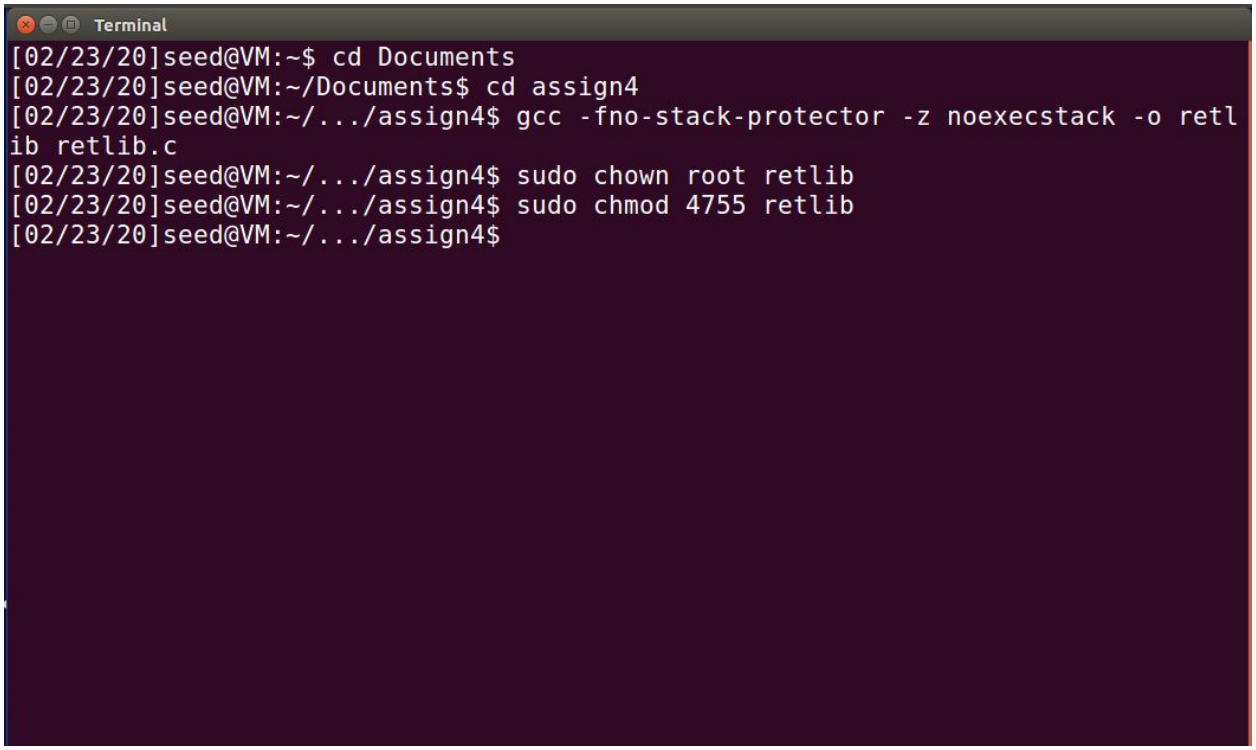
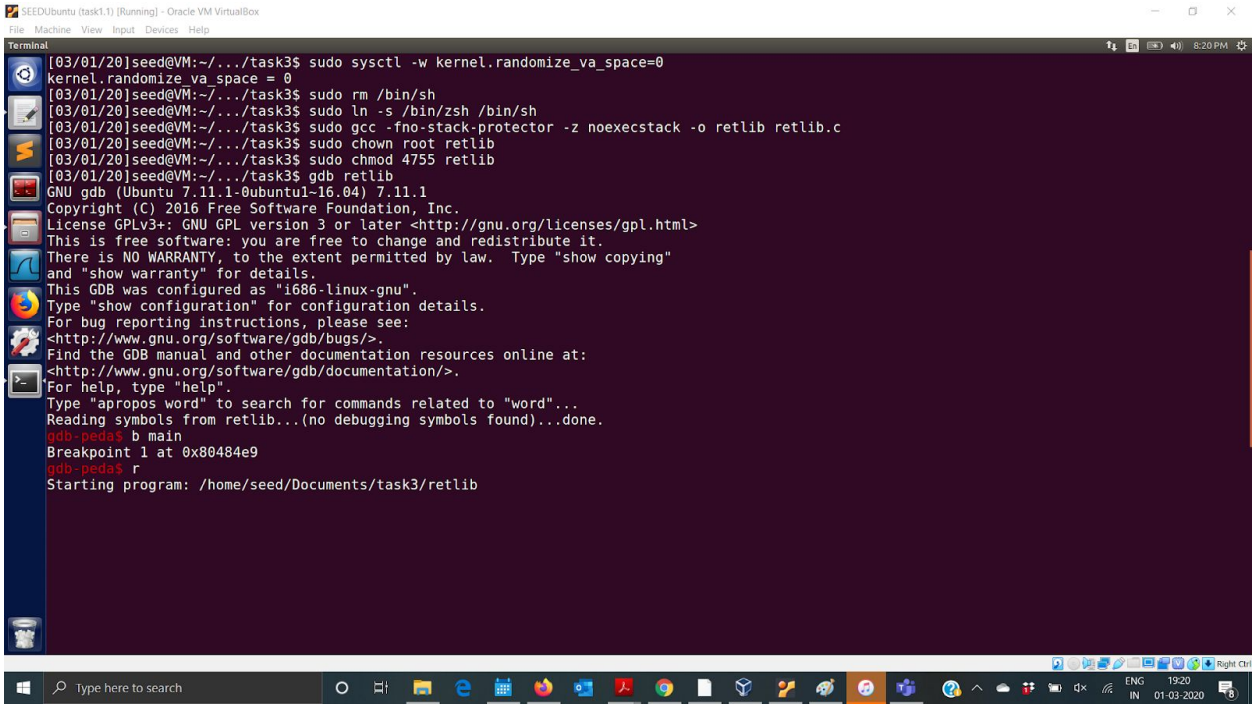
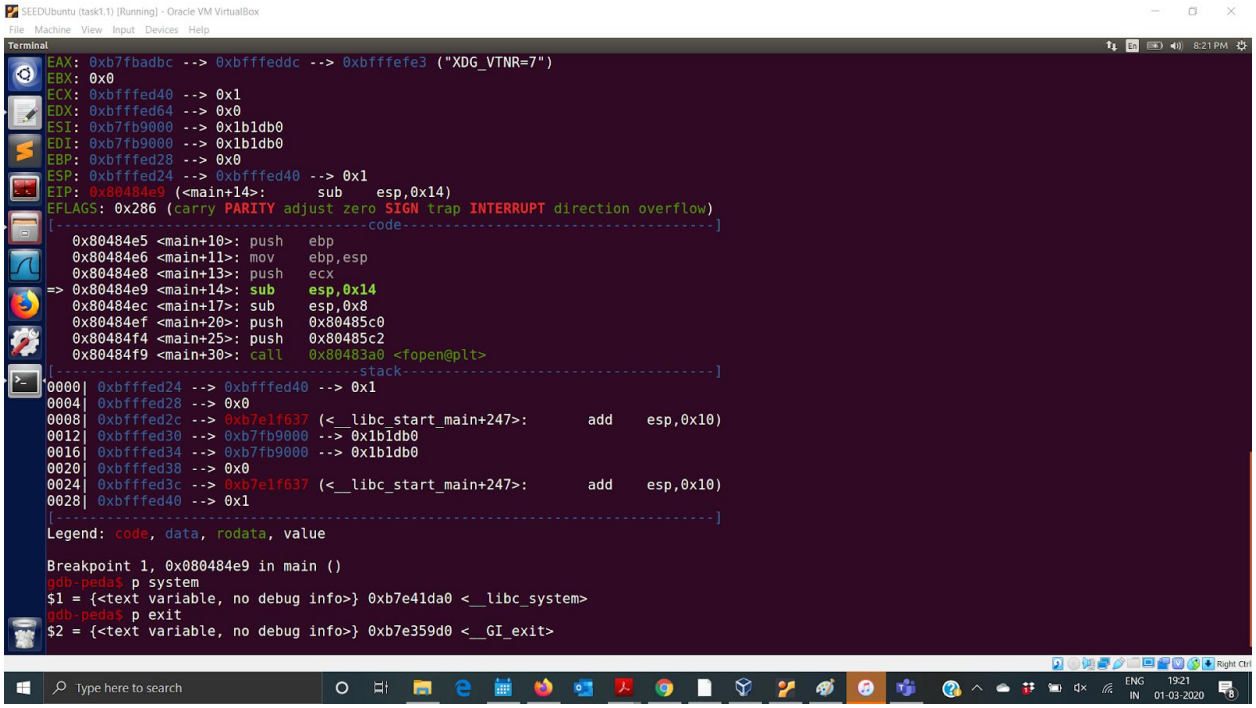
Name : Samiksha Dharmadhikari
Student id : 1001740496



