introduction.md summary.md

Software ‘Security’ {

[Function Hooking]

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>

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}

basic-asm-title.md basic-asm-1.md

01 {

[Basic introduction to some Assembly concepts]

< All you need to understand
function hooking internal concepts >

}

Intel Assembly x86 < /1 > {

> Operands order:
> opcode destination, source
>
> Some instructions to know:
> JMP <relative address>
>
> NOP
>
> PUSH <register | address>
>
> POP <register | address>
>
> MOV <destination>, <source>

}

Register	Purpose
EAX	Accumulator register
ECX	Counter register
EDX	Data register
EBX	Base register
ESP	Stack pointer register
EBP	Stack base pointer register
ESI	Source index register
EDI	Destination index register

Intel Assembly x86 < /2 > {

> Assembly instructions are bytes array:
>
> JMP 0x40000 => 0xE9 0x00 0x00 0x00 0x40
>
> NOP => 0x90
>
> Each instruction have an RAM address (can be dynamic or static):
>
> ```
> Address   Bytes     Opcode
> ---------------------------
> 0x0400    55        push ebp
> 0x0401    8B EC     mov ebp, esp
> 0x0403    8B 45 08  mov eax, [ebp+08]
> 0x0406    03 C8     add ecx, eax
> ```

}

What is a function? < /3 > {

```c
int sum(int a, int b) {
    return a + b;
}
```

```
Address   Bytes     Opcode
──────────────────────────────────
0x0400    55        push ebp
0x0401    8B EC     mov ebp, esp
0x0403    8B 45 08  mov eax, [ebp+08] // a
0x0406    03 45 0C  add eax, [ebp+0C] // b
0x0409    5D        pop ebp
0x040A    C3        ret
```

}

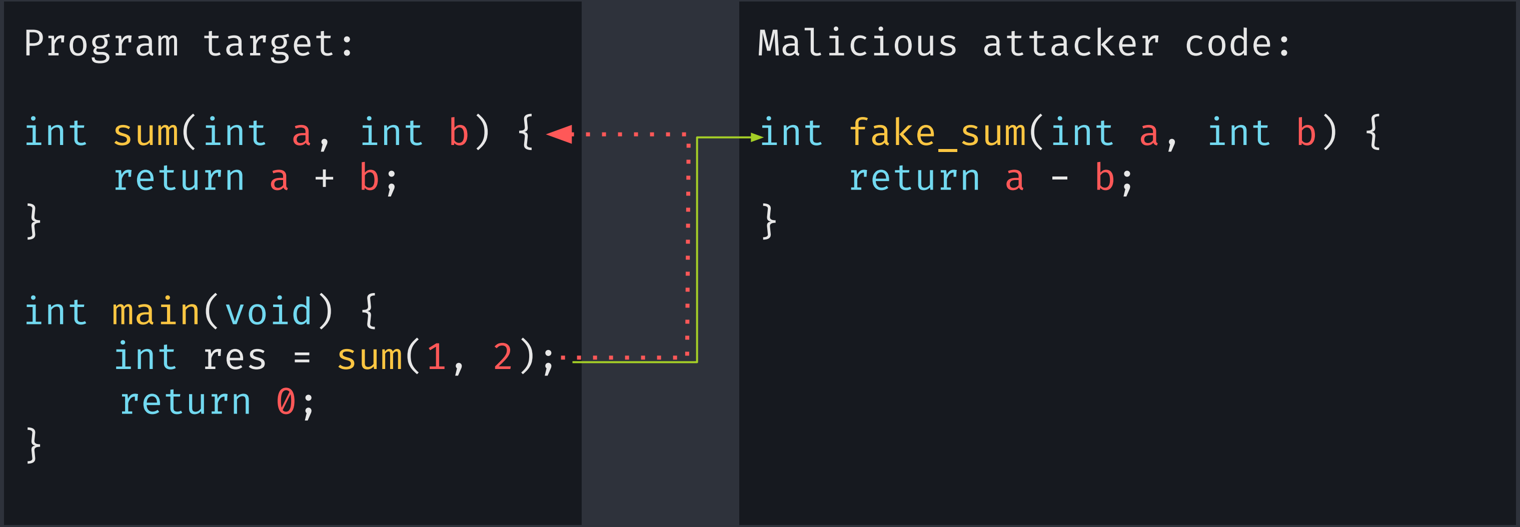
02 {

[The Function Hooking and Trampoline]

