Processes

Shell commands for Pipes and redirections

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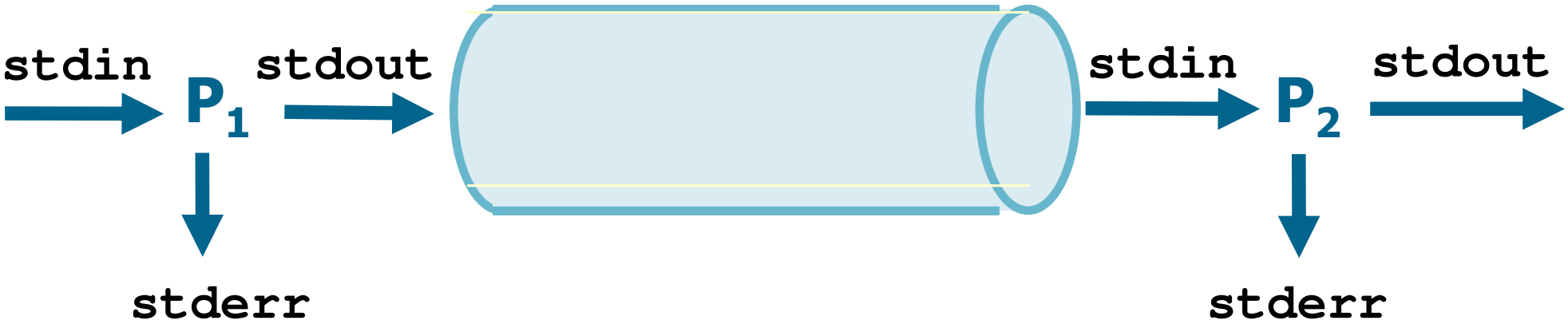
Pipes

- Inter-process communication can be performed also by processes executed by shell commands
- A shell **pipe** connects the standard output of a sender process, and the standard input of a receiving process



Pipe

command$_1$ | command$_2$
command$_1$ | command$_2$ | command$_3$ ...

- Examples
  - ls -la | more
  - ps | grep main
  - cat file1.txt file2.txt file3.txt | sort
  - ls -laR *.c | wc

I/O redirection

- The term redirection indicates the deviation of the standard channels, i.e.
  - Standard input (stdin, 0)
  - Standard output (stdout, 1)
  - Standard error (stderr, 2)
- In practice, a process (a command) reads/writes data from a source/destination different with respect to the predefined standard ones

I/O redirection

- A special file
  - `/dev/null`

- Writing on `/dev/null` does not produce any output (`/dev/null` is a sink)
- Reading from `/dev/null` returns a sequence of zeros

Standard input

```
command < file
```

- Standard input redirection (reads from a file)

```
command << marker
... text ...
marker
```

- Standard input redirection (reads from terminal)
  - "here document"
  - marker is a generic string
    - Often **EOF**

Standard output

```
command   >   file
command   1>   file
```

- Standard output redirection on a file
  - If the file exist it is overwritten
  - Descriptor 1 (stdout) is the default
    - Thus it is normally omitted

```
command   >>   file
```

- Standard output redirection on a file (append)

```
ls -laR > file_out.
wc pgrm.c > file_pout.txt
```

```
ls -laR >> file_out.
wc pgrm.c >> file_pout.txt
```

Standard error

```
command  2>  file

command  2>>  file
```

- Standard error redirection on a file
- Standard error redirection on a file (append)

Both streams

```
command   &>   file

command   &>>   file
```

& is not the last character of the line !!

- Standard output **and** error redirection on a file
- Standard output **and** error redirection on a file (append)

Multiple redirection

```
Bash Shell
command  1>  fileOut  2>  fileErr

Tcsh Shell
command   >  fileOut  >&  fileErr
```

- Redirection on different files of
  - Standard output
  - Standard error

Example

Redirection of stdin, stdout, stderr

```
int main () {
   char c;
   setbuf(stdout,0);
   setbuf(stderr,0);
   while (scanf ("%c", &c) == 1) {
      fprintf (stdout, "stdout:%c\n", c);
      fprintf (stderr, "stderr:%c\n", c);
   }
   return (0);
}
```

- Redirection

```
comando | pgrm
pgrm < file
pgrm > file
pgrm 1> fileOut 2> fileErr
pgrm < fileIn 1> fileOut 2> fileErr
```