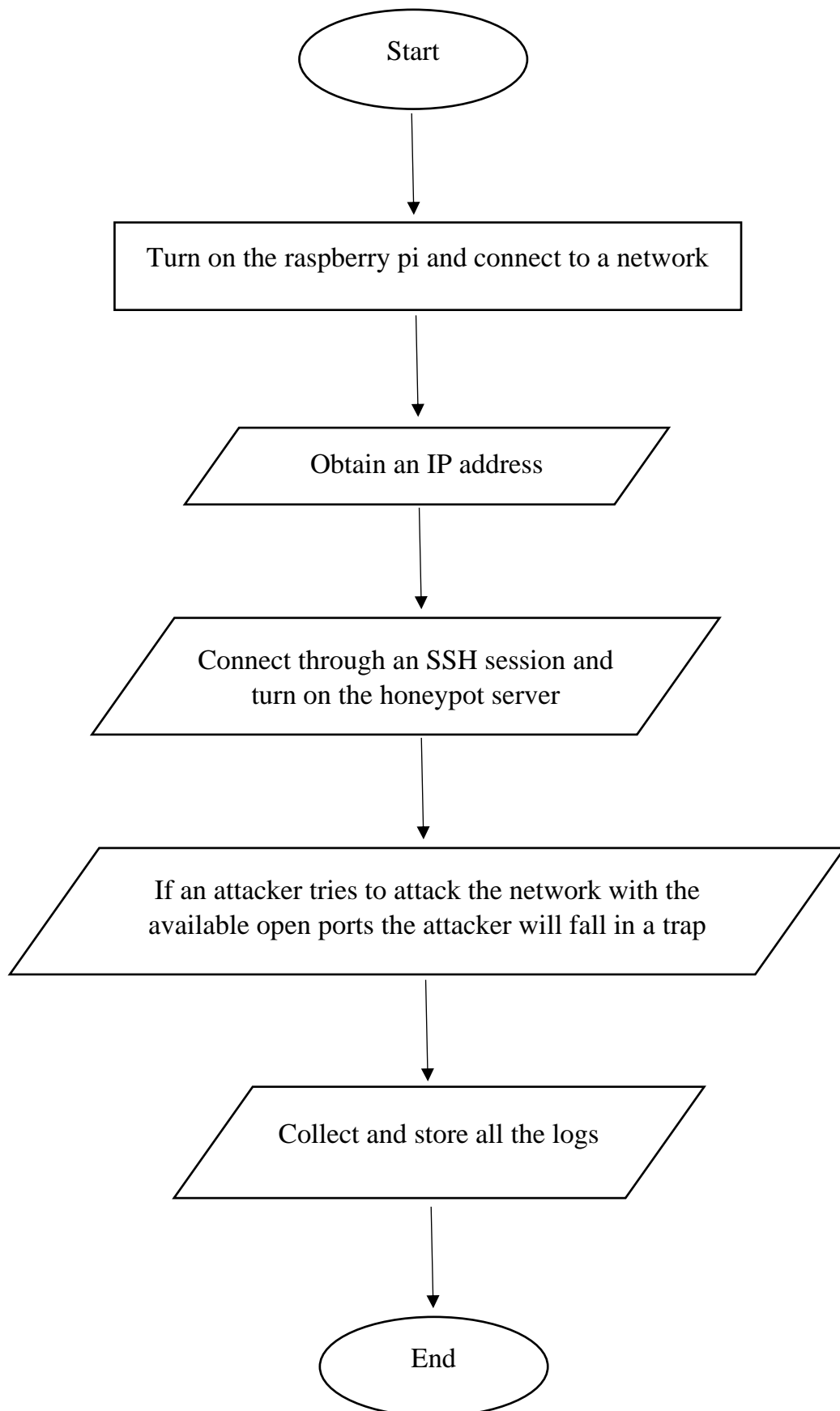


Figure 9: Control flow of the system

The above flowchart shows how things proceed in a small network with a Raspberry Pi honeypot and an outside attacker, starting with setup and ending with the identification and handling of any threats.

Start: The Raspberry Pi device must be physically started in this stage. To accomplish this, turn it on by plugging it into a power source, such as a power bank or USB adapter.

Turn on the Raspberry Pi and connect to a network: The Raspberry Pi must establish a network connection after being turned on. Usually, this entails utilising the proper network settings to connect it to an Ethernet or Wi-Fi network.

Obtain an IP address: The Raspberry Pi must first acquire an IP address after being connected to the network. With DHCP (Dynamic Host Configuration Protocol), this may be accomplished automatically. The Raspberry Pi will ask the network's DHCP server for an IP address.

Establish an SSH session to connect: A cryptographic network protocol called Secure Shell (SSH) is used to establish a secure connection over an unprotected network to a distant device. In this stage, you would use the Raspberry Pi's IP address and the necessary credentials (such as an SSH key or username and password) to establish a remote connection to it using an SSH client (such as PuTTY on Windows or Terminal on macOS/Linux). and activate the honeypot server, A honeypot server is a spoof system designed to identify, thwart, or stop attempts to access information systems without authorization. In this stage, you would boot up the Raspberry Pi's honeypot server software. Software known as a honeypot imitates open ports or vulnerable services to draw in attackers and learn about their strategies.

If an attacker tries to attack the network with the available open ports the attacker will fall in a trap: after the honeypot server is up and running, it watches for incoming connections on particular ports that are frequently targeted by attackers. Attackers who try to use these ports will inadvertently interact with the honeypot, which will let you watch what they do and learn more about their strategies.

Gather and preserve all of the logs: When the honeypot server communicates with possible attackers, it creates log files that are full of important details about the attacks that have been undertaken. These logs usually contain information about the attack type, payloads, and commands utilised, along with the attacker's IP address. For analysis and future use, it's critical to gather and safely preserve these records.

End: The procedure can be finished once the needed data has been gathered and recorded. This could be as simple as terminating the SSH session or turning off the Raspberry Pi.

