CSCI315 – Operating Systems Design

Department of Computer Science
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Inter-Process Communications: Unix Pipes

Ch 3.7.4

This set of notes is based on notes from the textbook authors, as well as L. Felipe Perrone, Joshua Stough, and other instructors.
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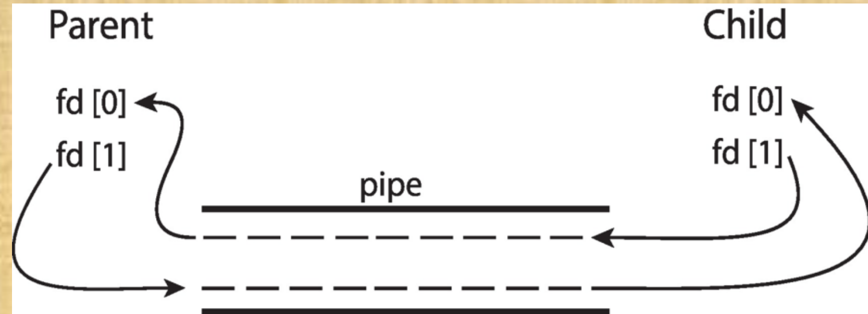
Interprocess Communication (IPC)

- Mechanism for processes to communicate and to synchronize their actions
  - **Message system** – processes communicate with each other through messages without resorting to shared variables
    - IPC facility provides two operations:
      - **send**(*message*) – message size fixed or variable
      - **receive**(*message*)
    - If processes *P* and *Q* wish to communicate, they need to:
      - establish a *communication link* between them
      - exchange messages via send/receive

Implementation Questions

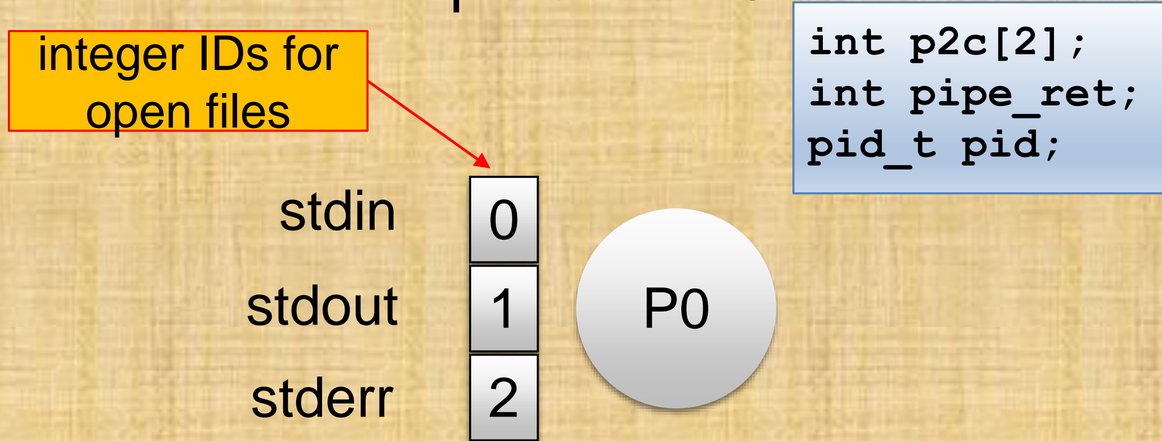
- How are links established?
- Can a link be associated with more than two processes?
- How many links can there be between every pair of communicating processes?
- What is the capacity of a link?
- Is the size of a message that the link can accommodate fixed or variable?
- Is a link unidirectional or bi-directional?
- We will examine one implementation first, **Unix Pipes**.

Unix pipe(2)



- Point to point
- Unidirectional
- Reliable delivery
- Stream of bytes
- FIFO
- For processes related by birth (same computer)
- Virtually identical to reading and writing to a file (low level file I/O)

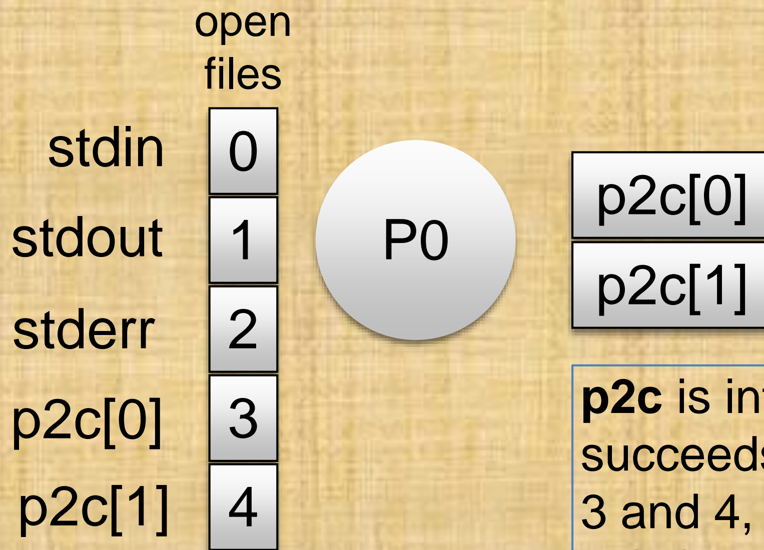
Unix pipe(2)




```
int p2c[2];
int pipe_ret;
pid_t pid;
```

