中国科学技术大学

《网络安全》

实验报告

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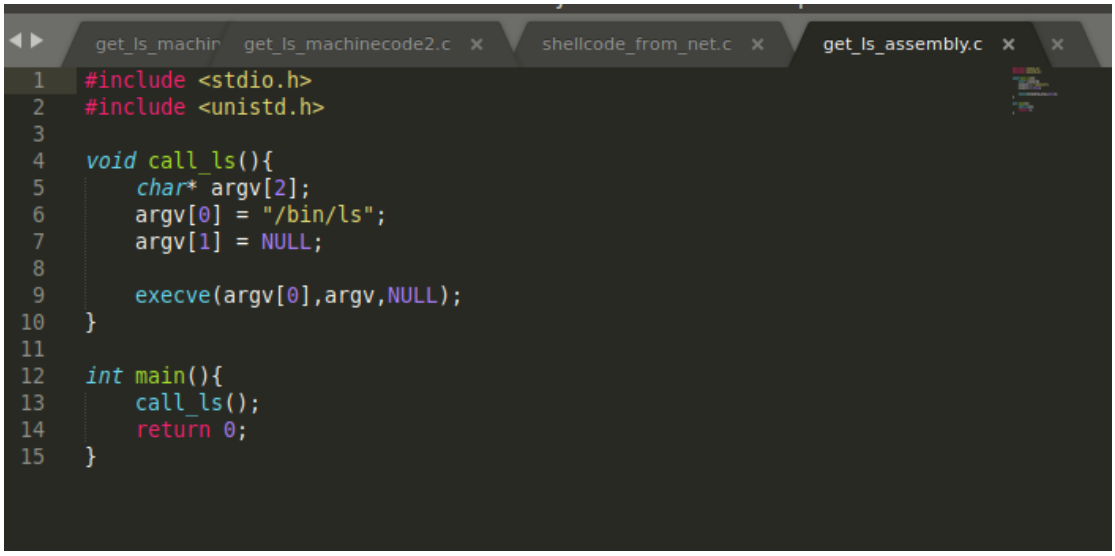
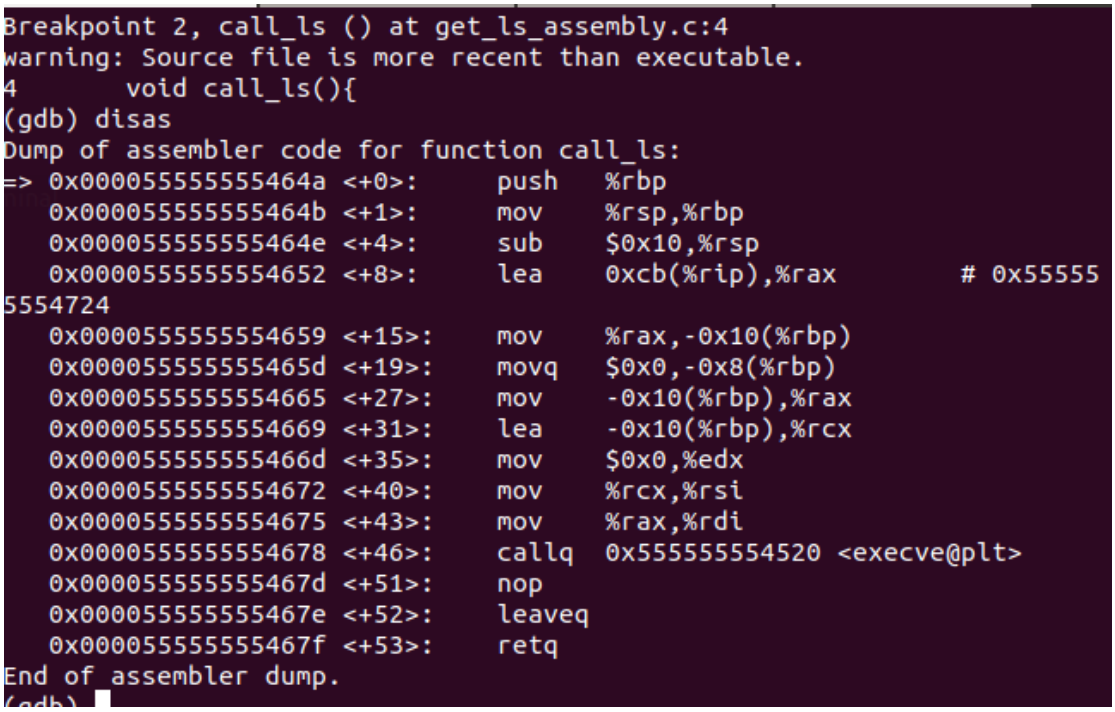
本实验基于 ubuntu18 64bit