The procedure for configuring a Raspberry Pi as a honeypot to identify and collect data about possible attackers aiming to breach a network is described in this flowchart. The first setup, network connection, honeypot server activation, attack detection, and result logging for analysis are all included.

Implementation

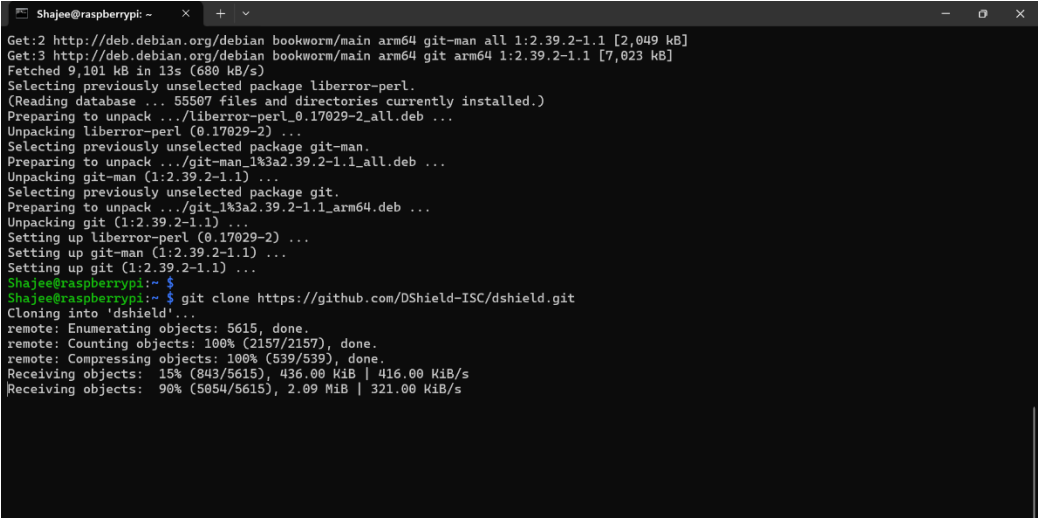
Using diagrammatic representation, all of the activities necessary to carry out the procedures are represented throughout the implementation phase.

Configure Raspberry pi

First and foremost, as mentioned above Raspberry Pi 4 model b was used here and write the operating system on it using the SD card reader. After that Pi is connected to the computer and ready to change to a honeypot.

Configuration of Honeypot

The configuration of the honeypot is the main module to proceed in any other further understanding of the project. For this DShield Raspberry Pi sensor was used from Git Hub.



```
Shajee@raspberrypi: ~  
Get:2 http://deb.debian.org/debian bookworm/main arm64 git-man all 1:2.39.2-1.1 [2,049 kB]  
Get:3 http://deb.debian.org/debian bookworm/main arm64 git arm64 1:2.39.2-1.1 [7,023 kB]  
Fetched 9,101 kB in 13s (680 kB/s)  
Selecting previously unselected package liberror-perl.  
(Reading database ... 55507 files and directories currently installed.)  
Preparing to unpack .../liberror-perl_0.17029-2_all.deb ...  
Unpacking liberror-perl (0.17029-2) ...  
Selecting previously unselected package git-man.  
Preparing to unpack .../git-man_1%3a2.39.2-1.1_all.deb ...  
Unpacking git-man (1:2.39.2-1.1) ...  
Selecting previously unselected package git.  
Preparing to unpack .../git_1%3a2.39.2-1.1_arm64.deb ...  
Unpacking git (1:2.39.2-1.1) ...  
Setting up liberror-perl (0.17029-2) ...  
Setting up git-man (1:2.39.2-1.1) ...  
Setting up git (1:2.39.2-1.1) ...  
Shajee@raspberrypi:~$  
Shajee@raspberrypi:~$ git clone https://github.com/DShield-ISC/dshield.git  
Cloning into 'dshield' ...  
remote: Enumerating objects: 5615, done.  
remote: Counting objects: 100% (2157/2157), done.  
remote: Compressing objects: 100% (539/539), done.  
Receiving objects: 15% (843/5615), 436.00 KiB | 416.00 KiB/s  
Receiving objects: 90% (5054/5615), 2.09 MiB | 321.00 KiB/s
```

Figure 10: Configuration of Honeypot

The lightweight DShield Honeypot is intended to mimic a weak system to obtain threat intelligence. After that, this data is submitted to the extensive data warehouse of SANS ISC for research purposes.

Honeypots aren't meant to store any sensitive information that could be hacked. Rather, these systems serve to draw in attackers who want to learn more about their methods, strategies, and operational procedures.

Install the honeypot on the Raspberry Pi

Once the configuration of the honeypot is finished, installation of the Honeypot begins which is shown in the above screenshot.

