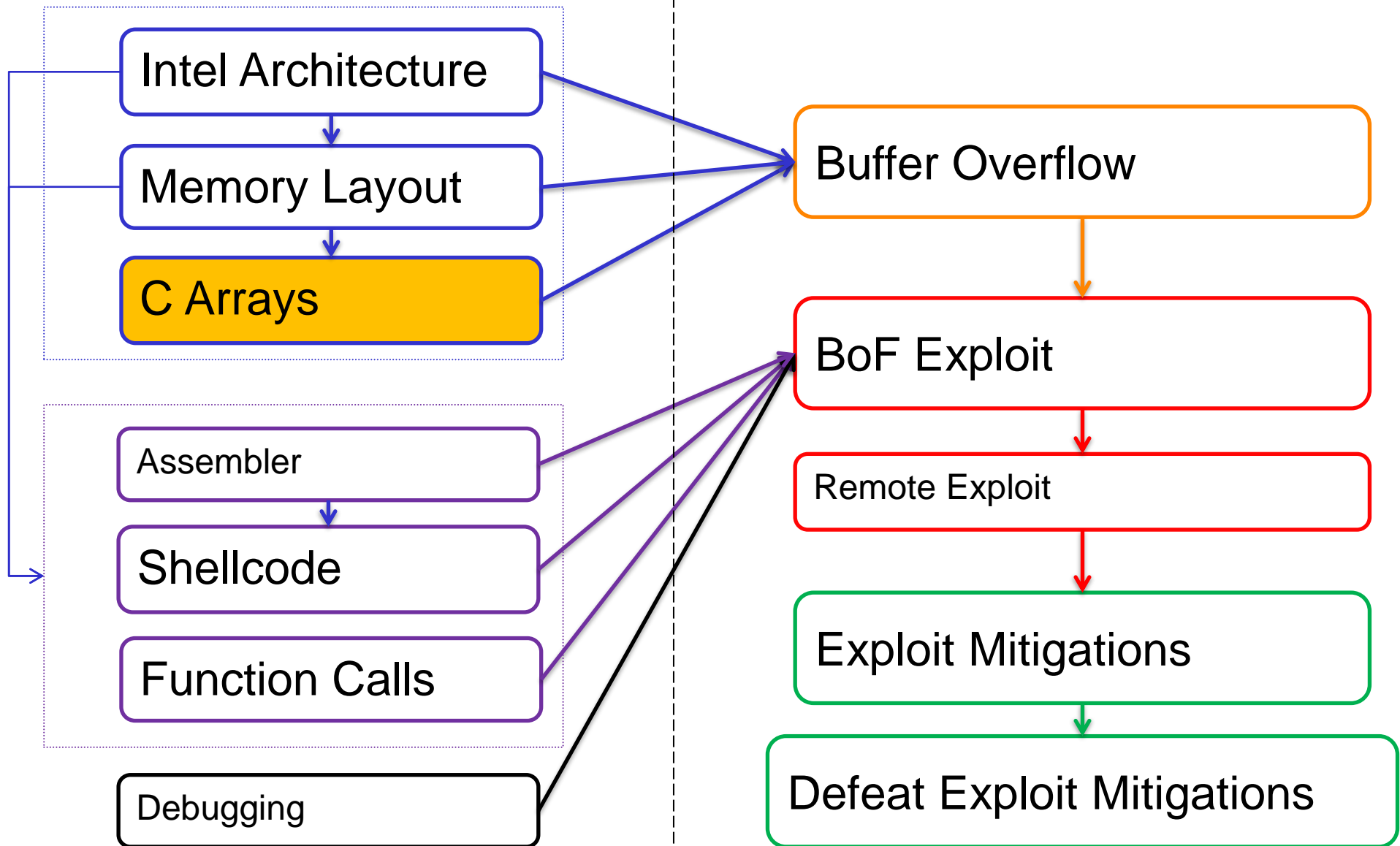

C Arrays and Pointers

Content



C Arrays & Pointers

C Arrays & Pointers

Valid C code:

```
int array[5] = {1, 2, 3, 4, 5};
```

```
array[0] = 0;
```

```
array[4] = 0;
```

C Arrays & Pointers

Valid C code:

```
int array[5] = {1, 2, 3, 4, 5};
```

```
array[0] = 0;
```

```
array[4] = 0;
```

```
array[5] = 0;
```

```
array[-1] = 0;
```

```
array[100] = 0;
```

```
printf("%i", array[1024]);
```

“Valid”!

