CYBER
CHALLENGE
CyberChallenge.IT

The
Roman
Xpl0it

A gentle introduction to the art of exploitation

Part 2a : Common Vulnerabilities

by anticlockwise & malweisse

What can possibly go wrong?

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EVERYTHING

What can possibly go wrong?

```
0x58 0x33 0x58 0x30
```

Any time you mess with the context you open the window to exploitation

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```
0x58 0x33 0x58 0x30
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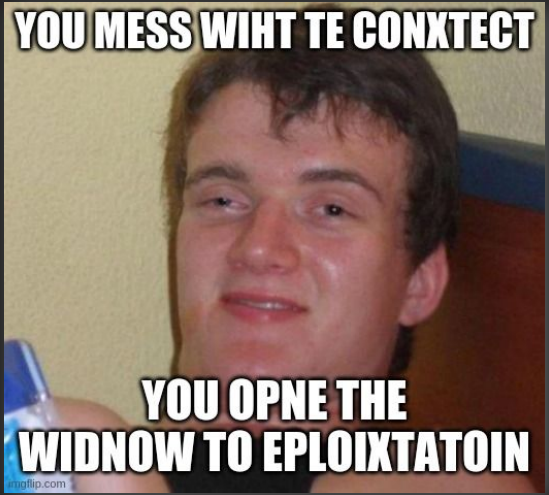

YOU MESS WIHT TE CONXTECT
YOU OPNE THE WIDNOW TO EPLOIXTATOIN
imgflip.com

WTF does this mean?
Give me examples bro !!11!1

Lots of examples mate

- Integers Overflow
- Type Confusions
- Writes out of bound
- Reads out of bound
- Uninitialized Memory
- ...Leet Tricks

Integer overflows/underflows - 1

- Numeric values have a fixed size
- Math operations could wrap around the limit values and produce unexpected behavior

```
unsigned short n = width * height;
char *buf = (char *)malloc(n);
for (i=0; i< height; i++)
    memcpy(&buf[i*width], rows[i], width);
```

Integer overflows/underflows - 1

- Numeric values have a fixed size
- Math operations could wrap around the limit values and produce unexpected behavior

```
unsigned short n = width * height;
char *buf = (char *)malloc(1);
for (i=0; i< height; i++)
    memcpy(&buf[i*width], rows[i], width);
```

```
0xffff * 0xffff = 0xfffe0001
```

Integer overflows/underflows - 2

- Numeric values have a fixed size
- Math operations could wrap around the limit values and produce unexpected behavior

```
int length = input();
char buf[1024] = {0};
if(length < 0 || length + 1 >= 1024){
    die("bad length: %d", value);
}
memcpy(buf, input, length);
```

Integer overflows/underflows - 2

- Numeric values have a fixed size
- Math operations could wrap around the limit values and produce unexpected behavior

```
0x7fffffff + 0x1 = 0x80000000 = -1
```

```c
int length = input();
char buf[1024] = {0};
if(length < 0 || length + 1 >= 1024){
    die("bad length: %d", value);
}
memcpy(buf, input, length);
```

Type confusion

- **signed/unsigned** confusion in one of the most common type confusion

```
int length = input();
char buf[1024] = {0};
if(length >= 1024){
    die("bad length: %d", value);
}
memcpy(buf, input, length);
```

Type confusion

- **signed/unsigned** confusion in one of the most common type confusion

```
int length = input();
char buf[1024] = {0};
if(length >= 1024){
    die("bad length: %d", value);
}
memcpy(buf, input, length);
```

-1

-1 => 0xffffffff

Writes out of bound - 1

- **buffer overflows**: data copied in a location exceeds the size of the reserved destination area

```
strcpy(char *dest, const char *src);
strcat(char *dest, const char *src);
sprintf(char* str, "%s", char* message);
gets(char *s);
scanf("%s", buffer);
```

Writes out of bound - 2

- **buffer overflows**: data copied in a location exceeds the size of the reserved destination area
- **off-by-one errors**: length calculation incorrect by one array element

```
char buf[1024];
if(strlen(input) > sizeof(buf))
    die("error: user string too long\n");
strcpy(buf, input);
```

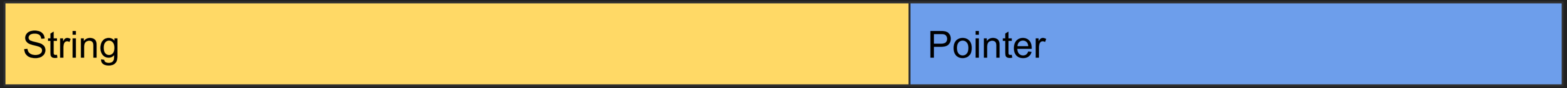
Reads out of bound

- Just like writing out of bound, reading out of bound is a ~~serious~~ useful vulnerability
- Disclose randomized data:
  1. Leak libc addresses
  2. Leak PIE base
  3. Leak heap address
  4. Leak stack canary

