

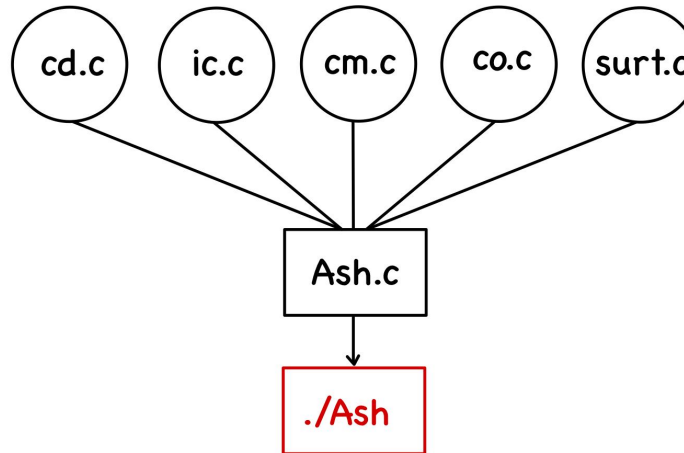
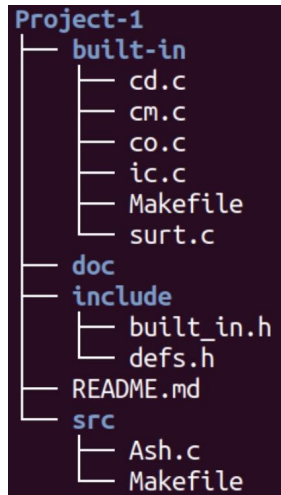
Ash shell



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Operating Systems - iTIC

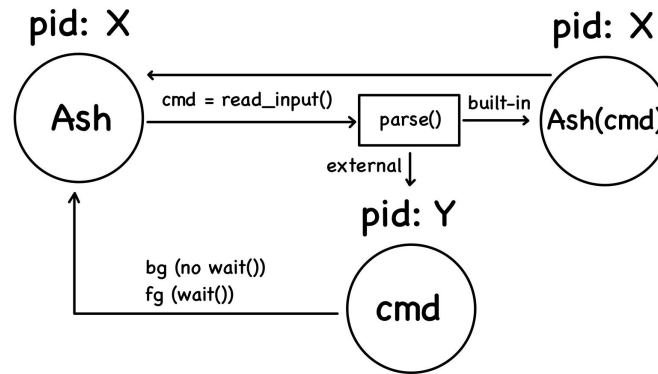
1 - Ash architecture

- Each built-in command will have its `*.c` file including a `built_in.h` header.



1 - Ash architecture

- ❑ For having a more flexible shell with undefined number of arguments, we'll use `getline()` (it uses `malloc()` and `realloc()`).
- ❑ For parsing the input we'll use `strtok()` and `strsep()`.
- ❑ For background processes:



2 - Commands

- ❑ Using *Makefile*, we'll generate the *./Ash* executable file and we'll give the capabilities to be able to execute *chmod()* (*CAP_CHOWN*) and manage the signals of *kill()* (*CAP_KILL*).

```
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ make
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o Ash.o Ash.c
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o ../built-in/cd.o ../built-in/cd.c
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o ../built-in/cm.o ../built-in/cm.c
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o ../built-in/co.o ../built-in/co.c
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o ../built-in/ic.o ../built-in/ic.c
gcc -Wall -std=gnu99 -Os -fshort-enums -c -o ../built-in/surt.o ../built-in/surt.c
gcc -Wall -std=gnu99 -Os -fshort-enums Ash.o ../built-in/cd.o ../built-in/cm.o ../built-in/co.o ../
built-in/ic.o ../built-in/surt.o -o Ash
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ make capabilities
sudo setcap CAP_CHOWN,CAP_KILL+ep ./Ash
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ getcap ./Ash
./Ash = cap_chown,cap_kill+ep
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$
```

