Reverse 0x01

ss8651twtw

https://ppt.cc/fEhfpx

wget https://ppt.cc/fEhfpx

環境設定

Windows

- 下載安裝 virtualbox / vmware
- 下載 ubuntu / kali iso
- 安裝虛擬機

Linux / Mac

- 不用做事 (´･ω･`)
- 要裝 strace ltrace

懶人包

- 註冊 picoCTF 2018
- 直接用他的 Shell
- https://2018game.picoctf.com/shell

Basic

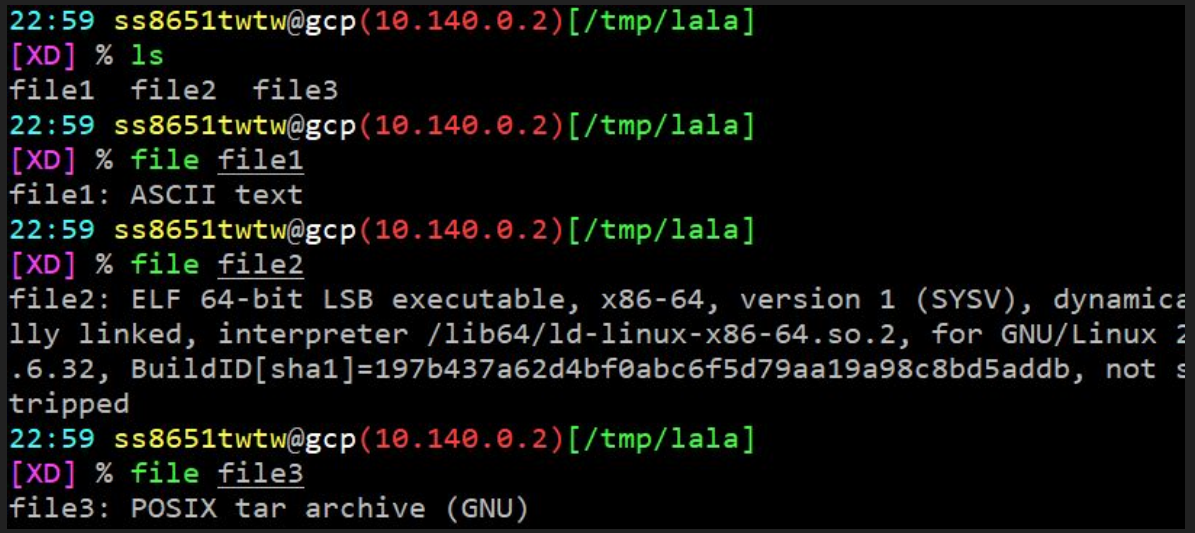
Outline

- 檔案類型
- 包含字串
- strace / ltrace
- objdump

檔案類型

$ file <something>

查看檔案類型



包含字串

$ strings <something>

印出檔案中的可視字串

$ strings -n <min-len> <something>

印出長度最短為 min-len 的可視字串

```
22:59 ss8651twtw@gcp(10.140.0.2)
[XD] % strings file2
/lib64/ld-linux-x86-64.so.2
{Czb
libc.so.6
fflush
exit
puts
__stack_chk_fail
putchar
printf
read
stdout
sleep
__libc_start_main
```

包含字串

$ strings <something> | grep "read"

在 strings 的結果中有包含 "read" 字串的結果

```
23:08 ss8651twtw@gcp(10.140.0.2)[/tmp/lala]
[XD] % strings file2 | grep "read"
read
read@@GLIBC_2.2.5
```

小練習

- EasyCTF IV
  - hexedit
- EasyCTF 2017
  - Hexable

strace / ltrace

$ strace <binary>

查看 binary 執行時的 system call 和 signal

$ ltrace <binary>

查看 binary 執行時的 library call

strace / ltrace

```
23:34 ss8651twtw@gcp(10.140.0.2)[/tmp/lala]
[XD] % strace ./file2
execve("./file2", ["./file2"], [/* 21 vars */]) = 0
brk(NULL)                                       = 0x1d99000
access("/etc/ld.so.nohwcap", F_OK)              = -1 ENOENT (No such file or
 directory)
access("/etc/ld.so.preload", R_OK)              = -1 ENOENT (No such file or
 directory)
openat(AT_FDCWD, "/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
fstat(3, {st_mode=S_IFREG|0644, st_size=185501, ...}) = 0
mmap(NULL, 185501, PROT_READ, MAP_PRIVATE, 3, 0) = 0x7fbfa7185000
close(3)                                        = 0
access("/etc/ld.so.nohwcap", F_OK)              = -1 ENOENT (No such file or
 directory)
```

