

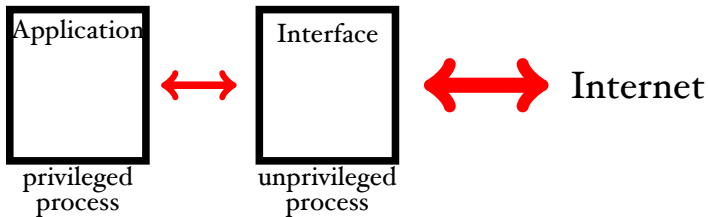
Access Control and Privacy Policies (3)

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Slides: KEATS (also home work is there)

Network Applications: Privilege Separation



- the idea is make the attack surface smaller and mitigate the consequences of an attack
- you need an OS that supports different roles (root vs. users)

Weaknesses of Unix AC

Not just restricted to Unix:

- if you have too many roles (i.e. too finegrained AC), then hierarchy is too complex
you invite situations like...let's be root
- you can still abuse the system...

A “Cron”-Attack

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- root:

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the shell behind the scenes:

```
rm /tmp/dir1/file1 /tmp/dir1/file2 /tmp/dir2/file1 ...
```

this takes time

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mkdir /tmp/a; cat > /tmp/a/passwd
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records that /tmp/a/passwd

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rm /tmp/a/passwd; rmdir /tmp/a;
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```
ln -s /etc /tmp/a
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Buffer Overflow Attacks



lectures so far

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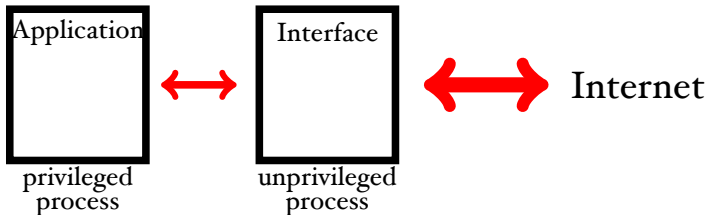


lectures so far



today

Network Applications: Privilege Separation



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Access Control in Unix

- access control provided by the OS
- authenticate principals (login)
- mediate access to files, ports, processes according to **roles** (user ids)
- roles get attached with privileges

The principle of least privilege:
programs should only have as much
privilege as they need

Process Ownership

- access control in Unix is very coarse

$$\frac{\text{root}}{\text{user}_1 \text{ user}_2 \dots \text{www, mail, lp}}$$

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root has $\text{UID} = 0$

you also have groups that can share access to a file

but it is difficult to exclude access selectively

Access Control in Unix (2)

- privileges are specified by file access permissions (“everything is a file”)
- there are 9 (plus 2) bits that specify the permissions of a file

```
$ ls - la
-rwxrw-r--  foo_file.txt
```

Login Process

- login processes run under $\text{UID} = 0$

```
ps -axl | grep login
```

- after login, shells run under $\text{UID} = \text{user}$ (e.g. 501)

```
id cu
```

Login Process

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- non-root users are not allowed to change the UID — would break access control
- but needed for example for `passwd`

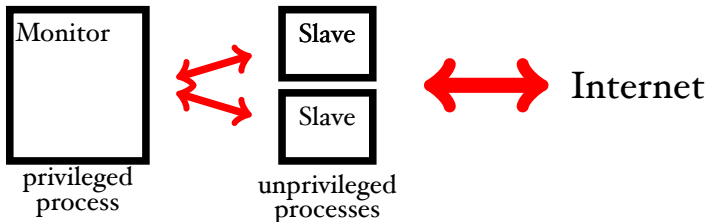
Setuid and Setgid

The solution is that unix file permissions are 9 +
2 Bits: **Setuid** and **Setgid** Bits

- When a file with setuid is executed, the resulting process will assume the UID given to the owner of the file.
- This enables users to create processes as root (or another user).
- Essential for changing passwords, for example.

```
chmod 4755 fobar_file
```

Privilege Separation in OpenSSH



- pre-authorisation slave
- post-authorisation
- 25% codebase is privileged, 75% is unprivileged

Network Applications

ideally network application in Unix should be designed as follows:

- need two distinct processes
 - one that listens to the network; has no privilege
 - one that is privileged and listens to the latter only (but does not trust it)
- to implement this you need a parent process, which forks a child process
- this child process drops privileges and listens to hostile data
- after authentication the parent forks again and the new child becomes the user

Famous Security Flaws in Unix

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```
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it first creates an i-node as root and then changes to ownership to the user's id

(race condition – can be automated with a shell script)

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- for del... (OpenBSD) ... provides a “cor...
Only failure makes us experts. – Theo de Raadt (OpenBSD, OpenSSH)
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one general defence mechanism is
defence in depth

Smash the Stack for Fun...

- “smashing the stack attacks” or “buffer overflow attacks”
- one of the most popular attacks (> 50% of security incidents reported at CERT are related to buffer overflows)

<http://www.kb.cert.org/vuls>

- made popular in an article by Elias Levy (also known as Aleph One):

“Smashing The Stack For Fun and Profit”

