Pipe example
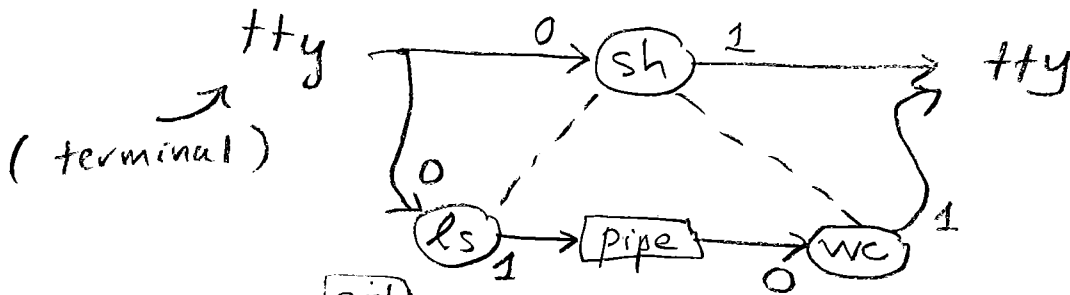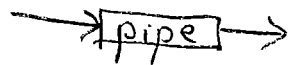
Goal: (functionality of > ls | wc)

Key

process with command = cmd
and process id = pid

Parent/child relation

pipe: <u>left</u> is write, <u>right</u> is read
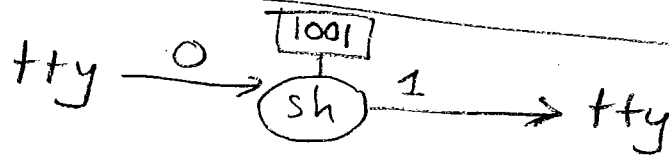
file descriptor i, open for reading
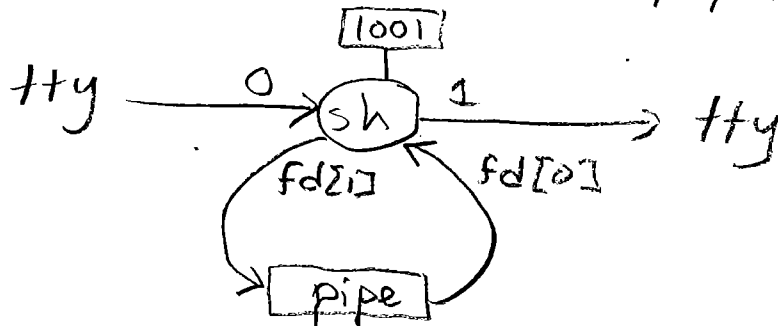
file descriptor j, open for writing

Initially: tty $\xrightarrow{0}$ [1001] sh $\xrightarrow{1}$ tty
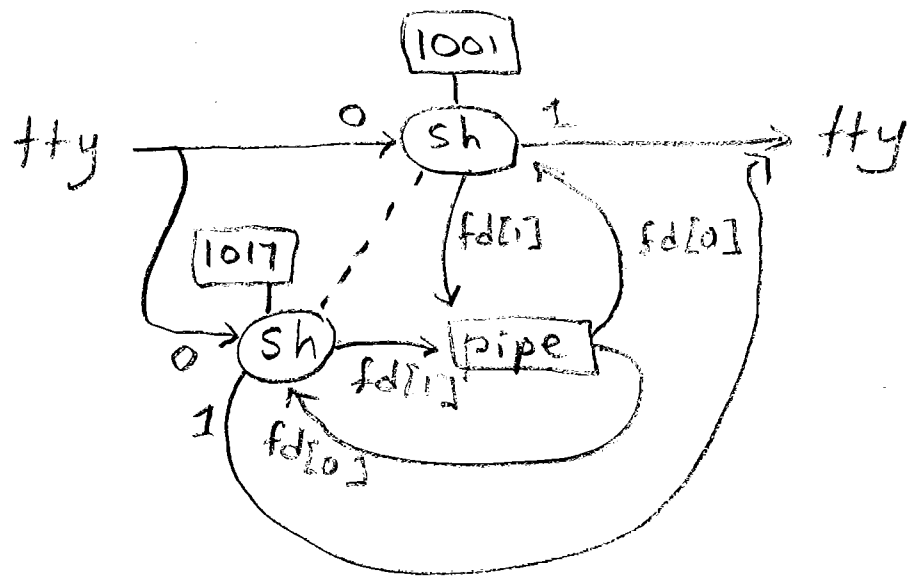
Steps

1) sh (1001) executes pipe(fd)

creates a
pipe and two
new open
file descriptors:

fd[0] = read

fd[1] = write

2) sh (1001) executes fork()

creates a new
process: sh (1017)
which has
copies of its
parent's open file
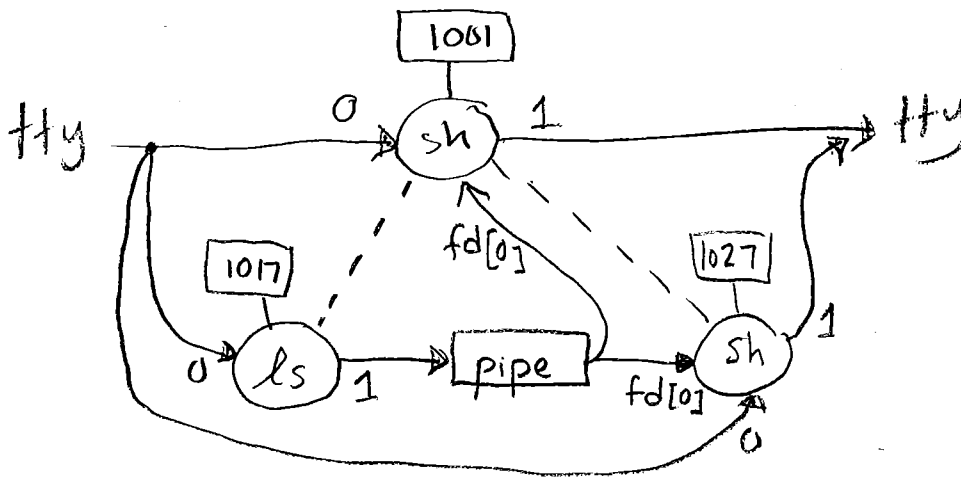descriptors
0, 1, fd[0], fd[1]