strace / ltrace

```
23:35 ss8651twtw@gcp(10.140.0.2)[/tmp/lala]
[XD] % ltrace ./file2
__libc_start_main(0x400f72, 1, 0x7ffc831c64a8, 0x400fd0 <unfinished
...>
puts("ANGRMAN X"ANGRMAN X
)                          = 10
puts("1 GAME START"1 GAME START
)                         = 13
puts("2 PASS WORD"2 PASS WORD
)                          = 12
puts("3 EXIT GAME"3 EXIT GAME
)                          = 12
read(0a
, "a\n", 2)                              = 2
+++ exited (status 0) +++
```

小練習

- CSIE 2017
  - strace

objdump

$ objdump -M intel -d <binary>

以 intel 格式顯示 binary 反組譯的結果 (組合語言)

$ objdump -M intel -d <binary> | less

把輸出結果導向到 less 方便查詢閱讀

objdump

```
23:37 ss8651twtw@gcp(10.140.0.2)[/tmp/lala]
[XD] % objdump -M intel -d ./file2

./file2:     file format elf64-x86-64


Disassembly of section .init:

00000000004005b8 <_init>:
  4005b8:       48 83 ec 08             sub    rsp,0x8
  4005bc:       48 8b 05 35 1a 20 00    mov    rax,QWORD PTR [rip+0x
201a35]        # 601ff8 <__gmon_start__>
  4005c3:       48 85 c0                test   rax,rax
  4005c6:       74 05                   je     4005cd <_init+0x15>
  4005c8:       e8 b3 00 00 00          call   400680 <__gmon_start_
_@plt>
  4005cd:       48 83 c4 08             add    rsp,0x8
  4005d1:       c3                      ret

Disassembly of section .plt:
```

