

2025.09.19

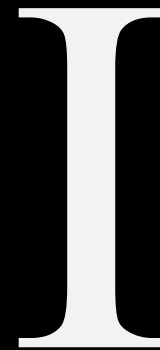
ROP

가디언 시스템 보안 & 취약점 분석 세미나 2.2

임준서

Security Mitigations

ASLR, PIE, NX, RELRO, CANRY



Security Mitigation

Summary

ASLR: stack 아무데나

Always on. Address Space Layout Randomization

NX: stack에서 shellcode 금지

No eXecute

PIE: .text 아무데나

Position Independent Executables

Security Mitigation

Summary

RELRO: .got overwrite 금지

RELocation Read-Only. 그리고 정확히는 Full RELRO

Canary: 스택에 parity 추가

Therefore, BOF 하다가 parity 건드리면 프로그램 터짐

Windows, Stack Cookie. Linux, Stack Canary

[카나리아] 또는 [카나리] 라고 읽는다

Security Mitigation

ASLR

Address Space Layout Randomization

Security Mitigation

NX

No-eXecute

Security Mitigation

PIE

Position Independent Executables

Security Mitigation

RELRO

RELocation Read-Only

Security Mitigation

Canary

Stack Smashing Protection

Security Mitigation

Canary

stack에 검증 값 삽입

return 과정에서 확인

틀리면 터짐

stack smashing detected!

첫번째 값은 \x00으로 고정. (출력 방지용)

Security Mitigation

NX

Ret2ShellCode는 NX 옵션에서 불가

대부분 NX on

ROP

Ret2_____

II

Return Oriented Programming

a.k.a. ROP

Somewhere in the code ...

(0x00400700)

pop rdi;

ret;

(0x00400900)

call system;

ret;

Ret2ShellCode

pop 하고 ret 하는 코드
조각을 사용하자!

RBP

$\text{RBP} - 0x20 = \text{RSP}$

Prog. Stack

Call sys

bin/sh

pop %rdi

Return Addr

retq

SPO

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

Buffer [0x20]

AAAAAAAA

ROP

ReturnOrientedProgramming

pop ____; ret;

코드 조각들을 모아 조작

RBP

$\text{RBP} - 0x20 = \text{RSP}$

Prog. Stack

00400900

/sh addr

Return Addr

00400700

SPO

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

Buffer [0x20]

AAAAAAAA

ROP

Return Oriented Programming

ROP에 쓰이는 코드조각을
gadget이라 한다.

RBP

$RBP - 0x20 = RSP$

Prog. Stack

00400900

/sh addr

Return Addr 00400700

SPO **AAAAAAAA**

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

Buffer [0x20] AAAAAAAAAA

도구라는 뜻임

ROP

ReturnOrientedProgramming

call read

8

pop rdx; ret;

addr of GOT

pop rsi; ret

0

pop rdi;ret;

RBP

$\text{RBP} - 0x20 = \text{RSP}$

Prog. Stack

...

pop %rdi

Return Addr

retq

SPO

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

Buffer [0x20]

AAAAAAAA

ROP

ReturnOrientedProgramming

call read

8

pop rdx; ret;

addr of GOT

pop rsi; ret

0

pop rdi;ret;

read(0, GOT, 8);

$RBP - 0x20 = RSP$

RBP

Prog. Stack

...

