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CSC574- Assignment#3

**Buffer Overflow Vulnerability Lab**

## Task# 1- Exploiting the Vulnerability

Here we begin the lab by understanding the dynamics of how data is handled by the system during run time. I spent about 8 to 10 hours going through a comprehensive buffer overflow tutorial that started off with the fundamentals of the compilation, assembly, debugging, and runtime environments. In short the fundamental structure is elaborated in the following depiction.

**Linux Virtual Memory:**

|  |
| --- |
| Args & Env. vars |
| Stack |
|  |
| Heap |
| Bss (initialized data) |
| Initialized data |
| Text (code) |

After being able to bring up a shell with call\_shellcode.c we can begin to exploit the buffer overflow vulnerability. Since the environment used is the Virtual Machine provided by SEED lab, we execute with the following:

*su root*

*sysctl -w kernel.randomize\_va\_space=0*

*su root*

*gcc -o stack -z execstack -fno-stack-protector stack.c*

*chmod 4755 stack*

*exit*

*gcc -o exploit exploit.c*

*./exploit*

*./stack*

**Stack from exploit.c**

|  |
| --- |
| Buffer[516] |
| ……..  …………  ……..  ………… |
| Buffer[0] |
| Badfile |
| Buffer\_reference |
| Stack\_plus\_offset |
| … |
| … |

Allocated to the stack 🡪 0x080484d1 <+6>: sub $0x240,%esp

= 576 bytes

The key to success in exploiting this vulnerability is correctly identifying the return address and writing the return addresses into ‘badfile’.

**Contents of Badfile:**

|  |
| --- |
| ‘\0’ |
| NOP  …  … |
| shellcode |
| NOP  …  … |
| Return value = Stack pointer + offset  Return value = Stack pointer + offset  Return value = Stack pointer + offset  Return value = Stack pointer + offset  …  …  … |
| …  …  NOP |

🡨 buffer[516]

🡨 buffer[511]

🡨 buffer[486]

🡨 stack pointer + offset + #of writes(e.g. 7 to 80)

🡨 stack pointer + offset(e.g. 375)

🡨 buffer[0]

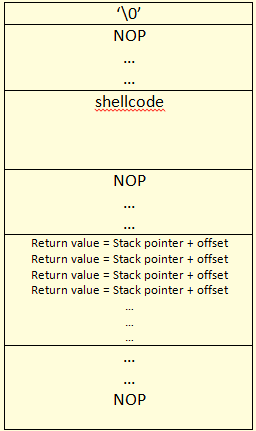
After editing exploit.c to create the badfile we are ready to hijack the vulnerable stack.c program:

**Hijacking stack.c:**

The following depicts the allocated stack during compilation.

|  |
| --- |
| str[516] |
| …  ……  ….  ………  …. |
| str[0] |
| badfile |
| str |
| Return address |
| Saved ebp |
| (Possibly dummy vars and/or saved ebx, esi, edi registers) |
| buffer[11] |
| ….  ……….. |
| buffer[0] |

During runtime the str array is loaded with the badfile. In turn this array is “copied” using ‘strcpy’ into the much smaller buffer array. Since the buffer is much smaller everything above it including the return address is overwritten.



|  |
| --- |
| badfile |
| str |
| Return address |
| Saved ebp |
| (Possibly dummy vars and/or saved ebx, esi, edi registers) |
| buffer[11] |
| ….  ……….. |
| buffer[0] |

strcpy(buffer, str)

Allocated to stack of stack.c 🡪 0x08048489 <+6>: sub $0x220,%esp

= 544 bytes

## Task# 2- Protection in /bin/bash

NOTE: Skipping this section since the Ubuntu 11.04 VM is used. The VM uses ‘dash’)

