

Buffer overflow

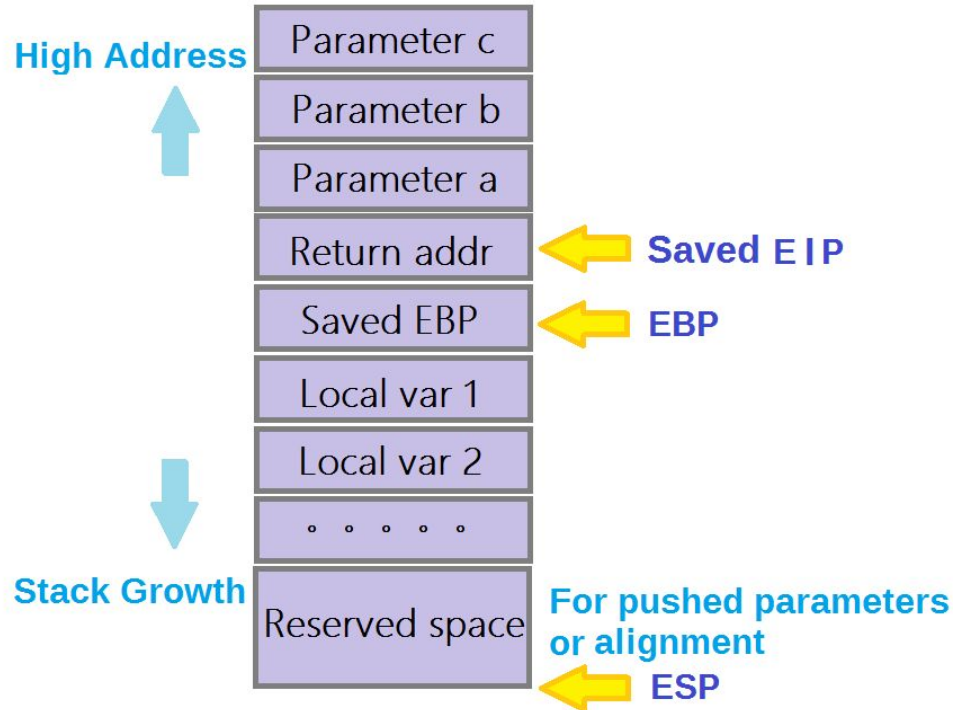
Bamboofox & NCTUCSC

Outline

1. Stack frame
2. Buffer overflow
3. Dangerous function
4. Strategy
5. Stack canary

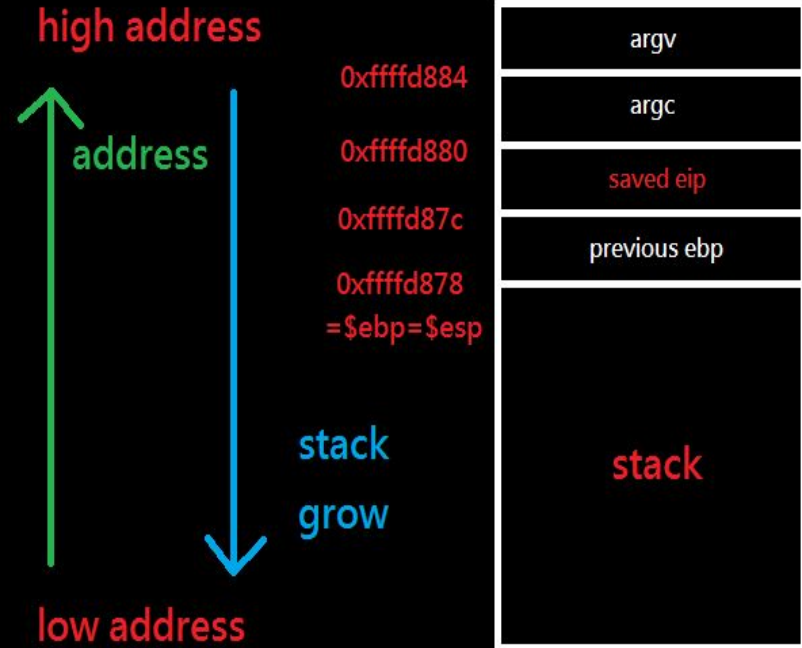
Stack frame

Function F(a, b, c);



Buffer overflow

```
1 #include<stdio.h>
2 int main(void)
3 {
4     char s[10];
5     scanf("%s", s);
6     return 0;
7 }
8
```



Buffer overflow

Reading symbols from bof...(no debugging symbols found)...done.

