PRACTICAL REVERSING VI - EXPLOIT DEVELOPMENT [ADVANCED]

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- Thanks to **ThoughtWorks** for the beautiful and bigger venue.

Reversing & Malware Analysis Training

This presentation is a part of our **Reverse Engineering & Malware Analysis** training program. Currently it is delivered only during our local meet for FREE of cost.

For complete details of this course, visit our Security Training page.

Who am I #1

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Agenda

- The material in this presentation is a bit complicated so I will be using the zig-zag approach.
  - Recap
  - Protections (GS and SAFESEH)
  - Client side exploits and Heap Spray
  - Protections (DEP)
  - Protections (ASLR)
- If time permits then few words on the following:
  - Heap buffer overflows

Recap

- In previous session we covered:
  - Stack based buffer overflow
    - EIP overwrite (saved return address)
    - SEH Overwrite
- We also discussed “why we need pop pop ret or other similar instruction in SEH overflow”
- Now Question: Which one is more reliable or considered to be more reliable in terms of exploitation ?
  - Consider we have overwritten EIP and SEH successfully.

Protections Enforced by OS and Processor

ASLR

DEP

SEHOP

GS Cookies

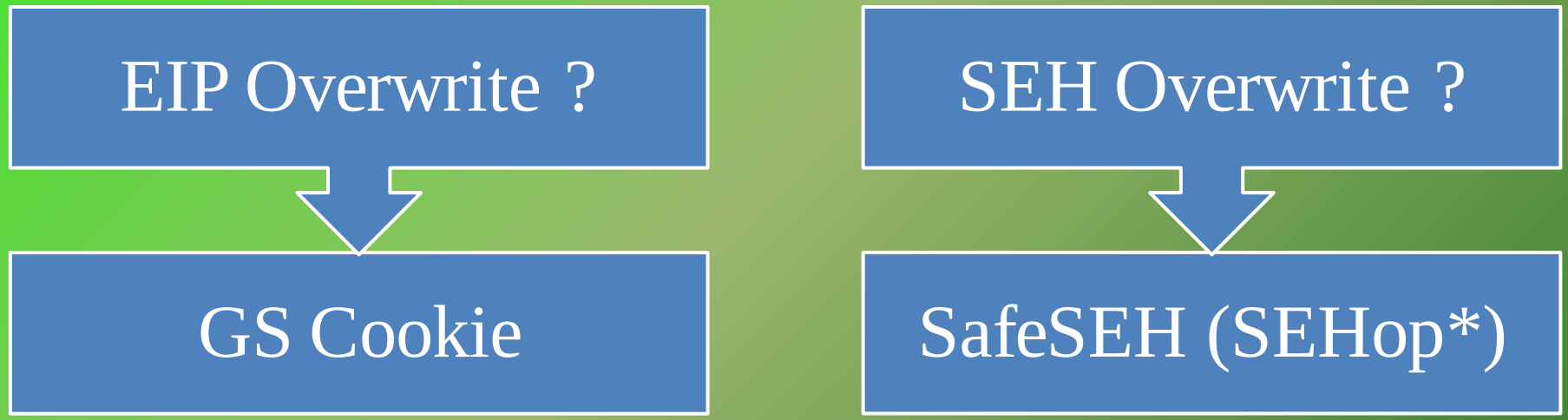
SAFESEH

Forced ASLR

*Safe unlinking, Heap cookies etc. are also protection methods added into the OS.

Protections for stack based buffer overflow (Primary)

- Fortunately or Unfortunately both protection schemes are based on compiler/Linker options.



- * SEHOP is a different protection scheme based on run time SEH chain validation, It is not based on compiler options however can be enabled or disabled through registry.

GS Cookie (/GS)

- Put some random value (cookie – 32 bit) on stack before return address.
- While returning, compare the value of saved cookie, if not same then we have an overwrite.
- Generate " Security Exception (if any)", terminate the Application.

/GS Cookie Cont...

Function Start:

```
mov     edi, edi
push    ebp
mov     ebp, esp
sub     esp, 0E0h
mov     eax, ___security_cookie
xor     eax, ebp        ; XOR Cookie with EBP
mov     [ebp+var_4], eax ; put on stack [ebp - 4]
mov     eax, [ebp+arg_4]
push    esi
```

Cookie check function (see “function end” in below picture.)

```
; __fastcall __security_check_cookie(x)
@__security_check_cookie@4 proc near
cmp     ecx, ___security_cookie
jnz     ___report_gsfailure
```

Function end:

```
mov     ecx, [ebp+var_4]
xor     ecx, ebp
pop     esi
call    @__security_check_cookie@4 ; __security_check_cookie(x)
leave
retn    0Ch
```

/GS Cookie Bypass

- Generate exception before cookie check
  - Code dependent – if some overwritten variables are used before function return.
  - Overwrite stack up to the end, further overwrite will generate exception
- Back to the question which exploitation (EIP or SEH) is more reliable ?
  - SEH method is considered to be a bit more safe and reliable regardless of this bypassing technique.

/GS Cookie Bypass Cont..