3) sh(1001) executes close(fd[1])
    sh(1017) executes
        close(fd[0]), dup2(fd[1],1),
        close(fd[1]), exec(ls)
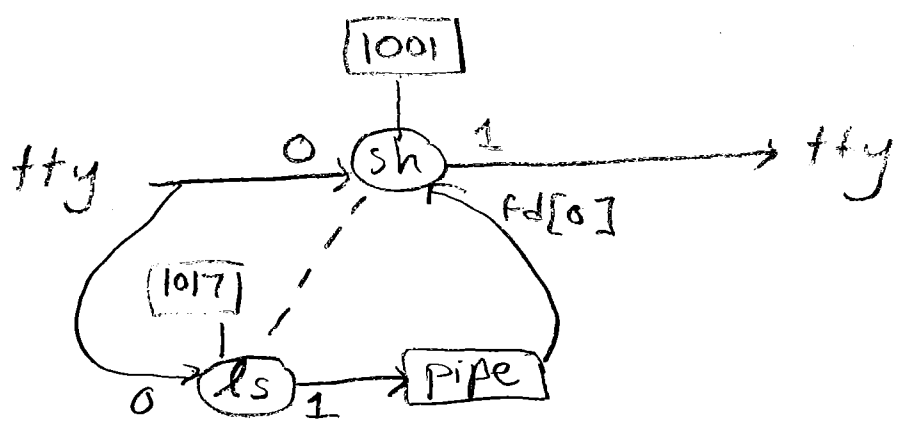
closes
unneeded
file descriptors,
replaces process
1017 fd 1
by write fd
for pipe,
starts ls

4) sh (1001) executes fork()

creates a
new process:
sh (1027)
which has
copies of it
parent's open
file descriptors:
0, 1, fd[0]

5) sh (1001) executes close(fd[0])
   and waits for both child
   processes (1017, 1027) to terminate

sh (1027) executes
   dup2(fd[0], 0), close(fd[0]), exec (wc)

closes
unneeded
file descriptor
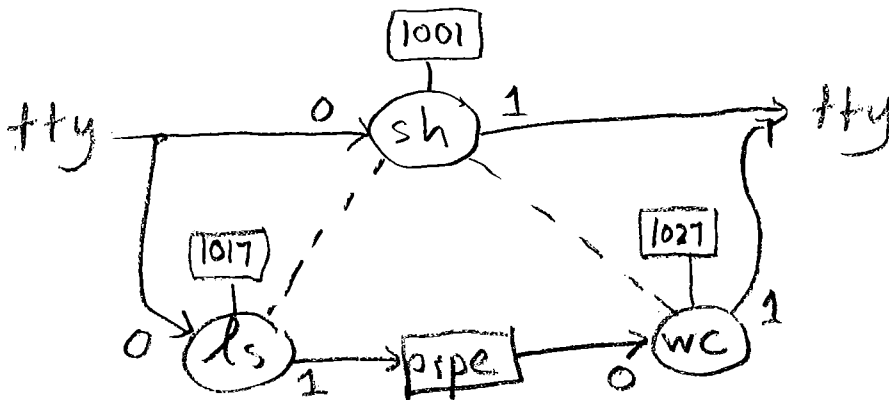
replaces
process 1027
fd 0 by
read fd for
pipe
starts wc

(sh (1001) suspends execution
   until the two child processes
   terminate)

[Goal achieved]

Another view of this is how
information in the process table changes.

Initially:

pid=1001	open fds
0	tty, r
1	tty, w
2	tty, w

1) sh (1001) executes pipe(fd)
(Assume it returns fd[0] = 3 and
fd[1] = 4.)

Then:

pid = 1001	open fds
0	tty, r
1	tty, w
2	tty, w
3	pipe, r
4	pipe, w

new fds
created for pipe

2) sh (1001) executes fork()

Then:

pid = 1001	open fds
0	tty, r
1	tty, w
2	tty, w
3	pipe, r
4	pipe, w

open fds
copied to
child
process

pid = 1017	open fds
0	tty, r
1	tty, w
2	tty, w
3	pipe, r
4	pipe, w

3) Suppose sh (1001) has executed close(fd[1])
and sh(1017) has executed close (fd[0])

Then:

pid=1001	open fds
0	tty,r
1	tty, w
2	tty, w
3	pipe,r

entry for 4 removed from 1001's table

pid 1017	open fds
0	tty,r
1	tty,w
2	tty, w
4	pipe, w

entry for 3 removed from 1017's table

3 continued) Suppose sh(1017) has now executed dup2(fd[1],1)

Then

pid=1001	open fds
0	tty,r
1	tty, w
2	tty, w
3	pipe,r

entry in 1017's table for 4 copied to 1

pid=1017	open fds
0	tty,r
1	pipe, w
2	tty, w
4	pipe, w

[And so on.]

DA 11/1/17