Reads out of bound - 1

An example how PIE can be leaked.

```
char string[16];
void* pointer_to_data_section;
read(0, string, sizeof(string));
printf(“%s”, string);
```



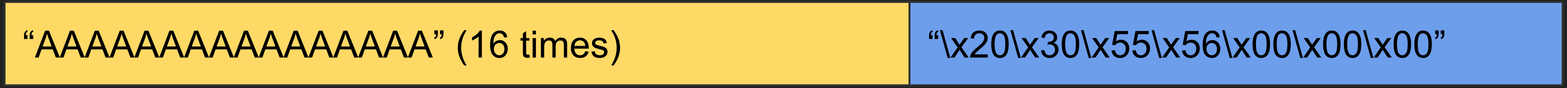
String

Pointer

Reads out of bound - 1

An example how PIE can be leaked.

```
char string[16];
void* pointer_to_data_section;
read(0, string, sizeof(string));
printf(“%s”, string);
```



“AAAAAAAAAAAAAAAA” (16 times)

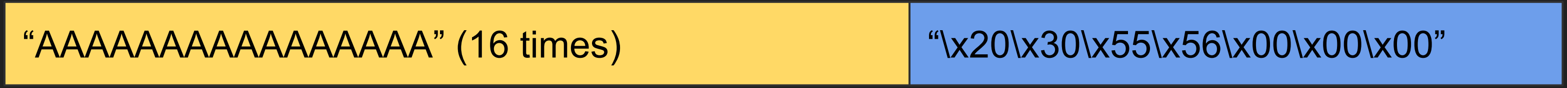
“\x20\x30\x55\x56\x00\x00\x00”

Reads out of bound - 1

An example how PIE can be leaked.

```
char string[16];
void* pointer_to_data_section;
read(0, string, sizeof(string));
printf(“%s”, string);
```

```
=> "AAAAAAAAAAAAAAAA\x20\x30\x55\x56"
```



“AAAAAAAAAAAAAAAA” (16 times)

“\x20\x30\x55\x56\x00\x00\x00”

Reads out of bound - 2

```
void * pointer = get_ptr_to_data();
int array[16];
int index = input();
if (index >= 16) die(“index out of bounds”);
printf(“%d\n”, array[index]);
```

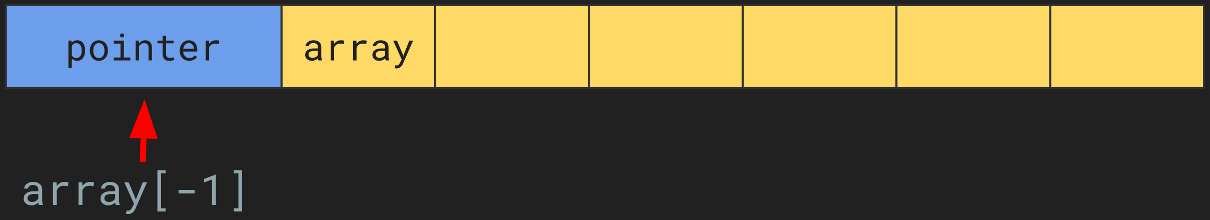
Reads out of bound - 2

```
void * pointer = get_ptr_to_data();
int array[16];
int index = input();
if (index >= 16) die(“index out of bounds”);
printf(“%d\n”, array[index]);
```

What happens if we insert -1?

Reads out of bound - 2

```
void * pointer = get_ptr_to_data();
int array[16];
int index = input();
if (index >= 16) die(“index out of bounds”);
printf(“%d\n”, array[index]);
```



What happens if we insert -1?

Uninitialized Memory

- Using uninitialized variables is BAD:
    1. Unexpected values could lead to memory corruption
    2. Variable usage may disclose randomized data

```
char buffer[1024];
read(0, buffer, 1024);
write(1, buffer, 1024);
```

Uninitialized Memory

- Using uninitialized variables is BAD:
    1. Unexpected values could lead to memory corruption
    2. Variable usage may disclose randomized data

```
char buffer[1024];

read(0, buffer, 1024);

write(1, buffer, 1024);
```

```
\x00\xf0\x38\xb9\xe8\x7f\x00\x00\x00\x00\x00\x00\x00\x00...
```

What if I send just one byte?

