CSE 410/510 Special Topics: Software Security

Instructor: Dr. Ziming Zhao

Location: Obrian 109
Time: Monday, Wednesday 5:00PM-6:20PM

This Class

1. Stack-based buffer overflow
    a. Place the shellcode at other locations.

This Class

1. Stack-based buffer overflow
    a. Overwrite Saved EBP.
    b. Defense.

Frame Pointer Attack (Saved EBP/RBP)

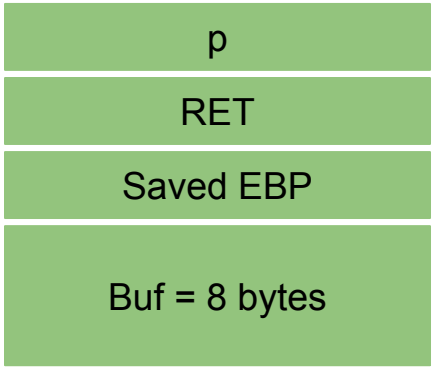
Change the upper level func’s return address

Overflow6 32bit

```
int vulfoo(char *p)
{
        char buf[4];

        memcpy(buf, p, 12);

        return 0;
}

int main(int argc, char *argv[])
{
        if (argc != 2)
                return 0;

        vulfoo(argv[1]);
}
```

Overflow6 32bit

```
000011cd <vulfoo>:
   11cd:        f3 0f 1e fb                 endbr32
   11d1:        55              push   %ebp
   11d2:        89 e5                       mov    %esp,%ebp
   11d4:        53              push   %ebx
   11d5:        83 ec 04                    sub    $0x4,%esp
   11d8:        e8 58 00 00 00              call   1235 <__x86.get_pc_thunk.ax>
   11dd:        05 fb 2d 00 00              add    $0x2dfb,%eax
   11e2:        6a 0c           push   $0xc
   11e4:        ff 75 08                    pushl  0x8(%ebp)
   11e7:        8d 55 f8                    lea    -0x8(%ebp),%edx
   11ea:        52              push   %edx
   11eb:        89 c3           mov    %eax,%ebx
   11ed:        e8 7e fe ff ff              call   1070 <memcpy@plt>
   11f2:        83 c4 0c                    add    $0xc,%esp
   11f5:        b8 00 00 00 00              mov    $0x0,%eax
   11fa:8b 5d fc                   mov    -0x4(%ebp),%ebx
   11fd:        c9              leave
   11fe:c3                 ret
```



Overflow6 32bit

```
000011cd <vulfoo>:
   11cd:        f3 0f 1e fb                 endbr32
   11d1:        55              push   %ebp
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   11f2:        83 c4 0c                    add    $0xc,%esp
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   11fd:        c9              leave
   11fe:c3                 ret
```
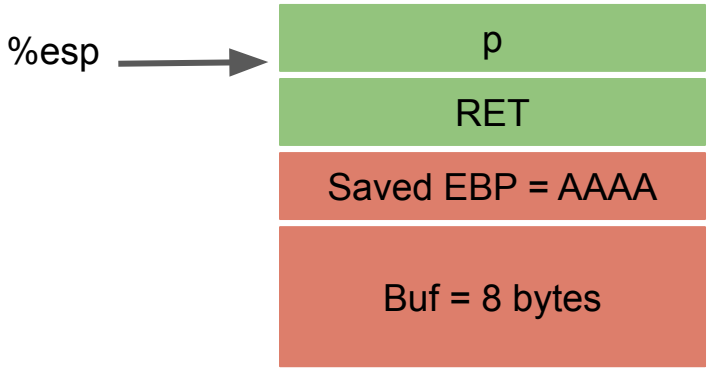
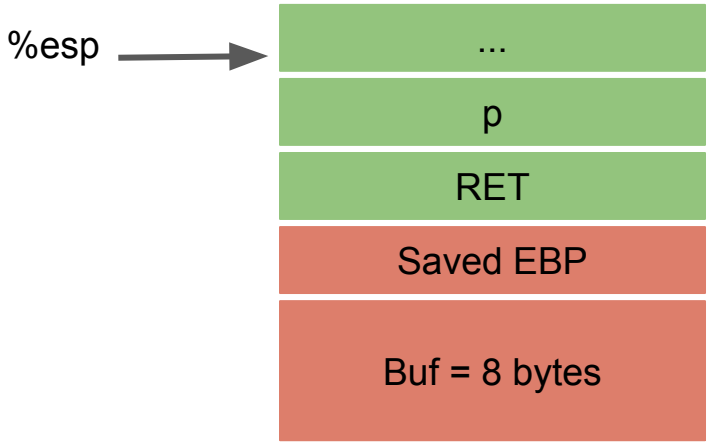