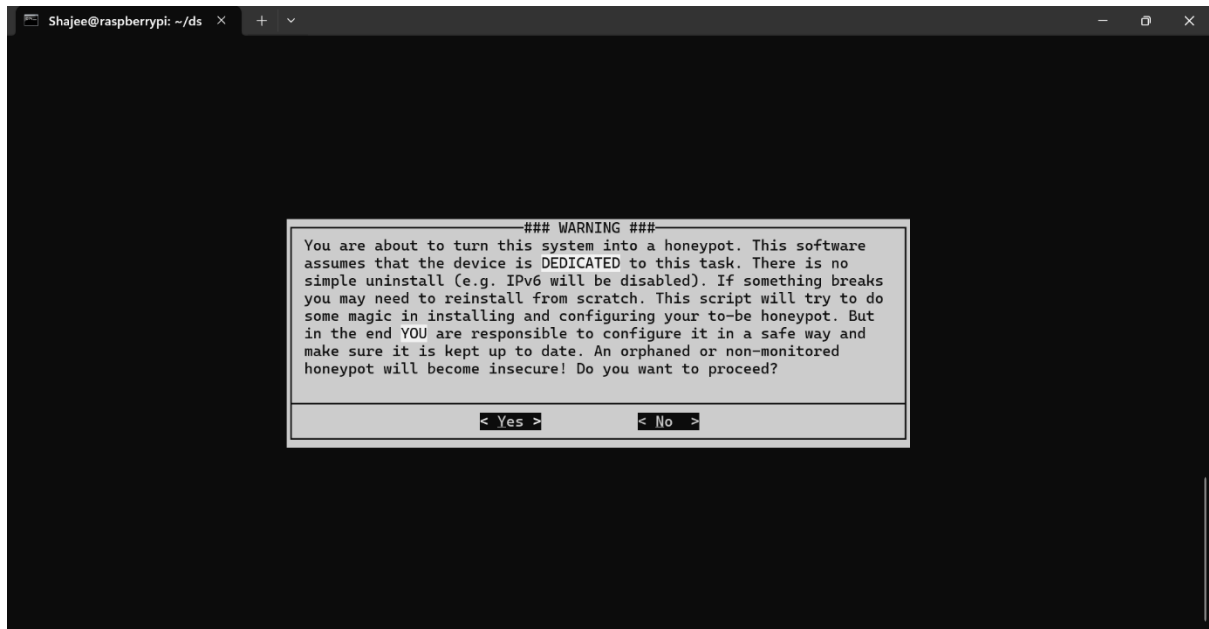


Figure 11: Configuration of Honeypot



Connect the Raspberry Pi to the network

Following the Pi's honeypot setup. Now that the Raspberry Pi is connected to a network, we can see it from the outside by displaying it as a device with all of its ports accessible. This makes the device open to attack, which will ultimately lead the attacker into the trap.

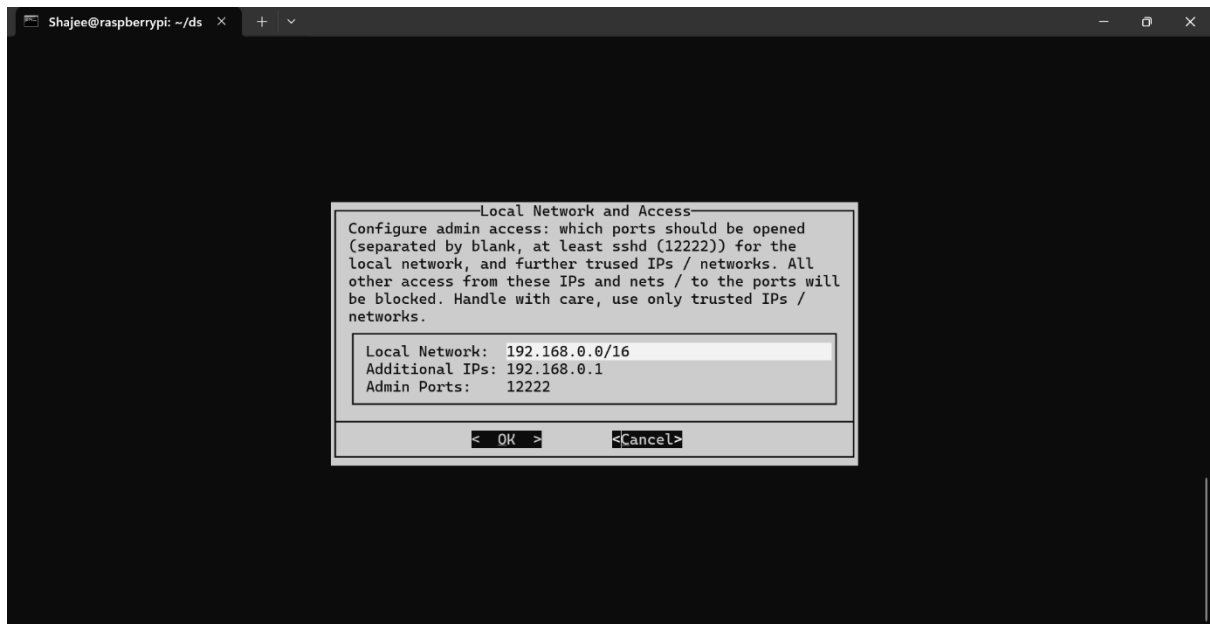


Figure 12: Connecting to the network

Get the IP address of the Raspberry Pi

Now that the Raspberry Pi is linked to a network, it will either have an IP address or we have set up the network adapter to obtain one. Upon obtaining an IP address, we must ensure that port 12222 is available for SSH sessions to communicate with the Pi without using an HDMI connection to the monitor. This is necessary for us to communicate with Pi to review the logs.

