## 5. User Identities



## Users and Groups

unique identifier for each user is a *numeric UID* (user id),

UID=0 is super user, usually called `root`

a user is member of one or more groups

one group is the principal group, the one found in `/etc/passwd`
this group is used as group owner for files the user created, unless he uses `newgrp`

other group memberships are located in `/etc/group`



## Which UIDs do processes have?

- RUID: real User–ID
  who starts the process
  this is also inherited from parent processes
- EUID: effective User–ID
  decides about access to system ressources

these two are different only if setuid–bit set

```
-r-sr-xr-x  2 root  wheel  5828 Jan 12 08:41 /usr/bin/passwd
```

this is controlled by the system call `execve()`



## Who am I?

Which UID do I have? Command Shell:

```
$ id
uid=2030(sysi30) gid=1000(stud) groups=1000(stud)
```

Which UID do I have? C–program:

```
uid_t u; /* this usually is a 16--bit--integer */
u=getuid();
```

There is a command

```
$ who am I
```

but it doesn't really show who I am ...

```
root             ttyp1    Jun 13 23:20 (localhost)
```

... but who that terminal belongs to.

## Changing UIDs within a process (1)

Why should we want to do that?

- permission issues that are not solved by the filesystem
- security *principle of least privilege*



## Changing UIDs within a process (2)

- from the command–shell: use command `su`
  - need username + password
  - with option ,,–" simulate login
- from a C–program: use functions `setuid()`, `seteuid()`
  - process has real UID and effective UID
  - only allowed to switch between original RUID and EUID
  - this is implemented storing the EUID on startup in a third (hidden) *saved UID*

set(e)uid() fails, if... `the user is not the super user and the ID specified is not the real, effective ID, or saved ID.`



## su–command, simulating login

```
# su dweber
[t] u@h(#)#


# su - dweber
[13:38:44] dweber@isl-c-01(1)$
```



## Managing UIDs: Programmer's View

functions that work with UIDs

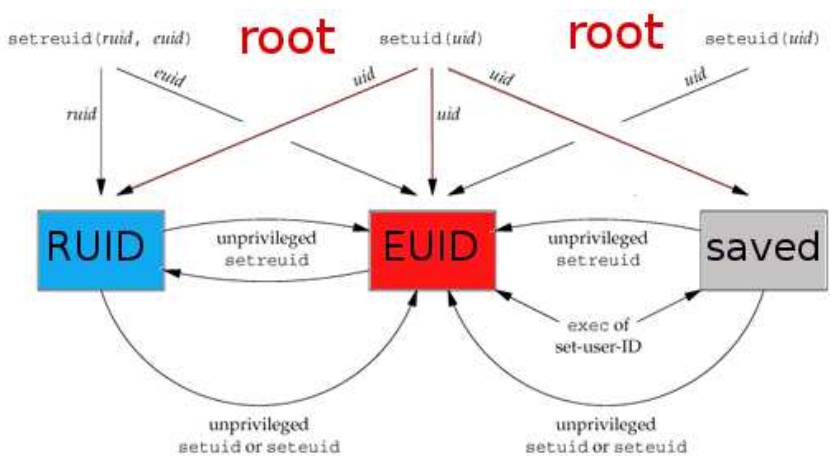
`setuid()` different historical implementations

⇝*setuid mess*, read article

`http://yarchive.net/comp/setuid_mess.html`

| | |
|---|---|
| `getuid()` | return real UID |
| `geteuid()` | return effective UID |
| `setuid()` | set effective UID (root: EUID+RUID) |
| `seteuid()` | set effective UID |
| `setreuid()` | set real and effective UID |

## Managing UIDs: Programmer's View (2)






## Managing UIDs: Programmer's View (3)

consequence/portability:

- use *seteuid()* whenever possible
- use *setuid()* to drop all privileges



## /etc/passwd Entries: Programmer's View




## Managing Users: Files (Linux/Solaris)

- user database is `/etc/passwd`

```
root:x:0:0:root,,,:/root:/bin/bash
ftpadmin:x:1004:1003:FTP Administrator:/home/ftp:/bin/tcsh
ftp:x:40:2:ftp account:/usr/local/ftp:/bin/true
user1:x:1001:1000:Some User:/home/user1:/bin/bash
```

```
name  x UID   GID description home dir   shell
```

*note: a user may change his default shell by* `chsh`.

- encrypted passwords are stored in `/etc/shadow`

```
user1:PkEZq9UQ/d9v.:11991:0:99999:7:::
user2:Ye4OQU1rqln8s:11992:0:99999:7:::
user3:aeFRGxtgxth.s:12064:0:99999:7:::
user4:KsiYtUF6aGDUQ:12123:0:99999:7:::
```

```
name, encrypted passwd, password aging info
```

## Managing Users: Files (BSD)

- user database is /etc/master.passwd

```
-rw-------  1 root  wheel  /etc/master.passwd
root:$1$8Mj4lzRQ$...:0:0::0:0:Charlie &:/root:/bin/csh
toor:*:0:0::0:0:Bourne-again Superuser:/root:
daemon:*:1:1::0:0:system processes:/root:/usr/sbin/nologin
user1:*:1000:1000::0:0:System &:/:/bin/csh
```

```
name  PWD UID   GID class pwd-change expire descr. home dir shell
```