%ebp = AAAA

Overflow6 32bit

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
   120b:       05 cd 2d 00 00            add    $0x2dcd,%eax
   1210:       83 7d 08 02               cmpl   $0x2,0x8(%ebp)
   1214:       74 07                     je     121d <main+0x1e>
   1216:       b8 00 00 00 00            mov    $0x0,%eax
   121b:       eb 16                     jmp    1233 <main+0x34>
   121d:       8b 45 0c                  mov    0xc(%ebp),%eax
   1220:       83 c0 04                  add    $0x4,%eax
   1223:       8b 00                     mov    (%eax),%eax
   1225:       50                 push   %eax
   1226:       e8 a2 ff ff ff            call   11cd <vulfoo>
   122b:       83 c4 04                  add    $0x4,%esp
   122e:       b8 00 00 00 00            mov    $0x0,%eax
   1233:       c9                 leave
   1234:       c3                 ret
```



%ebp = AAAA

Overflow6 32bit

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
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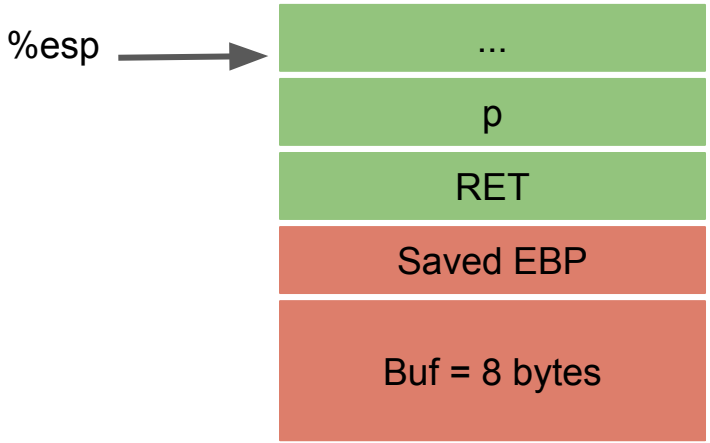

%ebp = AAAA

Overflow6 32bit

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
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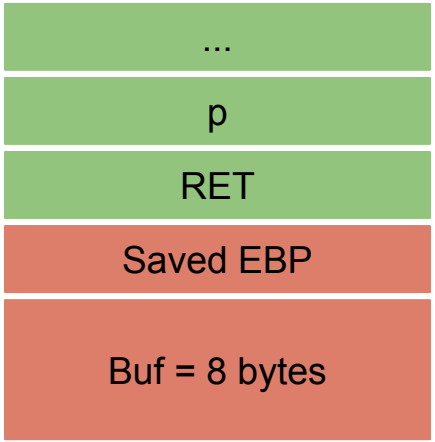
   122b:       83 c4 04                  add    $0x4,%esp
   122e:       b8 00 00 00 00            mov    $0x0,%eax
   1233:       c9                 leave
   1234:       c3                 ret
```

```
mov %ebp, %esp
pop %ebp
```