首先，写一个使用 execve 调用/bin/ls 的 c 语言程序。



然后使用 gcc 进行编译，并用 gdb 进行调试。

先在 call_ls 函数入口处设置断点，反汇编。



接着在 execve 函数入口处设置断点，反汇编。

```
(gdb) c
Continuing.

Breakpoint 1, execve () at ../sysdeps/unix/syscall-template.S:78
78      ../sysdeps/unix/syscall-template.S: No such file or directory.
(gdb) disas
Dump of assembler code for function execve:
=> 0x00007ffff7ac8e30 <+0>:     mov    $0x3b,%eax
   0x00007ffff7ac8e35 <+5>:     syscall
   0x00007ffff7ac8e37 <+7>:     cmp    $0xfffffffffffff001,%rax
   0x00007ffff7ac8e3d <+13>:    jae    0x7ffff7ac8e40 <execve+16>
   0x00007ffff7ac8e3f <+15>:    retq
   0x00007ffff7ac8e40 <+16>:    mov    0x306021(%rip),%rcx        # 0x7
ffff7dcee68
   0x00007ffff7ac8e47 <+23>:    neg    %eax
   0x00007ffff7ac8e49 <+25>:    mov    %eax,%fs:(%rcx)
   0x00007ffff7ac8e4c <+28>:    or     $0xffffffffffffffff,%rax
   0x00007ffff7ac8e50 <+32>:    retq
End of assembler dump.
(gdb)
```

可以看到，将寄存器 eax 的值设置为 0x3b 后，进行系统调用 syscall，此时查看寄存器的值。

```
(gdb) i r a
rax            0x555555554724   93824992233252
rbx            0x0      0
rcx            0x7fffffffdee0   140737488346848
rdx            0x0      0
rsi            0x7fffffffdee0   140737488346848
rdi            0x555555554724   93824992233252
rbp            0x7fffffffdef0   0x7fffffffdef0
rsp            0x7fffffffded8   0x7fffffffded8
r8             0x7ffff7dd0d80   140737351847296
r9             0x7ffff7dd0d80   140737351847296
r10            0x0      0
```

```
(gdb) x/s $rdi
0x555555554724: "/bin/ls"
```

可以看到，此时，寄存器 rdx 内容为 0，寄存器 rdi 指向字符串"/bin/ls"。

由此，可以写出如下汇编代码。

get_ls_machinecode.c × get_ls_machinecode2.c ×

```c
#include <stdio.h>

int main(){
    __asm__(
        "mov $0x736c2f6e69622f,%rax;"
        "push %rax;"
        "push %rsp;"
        "pop %rdi;"

        "xor %rdx,%rdx;"

        "mov $0x3b,%rax;"
        "syscall;");
    return 0;
}
```

使用 gcc 进行编译，使用 objdump 反汇编。

```
00000000000005fa <main>:
 5fa:   55                      push   %rbp
 5fb:   48 89 e5                mov    %rsp,%rbp
 5fe:   48 b8 2f 62 69 6e 2f    movabs $0x736c2f6e69622f,%rax
 605:   6c 73 00
 608:   50                      push   %rax
 609:   54                      push   %rsp
 60a:   5f                      pop    %rdi
 60b:   48 31 d2                xor    %rdx,%rdx
 60e:   48 c7 c0 3b 00 00 00    mov    $0x3b,%rax
 615:   0f 05                   syscall
 617:   b8 00 00 00 00          mov    $0x0,%eax
 61c:   5d                      pop    %rbp
 61d:   c3                      retq
 61e:   66 90                   xchg   %ax,%ax
```

