Format String Vulnerability



Lecture 17

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Countermeasures: Developer

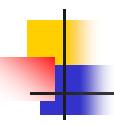
- Format string are used by many other functions
 - e.g., fprintf(), springf(), snprintf(), vprintf(), vfprintf(), vsprintf(), and vsnprintf()
 - those are C functions; other languages have similar functions that use format strings
- Good program habit: avoid using untrusted user inputs for format strings in functions like printf, sprintf, fprintf, vprintf, scanf, vfscanf

```
// Vulnerable version (user inputs become part of the format string):
    sprintf(format, "%s %s", user_input, ": %d");
    printf(format, program_data);

// Safe version (user inputs are not part of the format string):
    strcpy(format, "%s: %d");
    printf(format, user_input, program_data);
```

ask users for <u>data input</u>, but not for <u>code</u>





Countermeasures: Compiler

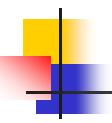
Compilers can detect potential format string vulnerabilities

- use two compilers to compile the program: gcc and clang
- we can see that there is a mismatch in the format string (line ①)
- none of them report line ②
- \$ gcc test_compiler.c
 test_compiler.c: In function main:
 test_compiler.c:7:4: warning: format %x expects a matching unsigned
 int argument [-Wformat]

 \$ clang test_compiler.c
 test_compiler.c:7:23: warning: more '%' conversions than data
 arguments
 [-Wformat]
 printf("Hello %x%x%x\n", 5, 4);
- with default settings, both compilers gave warning for the first printf()
- no warning was given out for the second printf()



1 warning generated.



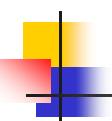
~ 2 warnings generated.

Countermeasures: Compiler

Compilers can detect potential format string vulnerabilities

- use two compilers to compile the program: gcc and clang
- we can see that there is a mismatch in the format string (line ①)
- \$ gcc -Wformat=2 test_compiler.c
 test_compiler.c:7:4: ... (omitted, same as before)
 test_compiler.c:8:4: warning: format not a string literal, argument
 types not checked
 [-Wformat-nonliteral]
 \$ clang -Wformat=2 test_compiler.c
 test_compiler.c:7:23: ... (omitted, same as before)
 test_compiler.c:8:11: warning: format string is not a string literal
 [-Wformat-nonliteral]
 printf(format, 5, 4);
- if we attach –Wformat=2 option in compiler command, both of them warm the developer
 - format string vulnerability





Countermeasures: Address Randomization

- If a program contains a vulnerable printf(), to access or modify the program's state, attackers still need to know the address of the targeted memory
- Turning on address randomization on a Linux system can make the task difficult for attackers, as it is more difficult to guess the right address
- Address Randomization: randomly arranging the memory addresses of key data areas in a process, such as the stack, heap, and libraries, making it harder for attackers to predict and exploit them

