Access Control and Privacy Policies (3)

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Slides: KEATS (also home work is there)

first lecture

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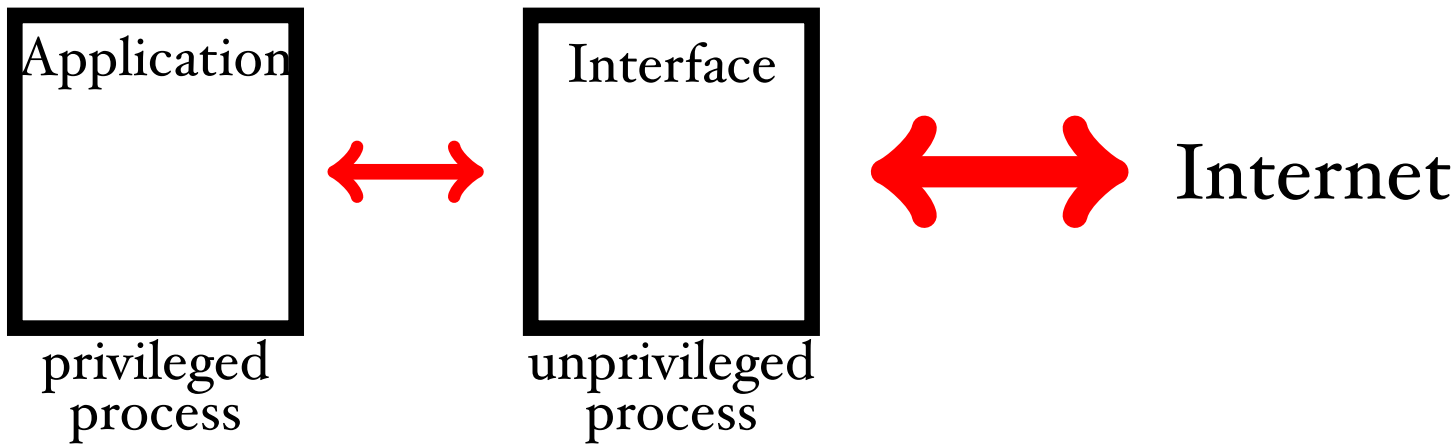
today

Network Applications: Privilege Separation



- the idea is make the attack surface smaller and mitigate the consequences of an attack

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

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

root has UID = 0

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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 UID = 0

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

- after login, shells run under UID = user (e.g. 501)

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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

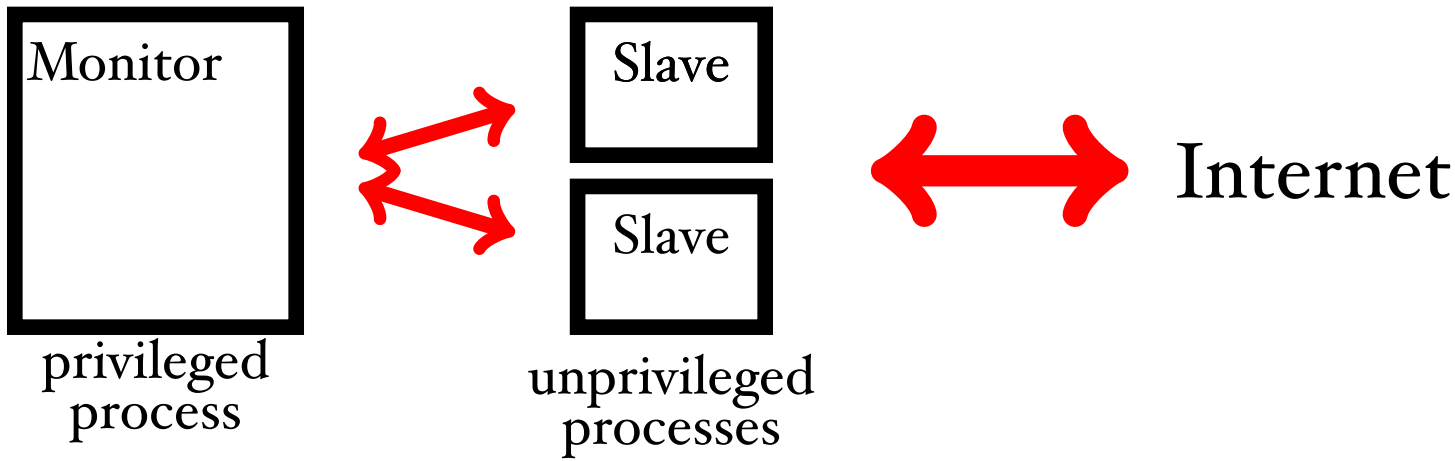
The solution is that unix file permissions are 9 + 2 Bits: Setuid and Setgid Bits