To get to know the IP address of the Raspberry Pi we use an advanced IP scanner

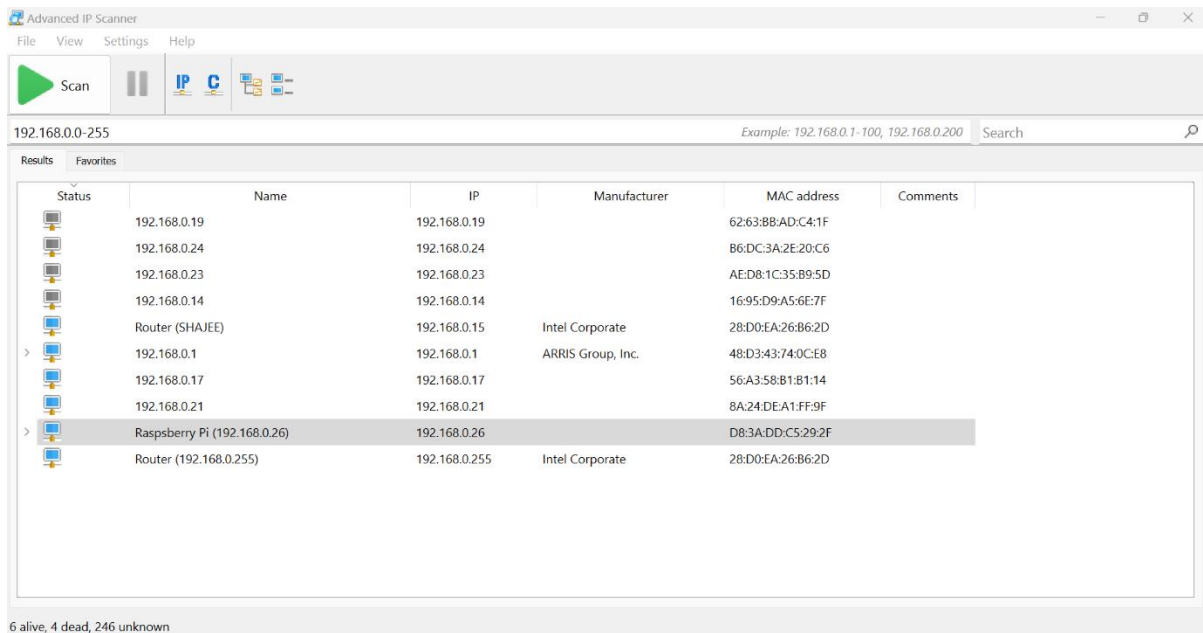


Figure 13: Advanced IP scanner

Connect to an SSH session using PUTTY

We are utilising PUTTY, an open-source terminal that is frequently used to interface with Linux computers and other devices, to establish an SSH session. Since our Raspberry Pi runs Linux and port 12222 is open, we can use Putty to set up the device or honeypot and use the same programme to see the logs.

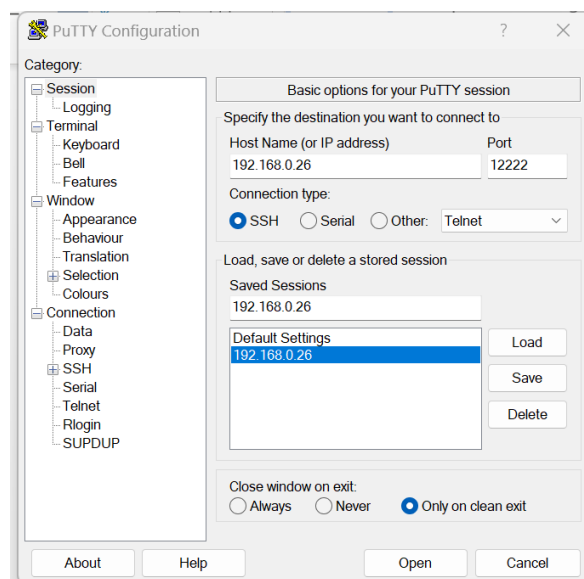


Figure 14: Connecting to the SSH session

Enter login credentials to access

We require a fundamental security entity, which is our device login credentials, to carry out all of those tasks.

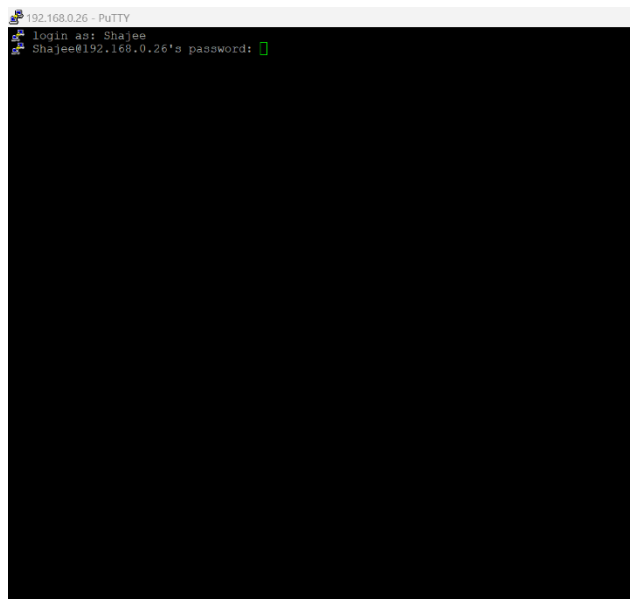
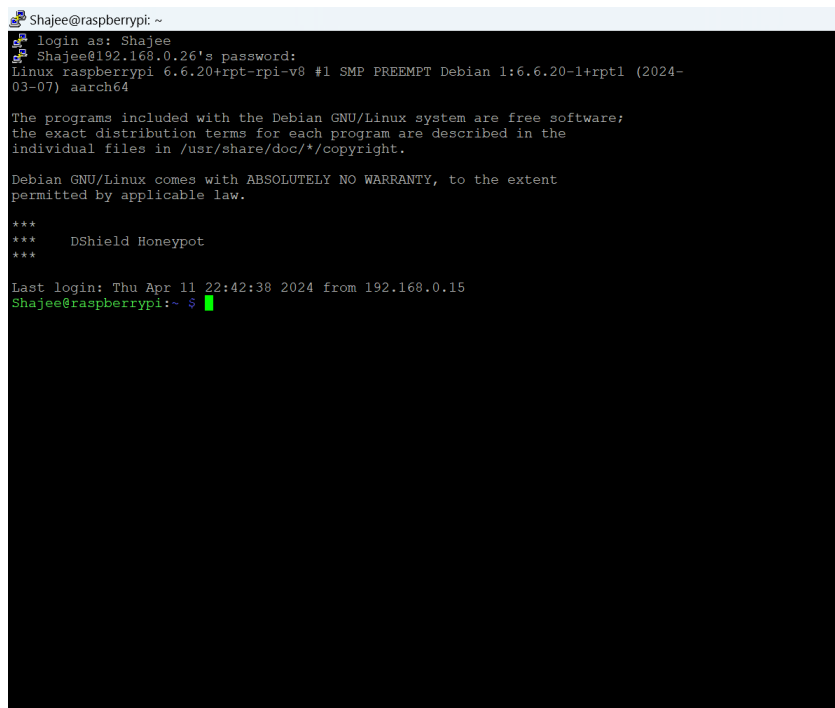


Figure 15: Enter login credential

Start the honeypot server, by running the honeypot

Now that everything is configured, we can launch the honeypot server, which is located on the Pi and has an IP address given to it. When the server is turned on, we need to continuously monitor the logs and wait for an attacker to try to get through. If that happens, the honeypot will begin collecting their personal information. Because we are all connected to the internet, which is the case for 80% of the world's machines and 90% of all machines connected to networks, attacks can occur at any time.