2 - Commands

- Running Ash, we can see ic, cd, external commands (ls -la, touch file1), cm:

```
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> ic
Ash.c
Ash
tst.c
Ash.o
.
..
Makefile
% /home/so/OS/OS-Projects/Project-1/src> cd ..
% /home/so/OS/OS-Projects/Project-1> cd
% /home/so> cd OS/OS-Projects/Project-1/src
```

```
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 36
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> touch file1
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 44
drwxrwxr-x 2 so so 4096 dic 12 21:08 .
drwxrwxr-x 5 so so 4096 dic 12 14:07 ..
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rw-rw-r-- 1 so so 0 dic 12 21:08 file1
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> cm file1 0777
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 44
drwxrwxr-x 2 so so 4096 dic 12 21:08 .
drwxrwxr-x 5 so so 4096 dic 12 14:07 ..
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rwxrwxrwx 1 so so 0 dic 12 21:08 file1
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src>
```

2 - Commands

- ❑ We can also see the `co` built-in command.

```
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 36
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rwxrwxrwx 1 so so 0 dic 12 21:08 file1
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> co file1 newuser2
% /home/so/OS/OS-Projects/Project-1/src> touch file2
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 36
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rwxrwxrwx 1 newuser2 so 0 dic 12 21:08 file1
-rw-rw-r-- 1 so so 0 dic 12 21:13 file2
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> co file2 root
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 36
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 6016 dic 12 21:07 Ash.o
-rwxrwxrwx 1 newuser2 so 0 dic 12 21:08 file1
-rw-rw-r-- 1 root so 0 dic 12 21:13 file2
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> █
```

3 - Features

- ❑ No processes are left alive before the Ash parent process dies.

```
so@soVM:~/OS-Projects/Project-1/src$ cat tst.c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main(void) {
    while(1);

    for (int i = 1; i < 11; i++) {
        sleep(1);
        printf("Time: %d\n", i);
    }

    exit(EXIT_SUCCESS);
}

so@soVM:~/OS-Projects/Project-1/src$ cc tst.c
so@soVM:~/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS-Projects/Project-1/src> a.out&
% /home/so/OS-Projects/Project-1/src> a.out&
% /home/so/OS-Projects/Project-1/src> a.out&
% /home/so/OS-Projects/Project-1/src> a.out&
% /home/so/OS-Projects/Project-1/src> a.out&
% /home/so/OS-Projects/Project-1/src> a.out
% /home/so/OS-Projects/Project-1/src> surt
so@soVM:~/OS-Projects/Project-1/src$
```

```
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ ps -ef | grep Ash
so      2094 20437  0 21:22 pts/0    00:00:00 ./Ash
so      2127 21273  0 21:22 pts/1    00:00:00 grep --color=auto Ash
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ ps -ef | grep a.out
so      2100 2094 47 21:22 pts/0    00:00:13 /home/so/OS-Projects/Project-1/src/a.out
so      2103 2094 44 21:22 pts/0    00:00:11 /home/so/OS-Projects/Project-1/src/a.out
so      2104 2094 40 21:22 pts/0    00:00:09 /home/so/OS-Projects/Project-1/src/a.out
so      2108 2094 37 21:22 pts/0    00:00:08 /home/so/OS-Projects/Project-1/src/a.out
so      2111 2094 36 21:22 pts/0    00:00:07 /home/so/OS-Projects/Project-1/src/a.out
so      2120 2094 32 21:22 pts/0    00:00:03 /home/so/OS-Projects/Project-1/src/a.out
so      2131 21273  0 21:22 pts/1    00:00:00 grep --color=auto a.out
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$ ps -ef | grep a.out
so      2144 21273  0 21:22 pts/1    00:00:00 grep --color=auto a.out
so@soVM:~/Desktop/new/OS-Projects/Project-1/src$
```