Uninitialized Memory

- Using uninitialized variables is BAD:
  1. Unexpected values could lead to memory corruption
  2. Variable usage may disclose randomized data

```
char buffer[1024];
read(0, buffer, 1024);
write(1, buffer, 1024);
```

```
\xaa\xf0\x38\xb9\xe8\x7f\x00\x00\x00\x00\x00\x00\x00\x00...
```

Uninitialized Memory

- Using uninitialized variables is BAD:
  1. Unexpected values could lead to memory corruption
  2. Variable usage may disclose randomized data

```c
char buffer[1024];
read(0, buffer, 1024);
write(1, buffer, 1024);
```

```
=> "\xaa\xf0\x83\xb9\xe8\x7f\x00\x00.."
```

```
\xaa\xf0\x38\xb9\xe8\x7f\x00\x00\x00\x00\x00\x00\x00\x00...
```

Leet tricks - 1

```
char buf[100];
int i = input();



use(buf[i % 100]);
```

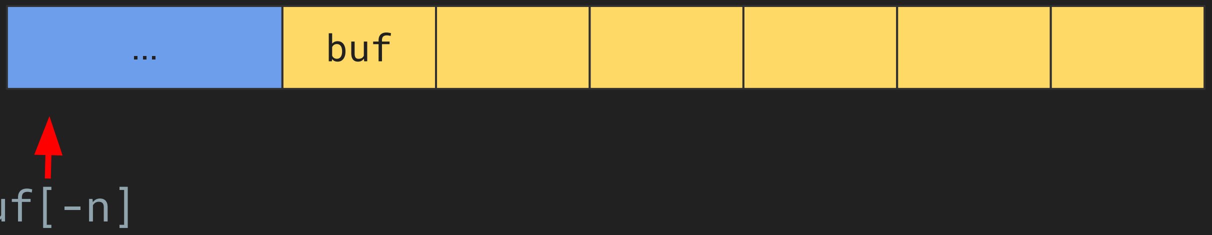
Is it safe?

Leet tricks - 1

```
char buf[100];
int i = input();


use(buf[i % 100]);
```

```
i < 0 => (i % 100) < 0
```

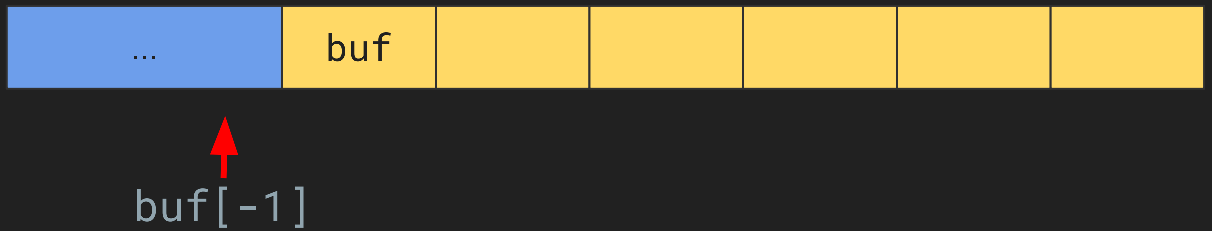


Is it safe?

Leet tricks - 1

```
char buf[100];
int i = input();    -1


use(buf[i % 100]);    -1
```



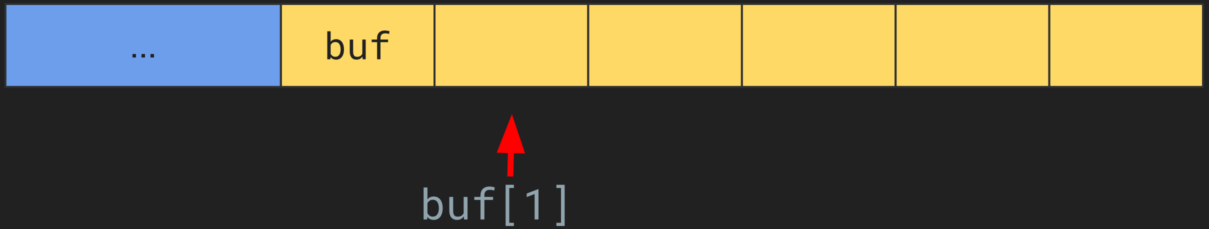
Is it safe?