By completing these, we may begin gathering knowledge about our implementation, and the attacker will only be deceived into falling into the trap.



```
Shajee@raspberrypi: ~  
login as: Shajee  
Shajee@192.168.0.26's password:  
Linux raspberrypi 6.6.20+rpt-rpi-v8 #1 SMP PREEMPT Debian 1:6.6.20-1+rpt1 (2024-03-07) aarch64  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
  
***  
***      DShield Honeypot  
***  
  
Last login: Thu Apr 11 22:42:38 2024 from 192.168.0.15  
Shajee@raspberrypi:~$
```

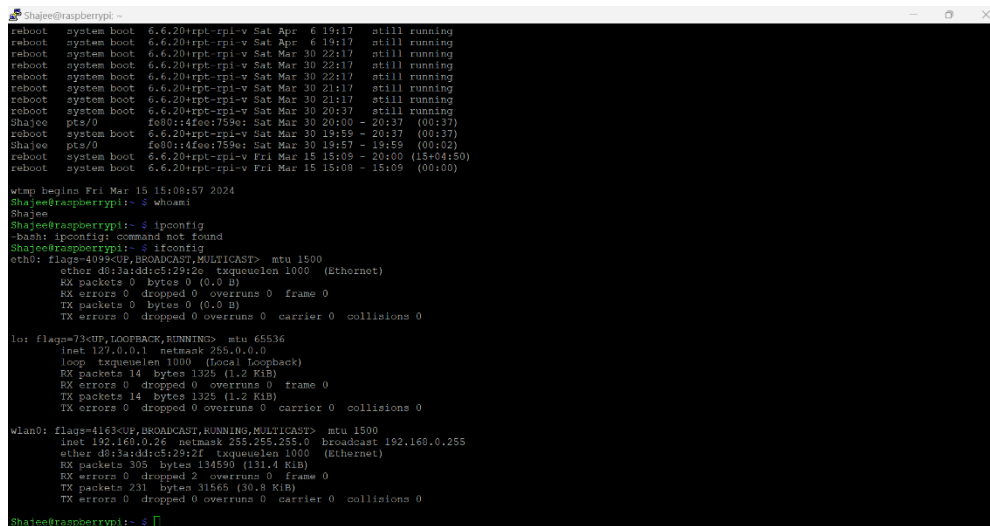
Figure 16: Starting the honeypot server

Results

This part presents the project's output from both the attacker's and victim's points of view, providing us with a comprehensive understanding of the project's capabilities. We will examine the project in-depth and explain it here.

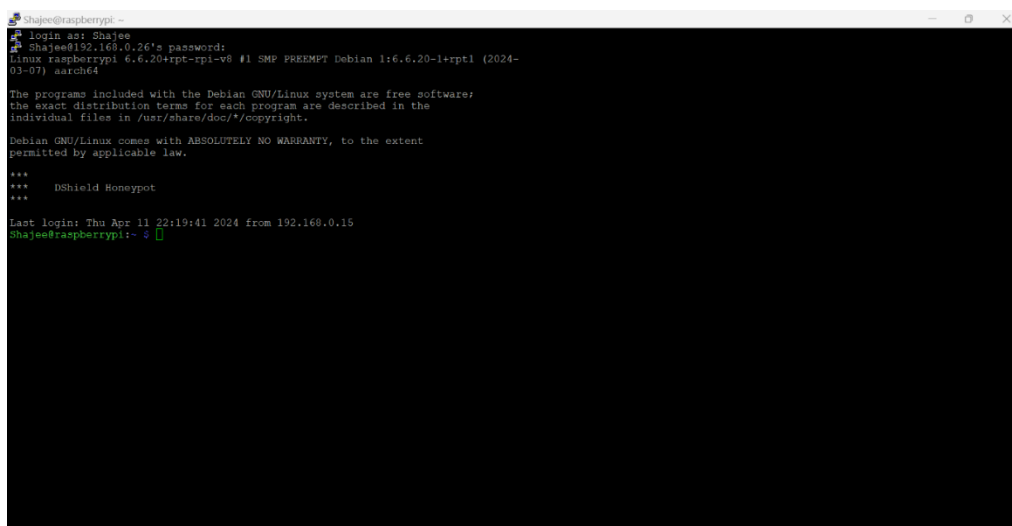
Once the honeypot is connected to the network, we must identify the IP address to use SSH to enter the honeypot and launch the honeypot server. We use PUTTY to connect to the Raspberry and NMAP to search for the IP address within the network.

After determining the Raspberry's IP address, we use a PUTTY terminal to log in and connect to the server via port 12222.



```
Shajee@raspberrypi:~  
reboot system boot 6.6.20+rpt-rpi-v Sat Apr 6 19:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Apr 6 19:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 22:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 22:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 21:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 21:17 still running  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 20:37 still running  
Shajee pts/0 fe80::4fee:759e: Sat Mar 30 20:00 - 20:37 (00:37)  
reboot system boot 6.6.20+rpt-rpi-v Sat Mar 30 19:59 - 20:37 (00:37)  
Shajee pts/0 fe80::4fee:759e: Sat Mar 30 19:57 - 19:59 (00:02)  
reboot system boot 6.6.20+rpt-rpi-v Fri Mar 15 15:09 - 20:00 (15+04:50)  
reboot system boot 6.6.20+rpt-rpi-v Fri Mar 15 15:08 - 15:09 (00:00)  
  
wtmp begins Fri Mar 15 15:08:57 2024  
Shajee@raspberrypi:~$ whoami  
Shajee  
Shajee@raspberrypi:~$ ipconfig  
-bash: ipconfig: command not found  
Shajee@raspberrypi:~$ ifconfig  
eth0: flags=4096<UP,BROADCAST,MULTICAST> mtu 1500  
ether d8:3a:dd:c5:19:2e txqueuelen 1000 (Ethernet)  
RX packets 0 bytes 0 (0.0 B)  
RX errors 0 dropped 0 overruns 0 frame 0  
TX packets 0 bytes 0 (0.0 B)  
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536  
inet 127.0.0.1 netmask 255.0.0.0  
loop txqueuelen 1000 (local loopback)  
RX packets 14 bytes 1325 (1.2 KiB)  
RX errors 0 dropped 0 overruns 0 frame 0  
TX packets 14 bytes 1325 (1.2 KiB)  
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500  
inet 192.168.0.26 netmask 255.255.255.0 broadcast 192.168.0.255  
ether d8:3a:dd:c5:12:2f txqueuelen 1000 (Ethernet)  
RX packets 305 bytes 134590 (131.4 KiB)  
RX errors 0 dropped 2 overruns 0 frame 0  
TX packets 231 bytes 31565 (30.8 KiB)  
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0  
  
Shajee@raspberrypi:~$
```

