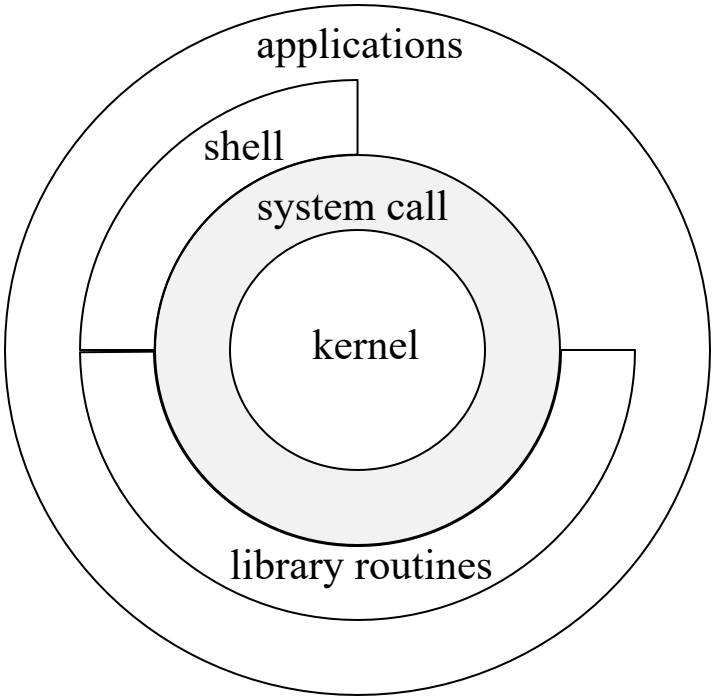
Unix System Overview

Unix architecture

- Architecture of UNIX operating system



Kernel : SW to control the HW resources &
provide a program execution environment

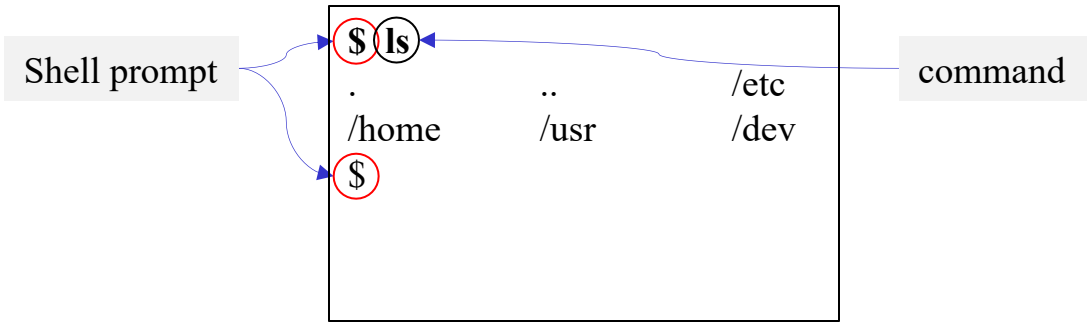
Logging in

- Login
  - UNIX is a multi-user system
  - Thus, log in to a UNIX system with “login name + password”
  - Search the login name in /etc/passwd file composed with
    login_name:password:UID:GID:comment:home_directory:shell

```
login as: kwon
kwon@sp.ulsan.ac.kr's password:
```