(gdb) b main

Breakpoint 1 at 0x804843f

(gdb) r

Starting program: /net/cs/101/0116320/bamboofox/bof/bof

Breakpoint 1, 0x804843f in main ()

(gdb) info frame

Stack level 0, frame at 0xffffd880:

eip = 0x804843f in main; saved eip = 0xf7e12637

Arglist at 0xffffd878, args:

Locals at 0xffffd878, Previous frame's sp is 0xffffd880

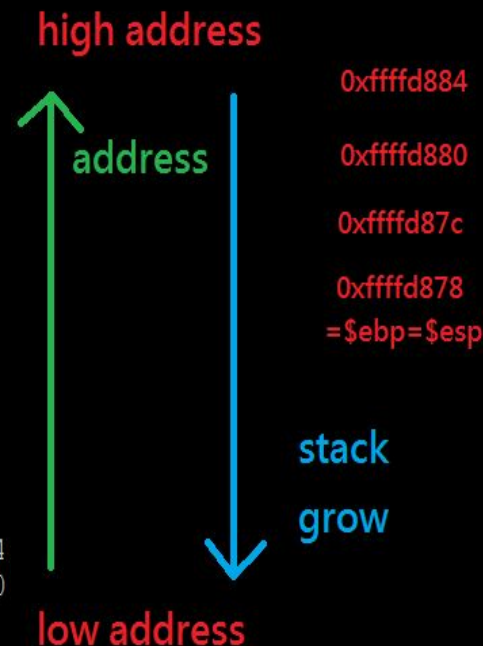
Saved registers:

ebp at 0xffffd878, eip at 0xffffd87c

(gdb) x/10x \$ebp previous ebp

	previous ebp	eip	argc	argv
0xffffd878:	0x00000000	0xf7e12637	0x00000001	0xffffd914
0xffffd888:	0xffffd91c	0x00000000	0x00000000	0x00000000
0xffffd898:	0xf7fad000	0x08048224		

(gdb)



Buffer overflow

Reading symbols from bof...(no debugging symbols found)...done.

(gdb) b __isoc99_scanf

Breakpoint 1 at 0x8048340

(gdb) r

Starting program: /net/cs/101/0116320/bamboofox/bof/bof

Breakpoint 1, 0xf7e58af6 in __isoc99_scanf () from /usr/lib32/libc.so.6

(gdb) info frame

Stack level 0, frame at 0xffffd850:

eip = 0xf7e58af6 in __isoc99_scanf; saved eip = 0x8048459

called by frame at 0xffffd880

Arglist at 0xffffd848, args:

Locals at 0xffffd848, Previous frame's sp is 0xffffd850

Saved registers:

ebx at 0xffffd83c, ebp at 0xffffd848, esi at 0xffffd840, edi at 0xffffd844,

eip at 0xffffd84c

(gdb) x/10x \$ebp

	previous ebp	eip	"%s" string address	buf address
0xffffd848:	0xffffd878	0x08048459	0x080484f0	0xffffd866
0xffffd858:	0xffffd91c	0xf7e28b7b	0xf7fad3dc	0x080481f4
0xffffd868:	0x0804847b	0x00000000		

(gdb) █



Buffer overflow

Reading symbols from bof...(no debugging symbols found)...done.

(gdb) b __isoc99_scanf

Breakpoint 1 at 0x8048340

(gdb) r

Starting program: /net/cs/101/0116320/bamboofox/bof/bof

Breakpoint 1, 0xf7e58af6 in __isoc99_scanf () from /usr/lib32/libc.so.6

(gdb) info frame

Stack level 0, frame at 0xffffd850:

eip = 0xf7e58af6 in __isoc99_scanf; saved eip = 0x8048459

called by frame at 0xffffd880

Arglist at 0xffffd848, args:

Locals at 0xffffd848, Previous frame's sp is 0xffffd850

Saved registers:

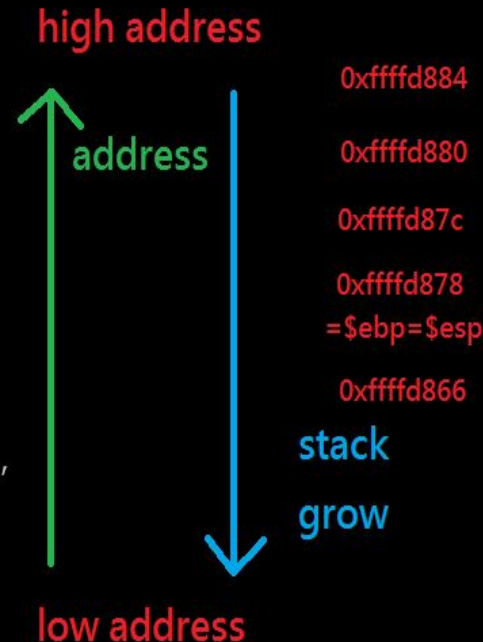
ebx at 0xffffd83c, ebp at 0xffffd848, esi at 0xffffd840, edi at 0xffffd844,

eip at 0xffffd84c

(gdb) x/10x \$ebp

	previous ebp	eip	"%s" string address	buf address
0xffffd848:	0xffffd878	0x08048459	0x080484f0	0xffffd866
0xffffd858:	0xffffd91c	0xf7e28b7b	0xf7fad3dc	0x080481f4
0xffffd868:	0x0804847b	0x00000000		