C Arrays & Pointers

Arrays are just pointers. They lose type information.

```
int array[5] = {1, 2, 3, 4, 5};
```

```
int *a = array; // pointer
```

```
a[2] = 0;
```

```
a += 100;
```

```
*a = 0;
```

array	=	a	=	0x1000
-------	---	---	---	--------

array[2]	=	a + 4 * 2	=	0x1008
----------	---	-----------	---	--------

array[100]	=	a + 4 * 100	=	0x11F4
------------	---	-------------	---	--------

(int is 32 bit = 4 bytes)

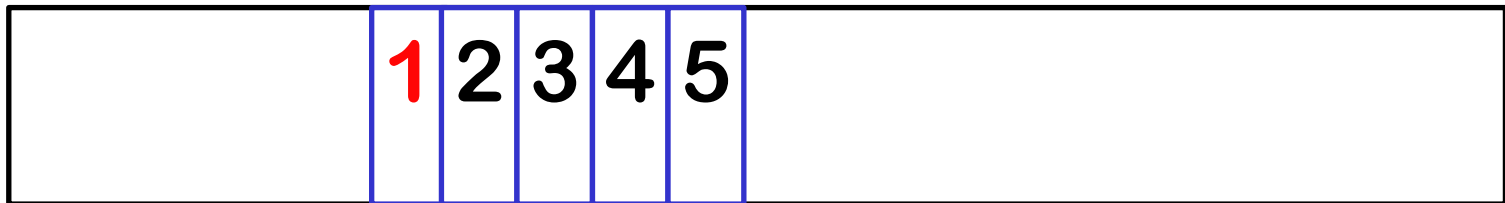
C Arrays & Pointers

Valid C code:

```
int array[5] = {1, 2, 3, 4, 5};
```

```
int *a = array;
```

***array = *a = 1**



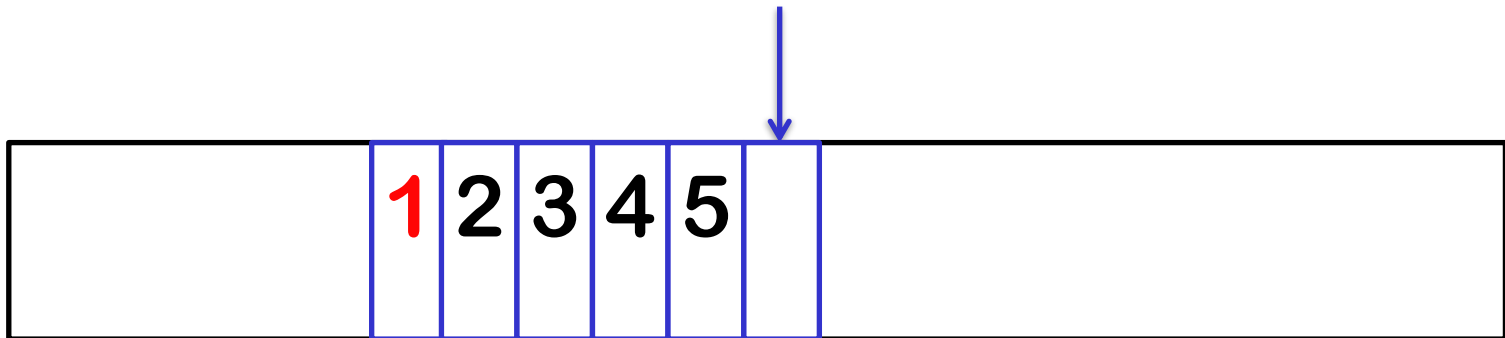
C Arrays & Pointers

Valid C code:

```
int array[5] = {1, 2, 3, 4, 5};
```

```
int *a = &array[5];
```

***array[5] = *a = ?**



C Arrays & Pointers

Other c code:

```
int a = 42;  
int *b = &a;
```

```
printf("%i", a);    // 42
```

```
printf("%i", *b);  // 42
```

```
b--;
```

```
printf("%i", *b);  // ??
```

C Arrays & Pointers

Other c code:

```
int a = 42;  
int *b = &a;
```

```
printf("%i", a);      // 42  
printf("%i", &a);     // 0x1000  
printf("%i", b);      // 0x1000  
printf("%i", *b);     // 42
```

```
b--;
```

```
printf("%i", b);      // 0x0FFC  
printf("%i", *b);     // ??
```