3 - Features

- ❑ Error handling, we can clearly see that mostly of the errors are handled and displayed on stderr

```
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 28
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> mkdir dir
% /home/so/OS/OS-Projects/Project-1/src> cd mydir
-Ash: cd: No such file or directory
% /home/so/OS/OS-Projects/Project-1/src> rm -rf mydir
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 40
drwxrwxr-x 3 so so 4096 dic 12 21:45 .
drwxrwxr-x 5 so so 4096 dic 12 14:07 ..
-rwxrwxr-x 1 so so 14000 dic 12 21:07 Ash
-rw-rw-r-- 1 so so 3845 dic 12 17:38 Ash.c
drwxrwxr-x 2 so so 4096 dic 12 21:45 dir
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> mv dir tst.c
/bin/mv: cannot overwrite non-directory 'tst.c' with directory 'dir'
% /home/so/OS/OS-Projects/Project-1/src> mv dir dir1
% /home/so/OS/OS-Projects/Project-1/src> mv dir1 dir1
/bin/mv: cannot move 'dir1' to a subdirectory of itself, 'dir1/dir1'
% /home/so/OS/OS-Projects/Project-1/src> lllls
-Ash: lllls: command not found
% /home/so/OS/OS-Projects/Project-1/src> surtt
-Ash: surtt: command not found
% /home/so/OS/OS-Projects/Project-1/src> lss&
-Ash: lss: command not found
% /home/so/OS/OS-Projects/Project-1/src> cd ...
-Ash: cd: No such file or directory
% /home/so/OS/OS-Projects/Project-1/src> mkdir dir1
-Ash: mkdir: command not found
% /home/so/OS/OS-Projects/Project-1/src> mkdir dir1
/bin/mkdir: cannot create directory 'dir1': file exists
% /home/so/OS/OS-Projects/Project-1/src> surt
so@soVM:~/OS/OS-Projects/Project-1/src$
```

```
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 32
-rwxrwxr-x 1 so so 14000 dic 12 21:48 Ash
-rw-rw-r-- 1 so so 3856 dic 12 21:48 Ash.c
drwxrwxr-x 2 so so 4096 dic 12 21:48 hello
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> mkdir mydir28
% /home/so/OS/OS-Projects/Project-1/src> touch mydir3/file.tex
/bin/touch: cannot touch 'mydir3/file.tex': No such file or directory
% /home/so/OS/OS-Projects/Project-1/src> touch mydir2/file.tex
% /home/so/OS/OS-Projects/Project-1/src> ls -l mydir2
total 0
-rw-rw-r-- 1 so so 0 dic 12 21:49 file.tex
% /home/so/OS/OS-Projects/Project-1/src> rm -rf mydir2 &
% /home/so/OS/OS-Projects/Project-1/src> ls -l mydir2
/bin/ls: cannot access 'mydir2': No such file or directory
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 40
drwxrwxr-x 3 so so 4096 dic 12 21:50 .
drwxrwxr-x 5 so so 4096 dic 12 14:07 ..
-rwxrwxr-x 1 so so 14000 dic 12 21:48 Ash
-rw-rw-r-- 1 so so 3856 dic 12 21:48 Ash.c
drwxrwxr-x 2 so so 4096 dic 12 21:48 hello
-rw-rw-r-- 1 so so 713 dic 12 17:38 Makefile
-rw-rw-r-- 1 so so 200 dic 12 17:06 tst.c
% /home/so/OS/OS-Projects/Project-1/src> surt
so@soVM:~/OS/OS-Projects/Project-1/src$
```