< The art of detouring a function >

}

What is a detour? < /1 > {



Program target:

```c
int sum(int a, int b) {
    return a + b;
}

int main(void) {
    int res = sum(1, 2);
    return 0;
}
```

Malicious attacker code:

```c
int fake_sum(int a, int b) {
    return a - b;
}
```

}

How to detour? < /2 > {

sum(int, int) function:

```
Address   Bytes      Opcode
0x0400    55         push ebp
0x0401    8B EC      mov ebp, esp
0x0403    8B 45 08   mov eax, [ebp+08] // a
0x0406    03 45 0C   add eax, [ebp+0C] // b
0x0409    5D         pop ebp
0x040A    C3         ret
```

fake_sum(int, int) function:

```
Address   Bytes      Opcode
0x0800    55         push ebp
0x0801    8B EC      mov ebp, esp
0x0803    8B 45 08   mov eax, [ebp+08] // a
0x0806    2B 45 0C   sub eax, [ebp+0C] // b
0x0809    5D         pop ebp
0x080A    C3         ret
```

Remember the JMP instruction: JMP <relative address>

}

How to detour? < /2 > {

sum(int, int) function:

```
Address   Bytes      Opcode
──────────────────────────────────────
0x0400    55         jmp fake_sum
0x0401    8B EC      mov ebp, esp
0x0403    8B 45 08   mov eax, [ebp+08] // a
0x0406    03 45 0C   add eax, [ebp+0C] // b
0x0409    5D         pop ebp
0x040A    C3         ret
```

fake_sum(int, int) function:

```
Address   Bytes      Opcode
──────────────────────────────────────
0x0800    55         push ebp
0x0801    8B EC      mov ebp, esp
0x0803    8B 45 08   mov eax, [ebp+08] // a
0x0806    2B 45 0C   sub eax, [ebp+0C] // b
0x0809    5D         pop ebp
0x080A    C3         ret
```

But the JMP instruction take 5 bytes:

```
JMP 0x40000 ⇒ 0xE9 0x00 0x00 0x00 0x40
```

}

How to detour? < /2 > {

sum(int, int) function:

Address	Bytes	Opcode
0x0400	E9 FB 03 00 00	jmp fake_sum
0x0405	08	? ?
0x0406	03 45 0C	add eax, ...
0x0409	5D	pop ebp
0x040A	C3	ret

fake_sum(int, int) function:

Address	Bytes	Opcode
0x0800	55	push ebp
0x0801	8B EC	mov ebp, esp
0x0803	8B 45 08	mov eax, [ebp+08] // a
0x0806	2B 45 0C	sub eax, [ebp+0C] // b
0x0809	5D	pop ebp
0x080A	C3	ret

The NOP instruction to the rescue!

}

How to detour? < /2 > {

sum(int, int) function:

```
Address   Bytes            Opcode
--------------------------------------------
0x0400    E9 FB 03 00 00   jmp fake_sum
0x0405    90               nop
0x0406    03 45 0C         add eax, ...
0x0409    5D               pop ebp
0x040A    C3               ret
```

fake_sum(int, int) function:

```
Address   Bytes      Opcode
------------------------------
0x0800    55         push ebp
0x0801    8B EC      mov ebp, esp
0x0803    8B 45 08   mov eax, [ebp+08] // a
0x0806    2B 45 0C   sub eax, [ebp+0C] // b
0x0809    5D         pop ebp
0x080A    C3         ret
```

Our hook is a success!

