



Lecture 08
Code Reuse (part 1)

Computer and Network Security
November 18, 2019
Computer Science and Engineering Department



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└ Defense Mechanisms

- ▶ static & dynamic analysis
- ▶ ASCII armored address space
- ▶ stack guard, canary value
- ▶ DEP: Data Execution Prevention
- ▶ ASLR: Address Space Layout Randomization

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└ Data Execution Prevention

- ▶ writable code may not be executed
- ▶ stack, heap, data, bss
- ▶ you cannot (easily) inject code (and run it)

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└ Code Reuse

- ▶ use existing code
- ▶ text and library text
- ▶ interesting to use/call functions
- ▶ smaller pieces may also be used
- ▶ no need to inject code

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└─ return-to-libc

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└ Return-Oriented Programming

- ▶ use smaller pieces of code
- ▶ pieces are called *ROP gadgets*, ending in `ret` instruction
- ▶ payload consists of data on stack and pointers to ROP gadgets

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- ▶ identify function addresses and addresses of arguments (such as the `"/bin/sh"` string)
- ▶ overwrite code pointer with function address
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└ Sample Payloads for ret-to-libc attack

```
▶ padding + overwrite_lib_address +  
irrelevant_ret_address + arg1 + arg2 + ...  
▶ offset*"A" + p32(system_address) + 4*"B" +  
p32(bin_sh_address)  
▶ offset*"A" + p32(write) + 4*"B" + p32(1) +  
p32(buf_address) + p32(buf_len)
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└─ Protecting Against ret-to-libc Attacks

- ▶ use ASLR to randomize function addresses in library
- ▶ use stack canary
- ▶ need information leak to bypass protection mechanisms

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- ▶ you may use pop2-ret or pop3-ret etc.

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```
▸ offset*"A" + p32(puts) + p32(pop_ret_gadget) +  
  p32(puts_string_address)  
▸ offset*"A" + p32(write) + p32(pop3_ret_gadget) +  
  p32(1) + p32(buf) + p32(buf_len)
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- ▶ do information leak, rewrites, open sockets, run shells

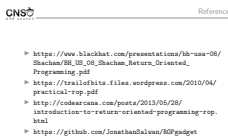
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- ▶ open shell
- ▶ call `mprotect()` to disable DEP and then inject shellcode

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- ▶ return-to-libc
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- ▶ https://www.blackhat.com/presentations/bh-usa-08/Shacham/BH_US_08_Shacham_Return_Oriented_Programming.pdf
- ▶ <https://trailofbits.files.wordpress.com/2010/04/practical-rop.pdf>
- ▶ <http://codearcana.com/posts/2013/05/28/introduction-to-return-oriented-programming-rop.html>
- ▶ <https://github.com/JonathanSalwan/ROPgadget>