Shell

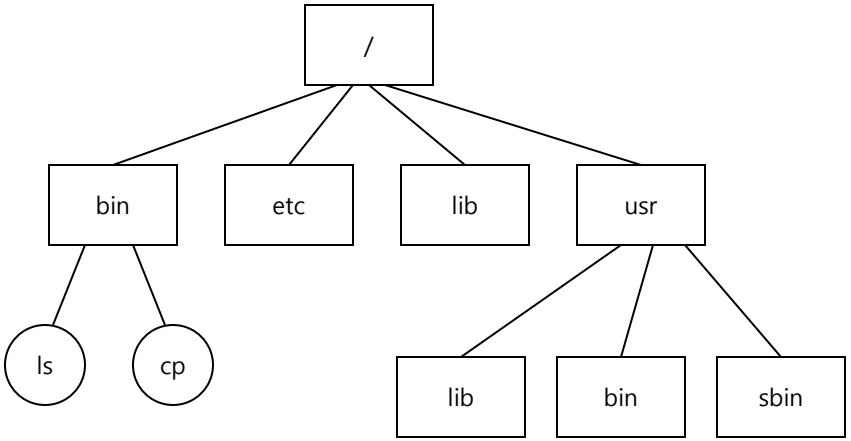
- Shell
  - A command-line interpreter that reads user input & executes commands



  - Shell types
    - Bourne shell, C shell, Korn shell, Tenex C shell, Born Again shell

File system

- UNIX File system
  - File
  - Directory
    - Set of directory entries(file name + attribute pointer)



Hierarchical structure

File system

- Attribute
  - Per file data structure
  - Type, size, owner, permission, access time, etc.

```
$ ls -al
drwxr-xr-x  13 kwon users   4096 Apr  5 12:39 .
drwxr-xr-x  32 kwon users   4096 Nov 15 23:38 ..
-rw-r--r--   1 kwon users     20 Oct 13  2004 Readme
drwxr-xr-x   2 kwon users   4096 Oct 13  2004 adir
$
```

File system

- Filename
  - Excluding the NULL character and ‘/’
  - BSD restricts the filename to 255 chars.
  - Special filenames
    - . (current directory)
    - .. (parent directory)

File system

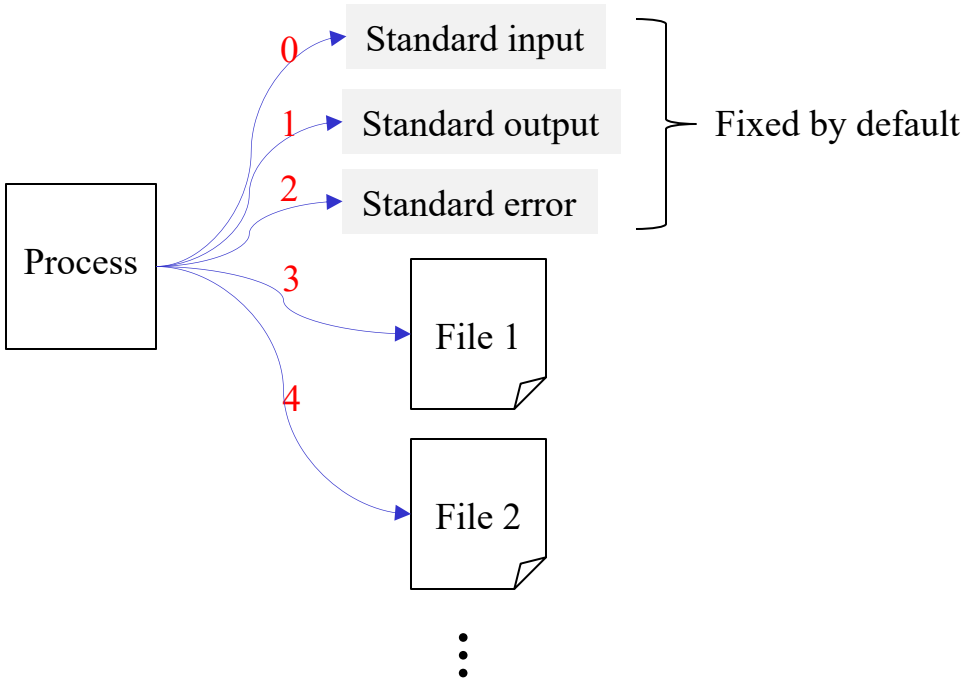
- Pathname
  - Absolute pathname vs. Relative pathname
  - /home/obama ➔ home directory (at login time)
  - /home/obama/test ➔ working directory

```
$ pwd
/home
$ cd obama          relative path
$ pwd
/home/obama
$ cd /usr/bin       Absolute path
$ pwd
/usr/bin
$ cd
$ pwd
/home/obama
$
```

```
% cd ~          // is equivalent to 'cd'
% cd -          // is equivalent to $OLDPWD
```