Leverage the implementation. Did you see something ?

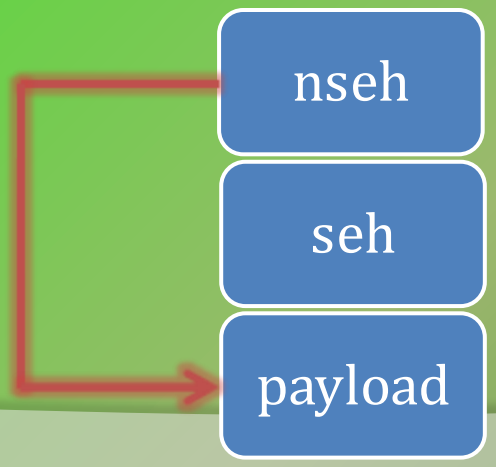
```
mov     dword_4AD24378, esi
mov     dword_4AD24374, edi
mov     word_4AD243A0, ss
mov     word_4AD24394, cs
mov     word_4AD24370, ds
mov     word_4AD2436C, es
mov     word_4AD24368, fs
mov     word_4AD24364, gs
pushf
pop     dword_4AD24398
mov     eax, [ebp+0]
mov     dword_4AD2438C, eax
mov     eax, [ebp+4]
mov     dword_4AD24390, eax
lea     eax, [ebp+arg_0]
mov     dword_4AD2439C, eax
mov     eax, [ebp+var_320]
mov     dword_4AD242D8, 10001h
mov     eax, dword_4AD24390
mov     dword_4AD24294, eax
mov     dword_4AD24288, 0C0000409h
mov     dword_4AD2428C, 1
mov     eax, ___security_cookie
mov     [ebp+var_328], eax
mov     eax, ___security_cookie_complement
mov     [ebp+var_324], eax
push    0               ; lpTopLevelExceptionFilter
call    ds:__imp__SetUnhandledExceptionFilter@4 ; SetUnhandledExceptionFilter(x)
push    offset ExceptionInfo ; ExceptionInfo
call    ds:__imp__UnhandledExceptionFilter@4 ; UnhandledExceptionFilter(x)
push    0C0000409h      ; uExitCode
call    ds:__imp__GetCurrentProcess@0 ; GetCurrentProcess()
push    eax             ; hProcess
call    ds:__imp__TerminateProcess@8 ; TerminateProcess(x,x)
leave
retn
```

SafeSEH

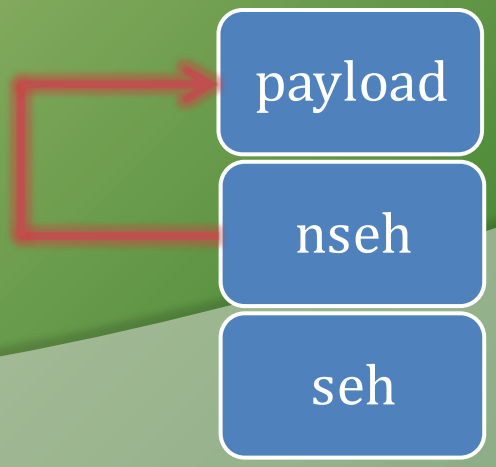
- Compiler [Linker] /SAFESEH option
- Static list of known good exception handlers for the binary.
- Checks every time when a handler is called against the static list, if not in the list then handler is invalid and takes preventive measures.
- Load configuration directory stores meta information about safe exception handlers.
- If any module is not compiled with /SAFESEH then no check is done to ensure the integrity of the handler for that module.

/SAFESEH Bypassing

- If any loaded module in the vulnerable binary is not /SAFESEH compiled then no check is done to ensure the integrity of the handler for that module, so we can use any p/p/r address from that module.
- Use the address that is outside the address range of loaded modules.
- Importance of forward and backward jump.



Forward jump



Backward jump

DEP (Data Execution Prevention)

- Two types:
  - Software DEP (forget it)
  - Hardware DEP (NX/XD enabled processors) – we will be talking about it in the rest of the session.
- We can't execute the code from non executable area anymore.
- We are directly dealing with processer in this case.

DEP (HW) Bypass

- ROP (Return Oriented Programming)
  - Use the system/existing code
  - How stack works ?
- Main theme
  - Either make non executable area executable
  - Or allocate new area with executable permissions
  - How ?
    - Well, use ROP ☺

Stack Heap Flipping (Stack Pivoting)

- I think this deserve a dedicated slide
- Depending on the conditions we may have large ROP payload while space on stack may be less or may be our entire payload is on heap.
- Flip the heap on to the stack so that we can get larger room.
- Instructions like XCHG ESP[REG], REG[ESP] can be used.
- We can also jump inside the valid instructions to change their meaning.
  - Example: jump one byte inside "**setz al**" instruction (From Adobe U3D exploit in wild)

DEP (HW) Bypass (DEMO)

- Methods
  - HeapCreate
  - VirtualAlloc
  - VirtualProtect
  - WriteProcessMemory (DEMO – simple, easy, demonstrate the entire concept – XpSp3)
- Often times the small code chunks in ROP are termed as "gadgets"