pop %rdi

Return Addr

retq

SPO

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

AAAAAAAA

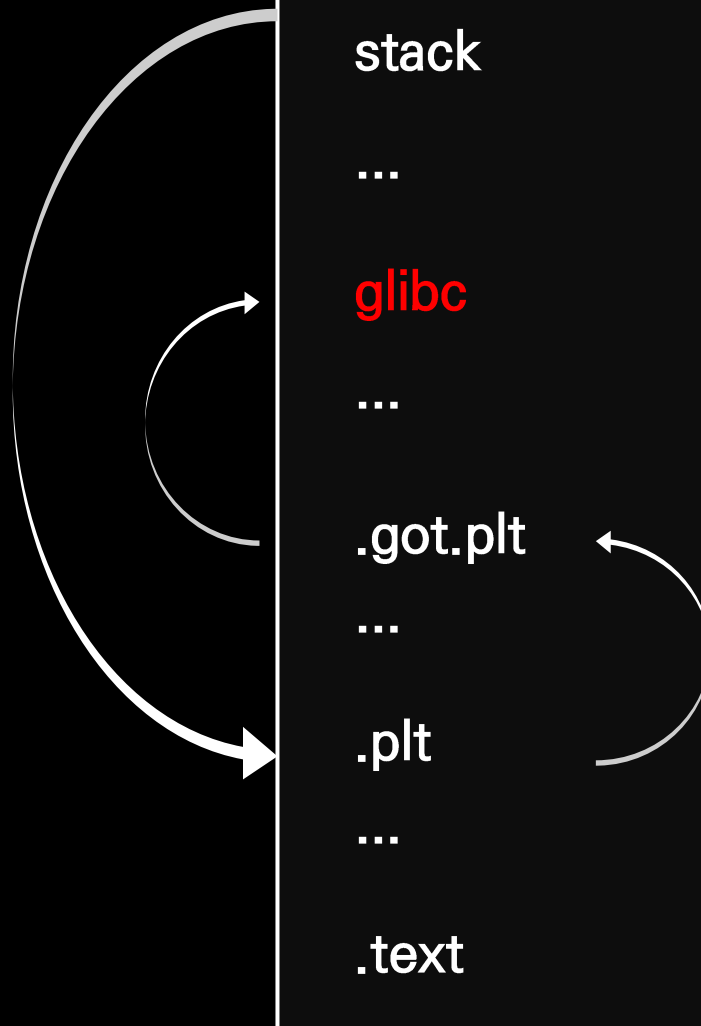
AAAAAAAA

Buffer [0x20]

AAAAAAAA

Library

Memory



glibc의 위치는 매번 바뀜 (ASLR...)
단, 하위 12비트(3글자)는 고정.

Library

```
.plt:0000000000400620
.plt:0000000000400620 ; int puts(const char *s)
.plt:0000000000400620 _puts          proc near          ; CODE XREF: main+41↓p
.plt:0000000000400620                jmp          cs:off_601018
.plt:0000000000400620 _puts          endp
.plt:0000000000400620
.plt:0000000000400626 ; -----
.plt:0000000000400626                push         0
.plt:000000000040062B                jmp          sub_400610
.plt:0000000000400630
.plt:0000000000400630 ; ===== S U B R O U T I N E =====
.plt:0000000000400630 ; Attributes: thunk
.plt:0000000000400630 ; size_t fread(void *ptr, size_t size, size_t n, FILE *stream)
.plt:0000000000400630 _fread         proc near          ; CODE XREF: main+C1↓p
.plt:0000000000400630                jmp          cs:off_601020
.plt:0000000000400630 _fread         endp
.plt:0000000000400630
.plt:0000000000400636 ; -----
.plt:0000000000400636                push         1
.plt:000000000040063B                jmp          sub_400610
.plt:0000000000400640
.plt:0000000000400640 ; ===== S U B R O U T I N E =====
.plt:0000000000400640 ; Attributes: thunk
.plt:0000000000400640 ; int fclose(FILE *stream)
.plt:0000000000400640 _fclose        proc near          ; CODE XREF: main+D0↓p
.plt:0000000000400640                jmp          cs:off_601028
.plt:0000000000400640 _fclose        endp
.plt:0000000000400640
.plt:0000000000400646 ; -----
```