2.3 Task 1: Finding out the addresses of libc functions

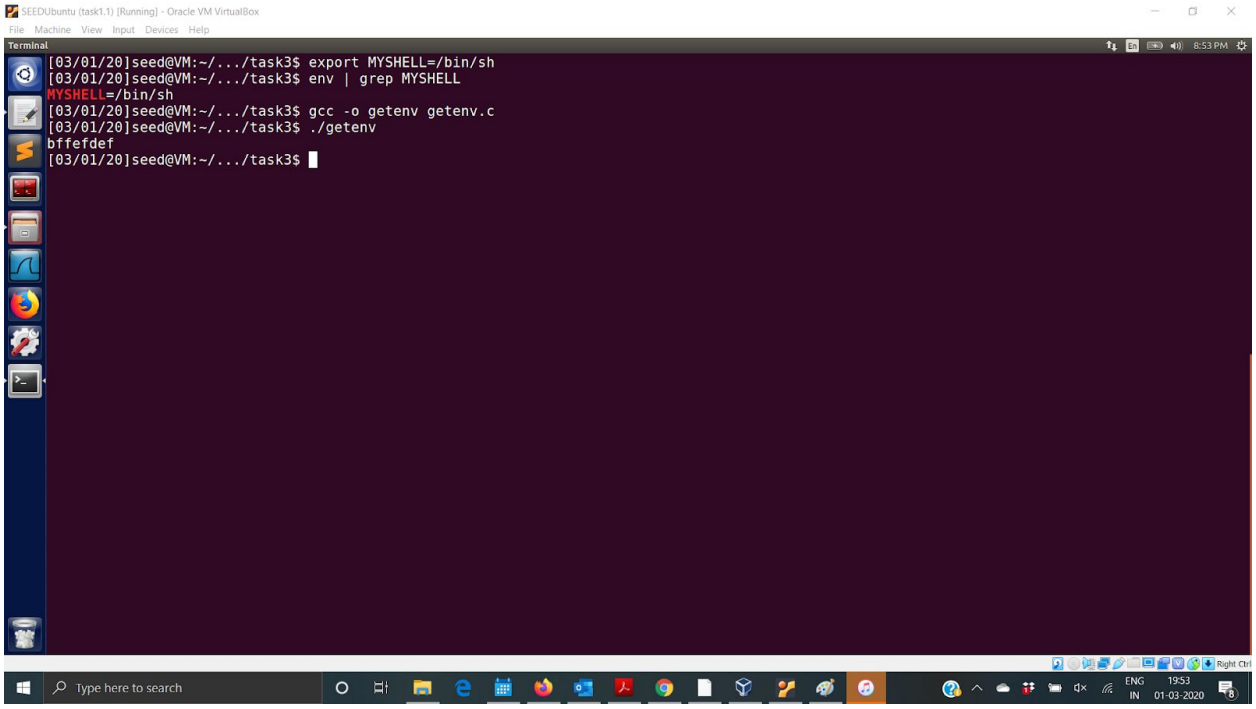
In this task we find out the address of the libc functions which are p system and p exit. We run an arbitrary program in our case retlib. And then we use b main to set breakpoint. We then print the addresses of system and exit which are for system : 0xb7e41da0 and for exit : 0xb7e359d0.


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:20 PM
[03/01/20]seed@VM:~/.../task3$ sudo sysctl -w kernel.randomize_va_space=0
kernel.randomize_va_space = 0
[03/01/20]seed@VM:~/.../task3$ sudo rm /bin/sh
[03/01/20]seed@VM:~/.../task3$ sudo ln -s /bin/zsh /bin/sh
[03/01/20]seed@VM:~/.../task3$ sudo gcc -fno-stack-protector -z noexecstack -o retlib retlib.c
[03/01/20]seed@VM:~/.../task3$ sudo chown root retlib
[03/01/20]seed@VM:~/.../task3$ sudo chmod 4755 retlib
[03/01/20]seed@VM:~/.../task3$ gdb retlib
GNU gdb (Ubuntu 7.11.1-0ubuntu1~16.04) 7.11.1
Copyright (C) 2016 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law. Type "show copying"
and "show warranty" for details.
This GDB was configured as "i686-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from retlib...(no debugging symbols found)...done.
gdb-peda$ b main
Breakpoint 1 at 0x80484e9
gdb-peda$ r
Starting program: /home/seed/Documents/task3/retlib
Right Ctrl
Type here to search
ENG
IN
19:20
01-03-2020