Before creating a child with whom it will communicate, the parent creates a pipe through system call **pipe()**.

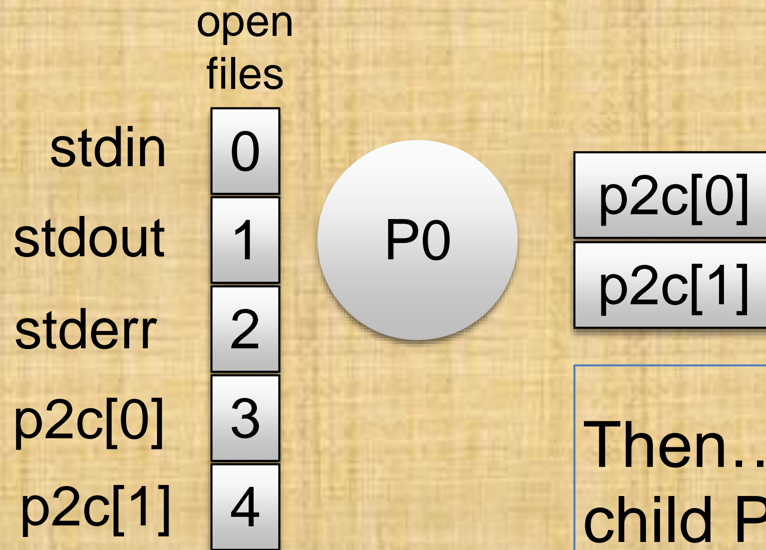
Unix pipe(2)




```
pipe_ret = pipe(p2c);
if (pipe_ret == -1)
// error
...
```

p2c is int array of 2. If call to pipe(2) succeeds, the p2c values should be 3 and 4, continuing from the existing open file IDs.

Unix pipe(2)



p2c[0]

p2c[1]

```
pid = fork();
if (pid < 0)
// error
...
```

Then… it creates child P1 with fork

Unix pipe(2)

```
else if (pid > 0) {
   // P0
} else {   // child
   // P1
}
```

P1’s local copy with values inherited from P0

Unix pipe(2)

Unix pipes are unidirectional, read from p[0] and write to p[1]

P0 closes the read end of the pipe (**index 0**)

P1 closes the write end of the pipe (**index 1**)

P0 and P1 each have a pair of pipes, p2c[0] and p2c[1]

Unix pipe(2)

Setting up for P0 to write to P1 …

P0 closes the read end of the pipe (**index 0**)

P1 closes the write end of the pipe (**index 1**)

Unix pipe(2)

Setting up for P0 to write to P1 …

P0 writes to file descriptor p2c[1]

P1 reads from file descriptor p2c[0]

write(p2c[1], buf, size);

read(p2c[0], buf, size);

How to revise the setup such that P0 and P1 can write to **each other**?

Synchronization

- *Message passing* may be either blocking or non-blocking.
- Blocking is considered **synchronous**:
  - **Blocking send** has the sender blocked until the message is received.
  - **Blocking receive** has the receiver blocked until a message is available.
- Non-blocking is considered **asynchronous**
  - **Non-blocking** send has the sender send the message and continue.
  - **Non-blocking** receive has the receiver receive a valid message or null.

Buffering

Queue of messages attached to the link; implemented in one of three ways:

1. Zero capacity – 0 messages
   Sender must wait for receiver (rendezvous).
2. Bounded capacity – finite length of *n* messages.
   Sender must wait if buffer is full.
3. Unbounded capacity – infinite length. Sender never waits.

Many IPC Mechanisms

- File
- Pipe
- Named pipe
- Shared memory
- Message passing
- Mailbox
- Remote procedure calls
- Sockets (TCP, datagram)

- What are the properties of each?
- What are the advantages and disadvantages of each?
- How do you select one to use?

IPC Properties

- Buffering
- Capacity
- Synchronization
- Service model
- Shared memory
- Direct or indirect