于是，写出如下文件。

```c
#include <stdio.h>

char badshellcode[] = "\x48\xb8\x2f\x62\x69\x6e\x2f\x6c\x73\x00"
                      "\x50"
                      "\x54"
                      "\x5f"
                      "\x48\x31\xd2"
                      "\x48\xc7\xc0\x3b\x00\x00\x00"
                      "\x0f\x05";
int main(){
    (*(void (*)())badshellcode)();
    return 0;
}
```

使用 gcc 编译，并执行，结果如下。

```
wjm@ubuntu:~/Desktop/networksecurity/chapter9$ gcc -fno-stack-protector
 -z execstack -g -o shellcode shellcode.c
wjm@ubuntu:~/Desktop/networksecurity/chapter9$ ./shellcode
get_ls_assembly         get_sh_assembly     shellcode
get_ls_assembly.c       get_sh_assembly.c   shellcode.c
get_ls_machinecode.c    machinecode         shellcode_from_net
get_ls_machinecode2.c   machinecode2        shellcode_from_net.c
wjm@ubuntu:~/Desktop/networksecurity/chapter9$
```

下面完善 shellcode，将 shellcode 中的\x00 去除。

```c
#include <stdio.h>

int main(){
    __asm__(
        "xor %rax,%rax;"
        "push %rax;"
        "mov $0x736c2f2f6e69622f,%rax;"
        "push %rax;"
        "push %rsp;"
        "pop %rdi;"

        "xor %rdx,%rdx;"

        "xor %rax,%rax;"
        "mov $0x3b,%al;"
        "syscall;");
    return 0;
}
```

使用 gcc 编译，objdump 进行反汇编。

```
00000000000005fa <main>:
 5fa:   55                      push   %rbp
 5fb:   48 89 e5                mov    %rsp,%rbp
 5fe:   48 31 c0                xor    %rax,%rax
 601:   50                      push   %rax
 602:   48 b8 2f 62 69 6e 2f    movabs $0x736c2f2f6e69622f,%rax
 609:   2f 6c 73
 60c:   50                      push   %rax
 60d:   54                      push   %rsp
 60e:   5f                      pop    %rdi
 60f:   48 31 d2                xor    %rdx,%rdx
 612:   48 31 c0                xor    %rax,%rax
 615:   b0 3b                   mov    $0x3b,%al
 617:   0f 05                   syscall
 619:   b8 00 00 00 00          mov    $0x0,%eax
 61e:   5d                      pop    %rbp
 61f:   c3                      retq
```

写出如下文件。

get_ls_assembly.c | shellcode_from_net.c | shellcode.c | shellcode_without0x00.c

```c
#include <stdio.h>

char badshellcode[] = "\x48\x31\xc0"
                      "\x50"
                      "\x48\xb8\x2f\x62\x69\x6e\x2f\x2f\x6c\x73"
                      "\x50"
                      "\x54"
                      "\x5f"
                      "\x48\x31\xd2"
                      "\x48\x31\xc0"
                      "\xb0\x3b"
                      "\x0f\x05";
int main(){
    (*(void (*)())badshellcode)();
    return 0;
}
```

使用 gcc 编译，并运行，结果如下。

```
wjm@ubuntu:~/Desktop/networksecurity/chapter9$ gcc -fno-stack-protector
 -z execstack -g -o shellcode_without0x00 shellcode_without0x00.c
wjm@ubuntu:~/Desktop/networksecurity/chapter9$ ./shellcode_without0x00
get_ls_assembly       get_ls_machinecode2.c  machinecode   shellcode.c
          shellcode_without0x00
get_ls_assembly.c     get_sh_assembly        machinecode2  shellcode_fr
om_net    shellcode_without0x00.c
get_ls_machinecode.c  get_sh_assembly.c      shellcode     shellcode_fr
om_net.c
```