- 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

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-rwxr-xr-x 1 root wheel /bin/mkdir
```

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

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> Only failure makes us experts. – Theo de Raadt (OpenBSD, OpenSSH)

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

A "Cron"-Attack

1. **attacker** (creates a fake passwd file)
   mkdir /tmp/a; cat > /tmp/a/passwd
2. **root** (does the daily cleaning)
   rm /tmp/*/*

   records that /tmp/a/passwd

   should be deleted, but does not do it yet
3. **attacker** (meanwhile deletes the fake passwd file, and establishes a link to the real passwd file)
   rm /tmp/a/passwd; rmdir /tmp/a;
   ln -s /etc /tmp/a
4. **root now deletes the real passwd file**

A "Cron"-Attack

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   mkdir /tmp/a; cat > /tmp/a/passwd
2. ro
   rm

To prevent this kind of attack, you need additional policies (don't do such operations as root).

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3. attacker (meanwhile deletes the fake passwd file, and establishes a link to the real passwd file)
   rm /tmp/a/passwd; rmdir /tmp/a;
   ln -s /etc /tmp/a
4. root now deletes the real passwd file

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 }
```

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  }
```

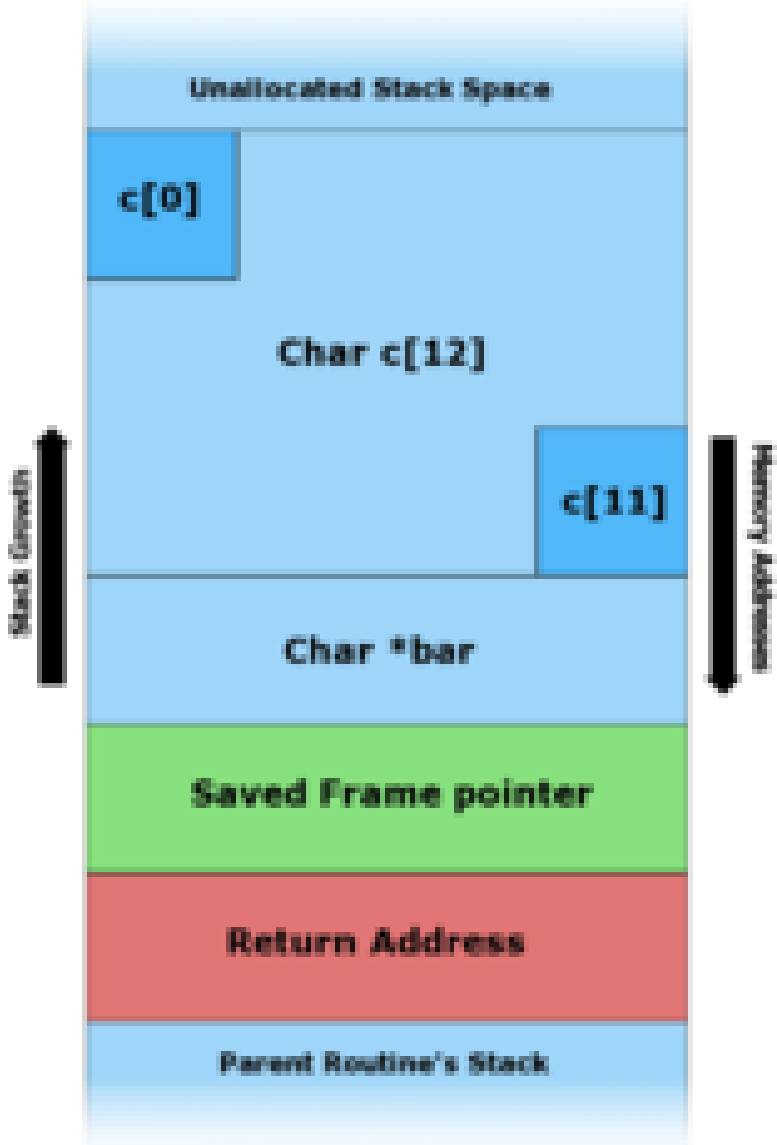
- the resulting problems are often remotely exploitable
- can be used to circumvents all access control (for grooming botnets for further attacks)

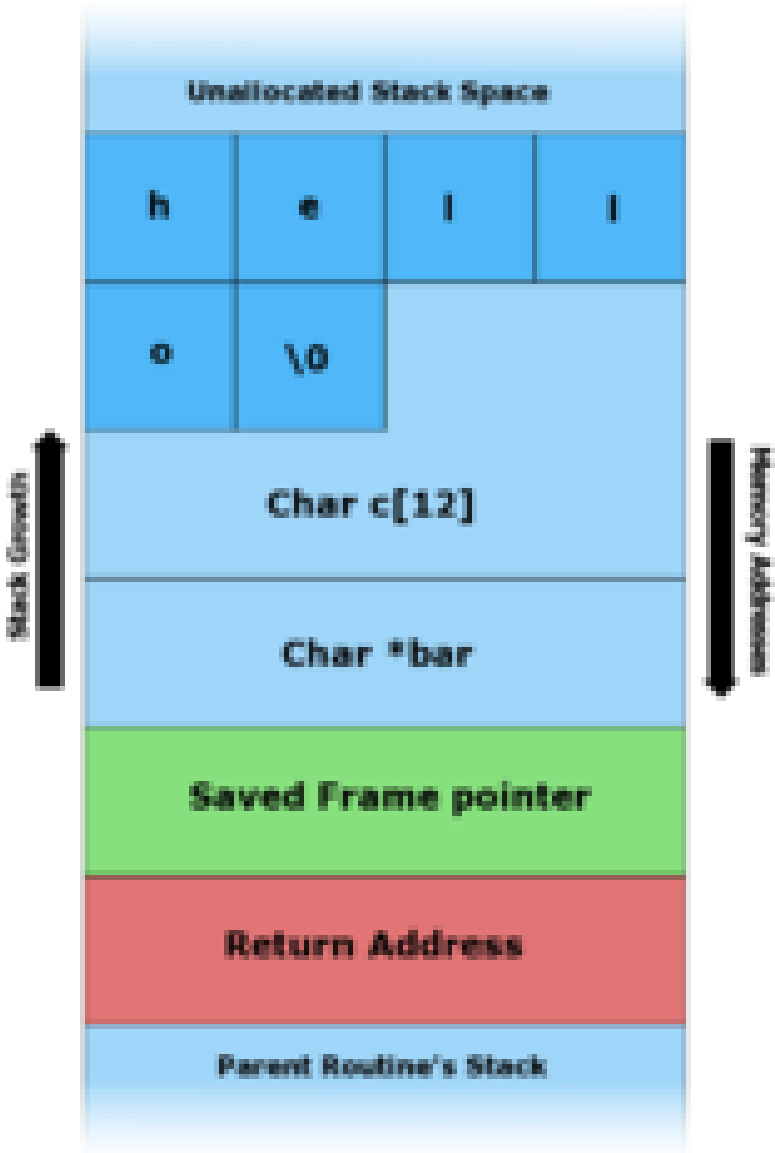
Variants

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)


Unallocated Stack Space
c[0]
Char c[12]
c[11]
Char *bar
Saved Frame pointer
Return Address
Parent Routine's Stack
Stack Growth
Memory Addresses


Unallocated Stack Space
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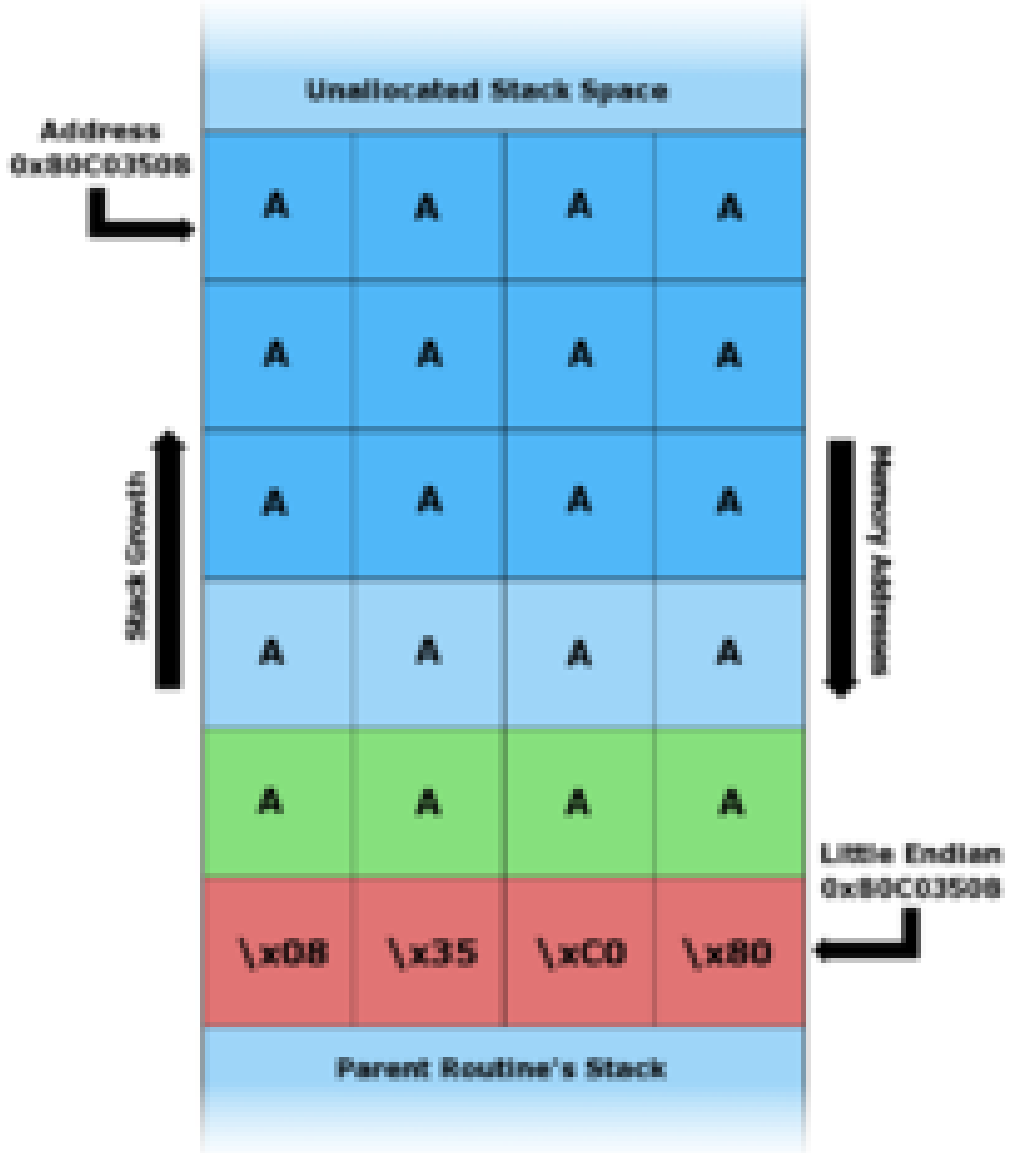
Unallocated Stack Space
Address
0x80C03508
A
A
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A
A
\x08
\x35
\xC0
\x80
Parent Routine's Stack
Stack Growth
Memory Addresses
Little Endian
0x80C03508

```
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"); exit(0); }
9  void goodbye() { printf("Invalid identity, exiting!\n"); exit(1); }
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
20   if(match(name, pw) == 0)
21     welcome();
22   else
23     goodbye();
24 }
```

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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

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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 caneries
- 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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- Authenticity (needed for access control)
- 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?