- copy w/o passwords is stored in /etc/passwd

```
-rw-r--r--  1 root  wheel  1357 Mar 12 12:35 /etc/passwd
root:*:0:0:Charlie &:/root:/bin/csh
toor:*:0:0:Bourne-again Superuser:/root:
daemon:*:1:1:system processes:/root:/usr/sbin/nologin
user1:*:1000:1000:System &:/:/bin/csh
```



## The Password Encryption/Hash

iterated versions of the following encryption– or hash–methods

- DES cipher:
  encrypt 000...0
  with key = password (25 iterations)
- Blowfish cipher
- MD5 hash (1000 iterations)
- SHA–256 hash
- SHA–512 hash


see manual page `crypt(3)` for more information



## Examples

outdated DES is default method (and fallback) for passwords

```
openssl passwd -salt AbCdEfG secret_password
Warning: truncating password to 8 characters
AbKLsS6u5sAh6
```

several systems today use MD5

```
openssl passwd -1 -salt AbCdEfG secret_password
$1$AbCdEfG$PPiziSx3vbgV1HnIvpJAZ0
```



## Attacks

invert Hashing / Encryption
⇝analyze algorithm, very hard (crypto research topic)

dictionary attack (variations of dictionary words)

brute force (= exhaustive search)

## Dictionary Attack

```
Aachen          250d6e3dc34afb195271904349fcf790
Aachener        bb6fae8a70240eb9f26b0c8a53345d08
Aachenerin      107b911e2cec78856a4676ea3ce16f92
Aachenerinnen 657b25a7aff45f9434c36d4b1479cde3
Aachenern       6bc4b0cbdda46a3c30b19d3a1a6fbf5c
...
zytotoxischer 9b64262fe97427370242dbc4061722ba
zytotoxisches 1efec802b37771252068b36ee1ce0067
zzgl            71832d182a57a01f13b11014a1264cf7
```

135,000 words in German Duden ($2^{17}$)



## Brute Force Attack

```
00000000000000000000000000000000
00000000000000000000000000000001
00000000000000000000000000000002
00000000000000000000000000000003
00000000000000000000000000000004
...
ffffffffffffffffffffffffffffffff
```

$2^{128}$ bit strings of length 128



## Defenses

against inverting: strong cryptographic hash

against dictionary/brute force:

- salt
- long passphrases / special characters
- * CPU–/RAM–intensive operation (GPUs have small RAM)
- password shadowing
- per user files (`/etc/tcb`), in OpenWall Linux, 2005

(*) proposal from OpenBSD: bcrypt



## Other Authentication Methods (1/2)

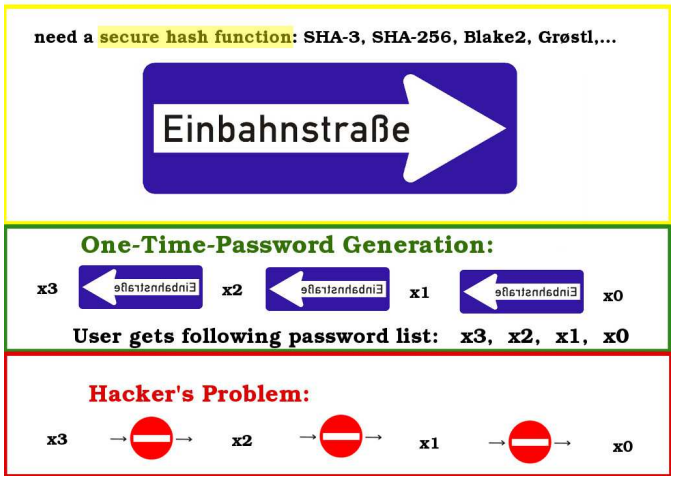
- Challenge/Response
  - server sends $x$, client sends $MD5(x + pass)$ to server
  - used in APOP, POP3–authentication
  - attacked in 2008 (Leurent)
  - drawback: clear-text passwords on the server
- One–Time-Passwords
  - a random password list (strong PRNG needed)
  - used in PIN/TAN, S/Key, OPIE
  - OPIE (library) *One time Passwords In Everything*
  - drawback: store password lists

## Other Authentication Methods (2/2)

- Public–Key–Crypto
  - used in SSH
  - explained later in this course
- Secure Remote Password protocol
- Kerberos ticket–granting–ticket



## A Note on Secure One–Time–Passwords and TANs (1)






## A Note on Secure One–Time–Passwords and TANs (2)

Implementation:

- INIT: system stores $x_4$
- the user enters $x_3$ as his first password
- the system compares $h(x_3) = x_4$, if unequal, permission denied
- the system stores $x_3$
- next time the user enters $x_2$
- the system compares $h(x_2) = x_3$, ...

⇝system does not need to store the whole list, only the last used password



## Other Password Use Cases than Login

⇝key–derivation function transforms password into key

- disk encryption
- securing ZIP–, RAR–files
- wireless networks (WPA2)
- GPG, PGP e–mail encryption
- password vaults

## Which Future Key–Derivation–Function?

GPU– and ASIC–unfriendly, the brute–force–attacking devices

- not 32–bit–based
- huge memory requirements (more than a GPU–thread can handle)
- lots of data dependent branching (no similar results in each thread)

$\rightsquigarrow$not necessarily standard hash functions ($\rightsquigarrow$scrypt?)

May 2014:
specialized ASIC mining hardware for scrypt-based cryptocurrencies.