Library

```
.got.plt:0000000000601000 ; =====
.got.plt:0000000000601000
.got.plt:0000000000601000 ; Segment type: Pure data
.got.plt:0000000000601000 ; Segment permissions: Read/Write
.got.plt:0000000000601000 _got_plt      segment qword public 'DATA' use64
.got.plt:0000000000601000                assume cs:_got_plt
.got.plt:0000000000601000                ;org 601000h
.got.plt:0000000000601000 _GLOBAL_OFFSET_TABLE_ dq offset _DYNAMIC
.got.plt:0000000000601008 qword_601008    dq 0 ; DATA XREF: sub_400610↑r
.got.plt:0000000000601010 qword_601010    dq 0 ; DATA XREF: sub_400610+6↑r
.got.plt:0000000000601018 off_601018     dq offset puts ; DATA XREF: _puts↑r
.got.plt:0000000000601020 off_601020     dq offset fread ; DATA XREF: _fread↑r
.got.plt:0000000000601028 off_601028     dq offset fclose ; DATA XREF: _fclose↑r
.got.plt:0000000000601030 off_601030     dq offset __stack_chk_fail
.got.plt:0000000000601030                ; DATA XREF: __stack_chk_fail↑r
.got.plt:0000000000601038 off_601038     dq offset printf ; DATA XREF: _printf↑r
.got.plt:0000000000601040 off_601040     dq offset __libc_start_main
.got.plt:0000000000601040                ; DATA XREF: __libc_start_main↑r
.got.plt:0000000000601048 off_601048     dq offset ftell ; DATA XREF: _ftell↑r
.got.plt:0000000000601050 off_601050     dq offset fseek ; DATA XREF: _fseek↑r
.got.plt:0000000000601058 off_601058     dq offset fopen ; DATA XREF: _fopen↑r
.got.plt:0000000000601060 off_601060     dq offset fwrite ; DATA XREF: _fwrite↑r
.got.plt:0000000000601060 _got_plt      ends
```

ROP

GOT Overwrite

Read 호출 → PLT 호출

Procedure Linkage Table

read의 GOT 확인

system으로 overwrite

Read 실행 = system 호출

잘못 조작하면 프로그램 터짐

heap 조작으로 AAR/AAW할 때도 종종 쓰임

Security Mitigation

RELRO

RELocation Read-Only

No RELRO

PARTIAL RELRO

FULL RELRO

실습 [ROP]

dreamhack.io/wargame/challenges/354

```
$ checksec rop[*]  
'/home/dreamhack/rop'  
Arch:      amd64-64-little  
RELRO:     Partial RELRO  
Stack:     Canary found  
NX:        NX enabled  
PIE:       No PIE (0x400000)
```

```
int main() {  
    char buf[0x30];  
  
    setvbuf(stdin, 0, _IONBF, 0);  
    setvbuf(stdout, 0, _IONBF, 0);  
  
    // Leak canary  
    puts("[1] Leak Canary");  
    write(1, "Buf: ", 5);  
    read(0, buf, 0x100);  
    printf("Buf: %s\n", buf);  
  
    // Do ROP  
    puts("[2] Input ROP payload");  
    write(1, "Buf: ", 5);  
    read(0, buf, 0x100);  
  
    return 0;  
}
```


Homework [dowell]

dreamhack.io/wargame/challenges/1568

여러번 입력을 받을 수는 없을까?

ROP

Ret2main

기회가 1번이면 ROP 어려움

return to main!

여러번 ROP가 가능하다

ROP 中 RTL

Return To Libc

원하는 gadget이 없다면?

Return To Libc!

libc에 좋은 gadget이 차고 넘친다. system, /bin/sh 까지 다 있다.

굉장히 유명하고 간편함

대신 libc의 시작 주소를 알아야 함.

ROP 中 RTL

One_gadget

libc 에 좋은게 많으니 한번에 쉘을 따자

onegadget ./libc.so.6

조건만 맞으면 한번에 쉘이 나온다.

libc의 버전이 높을수록 onegadget의 제약 조건이 많아진다

2025.09.19

Q&A

질문이 있다면 하십시오

임준서

2.5cm-2.5cm 떨어진 제목 36px

제목 하단의 부제목 18px

3.5cm 떨어진 내용 1 32px

좌측으로 0.5cm 떨어진 내용 하단의 설명 18px

3.5cm 떨어진 내용 2 32px

좌측으로 0.5cm 떨어진 내용 하단의 설명 18px

3.5cm 떨어진 내용 3 32px

좌측으로 0.5cm 떨어진 내용 하단의 설명 18px

1cm-1cm 떨어진 주석 12px

1cm-1cm 떨어진 주석 12px

2.5cm-3.5cm 떨어진 제목 36px

제목 하단의 부제목 18px

3.5cm 떨어진 내용 1 32px

Git init	Git add .
Git status	Git reset .
Git add text.txt	Git commit -m "add README"
Git add .	Git log --oneline -n 3
Git commit	Git commit -a -m "hello"
Ctrl+C	
Git commit -m "genesis"	
Git log	
Git log --oneline	

1cm-1cm 떨어진 주석 12px

1cm-1cm 떨어진 주석 12px

중심에서 0.3cm 떨어진 소속 18px