C Arrays & Pointers

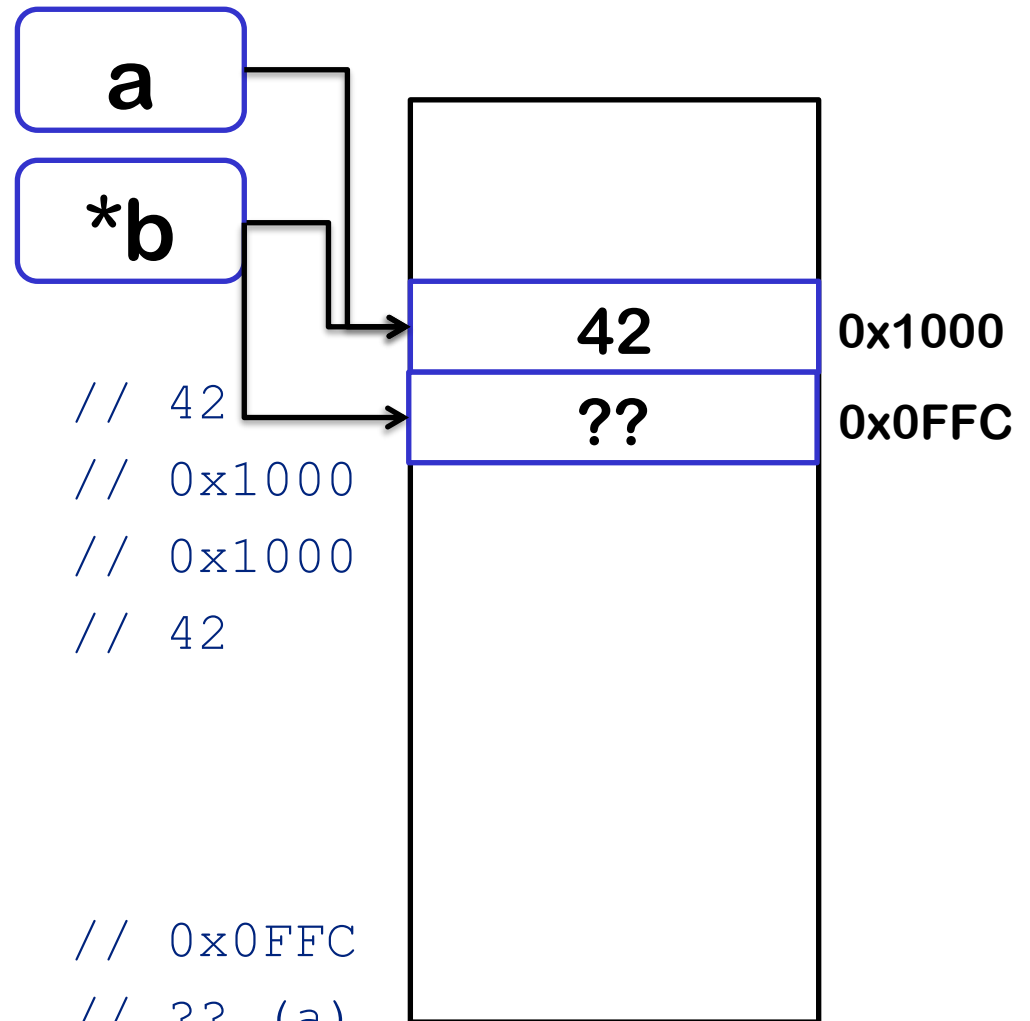
Other c code:

```
int a = 42;  
int *b = &a;
```

```
printf("%i", a);      // 42  
printf("%i", &a);    // 0x1000  
printf("%i", b);     // 0x1000  
printf("%i", *b);    // 42
```

```
b--;
```

```
printf("%i", b);     // 0x0FFC  
printf("%i", *b);    // ?? (a)
```



Copying Data

Copying Data

Strings in C are byte-arrays:

```
char string[16];  
uint8_t string[16];
```

To copy strings:

```
strcpy(destination, source);  
memcpy(destination, source, len);  
gets(destination);
```

What is a common vulnerability?

```
strcpy(destination, source);  
strcpy(d, "Hallo");
```

What is a common vulnerability?

```
strcpy(destination, source);  
strcpy(d, "Hallo");
```

How much does strcpy() actually copy?