小練習

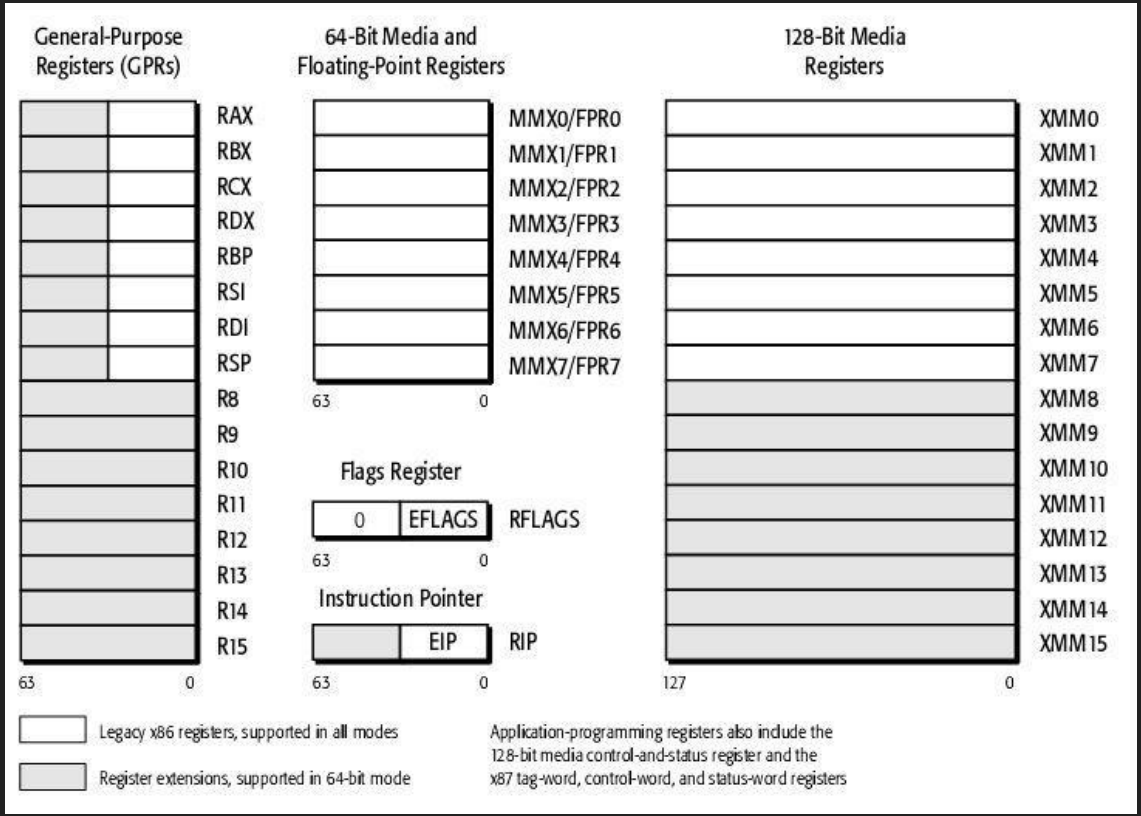
- Reverse CTF
  - find
  - search

組合語言

Outline

- 暫存器
- stack
- 組合語言指令
- 組合語言與 C 的轉換

暫存器

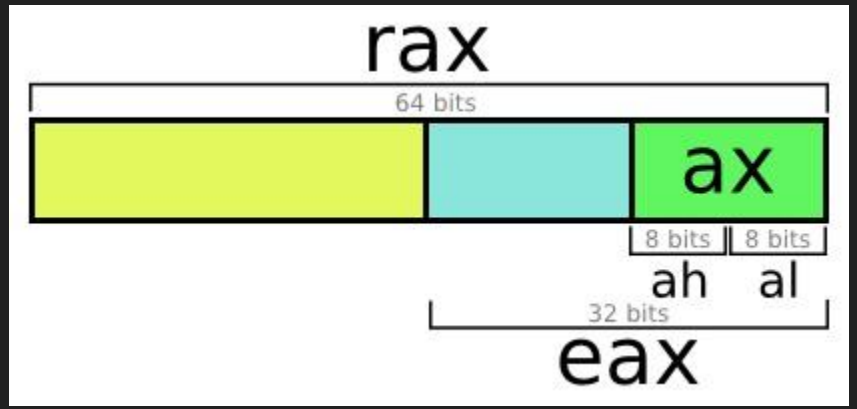

General-Purpose Registers (GPRs)
64-Bit Media and Floating-Point Registers
128-Bit Media Registers
RAX
RBX
RCX
RDX
RBP
RSI
RDI
RSP
R8
R9
R10
R11
R12
R13
R14
R15
MMX0/FPR0
MMX1/FPR1
MMX2/FPR2
MMX3/FPR3
MMX4/FPR4
MMX5/FPR5
MMX6/FPR6
MMX7/FPR7
XMM0
XMM1
XMM2
XMM3
XMM4
XMM5
XMM6
XMM7
XMM8
XMM9
XMM10
XMM11
XMM12
XMM13
XMM14
XMM15
63
0
Flags Register
0
EFLAGS
RFLAGS
Instruction Pointer
EIP
RIP
127
Legacy x86 registers, supported in all modes
Register extensions, supported in 64-bit mode
Application-programming registers also include the 128-bit media control-and-status register and the x87 tag-word, control-word, and status-word registers

暫存器

- rax - accumulator
- rbx - base
- rcx - count
- rdx - data
- rsi - source index
- rdi - destination index
- rbp - base pointer
- rsp - stack pointer