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:21 PM
EAX: 0xb7fbadbc --> 0xbfffeddc --> 0xbfffefe3 ("XDG_VTNR=7")
EBX: 0x0
ECX: 0xbfffed40 --> 0x1
EDX: 0xbfffed64 --> 0x0
ESI: 0xb7fb9000 --> 0x1b1db0
EDI: 0xb7fb9000 --> 0x1b1db0
EBP: 0xbfffed28 --> 0x0
ESP: 0xbfffed24 --> 0xbfffed40 --> 0x1
EIP: 0x80484e9 (<main+14>: sub esp,0x14)
EFLAGS: 0x286 (carry PARITY adjust zero SIGN trap INTERRUPT direction overflow)
[----------code----------]
0x80484e5 <main+10>: push ebp
0x80484e6 <main+11>: mov ebp,esp
0x80484e8 <main+13>: push ecx
=> 0x80484e9 <main+14>: sub esp,0x14
0x80484ec <main+17>: sub esp,0x8
0x80484ef <main+20>: push 0x80485c0
0x80484f4 <main+25>: push 0x80485c2
0x80484f9 <main+30>: call 0x80483a0 <fopen@plt>
[----------stack----------]
0000| 0xbfffed24 --> 0xbfffed40 --> 0x1
0004| 0xbfffed28 --> 0x0
0008| 0xbfffed2c --> 0xb7e1f637 (<__libc_start_main+247>: add esp,0x10)
0012| 0xbfffed30 --> 0xb7fb9000 --> 0x1b1db0
0016| 0xbfffed34 --> 0xb7fb9000 --> 0x1b1db0
0020| 0xbfffed38 --> 0x0
0024| 0xbfffed3c --> 0xb7e1f637 (<__libc_start_main+247>: add esp,0x10)
0028| 0xbfffed40 --> 0x1
[----------]
Legend: code, data, rodata, value
Breakpoint 1, 0x080484e9 in main ()
gdb-peda$ p system
$1 = {<text variable, no debug info>} 0xb7e41da0 <__libc_system>
gdb-peda$ p exit
$2 = {<text variable, no debug info>} 0xb7e359d0 <__GI_exit>
Right Ctrl
Type here to search
ENG
IN
19:21
01-03-2020

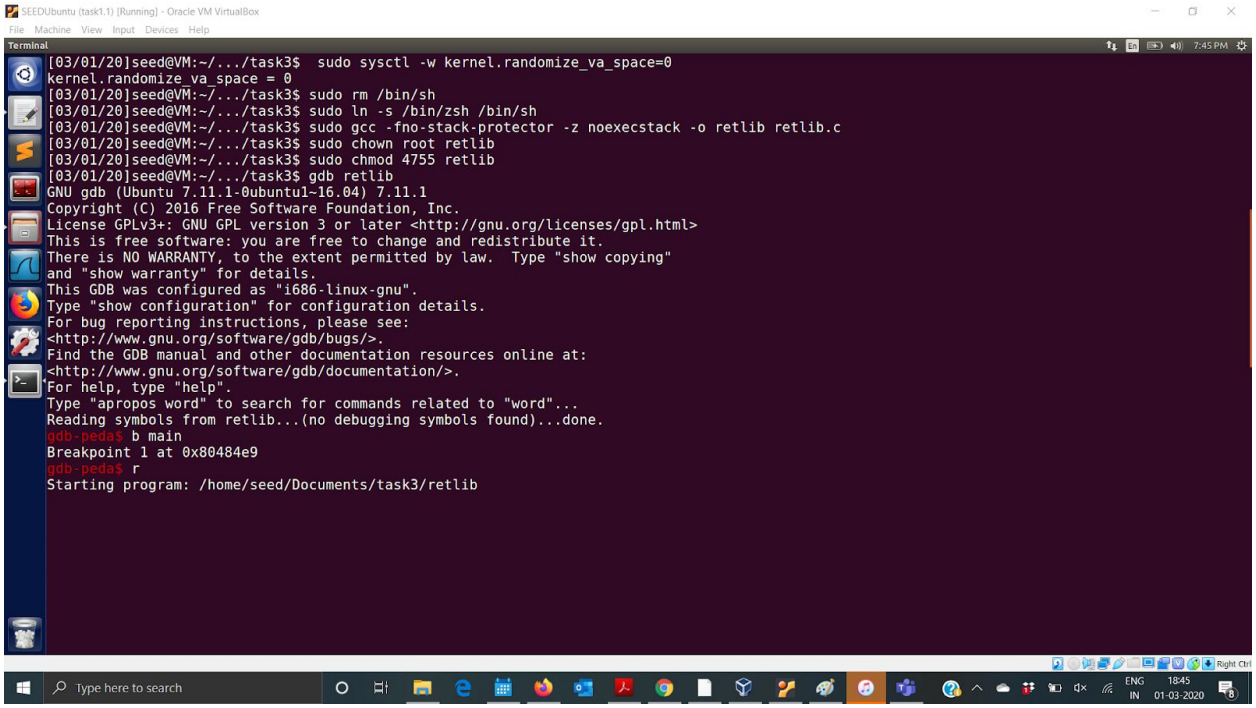
2.4 Task 2: Putting the shell string in the memory

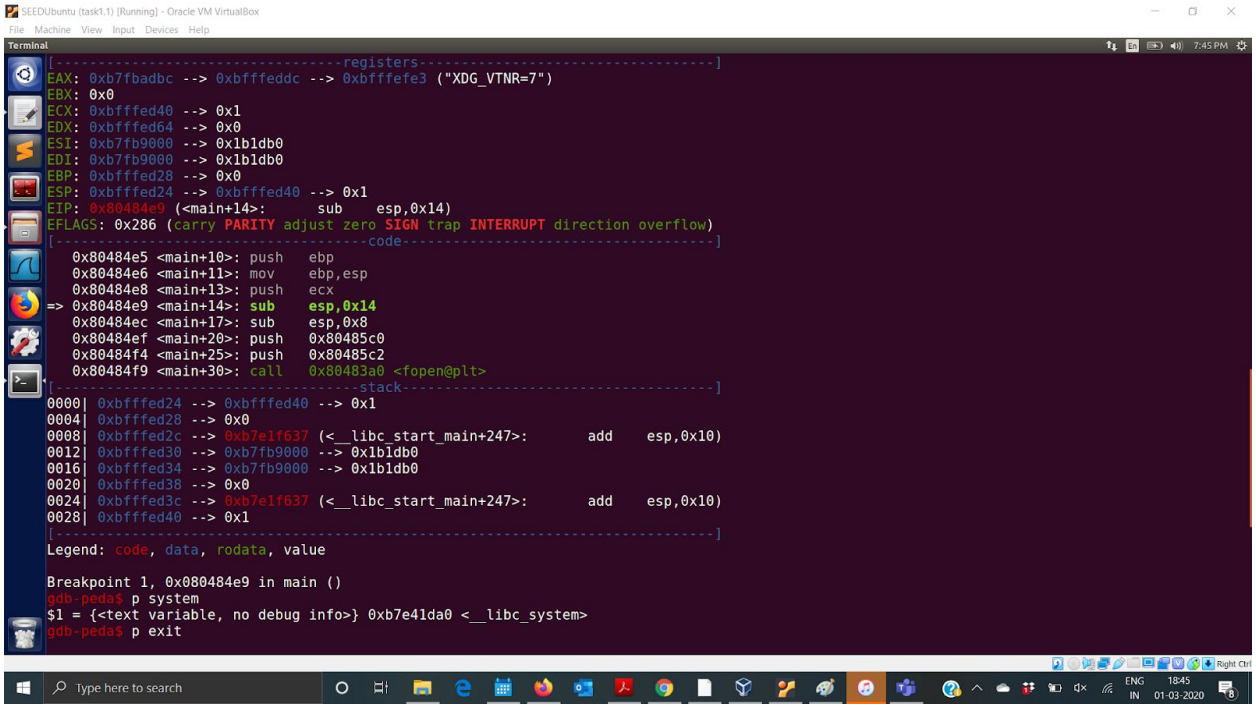
In this task we have to put the shell string into the memory. For this there are many strategies but we use methods that use environment variables. And the new shell variable MYSHELL, and let it contain the string "/bin/sh ". Shell actually spawns a child process to execute the program and verify this using grep command. The location of this variable in the memory can be found in the output of our program.