Leet tricks - 1

```
char buf[100];
int i = input();
if (i < 0)
    i = -i;
use(buf[i % 100]);
```

-1

1



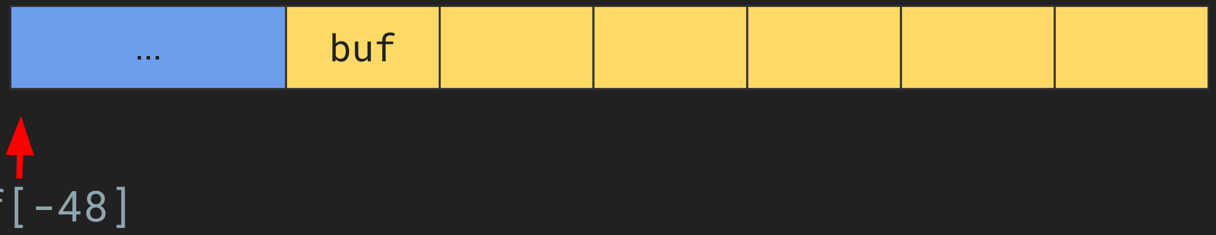
Leet tricks - 1

```
char buf[100];
int i = input();
if (i < 0)
    i = -i;
use(buf[i % 100]);
```

```
INT_MIN == 0x80000000 == -2147483648
```

```
-0x80000000 == 0x80000000 == -2147483648
```

```
(-2147483648 % 100) == -48
```



Leet tricks - 2

```
int snprintf(char *dest, size_t size, "%s", char* src);
```

What does `snprintf` returns?

Leet tricks - 2

```
int snprintf(char *dest, size_t size, "%s", char* src);
```

What does `snprintf` returns?

- **Common belief**: the number of characters written

Leet tricks - 2

```
int snprintf(char *dest, size_t size, "%s", char* src);
```

What does `snprintf` returns?

- ~~**Common belief**: the number of characters written~~ NO
- **Reality**: the number of characters (excluding the terminating null byte) which would have been written to the final string if enough space had been available

Leet tricks - 2

```
int snprintf(char *dest, size_t size, "%s", char* src);
```

What does `snprintf` returns?

- ~~**Common belief**: the number of characters written~~ NO
- **Reality**: the number of characters (excluding the terminating null byte) which would have been written to the final string if enough space had been available

so that:

```
int total_len = snprintf(NULL, 0, "%s", char* src);
char* dest = malloc(total_len + 1);
snprintf(dest, total_len + 1, "%s", char* src);
```

Leet tricks - 2

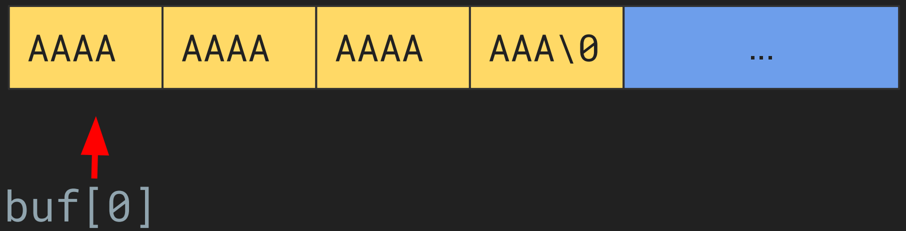
```c
char buf[16];
char* str1 = input();
int n = snprintf(buf, 16, "%s", str1);
char* str2 = input();
n += snprintf(&buf[n], 16 - n, "%s", str2);
```

Leet tricks - 2

```
char buf[16];
char* str1 = input();    <= "A"*17
int n = snprintf(buf, 16, "%s", str1);
char* str2 = input();
n += snprintf(&buf[n], 16 - n, "%s", str2);
```

Leet tricks - 2

```
char buf[16];
char* str1 = input();    <= "A"*17
int n = snprintf(buf, 16, "%s", str1);
char* str2 = input();
n += snprintf(&buf[n], 16 - n, "%s", str2);
```

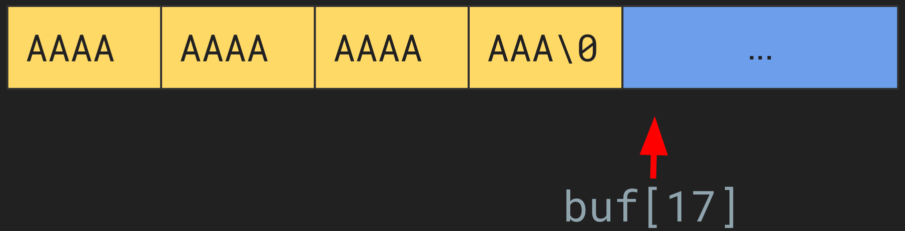


AAAA	AAAA	AAAA	AAA\0	...

buf[0]

Leet tricks - 2

```
char buf[16];
char* str1 = input();       <= "A"*17
int n = snprintf(buf, 16, "%s", str1);
char* str2 = input();
n += snprintf(&buf[17], 16 - n, "%s", str2);
                        0xffffffff
```



AAAA | AAAA | AAAA | AAA\0 | ...

buf[17]

Read more on...

The Art of Software Security Assessment - Identifying and Preventing Software Vulnerabilities