If Data is Non-Alterable and Confidential but not Available

,,Your message with authenticator

`08931281763e1de003e5f930c449bf791c9f0db6`

has been received, but unfortunately the server is down.

Your mail-service will never be accessible."

Example: lavabit.com, Snowden's e-Mail-Provider

Authorization: Who is Allowed to Do All This?

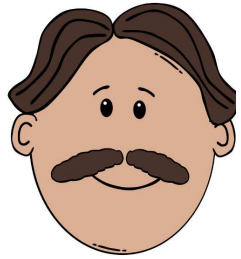
Authorized entities only.

Only **Bob** *is allowed to enter here.*

We have to identify persons, processes and their roles.

Problem: Person/Process/Role $\Longleftrightarrow$ String (1)

Person identified by picture



this is Bob

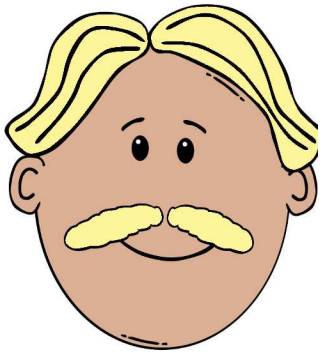
String identified by equality relation.

Problem: Person/Process/Role $\Longleftrightarrow$ String (2)

How to link a person to a string?

- Person knows something (password, secret cryptographic key).
- Person has something (token, USB–key, chipcard).
- Person is something (biometrics, fingerprint etc.).

Proof of Identity is Called Authentication



Proof of Identity: Links Person to a String

Third party guarantees real identity. **Has** something: ID–card.

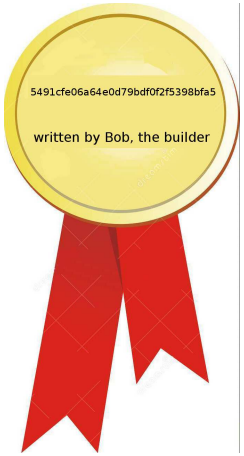
Proof of True Source is Called Authenticity

Authentic Messages

depends on **author (key) and message**

Either symmetric: *Message authentication code*

Or by public key: *Digital signature*



Management of a Computer System

the user of a computer system needs

- reliability of his processes
- security of his data
- access to the attached devices
- access to the network

⇝job of system administrator

What this course is about...

1. UNIX Philosophy
2. Files / Inodes
3. Shell
4. Processes
5. User Identities
6. File System
7. Network
8. Kernel & Booting
9. Security Issues
10. Local Security
11. Network Security

Literature

- FreeBSD Handbook
  `http://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/`
- the manual pages of the FreeBSD system, for example
  `man security`
- the Internet
  `sans.org, schneier.com, www.heise.de/security/`

Parts of an OS

An operating system consists of software to enable

- process management
- memory management
- file system
- input/output

of a computer system.

UNIX History

"...the number of UNIX installations has grown to 10,

with more expected..."

- Dennis Ritchie and Ken Thompson, June 1972

1973 first UNIX system by AT&T

1979 UNIX V6 (1BSD) with C, UUCP, Bourne Shell

1980 Microsoft: Xenix

1984 U. of California (Berkeley): 4.2BSD with TCP/IP

1986 U. of California (Berkeley): 4.3BSD with DNS and NFS

1987 MIT: X11 ($\rightsquigarrow$ XFree86 $\rightsquigarrow$ X.org)

1991 U. of California (Berkeley): stop financial support of BSD

1991 386BSD splits into FreeBSD and NetBSD

1991 Linus Torvalds: Linux

1993 Novell buys AT&T UNIX Lab

1993 FreeBSD 1.0

1994 Linux 1.0

1995 OpenBSD splits from NetBSD (security)

...

2005 X.org splits from XFree86 (license debate)

...

2008 OpenSolaris

...

2010 Linux 2.6.33.2, FreeBSD 8.1, OpenBSD 4.7, NetBSD 5.0.2

...

2012 Linux 3.3.2, FreeBSD 9.0, OpenBSD 5.1, NetBSD 5.1.2

...