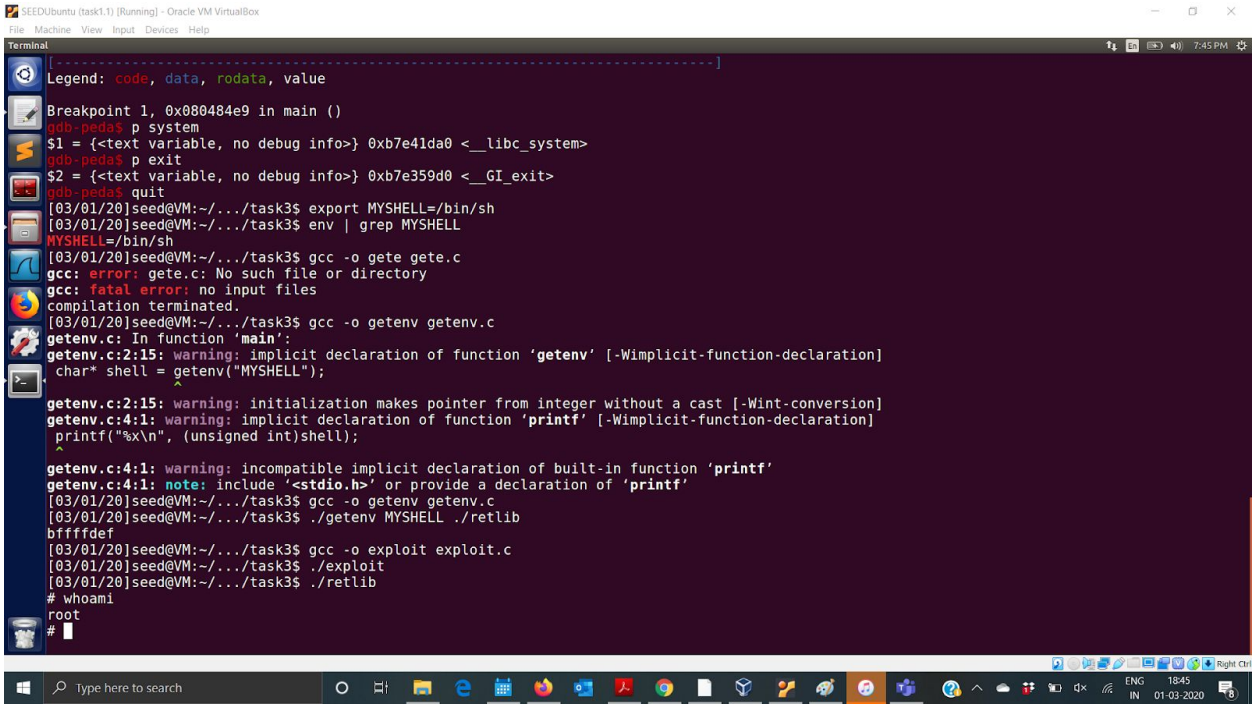


2.5 Task 3: Exploiting the Buffer-Overflow Vulnerability

First we need to turn off address randomization. Then /bin/sh symbolic link points to the /bin/dash shell. Then compile the code and turn it into a root-owned Set-UID program and include -fno-stack-protector option. Run gdb retlib. By running p system we get an address for system which is 0xb7e41da0 and for exit address is 0xb7e359d0. We then run the getenv.c program which provides us with a shell address. We include all these addresses in our exploit.c. we then compile and run exploit also run retlib. And we get access to the root.