## Task# 3- Address Randomization

*seed@ubuntu:~$ su root*

*Password:*

*root@ubuntu:/home/seed# sysctl -w kernel.randomize\_va\_space=2*

*kernel.randomize\_va\_space = 2*

*root@ubuntu:/home/seed# exit*

*exit*

*seed@ubuntu:~/Desktop$ gcc -o exploit exploit.c*

*seed@ubuntu:~/Desktop$ ./exploit*

*seed@ubuntu:~/Desktop$ ./stack*

*Segmentation fault*

*seed@ubuntu:~/Desktop$ su root*

*Password:*

*root@ubuntu:/home/seed/Desktop# sysctl -w kernel.randomize\_va\_space=0*

*kernel.randomize\_va\_space = 0*

*root@ubuntu:/home/seed/Desktop# exit*

*exit*

*seed@ubuntu:~/Desktop$ gcc -o exploit exploit.c*

*seed@ubuntu:~/Desktop$ ./exploit*

*seed@ubuntu:~/Desktop$ ./stack*

*# exit*

*seed@ubuntu:~/Desktop$*

*sh -c "while [ 1 ]; do ./stack; done;"*

After turning the Address Randomization feature on I was unsuccessful in getting access to bash. This is theoretically possible by optimizing the badfile.

## Task# 4- Stack Guard

*seed@ubuntu:~/Desktop$ su root*

*Password:*

*root@ubuntu:/home/seed/Desktop# gcc -o stack -z execstack stack.c*

*root@ubuntu:/home/seed/Desktop# chmod 4755 stack*

*root@ubuntu:/home/seed/Desktop# exit*

*exit*

*seed@ubuntu:~/Desktop$ gcc -o exploit exploit.c*

*seed@ubuntu:~/Desktop$ ./stack*

*\*\*\* stack smashing detected \*\*\*: ./stack terminated*

*======= Backtrace: =========*

*/lib/i386-linux-gnu/libc.so.6(\_\_fortify\_fail+0x50)[0x225df0]*

*/lib/i386-linux-gnu/libc.so.6(+0xe5d9a)[0x225d9a]*

*./stack[0x80484f3]*

*[0xbffff2b0]*

*[0x90909090]*

*======= Memory map: ========*

*00110000-0012c000 r-xp 00000000 08:01 263123 /lib/i386-linux-gnu/ld-2.13.so*

*0012c000-0012d000 r-xp 0001b000 08:01 263123 /lib/i386-linux-gnu/ld-2.13.so*

*0012d000-0012e000 rwxp 0001c000 08:01 263123 /lib/i386-linux-gnu/ld-2.13.so*

*0012e000-0012f000 r-xp 00000000 00:00 0 [vdso]*

*0012f000-00132000 rwxp 00000000 00:00 0*

*00140000-0029a000 r-xp 00000000 08:01 263136 /lib/i386-linux-gnu/libc-2.13.so*

*0029a000-0029b000 ---p 0015a000 08:01 263136 /lib/i386-linux-gnu/libc-2.13.so*

*0029b000-0029d000 r-xp 0015a000 08:01 263136 /lib/i386-linux-gnu/libc-2.13.so*

*0029d000-0029e000 rwxp 0015c000 08:01 263136 /lib/i386-linux-gnu/libc-2.13.so*

*0029e000-002a2000 rwxp 00000000 00:00 0*

*002b1000-002cb000 r-xp 00000000 08:01 263164 /lib/i386-linux-gnu/libgcc\_s.so.1*

*002cb000-002cc000 r-xp 00019000 08:01 263164 /lib/i386-linux-gnu/libgcc\_s.so.1*

*002cc000-002cd000 rwxp 0001a000 08:01 263164 /lib/i386-linux-gnu/libgcc\_s.so.1*

*08048000-08049000 r-xp 00000000 08:01 1180443 /home/seed/Desktop/stack*

*08049000-0804a000 r-xp 00000000 08:01 1180443 /home/seed/Desktop/stack*

*0804a000-0804b000 rwxp 00001000 08:01 1180443 /home/seed/Desktop/stack*

*0804b000-0806c000 rwxp 00000000 00:00 0 [heap]*

*bffdf000-c0000000 rwxp 00000000 00:00 0 [stack]*

*Aborted*

## Task# 5- Non-executable Stack

*root@ubuntu:/home/seed/Desktop# gcc -o stack -z noexecstack -fno-stack-protector stack.c*

*root@ubuntu:/home/seed/Desktop# chmod 4755 stack*

*root@ubuntu:/home/seed/Desktop# exit*

*exit*

*seed@ubuntu:~/Desktop$ gcc -o exploit exploit.c*

*seed@ubuntu:~/Desktop$ ./exploit*

*seed@ubuntu:~/Desktop$ ./stack*

*Segmentation fault*