暫存器

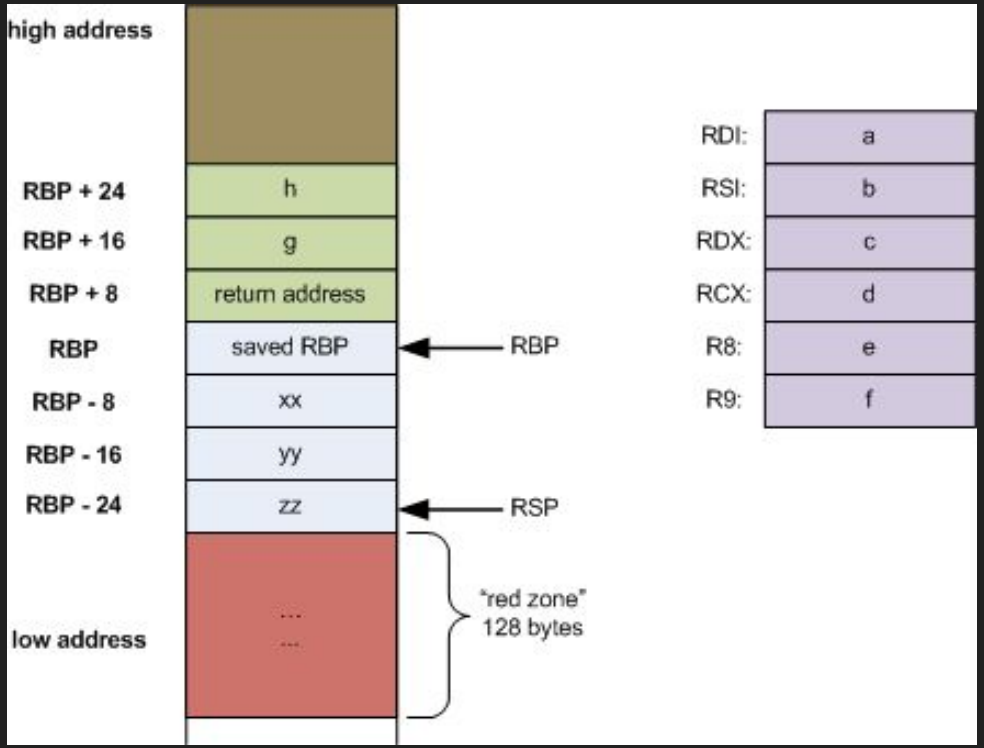
- r[a-d]x register layout



Stack

- rsp、rbp 所指向的記憶體間的空間
- 可以用來記錄
  - return address
  - local variable

Stack


high address
RBP + 24
h
RBP + 16
g
RBP + 8
return address
RBP
saved RBP
RBP
RBP - 8
xx
RBP - 16
yy
RBP - 24
zz
RSP
low address
...
...
"red zone"
128 bytes
RDI:
a
RSI:
b
RDX:
c
RCX:
d
R8:
e
R9:
f

組合語言指令

- **mov**
- syntax
  - mov dest, source
- example
  - mov rax, rbx // rax = rbx
  - mov rax, [rbp - 4] // rax = *(rbp - 4)
  - mov [rax], rbx // *rax = rbx

組合語言指令

- **add、sub、imul、idiv、and、or、xor**
- syntax
  - add dest, source
- example
  - sub rbx, [rbp - 4] // rbx = rbx - *(rbp - 4)
  - mul rcx, 2 // rcx = rcx * 2
  - xor [rsp], rax // *rsp = (*rsp) ^ rax

組合語言指令

- **inc、dec、neg、not**
- syntax
  - inc dest
- example
  - dec rbx // rbx = rbx - 1
  - neg rcx // rcx = -rcx
  - not byte [rsp] // convert [rsp] to byte
    *rsp = ~(*rsp)

組合語言指令

- **if dest is memory access and source is not register, need to specify the dest's type**
- example
  - mov **byte** [rcx], 0x61 // byte = 8 bits
  - mul **word** [rax], 0x87 // word = 2 bytes
  - inc **dword** [rbp] // dword = 2 words
  - not **qword** [rsp] // qword = 2 dwords

組合語言指令

- dest and source must be the **same type**
- rip could NOT be dest

組合語言指令

- **cmp**
- syntax
  - cmp value1, value2
- example
  - cmp rax, 5 // compare the values and set the flag
  - cmp rbx, rcx
  - cmp word [rsp], 0x1234

組合語言指令

- **jmp**
- syntax
  - jmp label
- example
  - loop: // set a label
  - ; do something
  - jmp loop // jump to loop label

組合語言指令

- **ja、jb、jna、jbe、je、jne、jz**
- syntax
  - ja label
- example
  - cmp rax, 10 // compare the values and set flag
  - je quit // check flag if equal jump to quit

http://www.felixcloutier.com/x86/Jcc.html

小練習

- picoCTF 2017
  - Programmers Assemble
  - 題目為 AT&T 格式
  - 可參考下一頁 Intel 格式的題目

小練習

```
.global main

main:
    mov eax, XXXXXXX
    mov ebx, 0
    mov ecx, 0x5
```

```
loop:
    test eax, eax
    jz fin
    add ebx, ecx
    dec eax
    jmp loop
```

```
fin:
    cmp ebx, 0x7ee0
    je good
    mov eax, 0
    jmp end
good:
    mov eax, 1
end:
    ret
```

小練習

eax = xxxxxxx

ebx = 0

ecx = 5

```
while (eax != 0) {
    ebx += ecx
    eax--
}
```

```
if (ebx == 0x7ee0) {
    // good
    eax = 1
    return
}
else {
    eax = 0
    return
```