Input and output

- File descriptor
  - Non-negative integers that the kernel uses to identify the files being accessed by a process



Programs and processes

- Program
  - An executable file residing on disk
- Process
  - An executing instance of a program (also called task)
  - Process id: a unique numeric identifier for process

```
% ps
  PID  TTY          TIME CMD
24098 pts/2    00:00:00 bash
24162 pts/2    00:00:00 ps
```

Error handling

- When an error occurs,
  - A negative value is often returned
  - errno is set to a value that gives additional information
    - E.g. open() returns -1 if an error occurs
    - error from open() has 15 possible errno values
      - file doesn't exit, permission problem, …
  - <errno.h> (e.g. /usr/include/asm-generic/errno-base.h)
    - Defines errno symbols and constants for each error.
    - Each constant begins with the character E.
      - E.g. ENOENT, EACCESS, …

Error handling

```
#include <string.h>
char *strerror(int errnum);
/* maps errnum(errno value) into an error message string & returns a pointer to the string */
```

```
#include <stdio.h>
void perror(const char *msg);          /* outputs the string pointed to by msg */
                                       /* output format "string pointed by msg: error message" */
```

Example) strerror & perror

```
#include "apue.h"
#include <errno.h>

int main(int argc, char *argv[])
{
        fprintf(stderr, "EACCES: %s\n", strerror(EACCES));
        errno = ENOENT;
        perror(argv[0]);
        exit(0);
}
```

FYI)
"apue.h" is widely used in APUE textbook.
- It includes some standard system headers, constants, and function prototypes.

```
$ ./a.out
EACCES: Permission denied
./a.out: No such file or directory
```

User identification

- user ID
  - a numeric value that identifies the user
  - is assigned by the system administrator.
  - 0: superuser or root
- group ID
  - is used to collect users together into projects.

- If the full ASCII user/group name is used instead?
  - additional disk space will be required.
  - the cost of string comparison for permission check is high.

User identification

- Example) Print userID & groupID

```
#include "apue.h"

int main(void)
{
    printf("uid = %d, gid = %d\n", getuid(), getgid());
    exit(0);
}
```

Running result)

```
$ ./a.out
  uid = 205, gid = 105
```

Signals

- Signal
  - is used to notify a process that some condition has occurred.
  - e.g. if divide by zero, SIGFPE(floating point exception) is sent to the process.

- Action of process received the signal
  - ignore the signal.
  - let the default action occur.
  - execute your own action.

Signals

- Signal Ex.
  - kill

```
$ ps
  PID TTY STAT  TIME COMMAND
28478 pp1 S     0:00 -bash
28616 pp1 R     0:02 yes
28617 pp1 R     0:00 ps
$ kill 28616
$ ps
  PID TTY STAT  TIME COMMAND
28478 pp1 S     0:00 -bash
28624 pp1 R     0:00 ps
[1]  + Terminated            yes > /dev/null
$
```

Time values

- calendar time
  - the number of seconds since the Epoch
    - Epoch is 00:00:00 January 1, 1970.
  - time_t
- process time (CPU time)
  - CPU time used by a process (measured in clock ticks.)
    - clock ticks are 50, 60, 100 ticks/seconds.
  - clock_t

Time values

- Representation of Process time
  - clock time
    - the amount of time the process takes to run
    - depends on the number of other processes being run on the system
  - user CPU time
    - CPU time attributed to user instruction
  - system CPU time
    - CPU time attributed to the kernel

```
$ cd /usr/include
$ time -p grep _POSIX_SOURCE */*.h > /dev/null
real    0m0.81s
user    0m0.11s
sys     0m0.07s
```