Figure 17: In to the SSH session



```
Shajee@raspberrypi:~  
login as: Shajee  
Shajee@192.168.0.26's password:  
Linux raspberrypi 6.6.20+rpt-rpi-v8 #1 SMP PREEMPT Debian 1:6.6.20-1-rpt1 (2024-03-07) aarch64  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/*copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
  
***  
*** DSshield HoneyPot  
***  
  
Last login: Thu Apr 11 22:19:41 2024 from 192.168.0.15  
Shajee@raspberrypi:~$
```

Figure 18: In to the SSH session

Collecting the info of attackers

To test whether the honeypot server is working, there is a scan called NMAP scan which the attacker initially sends packets and examines the replies. From this attacker knows the open ports, and he/she will start their exploit by basically checking what's available. Nmap is used to find hosts and services on a network. Using the Kali Linux system, we are going to do the NMAP scan and check the results.

NMAP scan

Following NMAP scanning has been done by the attacker side and the above shows the results of it.

The Nmap scan was done in Kali using the `nmap -Pn -A` command. The command is used to perform a ping scan (-Pn) and aggressively scan (-A) all ports on the target system. This command can be used for network reconnaissance to discover hosts that are alive in the network and identify open ports running on those hosts. The following figure shows that the attacker sees a lot of ports open and may think there's a site which is hosted.

```
kali@kali:~$ nmap -Pn -A 192.168.0.26
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-04-13 05:37 EDT
Nmap scan report for 192.168.0.26
Host is up (0.046s latency).
Not shown: 984 filtered tcp ports (no-response), 8 filtered tcp ports (host-unreach)
PORT      STATE SERVICE VERSION
22/tcp    open  ssh      OpenSSH 6.0p1 Debian 4+deb7u2 (protocol 2.0)
|_ ssh-hostkey:
|_ 2048 72:bc:d4:b8:56:cd:5a:43:87:b0:4f:c9:02:6c:4d:8f (RSA)
|_ 256 11:91:ce:73:d2:7b:15:65:5b:04:35:f5:6b:86:03:b4 (ECDSA)
|_ 256 e6:77:83:a2:5d:15:16:dc:86:4f:ff:c8:1b:e5:2c:3d (ED25519)
23/tcp    open  telnet?
|_ fingerprint-strings:
|_ DNSStatusRequestTCP, DNSVersionBindReqTCP, JavaRMI, LANDesk-RC, LDAPBindReq, NULL, NotesRPC, RPCCheck, TerminalServer, WMSRequest, X11Probe, afp, giop, t
n3270:
|_ login:
|_ FourOhFourRequest, GetRequest, HTTPOptions, LDAPSearchReq, RTSPRequest:
|_ login:
|_ Password:
|_ Login incorrect
|_ login:
|_ GenericLines:
|_ login:
|_ Password:
|_ programs included with the Debian GNU/Linux system are free software;
|_ exact distribution terms for each program are described in the
|_ individual files in /usr/share/doc/*/*copyright.
|_ Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
|_ permitted by applicable law.
[4h@hessalonian:~$
```

Figure 19: Nmap scan in kali

```
kali-linux-2024.1-vmware-amd64 - VMware Workstation 17 Player (Non-commercial use only)
Player
File Actions Edit View Help
Help, Kerberos, LPDString, SSLSessionReq, TerminalServerCookie:
login:
Password:
SIPOptions:
login:
Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
80/tcp open  http      Apache httpd 3.2.3
_http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
_http-server-header: Apache/3.2.3
_http-generator: WordPress 5.6.7
2323/tcp open  3d-nfsd?
fingerprint-strings:
DNSStatusRequestTCP, DNSVersionBindReqTCP, JavaRMI, LANDesk-RC, LDAPBindReq, NULL, NotesRPC, RPCCheck, TerminalServer, WMSRequest, X11Probe, afp, glsp, t
n3270:
login:
FourOhFourRequest, GetRequest, HTTPOptions, LDAPSearchReq, RTSPRequest:
login:
Password:
Login incorrect
login:
GenericLines:
```

Figure 20: Information on the attacker machine

```
kali-linux-2024.1-vmware-amd64 - VMware Workstation 17 Player (Non-commercial use only)
Player
File Actions Edit View Help
login:
GenericLines:
login:
Password:
programs included with the Debian GNU/Linux system are free software;
exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
[4hghessalonian:~$
Help, Kerberos, LPDString, SSLSessionReq, TerminalServerCookie:
login:
Password:
SIPOptions:
login:
Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
Login incorrect
login: Password:
5555/tcp open  http      Apache httpd 3.2.3
_http-server-header: Apache/3.2.3
_http-generator: WordPress 5.6.7
_http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
8000/tcp open  http      Apache httpd 3.2.3
```