(gdb) █



argv
argc
0xaaaa
0xaaaa
a*18
stack

Buffer overflow

```
Reading symbols from bof...(no debugging symbols found)...done.  
(gdb) r  
Starting program: /net/cs/101/0116320/bamboofox/bof/bof  
aaaaaaaaaaaaaaaaaaaaaaaaaaaaa a*26  
  
Program received signal SIGSEGV, Segmentation fault.  
0x61616161 in ?? ()  
(gdb)
```


Calc offset from the buffer to EIP

For example,

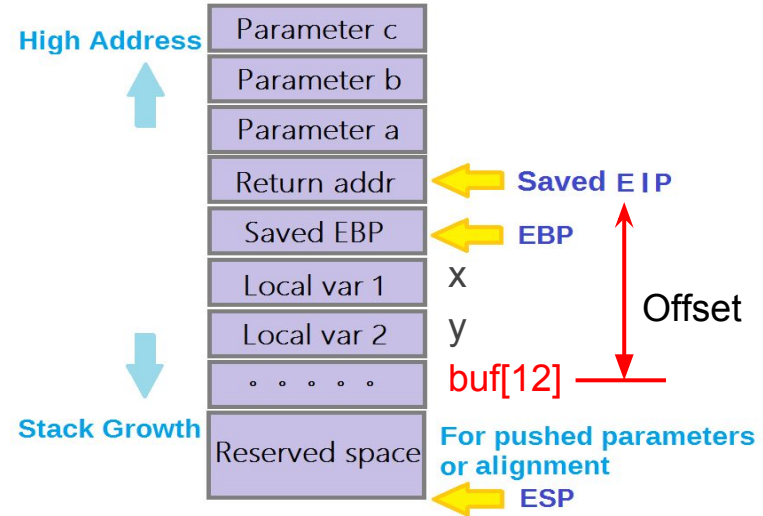
```
F(a,b,c){  
    int x,y;  
    char buf[12];  
    scanf("%s",buf);  
}
```

$EIP = EBP + 4$

$buf[0] = EBP - 12(buf) - 8(2 \text{ int}) - 8(\text{align})$

$\Rightarrow 28 \text{ bytes !}$

Function F(a, b, c);



```
-0000001C buf db 12 dup(?)  
-00000018 y dd ?  
-0000000C x dd ?  
-00000008 db ? ; undefined  
-00000007 db ? ; undefined  
-00000006 db ? ; undefined  
-00000005 db ? ; undefined  
-00000004 db ? ; undefined  
-00000003 db ? ; undefined  
-00000002 db ? ; undefined  
-00000001 db ? ; undefined  
+00000000 db 4 dup(?)
```

Easy practice

Mangic

<http://ctf.cs.nctu.edu.tw/problems/1>

<http://train.cs.nctu.edu.tw/files/magic>

nc 140.113.209.24 11000

Overflow

<http://ctf.cs.nctu.edu.tw/problems/2>

Dangerous function

- | | | |
|------------|---|-----------------------|
| 1. gets | → | • fgets |
| 2. sprintf | → | • snprintf |
| 3. strcpy | → | • strncpy |
| 4. strcat | → | • strncat |
| 5. scanf | → | • never use %s format |

Strategy

With this way, we could control eip.

And combine other strategies to get shell.

- Shellcode
- Return to libc
- Return-oriented programming

But there is a way to protect against the buffer overflow, which is called Stack Canary.

Stack canary (stack protector, stack guard)

In default, this protection is disabled.

`gcc -fstack-protector`

Modify function prologue and epilogue.

After prologue, add 4 bytes random value (called canary)

Before epilogue, xor canary with original value

```
if ( zero /* a.k.a equivalent */ ) return;
```

```
else terminated /* send the SIGSEGV signal */;
```

How does Linux generate the value of the stack canary :

<https://xorl.wordpress.com/2010/10/14/linux-glibc-stack-canary-values/>

Bypass stack canary

Leak stack canary

Canaries are fixed after load.

Leak it and overwrite stack with a same value.

Skip stack canary

Overwrite a buffer pointer which would be wrote and point it to return address, directly write EIP.

Overwrite a function pointer which would be called.

Reference

Behind the process (Recommand!)

<http://bottomupcs.sourceforge.net/csbu/x3564.htm>

Secure Programming : Smashing the stack

http://secprog.cs.nctu.edu.tw/files/Secure_Programming_Smashing_the_Stack.pdf

Stack Canary

https://en.wikipedia.org/wiki/Buffer_overflow_protection#GCC_Stack-Smashing_Protector_.28ProPolice.29