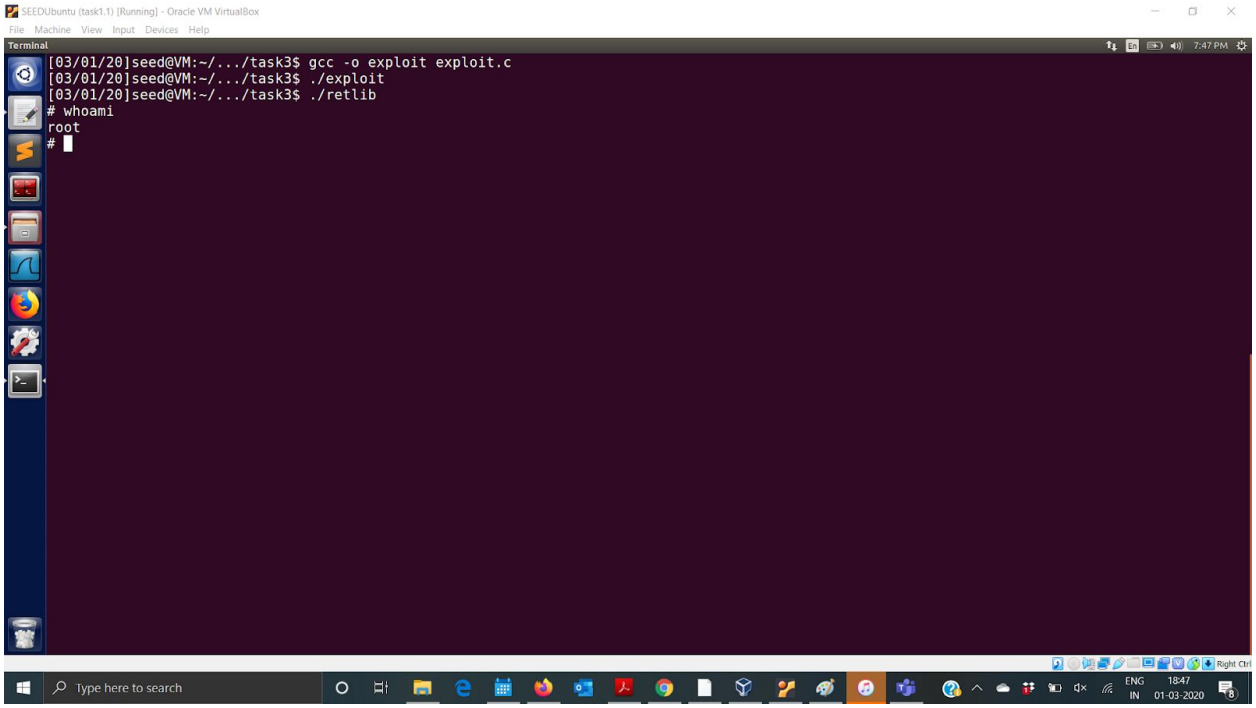

SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
7:45 PM
[03/01/20]seed@VM:~/.../task3$ sudo sysctl -w kernel.randomize_va_space=0
kernel.randomize_va_space = 0
[03/01/20]seed@VM:~/.../task3$ sudo rm /bin/sh
[03/01/20]seed@VM:~/.../task3$ sudo ln -s /bin/zsh /bin/sh
[03/01/20]seed@VM:~/.../task3$ sudo gcc -fno-stack-protector -z noexecstack -o retlib retlib.c
[03/01/20]seed@VM:~/.../task3$ sudo chown root retlib
[03/01/20]seed@VM:~/.../task3$ sudo chmod 4755 retlib
[03/01/20]seed@VM:~/.../task3$ gdb retlib
GNU gdb (Ubuntu 7.11.1-0ubuntu1~16.04) 7.11.1
Copyright (C) 2016 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law. Type "show copying"
and "show warranty" for details.
This GDB was configured as "i686-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from retlib...(no debugging symbols found)...done.
gdb-peda$ b main
Breakpoint 1 at 0x80484e9
gdb-peda$ r
Starting program: /home/seed/Documents/task3/retlib
Type here to search
ENG
IN
18:45
01-03-2020


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
7:45 PM
[----------registers----------]
EAX: 0xb7fbadbc --> 0xbfffeddc --> 0xbfffefe3 ("XDG_VTNR=7")
EBX: 0x0
ECX: 0xbfffed40 --> 0x1
EDX: 0xbfffed64 --> 0x0
ESI: 0xb7fb9000 --> 0x1b1db0
EDI: 0xb7fb9000 --> 0x1b1db0
EBP: 0xbfffed28 --> 0x0
ESP: 0xbfffed24 --> 0xbfffed40 --> 0x1
EIP: 0x80484e9 (<main+14>: sub esp,0x14)
EFLAGS: 0x286 (carry PARITY adjust zero SIGN trap INTERRUPT direction overflow)
[----------code----------]
0x80484e5 <main+10>: push ebp
0x80484e6 <main+11>: mov ebp,esp
0x80484e8 <main+13>: push ecx
=> 0x80484e9 <main+14>: sub esp,0x14
0x80484ec <main+17>: sub esp,0x8
0x80484ef <main+20>: push 0x80485c0
0x80484f4 <main+25>: push 0x80485c2
0x80484f9 <main+30>: call 0x80483a0 <fopen@plt>
[----------stack----------]
0000| 0xbfffed24 --> 0xbfffed40 --> 0x1
0004| 0xbfffed28 --> 0x0
0008| 0xbfffed2c --> 0xb7e1f637 (<__libc_start_main+247>: add esp,0x10)
0012| 0xbfffed30 --> 0xb7fb9000 --> 0x1b1db0
0016| 0xbfffed34 --> 0xb7fb9000 --> 0x1b1db0
0020| 0xbfffed38 --> 0x0
0024| 0xbfffed3c --> 0xb7e1f637 (<__libc_start_main+247>: add esp,0x10)
0028| 0xbfffed40 --> 0x1
[----------]
Legend: code, data, rodata, value
Breakpoint 1, 0x080484e9 in main ()
gdb-peda$ p system
$1 = {<text variable, no debug info>} 0xb7e41da0 <__libc_system>
gdb-peda$ p exit
Type here to search
ENG
IN
18:45
01-03-2020



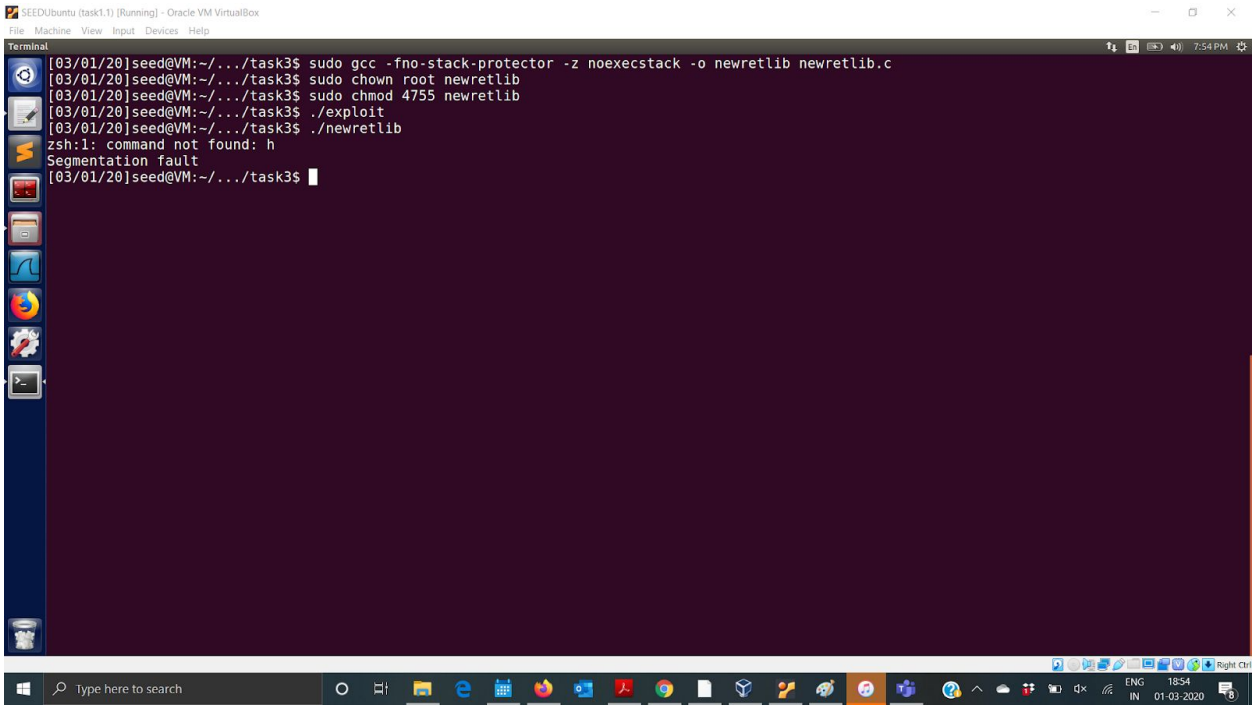
Variation 1

Address for exit is not necessary. Here we can still attack and we get access to shell.