}

The detour method code < /3 > {

```
bool DetourFunction(void * src, void * dst, int len)
{
    if (len < 5) return false;

    memset(src, 0x90, len);

    uintptr_t relativeAddress = ((uintptr_t)dst - (uintptr_t)src) - 5;

    *(BYTE*)src = 0xE9;
    *(uintptr_t*)((uintptr_t)src + 1) = relativeAddress;

    return true;
}
```

}

But can we go further? < /4 > {

Main drawback: No longer access to the original function

Consequence: We can not make any pre/post patching

Pre-patching (args):

```c
int fake_function(int a) {
    a = a + 1;

    return original_func(a);
}
```

Post-patching (returned value):

```c
int fake_function(int a) {
    int res = original_func(a);

    return res - 1;
}
```

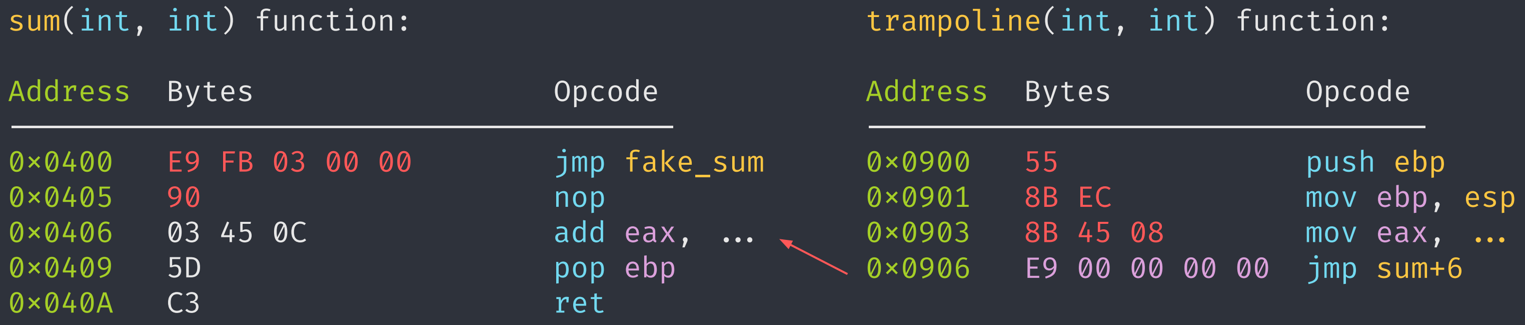
}

The trampoline solution < /5 > {

The solution: The trampoline!

}

What is a trampoline? < /6 > {



sum(int, int) function:

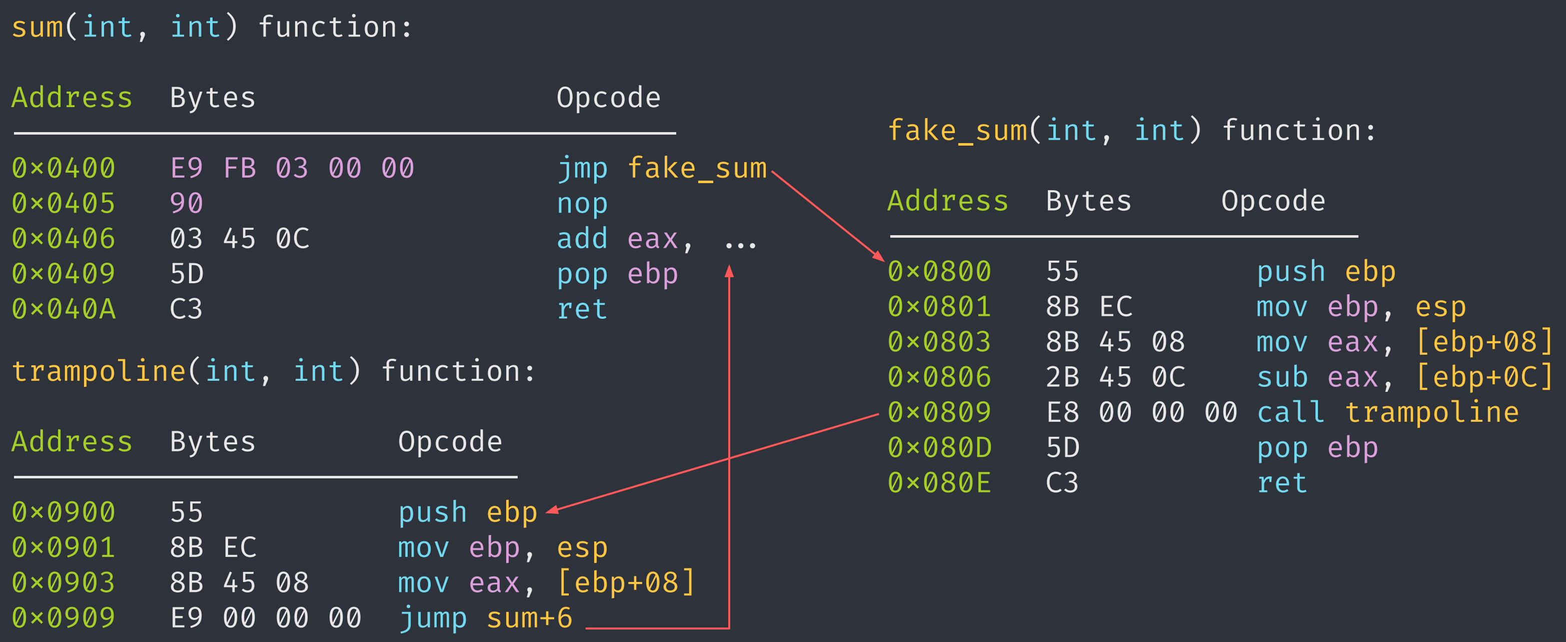
Address	Bytes	Opcode
0x0400	E9 FB 03 00 00	jmp fake_sum
0x0405	90	nop
0x0406	03 45 0C	add eax, ...
0x0409	5D	pop ebp
0x040A	C3	ret

trampoline(int, int) function:

Address	Bytes	Opcode
0x0900	55	push ebp
0x0901	8B EC	mov ebp, esp
0x0903	8B 45 08	mov eax, ...
0x0906	E9 00 00 00 00	jmp sum+6

}

What is a trampoline? < /6 > {



sum(int, int) function:

```
Address   Bytes             Opcode
---------------------------------------------
0×0400    E9 FB 03 00 00    jmp fake_sum
0×0405    90                nop
0×0406    03 45 0C          add eax, ...
0×0409    5D                pop ebp
0×040A    C3                ret
```

trampoline(int, int) function:

```
Address   Bytes         Opcode
--------------------------------------
0×0900    55            push ebp
0×0901    8B EC         mov ebp, esp
0×0903    8B 45 08      mov eax, [ebp+08]
0×0909    E9 00 00 00   jump sum+6
```

fake_sum(int, int) function:

```
Address   Bytes         Opcode
-----------------------------------------
0×0800    55            push ebp
0×0801    8B EC         mov ebp, esp
0×0803    8B 45 08      mov eax, [ebp+08]
0×0806    2B 45 0C      sub eax, [ebp+0C]
0×0809    E8 00 00 00   call trampoline
0×080D    5D            pop ebp
0×080E    C3            ret
```

}

The trampoline method code < /7 > {

```
char* TrampolineHook(char* src, char* dst, const intptr_t len)
{
      if (len < 5) return 0;

      void* gateway = VirtualAlloc(0, len + 5, MEM_COMMIT | MEM_RESERVE, PAGE_EXECUTE_READWRITE);

      memcpy(gateway, src, len);

      intptr_t  gatewayRelativeAddr = ((intptr_t)src - (intptr_t)gateway) - 5;
      *(char*)((intptr_t)gateway + len) = 0xE9;
      *(intptr_t*)((intptr_t)gateway + len + 1) = gatewayRelativeAddr;

      DetourFunction(src, dst, len);

      return (char*)gateway;
}
```

}

What the use of function hooking?