2015 Linux 3.19.5, FreeBSD 10.1, OpenBSD 5.7, NetBSD 6.1.5

UNIX Features

- multi–tasking
- multi–user
- virtual memory
- portable (written in C)
- symmetric multiprocessing (SMP)

UNIX Standards

Consortium OpenGroup `www.opengroup.org`

- Capgemini (Netherlands)
- Hewlett-Packard (USA)
- IBM (USA)
- SAP (Germany)
- Shenzhen Kingdee Middleware (China)
- Sun Microsystems (USA)

POSIX (since 1988) `en.wikipedia.org/wiki/POSIX`

$\rightsquigarrow$(since 2003) Opengroup+POSIX = Single UNIX Specification UNIX03

Virtual Memory

```
If it's there, and you can see it, it's real.

If it's not there, and you can see it, it's virtual.

If it's there, and you can't see it, it's transparent.

If it's not there, and you can't see it, you erased it.

- IBM, 1978, on virtual memory
```


Philosophy

```
"It is not UNIX's job to stop you from shooting your foot.

If you so choose to do so,

then it is UNIX's job

to deliver Mr. Bullet to Mr Foot

in the most efficient way it knows."

-- Terry Lambert
```

UNIX Basic Commands

`cp`	copy files
`mv`	move/rename files
`rm`	remove files
`cat`	show file contents
`more`	show file pagewise
`less`	show file pagewise
`gzip/gunzip`	compress files
`bzip2/bunzip2`	compress files
`tar`	create/extract file archive
`head`	show first lines of files
`tail`	show last lines of files

General Structure

```
command options files
```

Options are preceded by a *hyphen*: `-a -b -c ...`

Files are denoted by name or pattern

Patterns contain a

- "?" for an arbitrary character
- "*" for an arbitrary string

Manual pages contain possible options

Manual Pages

```
section meaning
    1   Shell commands (tools, utilities) [ls]
    2   System calls (kernel functions) [open]
    3   Library calls (C library functions) [sqrt]
    4   Device Drivers [lp]
    5   File formats [/etc/passwd]
    6   Games
    7   Macro packages and conventions [man, groff]
    8   System administration commands [mount]
    9   (BSD) Kernel internals [suser]
```

Manual pages are searched in this order – first match is displayed.

Manual pages are located in `/usr/share/man/`

```
man -t grep > grep.ps   # Save the PostScript version to a file
```


Manual Page: Example

```
TOUCH(1)       FreeBSD General Commands Manual          TOUCH(1)

NAME
     touch -- change file access and modification times

SYNOPSIS
     touch [-acfhm] [-r file] [-t [[CC]YY]MMDDhhmm[.SS]] file ...

DESCRIPTION
     The touch utility sets the modification and access times of files
     to the current time of day.  If the file doesn't exist, it is created
     with default permissions.
```

Manual Page: Example

```
OPEN(2)       FreeBSD System Calls Manual        OPEN(2)

NAME
     open -- open or create a file for reading or writing

LIBRARY
     Standard C Library (libc, -lc)

SYNOPSIS
     #include <fcntl.h>

     int
     open(const char *path, int flags, ...);
```


Manual Page: Example


```
ASCII(7) FreeBSD Miscellaneous Information Manual    ASCII(7)

NAME
    ascii -- octal, hex and decimal ASCII character sets

...
00 NUL   01 SOH   02 STX   03 ETX   04 EOT   05 ENQ   06 ACK   07 BEL
08 BS    09 HT    0A NL    0B VT    0C NP    0D CR    0E SO    0F SI
10 DLE   11 DC1   12 DC2   13 DC3   14 DC4   15 NAK   16 SYN   17 ETB
18 CAN   19 EM    1A SUB   1B ESC   1C FS    1D GS    1E RS    1F US
20 SP    21  !    22  "    23  #    24  $    25  %    26  &    27  ’
28  (    29  )    2a  *    2b  +    2c  ,    2d  -    2e  .    2f  /
30  0    31  1    32  2    33  3    34  4    35  5    36  6    37  7
38  8    39  9    3a  :    3b  ;    3c  <    3d  =    3e  >    3f  ?
40  @    41  A    42  B    43  C    44  D    45  E    46  F    47  G
48  H    49  I    4a  J    4b  K    4c  L    4d  M    4e  N    4f  O
50  P    51  Q    52  R    53  S    54  T    55  U    56  V    57  W
58  X    59  Y    5a  Z    5b  [    5c  \    5d  ]    5e  ^    5f  _
60  ‘    61  a    62  b    63  c    64  d    65  e    66  f    67  g
68  h    69  i    6a  j    6b  k    6c  l    6d  m    6e  n    6f  o
70  p    71  q    72  r    73  s    74  t    75  u    76  v    77  w
78  x    79  y    7a  z    7b  {    7c  |    7d  }    7e  ~    7f DEL
...
```