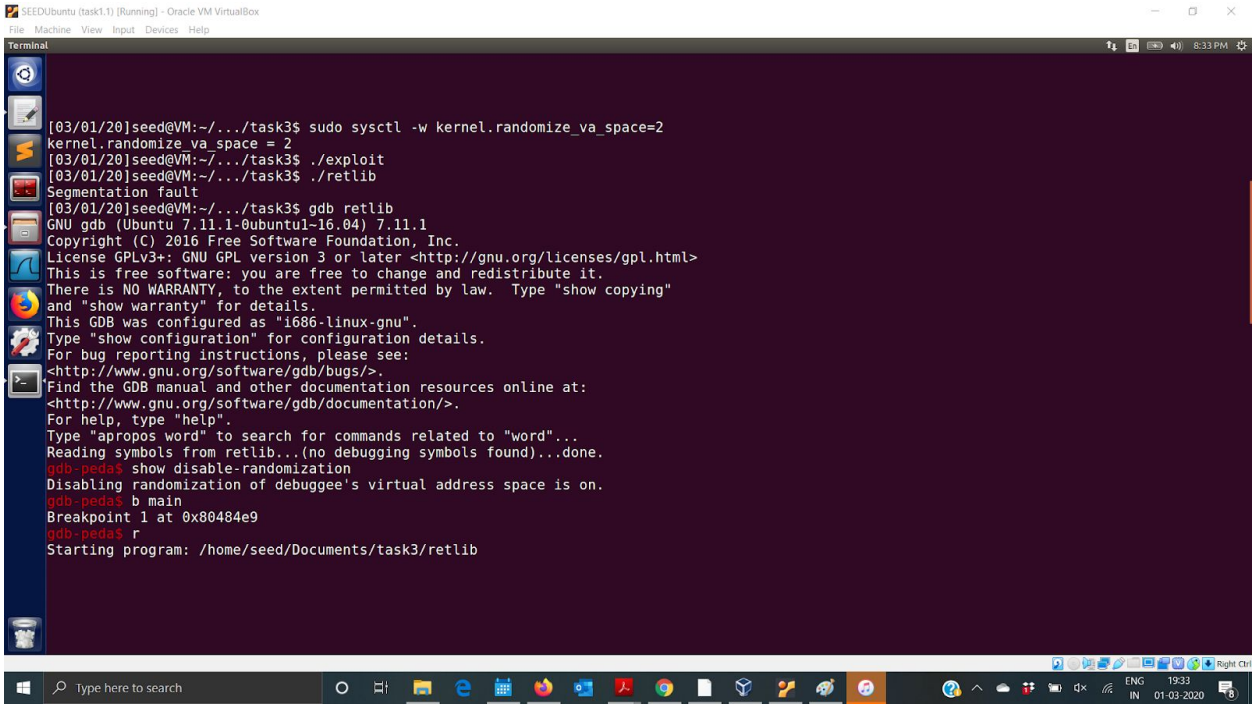
Attack variation 2

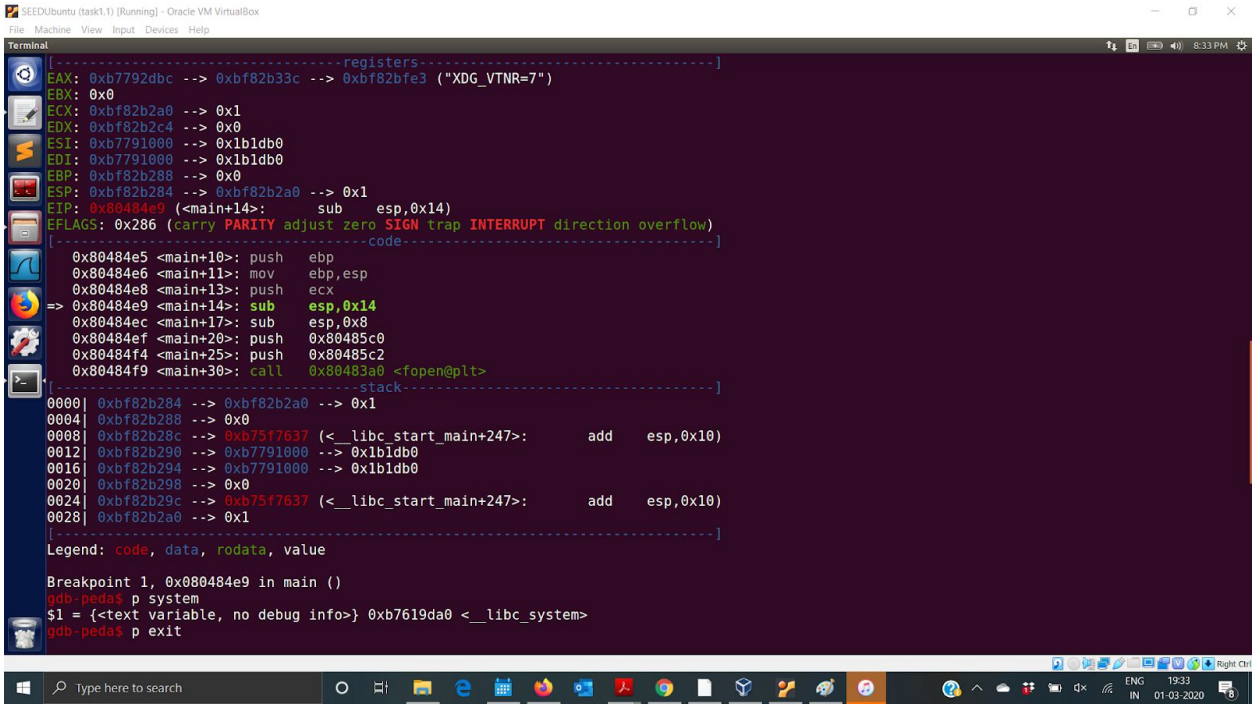
In this we need to change the name of the file to newretlib. Then give it root permission. Then run exploit and then run ./newretlib we get an error as zsh:1: command not found: h. The attack fails, this is because after changing the length of vulnerable program name, its length does not match with the name length of shell address finding program. Name length will affect the address of MYSHELL which means /bin/sh address in exploit.c is wrong now.