Figure 21: Information on the attacker machine

```
kali-linux-2024.1-vmware-amd64 - VMware Workstation 17 Player (Non-commercial use only)
Player
File Actions Edit View Help
SF:the\x20exact\x20distribution\x20terms\x20for\x20each\x20program\x20are\
SF:x20described\x20in\x20the\r\nindividual\x20files\x20in\x20usr/share/do
SF:c/+/copyright/.\r\n\r\nDebian\x20GNU/Linux\x20comes\x20with\x20ABSOLUT
SF:ELY\x20NO\x20WARRANTY,\x20to\x20the\x20extent\r\npermitted\x20by\x20app
SF:licable\x20law.\r\n\r\n[4@hessalonian:~]$ \x20) %r(GetRequest,2C,"log
SF:in:\x20\xff\xfb\x01Password:\x20\nLogin\x20incorrect\nlogin:\x20") %r(HT
SF:TPOptions,2C,"login:\x20\xff\xfb\x01Password:\x20\nLogin\x20incorrect\n
SF:login:\x20") %r(RTSPRequest,2C,"login:\x20\xff\xfb\x01Password:\x20\nLog
SF:in\x20incorrect\nlogin:\x20") %r(RPCCheck,7,"login:\x20") %r(DNSVersionBi
SF:ndReqTCP,7,"login:\x20") %r(DNSStatusRequestTCP,7,"login:\x20") %r(Help,1
SF:4,"login:\x20\xff\xfb\x01Password:\x20") %r(SSLSessionReq,14,"login:\x20
SF:\xff\xfb\x01Password:\x20") %r(TerminalServerCookie,14,"login:\x20\xff\x
SF:fb\x01Password:\x20") %r(Kerberos,14,"login:\x20\xff\xfb\x01Password:\x2
SF:0") %r(X11Probe,7,"login:\x20") %r(FourOhFourRequest,2C,"login:\x20\xff\x
SF:fb\x01Password:\x20\nLogin\x20incorrect\nlogin:\x20") %r(LPDString,14,"l
SF:ogin:\x20\xff\xfb\x01Password:\x20") %r(LDAPSearchReq,2C,"login:\x20\xff
SF:\xfb\x01Password:\x20\nLogin\x20incorrect\nlogin:\x20") %r(LDAPBindReq,7
SF:"login:\x20") %r(SIPOptions,BE,"login:\x20\xff\xfb\x01Password:\x20\nLo
SF:gin\x20incorrect\nlogin:\x20Password:\x20\nLogin\x20incorrect\nlogin:\x
SF:20Password:\x20\nLogin\x20incorrect\nlogin:\x20Password:\x20\nLogin\x20
SF:incorrect\nlogin:\x20Password:\x20\nLogin\x20incorrect\nlogin:\x20Passw
SF:ord:\x20") %r(LANDesk-RC,7,"login:\x20") %r(TerminalServer,7,"login:\x20"
SF:%r(NotesRPC,7,"login:\x20") %r(JavaRMI,7,"login:\x20") %r(WMSRequest,7,"
SF:login:\x20") %r(afp,7,"login:\x20") %r(giop,7,"login:\x20");
Service Info: OS: Linux; CPE: cpe:/o:linux:linux_kernel

Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 1 IP address (1 host up) scanned in 294.30 seconds

(kali@kali) [~]
$
```

Figure 22: Information on the attacker machine

```
kali-linux-2024.1-vmware-amd64 - VMware Workstation 17 Player (Non-commercial use only)
Player
File Actions Edit View Help
|_ login: Password:
5555/tcp open http Apache httpd 3.2.3
|_ http-server-header: Apache/3.2.3
|_ http-generator: WordPress 5.6.7
|_ http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
8000/tcp open http Apache httpd 3.2.3
|_ http-generator: WordPress 5.6.7
|_ http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
|_ http-server-header: Apache/3.2.3
|_ http-open-proxy: Potentially OPEN proxy.
|_ Methods supported:CONNECTION
8080/tcp open http Apache httpd 3.2.3
|_ http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
|_ http-generator: WordPress 5.6.7
|_ http-open-proxy: Potentially OPEN proxy.
|_ Methods supported:CONNECTION
|_ http-server-header: Apache/3.2.3
9000/tcp open http Apache httpd 3.2.3
|_ http-trane-info: Problem with XML parsing of /evox/about
|_ http-server-header: Apache/3.2.3
|_ http-generator: WordPress 5.6.7
|_ http-title: TurnKey Linux 6#8211; Just another WordPress 2024-04-13 site
2 services unrecognized despite returning data. If you know the service/version, please submit the following fingerprints at https://nmap.org/cgi-bin/submit.
cgi?new-service :
=====NEXT SERVICE FINGERPRINT (SUBMIT INDIVIDUALLY)=====
SF:Port23-TCP:V=7.94SVN&I=7&D=4/13&T=661A529E&P=x86_64-pc-linux-gnu&R(N
SF:ULL,7,"login:\x20") %r(GenericLines,151,"login:\x20\xff\xfb\x01Password:
SF:\x20\n\xff\xfb\x03\r\nThe\x20programs\x20included\x20with\x20the\x20Deb
SF:ian\x20GNU/Linux\x20system\x20are\x20free\x20software;\r\nthe\x20exact\
SF:x20distribution\x20terms\x20for\x20each\x20program\x20are\x20described\
SF:x20in\x20the\r\nindividual\x20files\x20in\x20usr/share/doc/+/copyright
```

Figure 23: Information on the attacker machine

The Reports

The following figure shows the results shown in the reports as we can see the web honeypot logs and their activity. Which can be done using by Internet Storm Center.