DEP (HW) Bypass (DEMO)

http://vimeo.com/49069964

ASLR

- Address Space Layout Randomization
- Involves randomly positioning the memory areas like base address of the binary, position of stack and heap.
- Compiler[linker] /DYNAMICBASE option

ASLR Bypass

- Search for Non-ASLR loaded libraries in the vulnerable application or if possible load one. ☺
  - JRE ?
- Memory leaks
- Brute force
- Heavily depends on vulnerability conditions

Client Side Exploits

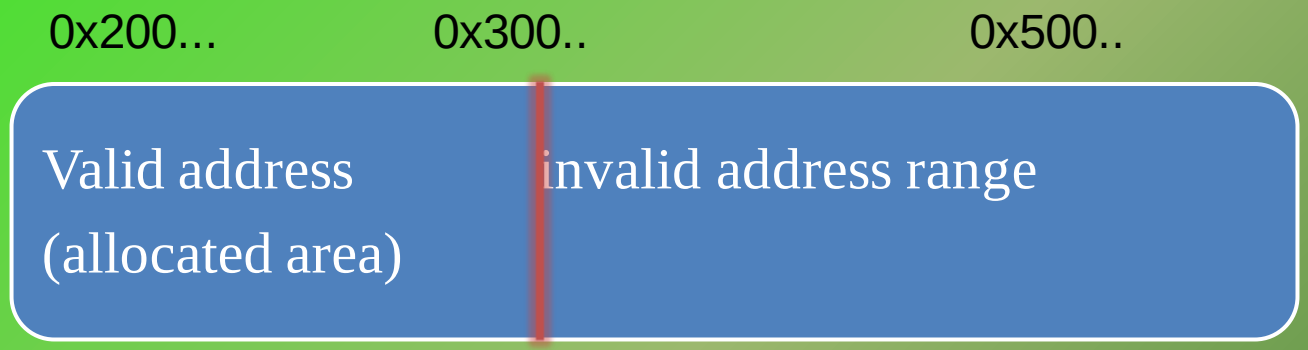
- Exploits that targets client applications like browsers, plugins, media players, readers etc.
- Much more dangerous then any other form of exploits
- Huge impact and landscape
- Provides solid infection vector
- Big malicious infrastructure.
  - Botnets, DDOS, Spam etc.

Heap Spray

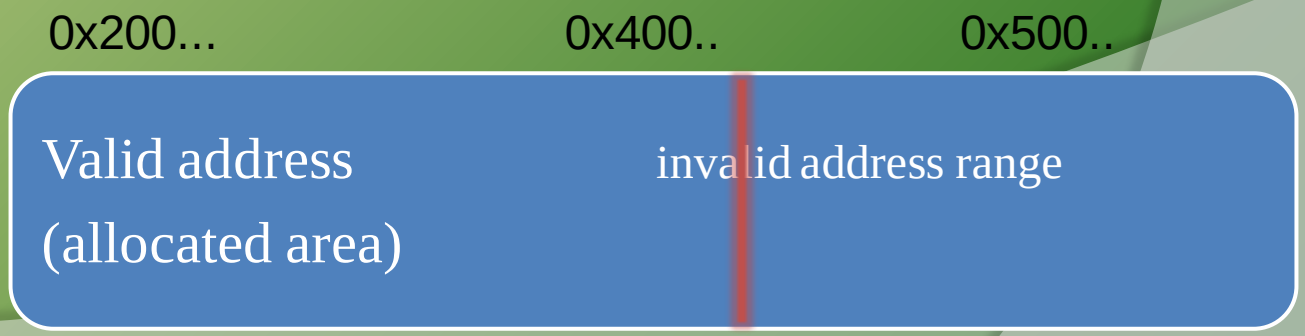
- A technique used in client side exploits
- IT'S NOT A VULNERABILITY or CLASS OF VUL.
- It's a technique used for code execution.
- Think about the followings again:
  - EIP overwrite
  - SEH overwrite
  - What we used in the above and why we used that ?
- Heap spray provides very simple method for code execution.

Heap Spray Cont...

- Fortunately or unfortunately client side scripting languages like javascript, vbscript etc. provides methods to allocate and deallocate memory on the client.
- Which means we can make invalid memory addresses valid.



Before Allocation



After Allocation (0x300.. To 0x400.. Is valid now)

Heap Spray Cont..

- Allocate memory and fill with nop + shellcode
- Overwrite the EIP or SEH with any address within the newly allocated area (the nop region).
- Here EIP overwrite or SEH overwrite can be by any means.
  - Stack buffer overflow, Heap buffer overflow, memory corruption, use after free etc..

Heap Spray (DEMO – IEPeers Vulnerability (IE6, IE7)

http://vimeo.com/49070337

Heap Spray (Stability Comments)

- Use intelligent guesses
- Stability depends on the exploitation conditions
- Fragmented heap, choose little higher addresses.
- Large number of allocations, choose little lower addresses ☺

Reference

- Complete Reference Guide for Reversing & Malware Analysis Training

Thank You !

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