3 - Features

- ❑ Ex: With co (capabilities or no username found) and same happens with cm (negative modes ...)

```
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 40
drwxrwxr-x 2 so so 4096 dic 12 22:20 .
drwxrwxr-x 6 so so 4096 dic 12 22:12 ..
-rwxrwxr-x 1 so so 14000 dic 12 22:19 Ash
-rw-rw-r-- 1 so so 3842 dic 12 22:17 Ash.c
-rw-rw-r-- 1 so so 6024 dic 12 22:19 Ash.o
-rw-rw-r-- 1 so so 702 dic 12 22:12 Makefile
% /home/so/OS/OS-Projects/Project-1/src> touch myfile
% /home/so/OS/OS-Projects/Project-1/src> cm myfile 0777
% /home/so/OS/OS-Projects/Project-1/src> co myfile so2
-Ash: co: Operation not permitted
% /home/so/OS/OS-Projects/Project-1/src> make capabilities
sudo setcap CAP_CHOWN,CAP_KILL+ep ./Ash
% /home/so/OS/OS-Projects/Project-1/src> so myfile so2
-Ash: so: command not found
% /home/so/OS/OS-Projects/Project-1/src> co myfile so2
-Ash: co: Operation not permitted
% /home/so/OS/OS-Projects/Project-1/src> surt
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> co myfile so2
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 40
drwxrwxr-x 2 so so 4096 dic 12 22:20 .
drwxrwxr-x 6 so so 4096 dic 12 22:12 ..
-rwxrwxr-x 1 so so 14000 dic 12 22:19 Ash
-rw-rw-r-- 1 so so 3842 dic 12 22:17 Ash.c
-rw-rw-r-- 1 so so 6024 dic 12 22:19 Ash.o
-rw-rw-r-- 1 so so 702 dic 12 22:12 Makefile
-rwxrwxrwx 1 so2 so 0 dic 12 22:20 myfile
% /home/so/OS/OS-Projects/Project-1/src> surt
so@soVM:~/OS/OS-Projects/Project-1/src$
```

```
so@soVM:~/OS/OS-Projects/Project-1/src$ ./Ash
% /home/so/OS/OS-Projects/Project-1/src> rm file2
/bin/rm: cannot remove 'file2': No such file or directory
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 32
-rwxrwxr-x 1 so so 14000 dic 12 22:32 Ash
-rw-rw-r-- 1 so so 3872 dic 12 22:32 Ash.c
-rw-rw-r-- 1 so so 6112 dic 12 22:32 Ash.o
-rw-rw-r-- 1 so so 702 dic 12 22:12 Makefile
% /home/so/OS/OS-Projects/Project-1/src> touch file2
% /home/so/OS/OS-Projects/Project-1/src> ls -l
total 32
-rwxrwxr-x 1 so so 14000 dic 12 22:32 Ash
-rw-rw-r-- 1 so so 3872 dic 12 22:32 Ash.c
-rw-rw-r-- 1 so so 6112 dic 12 22:32 Ash.o
-rw-rw-r-- 1 so so 0 dic 12 22:33 file2
-rw-rw-r-- 1 so so 702 dic 12 22:12 Makefile
% /home/so/OS/OS-Projects/Project-1/src> cm file2
-Ash: cm: Too few arguments given
% /home/so/OS/OS-Projects/Project-1/src> cm file2 -0777
-Ash: cm: Negative mode
% /home/so/OS/OS-Projects/Project-1/src> ls -la
total 40
drwxrwxr-x 2 so so 4096 dic 12 22:33 .
drwxrwxr-x 6 so so 4096 dic 12 22:12 ..
-rwxrwxr-x 1 so so 14000 dic 12 22:32 Ash
-rw-rw-r-- 1 so so 3872 dic 12 22:32 Ash.c
-rw-rw-r-- 1 so so 6112 dic 12 22:32 Ash.o
-rw-rw-r-- 1 so so 0 dic 12 22:33 file2
-rw-rw-r-- 1 so so 702 dic 12 22:12 Makefile
% /home/so/OS/OS-Projects/Project-1/src> co file2 username
-Ash: co: Username not found
% /home/so/OS/OS-Projects/Project-1/src> surt
so@soVM:~/OS/OS-Projects/Project-1/src$
```

4 - POSIX-compliant



```

anassanhari ~ /Desktop/OS-Projects/Project-1/src
➤ .Ash
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src mkdir mydir
mkdir: mydir: File exists
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src rm -r mydir
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src mkdir mydir
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src touch mydir/file
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src cm mydir/file -0777
-Ash: cm: Negative mode
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src cm mydir/file 0777
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src ls -la mydir/file
-rwxrwxrwx 1 anassanhari staff 0 Dec 12 23:00 mydir/file
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src cat tst.c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>

int main(void) {

    while(1);

    for (int i = 1; i < 11; i++) {
        sleep(1);
        printf("Time: %d\n", i);
    }

    exit(EXIT_SUCCESS);
}

% /Users/anassanhari/Desktop/OS-Projects/Project-1/src cc tst.c
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src a.out&
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src a.out&
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src a.out&
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src a.out&
% /Users/anassanhari/Desktop/OS-Projects/Project-1/src surt

anassanhari ~ /Desktop/OS-Projects/Project-1/src
➤

```



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