Manual Page: Structure

NAME

SYNOPSIS

DESCRIPTION

OPTIONS (Linux)

FILES

EXAMPLES (BSD)

SEE ALSO

BUGS

COMPATIBILITY (BSD)

STANDARDS (BSD)

HISTORY (BSD)

AUTHOR (Linux)

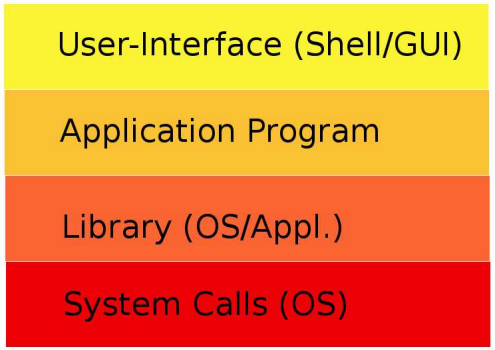
UNIX Design (Files)

- everything *is a file*, which means, *has a file interface*
  - plain files
  - directories
  - devices
  - main memory
  - ...
- users are contained in groups
- files are owned by a user and a group
- there is *one* super–user with special privileges

UNIX Design (Processes)

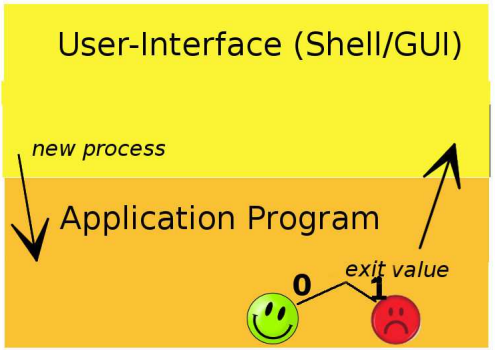
- a program is an executable file, this can be
  - a compiled program (from non–executable source C, C++)
  - an interpreted program (JAVA, Shell, Perl,...)
    but Shell, JAVA–, Perl–Interpreter are compiled programs
- a process is a program currently executed by a processor
- a process uses code of the programmer, C–library, operating system
- a process returns the value ...
  - 0 in case of success $\rightsquigarrow$*true*
  - > 0 and ≤ 255 in case of failure $\rightsquigarrow$*false*
- processes are owned by the user starting it, group owner of the process is the user's login group
- processes manipulate files
- the process table may be viewed using the command
  ps (process status)

Process: Layer-Model



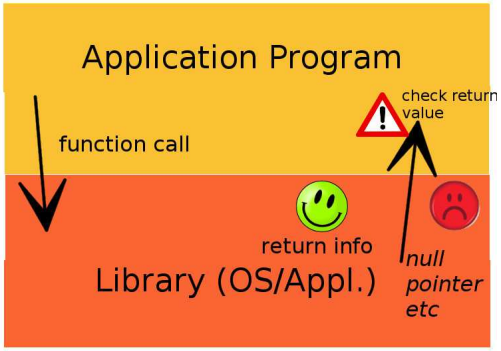
- delegate responsibility
- simplify bug fixes
- discourage reinventing the wheel

Process: Starting Other Processes



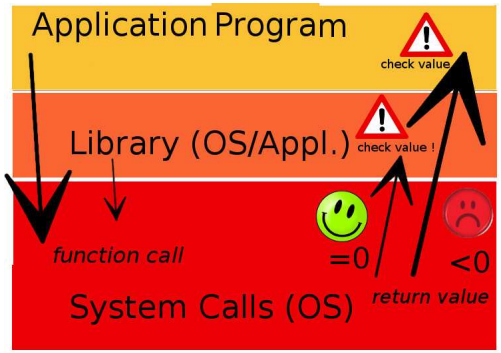
- processes are created by OS
- termination is accompanied by **exit value** $\rightsquigarrow$must be **checked**

Process: Programs Calling Libraries



- functions are called
- termination is accompanied by **return value** ⇝must be **checked**

Process: Programs/Libraries Calling System Interface



- system calls (functions) are called
- termination is accompanied by **return value**
- return value **must be** checked for < 0

Errors on System Call

The system call returns –1.

CHECK ALL RETURN VALUES OF ALL FUNCTION CALLS!

The system call sets a global variable `int errno`.

The global variable `errno` is defined in `errno.h`.

All possible values of `errno` are given by constants starting with `E`:
`ENOMEM, EACCES, EINVAL,...`

An error text for `errno` may be printed with `perror()`.

A string containing the error text may be created with `strerror()`.