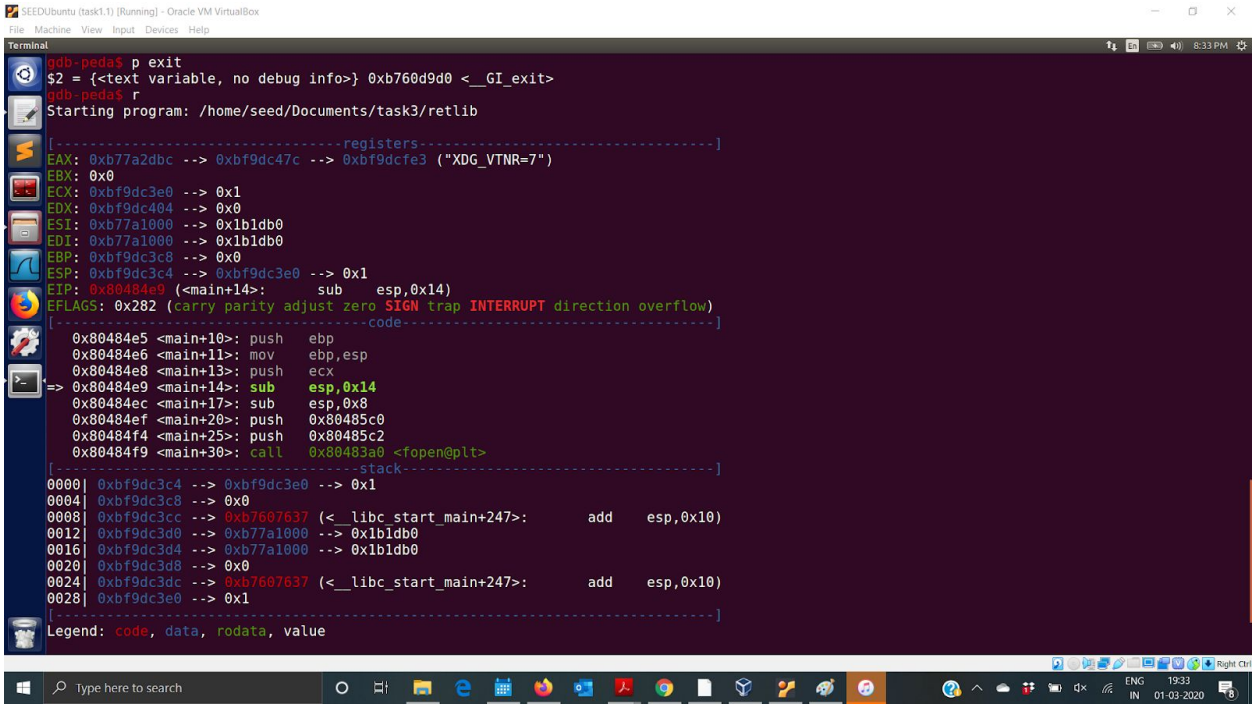


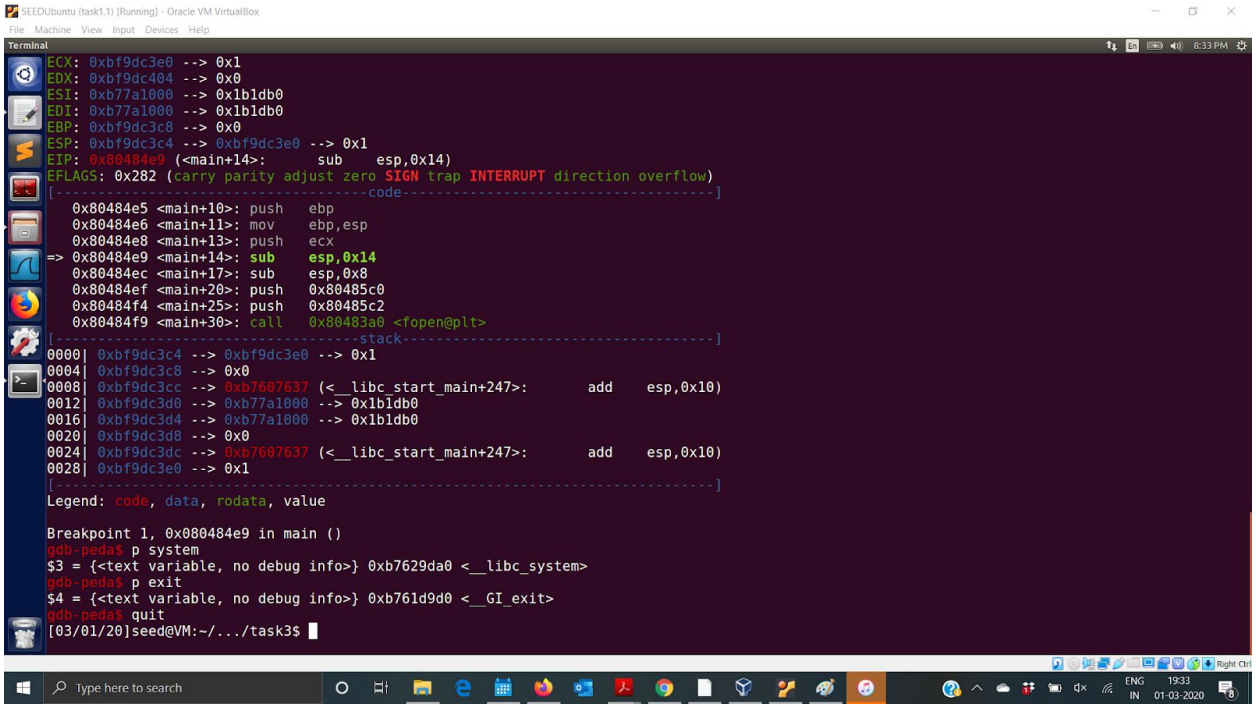
2.6 Task 4: Turning on Address Randomization

We first turn on the address randomization. We run the vulnerable program retlib.c and perform the same attack as previous task we get Segmentation fault. This is because the address of system() and exit() keeps on changing randomly. So the exact address cannot be predicted as the address keeps on changing. Therefore guessing the address probability becomes very less. And this acts as good protection. And in our screenshots we observe different addresses for system and exit each time we run the program.


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:33 PM
[03/01/20]seed@VM:~/.../task3$ sudo sysctl -w kernel.randomize_va_space=2
kernel.randomize_va_space = 2
[03/01/20]seed@VM:~/.../task3$ ./exploit
[03/01/20]seed@VM:~/.../task3$ ./retlib
Segmentation fault
[03/01/20]seed@VM:~/.../task3$ gdb retlib
GNU gdb (Ubuntu 7.11.1-0ubuntu1~16.04) 7.11.1
Copyright (C) 2016 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law. Type "show copying"
and "show warranty" for details.
This GDB was configured as "i686-linux-gnu".
Type "show configuration" for configuration details.
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>.
Find the GDB manual and other documentation resources online at:
<http://www.gnu.org/software/gdb/documentation/>.
For help, type "help".
Type "apropos word" to search for commands related to "word"...
Reading symbols from retlib...(no debugging symbols found)...done.
gdb-peda$ show disable-randomization
Disabling randomization of debuggee's virtual address space is on.
gdb-peda$ b main
Breakpoint 1 at 0x80484e9
gdb-peda$ r
Starting program: /home/seed/Documents/task3/retlib
Type here to search
ENG
IN
19:33
01-03-2020


