Inter-Process Communication

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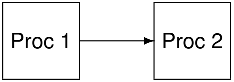

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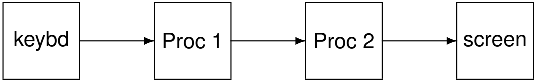

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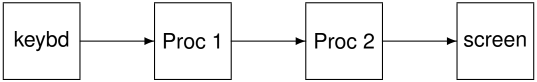

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And the pipes go via the kernel, not directly between processes

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But pipes also provide synchronisation

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Note there are two kinds of communication here: (1) the data, and (2) synchronisation on production/consumption of the data

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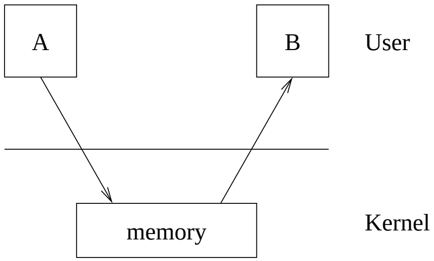
This is how the kernel can control blocking A and B, making sure A does not overfill the buffer and making sure B is not reading data that is not there

Inter-Process Communication

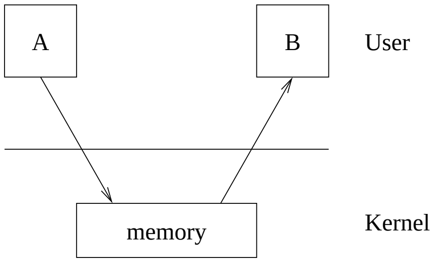
Pipes



Implementation of a Pipe

Inter-Process Communication

Pipes



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If A wants to write to the pipe, it makes a system call: the kernel can check for space in the buffer and block A if necessary

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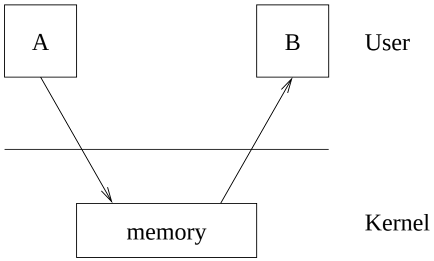

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Symmetrically for B reading from the pipe

Inter-Process Communication

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Pipes are supported well by Unix and are very easy to create and use when using a shell

Aside

A *shell* is just a program that waits for you to type something and then possibly creates some new processes according to what you typed: the *command line* interface

Popular with Unix derivatives, unpopular with Windows derivatives

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```
% ps | sort
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So this displays a sorted list of processes

Inter-Process Communication

Pipes

Pipes are also easy to create within programs: see the POSIX function `pipe`

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POSIX is a *library* standard: it contains a list of standard functions that provide a simple and uniform front end to OS syscalls (amongst doing useful other things) and describes their expected behaviours, e.g., `open`, `close` and `sqrt`

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Even though they live and operate in user mode

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(After a bit of technical fiddling) the pipe is now ready to use for IPC between parent and child

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Pipes are

- simple and efficient
- easy to use from programs and from a shell
- a powerful way of combining processes and programs
- used a great deal

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Pipes

But also

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- are unidirectional
- technical detail: are only between *related* processes. Often one is the parent of the other
- can trivially create deadlocks if you use them carelessly (A creates a child process B with two pipes A$\rightarrow$B and B$\rightarrow$A. . .)

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- Named Pipes: these can can be shared by unrelated processes (but have the naming problem that IPC using files have)
- Sockets: pipes between processes on different machines. The basis of the Internet

Inter-Process Communication

Sockets

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A lot of the modern world is built on top of sockets!

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