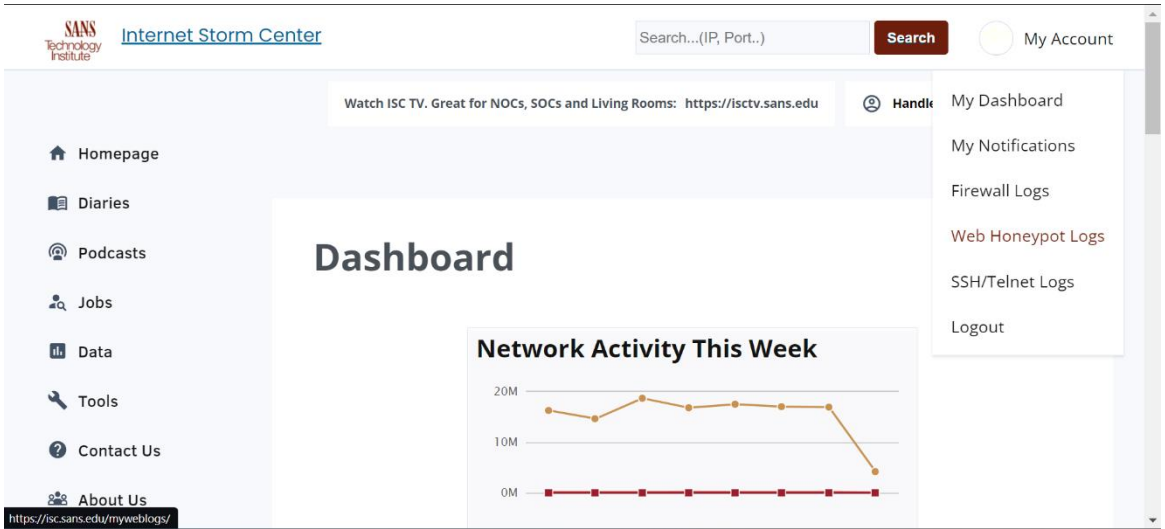
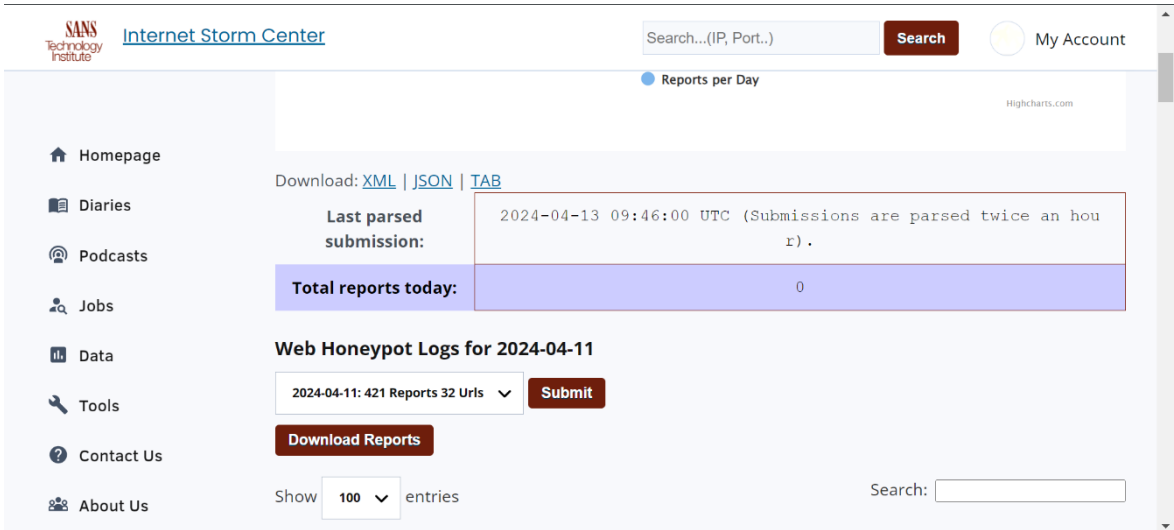


Figure 24: Reports of the results



Conclusion

As we can see, if we are not sufficiently security proof, even offering this level of protection can and will be in futile. While the project cannot guarantee total protection, it will assist in identifying the attacker and their goals. Nevertheless, the protection the device offers can still be circumvented by employing social engineering to get access to the network or by gaining access to it and then granting the user complete access.

This device offers protection against outsiders attempting to access the network through security flaws; nevertheless, if any other machine is out of date or has open ports, it is vulnerable to assault. We need more than just security, prevention, or protection to keep ourselves safe from harm. We also need to exercise caution.

Future Enhancement

In the future, a Raspberry Pi-based DShield honeypot may be improved in several ways to enhance its usability, security, and functionality. Here are a few possible improvements:

Improved Monitoring and Logging: To obtain more specific information about incoming threats, enhance the logging capabilities. For a more thorough investigation, this could involve logging timestamps, source IP geolocation information, and packet contents.

Integration with Threat Intelligence Feeds: To improve the quality of the data gathered, integrate the honeypot with threat intelligence feeds. With the use of this integration, attacks may be better understood and known malicious IPs, patterns, or signatures may be found.

Dynamic Response Mechanism: Use dynamic reaction mechanisms to take proactive measures in response to risks that are identified. For instance, dynamically modifying firewall rules to reduce ongoing attacks or automatically blocking malicious IPs at the network level.

Machine Learning for Anomaly Detection: To identify possible zero-day attacks and unusual activity, apply machine learning techniques. Teach the system to identify patterns in incoming data and to tell the difference between legitimate and malicious activities. Harmful IP addresses, patterns, or signatures and offer a more insightful explanation of the attacks.

Flexibility and Customisation: Give users additional ways to customise the honeypot to meet their unique requirements. This might include support for various protocols, adjustable reaction actions, and thresholds that can be set to start alerts.

Scalability and Performance: Make the honeypot software as efficient as possible in handling high traffic volumes. Performance tweaking, code optimisation, and support for distributed deployment architectures might all be part of this.

Improved Reporting and Visualisation: Create an intuitive web interface or dashboard to produce reports and visualise honeypot activities. Users would find it simpler to understand the gathered data and spot trends or patterns as a result.

Community Cooperation and Sharing: Put in place tools that help users collaborate and share knowledge. This could involve collaborative analytical tools, community forums for exchanging best practices, and a common repository for sharing threat intelligence data.

Security Hardening: To protect against emerging attacks, the honeypot software's security posture should be updated and improved regularly. Regular security audits, vulnerability analyses, and prompt patching of identified vulnerabilities are all part of this.

These improvements could make a Raspberry Pi-based DShield honeypot more effective in identifying and evaluating cyber threats, which would ultimately aid in the overall endeavour to strengthen cybersecurity posture.

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