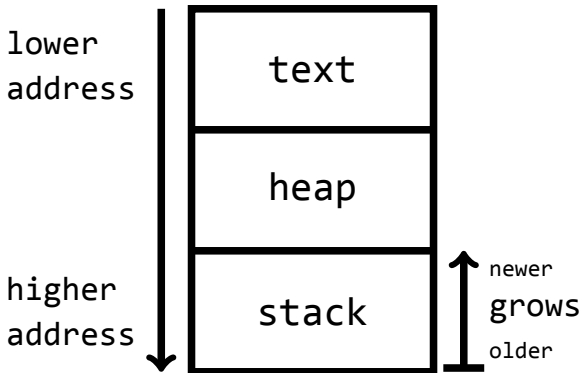
Issue 49, Article 14

A Float Printed “Twice”

```
1 void foo (char *bar)
2 {
3     float my_float = 10.5; // in hex: \x41\x28\x00\x00
4     char buffer[28];
5
6     printf("my float value = %f\n", my_float);
7     strcpy(buffer, bar);
8     printf("my float value = %f\n", my_float);
9 }
10
11 int main (int argc, char **argv)
12 {
13     foo("my string is too long !!!!! ");
14     return 0;
15 }
```

Memory

- each process will get a chunk of memory that is organised as follows:



The Problem

- The basic problem is that library routines in C look as follows:

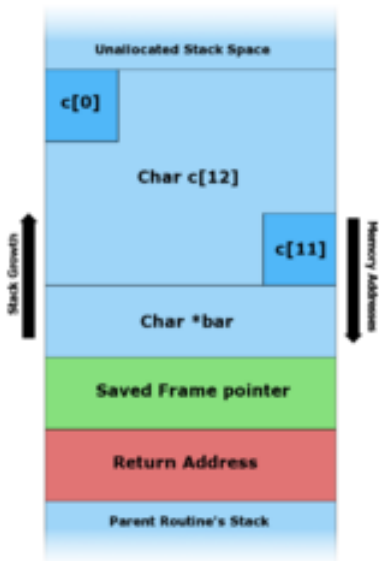
```
1 void strcpy(char *src, char *dst) {  
2     int i = 0;  
3     while (src[i] != "\0") {  
4         dst[i] = src[i];  
5         i = i + 1;  
6     }  
7 }
```

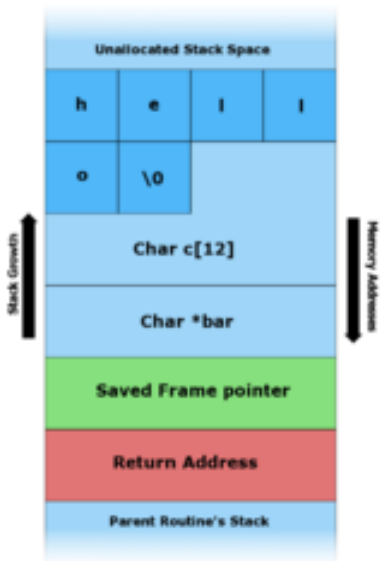
- the resulting problems are often remotely exploitable
- can be used to circumvent all access control (for grooming botnets for further attacks)

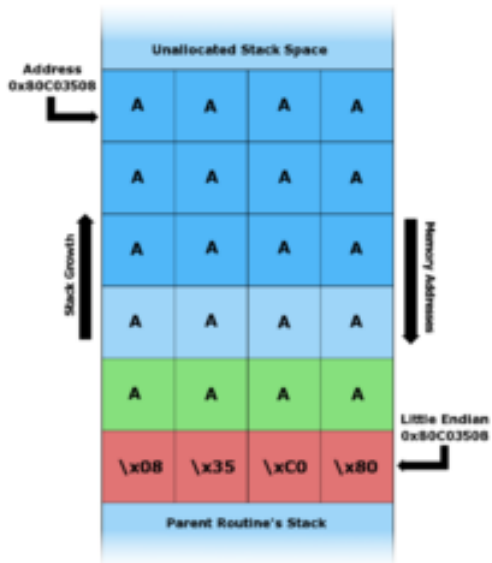
Variants

There are many variants:

- return-to-lib-C attacks
- heap-smashing attacks
(Slammer Worm in 2003 infected 90% of vulnerable systems within 10 minutes)
- “zero-days-attacks” (new unknown vulnerability)







```
1  int match(char *s1, char *s2) {
2      while( *s1 != '\0' && *s2 != '\0' && *s1 == *s2
3          s1++; s2++;
4      }
5      return( *s1 - *s2 );
6  }
7
8  void welcome() { printf("Welcome to the Machine!\n"); }
9  void goodbye() { printf("Invalid identity, exiting\n"); }
10
11 main(){
12     char name[8];
13     char pw[8];
14
15     printf("login: ");
16     get_line(name);
17     printf("password: ");
18     get_line(pw);
19
```

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- the idea is you store some code to the buffer
- you then override the return address to execute this payload
- normally you start a root-shell
- difficulty is to guess the right place where to “jump”

Payloads (2)

- another difficulty is that the code is not allowed to contain `\x00`:

```
xorl %eax, %eax
```

```
1 void strcpy(char *src, char *dst) {  
2     int i = 0;  
3     while (src[i] != "\0") {  
4         dst[i] = src[i];  
5         i = i + 1;  
6     }  
7 }
```

Format String Vulnerability

string is nowhere used:

```
1  #include<stdio.h>
2  #include<string.h>
3
4  // a program that "just" prints the argument
5  // on the command line
6
7
8  main(int argc, char **argv)
9  {
10     char *string = "This is a secret string\n";
11
12     printf(argv[1]);
13 }
```

this vulnerability can be used to read out the stack

Protections against Buffer Overflow Attacks

- use safe library functions
- stack canaries
- ensure stack data is not executable (can be defeated)
- address space randomisation (makes one-size-fits-all more difficult)
- choice of programming language (one of the selling points of Java)

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- Integrity (prevent unwanted modification or tampering)
- Availability and reliability (reduce the risk of DoS attacks)

Homework

- Assume format string attacks allow you to read out the stack. What can you do with this information?
- Assume you can crash a program remotely. Why is this a problem?