< /8 > {

A technique mostly used in game hacking:

- Can be used for man-in-the-middle (MITM) attacks
  - Listen to the send() and recv() functions

- Can be used for detouring graphic engines

- Can be used for patching any game function to change its behavior

}

Use case: send() and recv() MITM < /9 > {

In windows, two low-level functions are provided for sending/receiving data over a TCP connection:

```
ssize_t send(int s, const void *buf, size_t len, int flags);
ssize_t recv(int s, void *buf, ssize_t len, int flags);
```

We can hook those two functions to intercept all information exchanged between the game/program client and the game/program server.

By patching we can even change the contents sended or received by the game/program

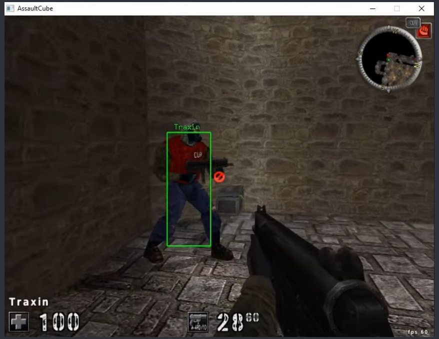
}

Use case: Graphic Engine

< /10 > {

For games, it is interesting to hook some engine functions to be able to add our own interface on top of the game for our malicious program.

For example with the engine OpenGL we can hook the function `wglSwapBuffers()` to add our own interface:



}

live-demo-title.md protection-title.md

03 {

[Live demonstration of trampoline hooking]

}

04 {

[Two methods to prevent function hooking]