- ✦ Until source “ends”
- ✦ Where is the end?
- ✦ 0 byte \x00

```
"Hallo\x00"
```

Exploitation Basics

strcpy() does not care about destination size

At all...

```
char destination[8];  
char source[16] = "1234567890123456\x00"  
  
strcpy(destination, source);
```


Exploitation Basics

strcpy() does not care about destination size

At all, because:

```
char destination[8];  
char *d = &destination;  
char source[16] = "123456789012345\x00"  
  
strcpy(d, source);
```

d loses its destination size

Exploitation Basics

strcpy() does not care about destination size

strncpy() does

```
char destination[8];
```

```
char source[16] = "123456789012345\x00"
```

```
strncpy(destination, source, 8);
```

Non-Arrays in C

Non-Arrays

C has:

- ✦ Basic Types (int, float)
- ✦ Enumerated Types
- ✦ Void Type (void)
- ✦ Derived Types

Derived types:

- ✦ Pointers
- ✦ Arrays
- ✦ Structure
- ✦ Union
- ✦ Function

Non-Arrays

Arrays: Multiple elements of the **same type** behind each other

xxx var[3] :



Structs: Multiple elements of **different types** behind each other

```
struct var {  
    short x;  
    long y;  
    char z[3];  
}
```



Enum is a special case of integer

Union is a special case of struct

Non-arrays

Remember:

Basic types are stored **in memory**, and can be loaded into **registers**

- ✦ Pointers are a bit special basic type (they can be dereferenced), but are otherwise identical

Derived types are stored **in memory**, and **contain basic types**

- ✦ They cannot be loaded into a register, only some of their content can

Both are stored somewhere in memory, and therefore have an **address**.

Basic types are **modified in registers**

- ✦ Load from memory to register, modify, store into memory

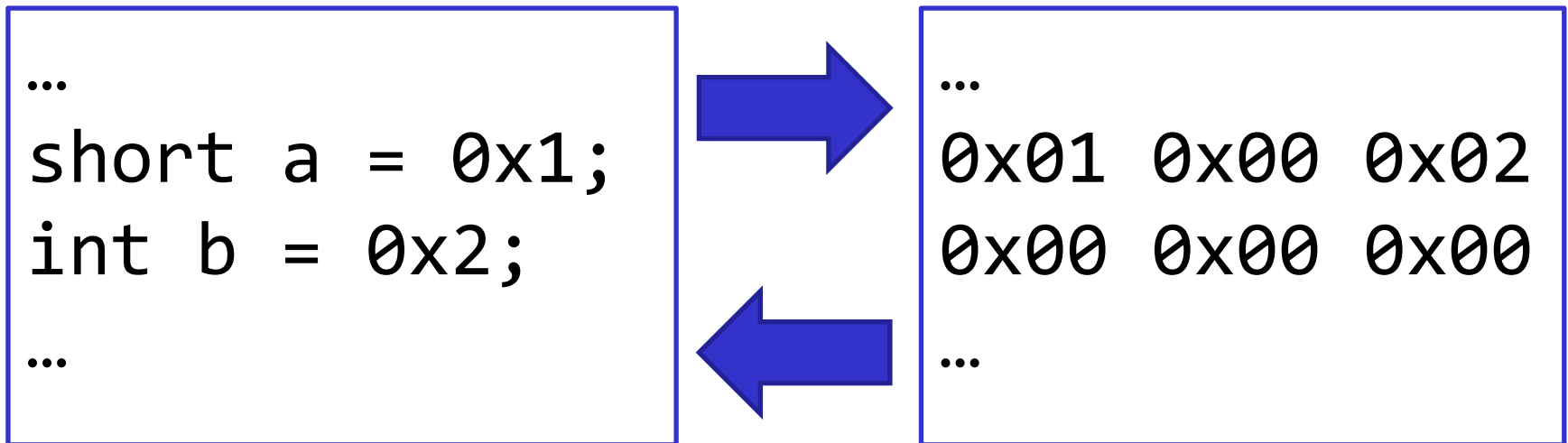
Non-arrays

Developers:

- ✦ The memory holds some variables of mine, which hold my data

Hackers:

- ✦ The memory contains data, which is associated with some variables



Conclusion

Exploitation Basics

Recap:

- ✦ C does not care about buffer boundaries
- ✦ strcpy() does not care about size of destination buffer (only 0-byte in source buffer)
- ✦ One buffer can overflow into another buffer
- ✦ Local variables/buffers are adjoint to each other
- ✦ Pointer can point to any memory address