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:33 PM
[----------registers----------]
EAX: 0xb7792dbc --> 0xbf82b33c --> 0xbf82bfe3 ("XDG_VTNR=7")
EBX: 0x0
ECX: 0xbf82b2a0 --> 0x1
EDX: 0xbf82b2c4 --> 0x0
ESI: 0xb7791000 --> 0x1b1db0
EDI: 0xb7791000 --> 0x1b1db0
EBP: 0xbf82b288 --> 0x0
ESP: 0xbf82b284 --> 0xbf82b2a0 --> 0x1
EIP: 0x80484e9 (<main+14>: sub esp,0x14)
EFLAGS: 0x286 (carry PARITY adjust zero SIGN trap INTERRUPT direction overflow)
[----------code----------]
0x80484e5 <main+10>: push ebp
0x80484e6 <main+11>: mov ebp,esp
0x80484e8 <main+13>: push ecx
=> 0x80484e9 <main+14>: sub esp,0x14
0x80484ec <main+17>: sub esp,0x8
0x80484ef <main+20>: push 0x80485c0
0x80484f4 <main+25>: push 0x80485c2
0x80484f9 <main+30>: call 0x80483a0 <fopen@plt>
[----------stack----------]
0000| 0xbf82b284 --> 0xbf82b2a0 --> 0x1
0004| 0xbf82b288 --> 0x0
0008| 0xbf82b28c --> 0xb75f7637 (<__libc_start_main+247>: add esp,0x10)
0012| 0xbf82b290 --> 0xb7791000 --> 0x1b1db0
0016| 0xbf82b294 --> 0xb7791000 --> 0x1b1db0
0020| 0xbf82b298 --> 0x0
0024| 0xbf82b29c --> 0xb75f7637 (<__libc_start_main+247>: add esp,0x10)
0028| 0xbf82b2a0 --> 0x1
[----------]
Legend: code, data, rodata, value
Breakpoint 1, 0x080484e9 in main ()
gdb-peda$ p system
$1 = {<text variable, no debug info>} 0xb7619da0 <__libc_system>
gdb-peda$ p exit
Type here to search
ENG
IN
19:33
01-03-2020


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:33 PM
gdb-peda$ p exit
$2 = {<text variable, no debug info>} 0xb760d9d0 <__GI_exit>
gdb-peda$ r
Starting program: /home/seed/Documents/task3/retlib
[----------registers----------]
EAX: 0xb77a2dbc --> 0xbf9dc47c --> 0xbf9dcfe3 ("XDG_VTNR=7")
EBX: 0x0
ECX: 0xbf9dc3e0 --> 0x1
EDX: 0xbf9dc404 --> 0x0
ESI: 0xb77a1000 --> 0x1b1db0
EDI: 0xb77a1000 --> 0x1b1db0
EBP: 0xbf9dc3c8 --> 0x0
ESP: 0xbf9dc3c4 --> 0xbf9dc3e0 --> 0x1
EIP: 0x80484e9 (<main+14>: sub esp,0x14)
EFLAGS: 0x282 (carry parity adjust zero SIGN trap INTERRUPT direction overflow)
[----------code----------]
0x80484e5 <main+10>: push ebp
0x80484e6 <main+11>: mov ebp,esp
0x80484e8 <main+13>: push ecx
=> 0x80484e9 <main+14>: sub esp,0x14
0x80484ec <main+17>: sub esp,0x8
0x80484ef <main+20>: push 0x80485c0
0x80484f4 <main+25>: push 0x80485c2
0x80484f9 <main+30>: call 0x80483a0 <fopen@plt>
[----------stack----------]
0000| 0xbf9dc3c4 --> 0xbf9dc3e0 --> 0x1
0004| 0xbf9dc3c8 --> 0x0
0008| 0xbf9dc3cc --> 0xb7607637 (<__libc_start_main+247>: add esp,0x10)
0012| 0xbf9dc3d0 --> 0xb77a1000 --> 0x1b1db0
0016| 0xbf9dc3d4 --> 0xb77a1000 --> 0x1b1db0
0020| 0xbf9dc3d8 --> 0x0
0024| 0xbf9dc3dc --> 0xb7607637 (<__libc_start_main+247>: add esp,0x10)
0028| 0xbf9dc3e0 --> 0x1
[----------]
Legend: code, data, rodata, value
Right Ctrl
Type here to search
ENG IN 19:33 01-03-2020


SEEDUbuntu (task1.1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Terminal
8:33 PM
ECX: 0xbf9dc3e0 --> 0x1
EDX: 0xbf9dc404 --> 0x0
ESI: 0xb77a1000 --> 0x1b1db0
EDI: 0xb77a1000 --> 0x1b1db0
EBP: 0xbf9dc3c8 --> 0x0
ESP: 0xbf9dc3c4 --> 0xbf9dc3e0 --> 0x1
EIP: 0x80484e9 (<main+14>: sub esp,0x14)
EFLAGS: 0x282 (carry parity adjust zero SIGN trap INTERRUPT direction overflow)
[----------code----------]
0x80484e5 <main+10>: push ebp
0x80484e6 <main+11>: mov ebp,esp
0x80484e8 <main+13>: push ecx
=> 0x80484e9 <main+14>: sub esp,0x14
0x80484ec <main+17>: sub esp,0x8
0x80484ef <main+20>: push 0x80485c0
0x80484f4 <main+25>: push 0x80485c2
0x80484f9 <main+30>: call 0x80483a0 <fopen@plt>
[----------stack----------]
0000| 0xbf9dc3c4 --> 0xbf9dc3e0 --> 0x1
0004| 0xbf9dc3c8 --> 0x0
0008| 0xbf9dc3cc --> 0xb7607637 (<__libc_start_main+247>: add esp,0x10)
0012| 0xbf9dc3d0 --> 0xb77a1000 --> 0x1b1db0
0016| 0xbf9dc3d4 --> 0xb77a1000 --> 0x1b1db0
0020| 0xbf9dc3d8 --> 0x0
0024| 0xbf9dc3dc --> 0xb7607637 (<__libc_start_main+247>: add esp,0x10)
0028| 0xbf9dc3e0 --> 0x1
[----------]
Legend: code, data, rodata, value
Breakpoint 1, 0x080484e9 in main ()
gdb-peda$ p system
$3 = {<text variable, no debug info>} 0xb7629da0 <__libc_system>
gdb-peda$ p exit
$4 = {<text variable, no debug info>} 0xb761d9d0 <__GI_exit>
gdb-peda$ quit
[03/01/20]seed@VM:~/.../task3$
Right Ctrl
Type here to search
ENG IN 19:33 01-03-2020

References

- https://github.com/Catalyzator/SEEDlab/blob/master/ReturnToLibc.pdf
- https://github.com/aasthayadav/CompSecAttackLabs/blob/master/3.%20Return-to-libc/Lab%203%20return-to-libc.pdf
- https://github.com/firmianay/Life-long-Learner/blob/master/SEED-labs/return-to-libc-attack-lab.md