< Just how to prevent from this nightmare ? >

}

protection-title.md protection-summary.md

Obfuscation / Packer < /1 > {

< Let's make the assembly code impossible to understand! >

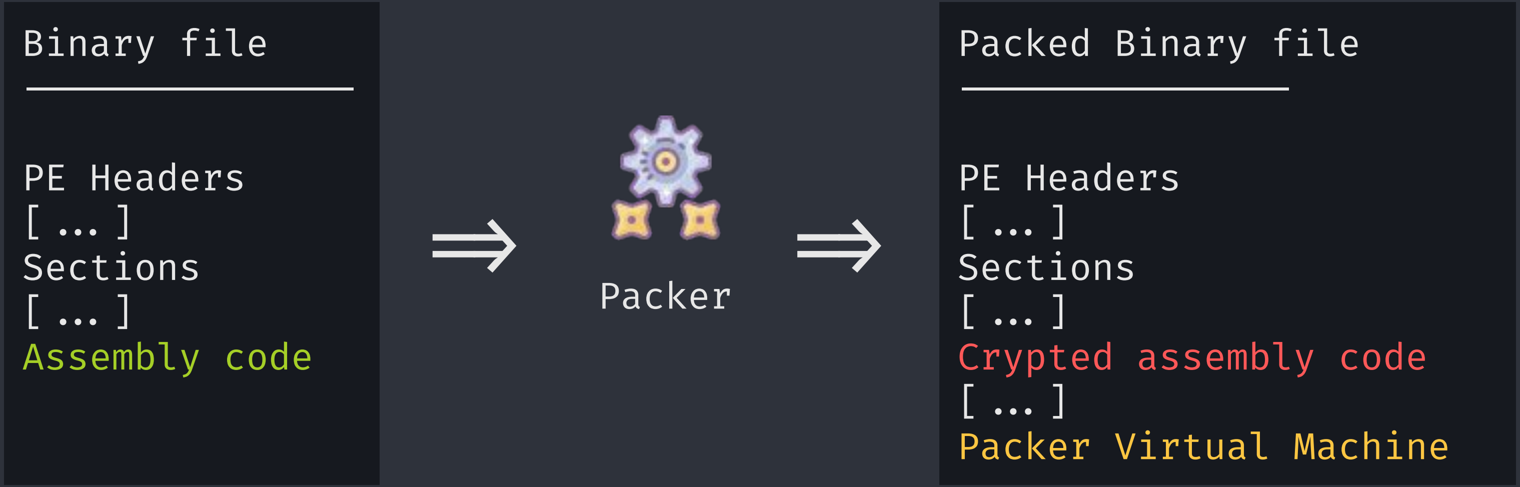
}

Memory fingerprint < /2 > {

< It is time to detect these unwanted changes! >

}

Obfuscation / Packer < /1 > {



Binary file

PE Headers
[…]
Sections
[…]
Assembly code

⇒ Packer ⇒

Packed Binary file

PE Headers
[…]
Sections
[…]
Crypted assembly code
[…]
Packer Virtual Machine

}

Obfuscation / Packer < /1 > {

Address	Bytes	Opcode
0×0400	55	push ebp
0×0401	8B EC	mov ebp, esp
0×0403	8B 45 08	mov eax, ebp
0×0406	03 C8	add ecx, eax

⇒

Address	Bytes	Opcode
0×0400	34	? ? ?
0×0401	22 01	? ? ?
0×0403	14 E5 B8	? ? ?
0×0406	75 F4	? ? ?

}

Memory fingerprint < /2 > {

```
Address   Bytes      Opcode
--------------------------------
0x0400    55         push ebp
0x0401    8B EC      mov ebp, esp
0x0403    8B 45 08   mov eax, [ebp+08]
0x0406    03 45 0C   add eax, [ebp+0C]
0x0409    5D         pop ebp
0x040A    C3         ret
```

Function payload: 55 8B EC 8B 45 08 03 45 0C 5D C3

}

Memory fingerprint < /2 > {

```
Address  Bytes     Opcode
──────────────────────────────────
0×0400   55        push ebp
0×0401   8B EC     mov ebp, esp
0×0403   8B 45 08  mov eax, [ebp+08]
0×0406   03 45 0C  add eax, [ebp+0C]
0×0409   5D        pop ebp
0×040A   C3        ret
```

```
SHA256(55 8B EC 8B 45 08 03 45 0C 5D C3) =

bd938e409fd7adea661f129903b0c423217965673832a58652967e992d90b850
```

}

Memory fingerprint < /2 > {

```
Address   Bytes            Opcode
────────────────────────────────────────────
0×0400    E9 E3 FF FF FF   jmp 00371000
0×0405    90               nop
0×0406    03 45 0C         add eax, [ebp+0C]
0×0409    5D               pop ebp
0×040A    C3               ret
```

```
SHA256(E9 E3 FF FF FF 90 03 45 0C 5D C3) =

e137dfc53100168f0aa460b2a9ae30db12c3ec49b577d41b5d4e2f44792c82fc
```

}

protection-packer.md protection-memory.md

Memory fingerprint < /2 > {

```
SHA256(55 8B EC 8B 45 08 03 45 0C 5D C3)
≠
SHA256(E9 E3 FF FF FF 90 03 45 0C 5D C3)

bd938e409fd7adea661f129903b0c423217965673832a58652967e992d90b850
≠
e137dfc53100168f0aa460b2a9ae30db12c3ec49b577d41b5d4e2f44792c82fc

Function tampering detected!
Result: Program execution aborted
```

}

conclusion-questions.md

Thanks; {

‘Do you have any questions?’

References used:
https://guidedhacking.com/threads/how-to-hook-functions-code-detouring-guide.14185/

http://jbremer.org/x86-api-hooking-demystified/

https://is.muni.cz/th/qe1y3/bk.pdf

Course + Demo: https://github.com/Astropilot/FunctionHookingCourse

}

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