Lecture 5
Exploiting. Shellcodes (part 2)
Computer and Network Security
October 28, 2019
Computer Science and Engineering Department

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CNSO CTF crunch
Placing Data in Shellcodes
push it on the stack and save the pointer
Data on stack
xor eax, eax
push eax
push 0x68732f2f
push 0x6e69622f
mov ebx, esp

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Placing Data in Shellcodes

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Data on stack

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Placing Data in Shellcodes (2)
do a jump-call trick (http://stackoverflow.com/a/15704848)
jump-call trick
jmp MESSAGE ; 1) lets jump to MESSAGE
GOBACK:
mov eax, 0x4
mov ebx, 0x1
pop ecx ; 3) we are poping into 'ecx', now we have the
; address of "Hello, World!\r\n"
MESSAGE:
call GOBACK ; 2) we are going back, since we used 'call', that means
; the return address, which is in this case the address
; of "Hello, World!\r\n", is pushed into the stack.
db "Hello, World!", 0dh, 0ah

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jump-call trick

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Breaking a Remote Service
- stack addresses may differ even if not using ASLR
- you need a remote connection to send data: netcat, socket API, expect/pexpect API
- you may need multiple ping-pongs with the remote service
- pwntools (https://github.com/Gallopsled/pwntools) makes it easier

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CNSO CTF crunch Outline
Shellcode Constraints
Tools
Conclusion

CNSO CTF crunch

Outline

Shellcode Constraints

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CNSO CTF crunch Alphanumeric

- strict input validation
- very limited set of instructions
- http://www.phrack.org/issues.html?issue=57&id=15#article
- use initial limited shell code to write extended shell code

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Alphanumeric

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CNSO CTF crunch
Using an Environment Variable
- initialize an environment variable with the shellcode string
- environment variable is placed on the stack of main
- may be large enough to store large shellcodes
- unable to be done if stack is non-executable

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CNSO CTF crunch Two-Stage Shellcodes

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- not enough the store the shellcode
- only use the buffer to overwrite the code pointer
- place the shellcode in a different location

CNSO CTF crunch

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CNSO CTF crunch
Call main again
- two-phase attack
- overwrite the code pointer with the address of main (or that of another function)
- call the vulnerable read/fgets/etc. function again
- you may use the first call to leak data or make some more room and the second call for the actual attack

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CNSO CTF crunch
Using the Heap
- place the shellcode on the heap
- requires a heap buffer overflow
- made difficult by ASLR and non-executable flags

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CNSO CTF crunch String Formatting

- uses printf() functions that don't do proper checking of arguments
- may use %x and %s to read arbitrary data and string from memory
- may use %n to write arbitrary data into memory and possibly trigger a shellcode execution
- puts() may be used; pass an address with information you want to leak

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CNSO CTF crunch
Return-to-libc
- if stack is non-executable, one may not execute code on the stack → no shellcode
- we could call the system library call with the "/bin/bash" argument
- with the help of a buffer overflow one overwrites the return address causing a call to libc
- this is restricted to only functions available in libc
- one must know in advance the address of the system library call
- the "/bin/bash" may be stored in an environment variable (or is already stored in the SHELL environment variable) and it's address may be placed on the stack

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Return-to-libc

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- one must know in advance the address of the `system` library call
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CNSO CTF crunch Return-Oriented Programming

- using existing sequences ending in ret from the program executable code
- sequences are programmed on the stack and then executed one by one to provide the required effect
- sequences are called gadgets
- we'll talk more about these in the future classes

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CNSO CTF crunch PEDA
Generate shellcode in PEDA
gdb-peda$ shellcode generate x86/linux exec

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PEDA

Generate shellcode in PEDA

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gdb-peda$ shellcode generate x86/linux exec
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CNSO CTF crunch pwntools

- https://docs.pwntools.com/en/stable/, https://github.com/Gallopsled/pwntools
- automate exploiting tasks
- channels
- ELF inspection
- return oriented programming
- shellcodes
- packing/unpacking

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pwntools

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CNSO CTF crunch pwntools skeleton

Skeleton for using pwntools
from pwn import *

local = False
if local == True:
io = process("/path/to/executable")
else:
HOST = "141.85.100.200"
PORT = 31337
io = remote(HOST, PORT)

TODO: Create shellcode, payload. Do ping-pong with the vulnerable program.
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pwntools skeleton

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CNSO CTF crunch
pwntools example
pwntools example
```
from pwn import *

io = process("/path/to/executable")

buffer_start = 0x08424242
buffer_to_ret_address_offset = 0x2c

# Craft payload: shellcode + padding + ovewrite_address
shellcode = asm(shellcraft.i386.linux.sh())
payload = shellcode + (buffer_to_ret_address_offset - \
      len(shellcode)) * "A" + p32(buffer_start)

# Send payload to overwrite return address with buffer
# start address (buffer stores shellcode).
io.send(payload)

# Do recv if required and other ping-pong with the vulnerable program.
...

# Turn interactive and use the shell.
io.interactive()
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CNSO CTF crunch
The Metasploit Project
- http://www.metasploit.com/
- metasploit framework (open source) + metasploit project
- penetration testing platform
- ships with hundreds of exploits (payloads)
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CNSO CTF crunch Keywords

- shellcode data
- jump-call trick
- alphanumeric shellcode
- environment variable
- string format attack
- return-to-libc
- pwntools
- shellcraft
- data packing
- pwntools tubes

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Keywords

- shellcode data
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CNSO CTF crunch Useful Links
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- http://www.shell-storm.org/shellcode/
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References

- The Ethical Hacker's Handbook, 3rd Edition
  - Chapter 13 & 14
- A Guide to Kernel Exploitation
  - Chapter 1: From User-Land to Kernel-Land Attacks
- The Art of Exploitation, 2nd Edition
  - Chapter 0x500. Shellcode
- Hacking Exposed. Malware and Rootkits
  - Part II: Rootkits
- https://www.win.tue.nl/~aeb/linux/hh/hh-10.html
- https://dhavalkapil.com/blogs/Shellcode-Injection/
- Smashing the Stack for Fun and Profit: http://insecure.org/stf/smashstack.html

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References

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