組合語言指令

- **push、pop**
- syntax
  - push source
  - pop dest
- example
  - push rax
  - push 0
  - pop rcx
  - pop word [rbx]

組合語言指令

- **push rax**
- push 0
- pop rcx
- pop word [rbx]

rax = 0x6161
rbx = 0x601000
rcx = 0x1234

組合語言指令

- push rax
- **push 0**
- pop rcx
- pop word [rbx]

rax = 0x6161
rbx = 0x601000
rcx = 0x1234

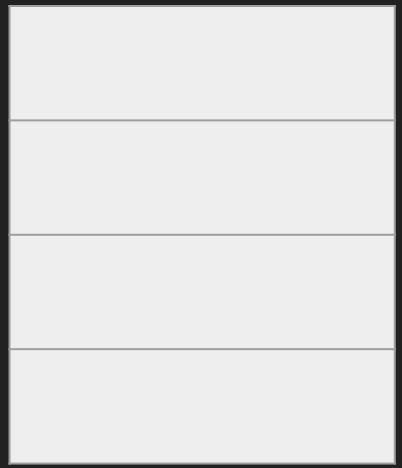
組合語言指令

- push rax
- push 0
- **pop rcx**
- pop word [rbx]

rax = 0x6161
rbx = 0x601000
rcx = 0

組合語言指令

- push rax
- push 0
- pop rcx
- **pop word [rbx]**



rax = 0x6161
rbx = 0x601000
rcx = 0
***(0x601000) = 0x6161**

小練習

- picoCTF 2017
  - A Thing Called the Stack
  - 題目為 AT&T 格式
  - 可參考下一頁 Intel 格式的題目

小練習

```
foo:
    push ebp
    mov ebp, esp
    push edi
    push esi
    push ebx
    sub esp, 0xf4
```

```
mov dword [esp], 0x1
mov dword [esp + 0x4], 0x2
mov dword [esp + 0x8], 0x3
mov dword [esp + 0xc], 0x4
```

組合語言指令

- **syscall**
- syntax
  - syscall
- example

%rax	System call	%rdi	%rsi	%rdx
0	sys_read	unsigned int fd	char *buf	size_t count
1	sys_write	unsigned int fd	const char *buf	size_t count
2	sys_open	const char *filename	int flags	int mode

http://blog.rchapman.org/posts/Linux_System_Call_Table_for_x86_64/

組合語言與 C 的轉換

- conditional statement

```
if (rax < 5) {
  // do something
}
else if (rax >= 5 && rax < 10) {
  // do something
}
else {
  // do something
}
```

組合語言與 C 的轉換

- conditional statement

```
cmp rax, 5
jae Lelseif
; do something
jmp Lend
Lelseif:
cmp rax, 10
jae Lelse
; do something
jmp Lend
Lelse:
; do something
Lend:
```

組合語言與 C 的轉換

- loop

```c
for (int i = 0; i < 10; i++) {
  // do something
}
```

組合語言與 C 的轉換

- loop

```
mov rcx, 0
Lloop:
cmp rcx, 10
jae Lend
; do something
inc rcx
jmp Lloop
Lend:
```

組合語言與 C 的轉換

- **function**
- parameter passing
  - rdi、rsi、rdx、rcx、r8、r9、push stack

```
int foo(int a, int b, int c, int d, int e, int f, int g)
        rdi    rsi    rdx    rcx    r8     r9     stack
```

組合語言與 C 的轉換

- function

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

int main() {
  int a = 1, b = 2;
  foo(a, b);
}
```

組合語言與 C 的轉換

- function

```
foo:
push   rbp
mov    rbp,rsp
mov    DWORD PTR [rbp-0x4],edi
mov    DWORD PTR [rbp-0x8],esi
mov    edx,DWORD PTR [rbp-0x4]
mov    eax,DWORD PTR [rbp-0x8]
add    eax,edx
mov    rsp, rbp
pop    rbp
ret
```

```
main:
push   rbp
mov    rbp,rsp
sub    rsp,0x10
mov    DWORD PTR [rbp-0x8],0x1
mov    DWORD PTR [rbp-0x4],0x2
mov    edx,DWORD PTR [rbp-0x4]
mov    eax,DWORD PTR [rbp-0x8]
mov    esi,edx
mov    edi,eax
call   660 <foo>
mov    eax,0x0
leave
ret
```

Thanks for listening!