1. %esp = AAAA
2. %ebp = *(AAAA); %esp += 4, AAAE

Overflow6 32bit

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
   120b:       05 cd 2d 00 00            add    $0x2dcd,%eax
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   1233:       c9                 leave
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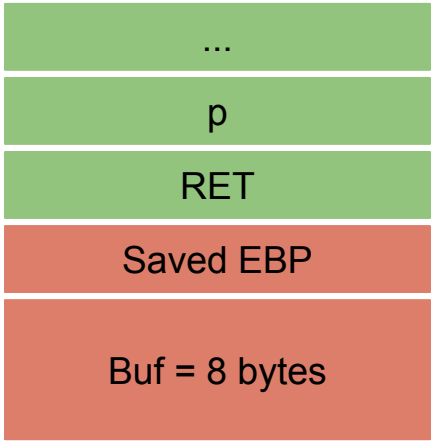
```



1. %eip = *(AAAE)

Overflow6 32bit: If we know where is buf is

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
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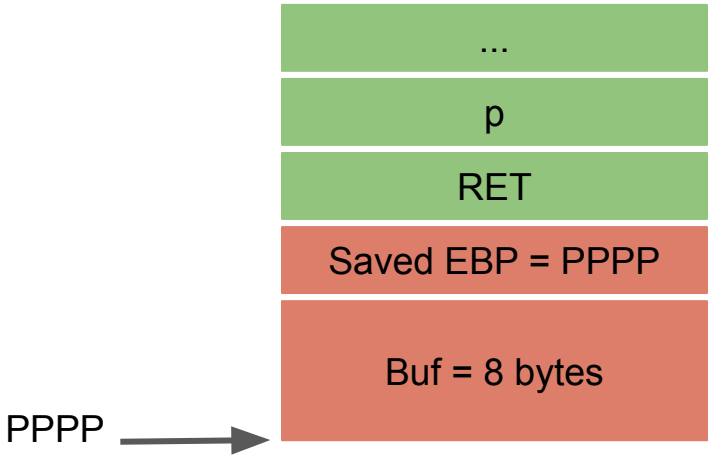
   1226:       e8 a2 ff ff ff            call   11cd <vulfoo>
   122b:       83 c4 04                  add    $0x4,%esp
   122e:       b8 00 00 00 00            mov    $0x0,%eax
   1233:       c9                 leave
   1234:       c3                 ret
```



Overflow6 32bit: If we don't know where is buf is

```
000011ff <main>:
   11ff: f3 0f 1e fb              endbr32
   1203:       55                 push   %ebp
   1204:       89 e5                     mov    %esp,%ebp
   1206:       e8 2a 00 00 00            call   1235 <__x86.get_pc_thunk.ax>
   120b:       05 cd 2d 00 00            add    $0x2dcd,%eax
   1210:       83 7d 08 02               cmpl   $0x2,0x8(%ebp)
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   1233:       c9                 leave
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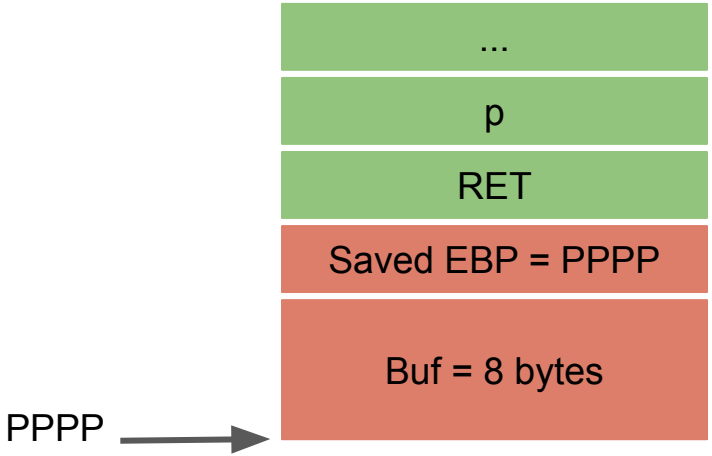

Conditions we depend on to pull off the attack of *returning to shellcode on stack*

1. The ability to put the shellcode onto stack (env, command line)
2. The stack is executable
3. The ability to overwrite RET addr on stack before instruction **ret** is executed or to overwrite Saved EBP
4. Know the address of the destination function