OPERATING SYSTEMS

PROCESSES

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OPERATING SYSTEM
Processes

What Is In This Chapter?

- Process Definition
- Scheduling Processes
- What Do Processes Do?
- Inter-process Communication

PROCESSES

Definitions

PROCESS CONCEPT:

A **program** is passive; a **process** active.

Attributes held by a process include

•hardware state,

•memory,

•CPU,

•progress (executing)

WHY HAVE PROCESSES?

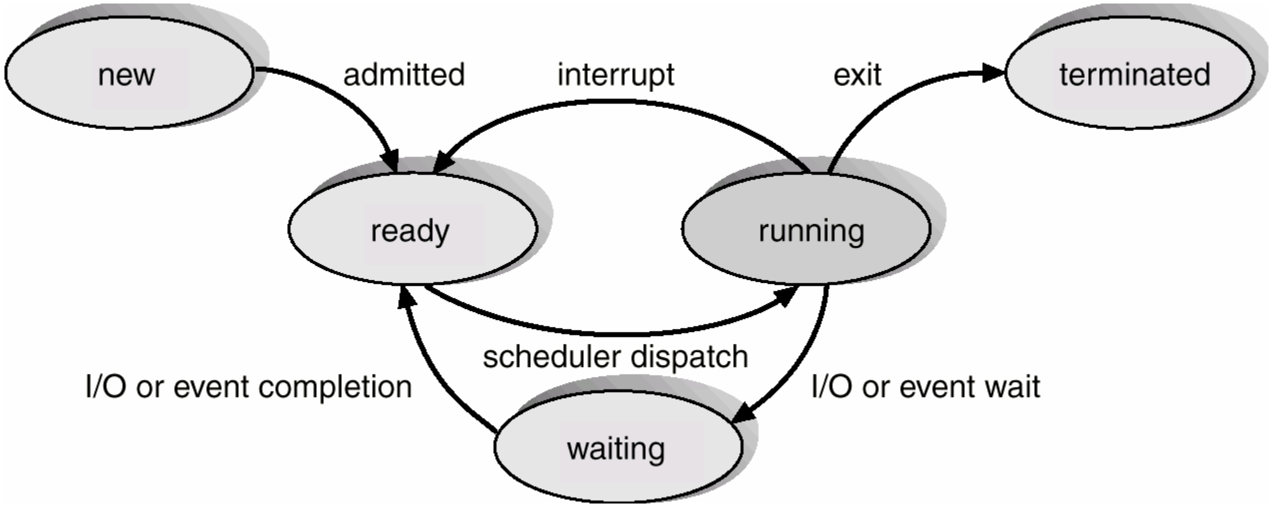
Resource sharing (logical (files) and physical(hardware)).

Computation speedup - taking advantage of multiprogramming – i.e. example of a customer/server database system.

Modularity for protection.

PROCESS STATE

- **New** The process is just being put together.
- **Running** Instructions being executed. This running process holds the CPU.
- **Waiting** For an event (hardware, human, or another process.)
- **Ready** The process has all needed resources - waiting for CPU only.
- **Suspended** Another process has explicitly told this process to sleep. It will be awakened when a process explicitly awakens it.
- **Terminated** The process is being torn apart.



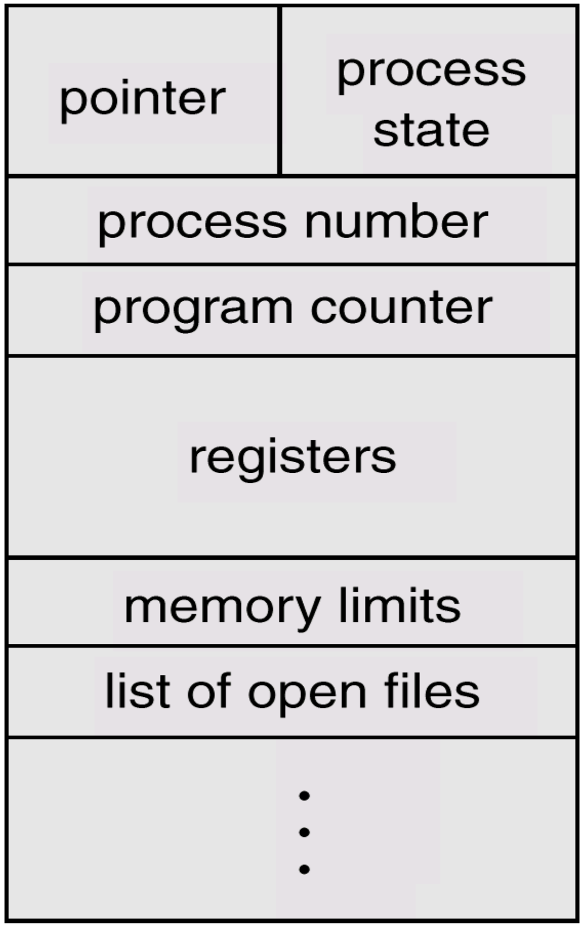
Process State

PROCESS CONTROL BLOCK:

CONTAINS INFORMATION ASSOCIATED WITH EACH PROCESS:

It's a data structure holding:

- PC, CPU registers,
- memory management information,
- accounting (time used, ID, ...)
- I/O status (such as file resources),
- scheduling data (relative priority, etc.)
- Process State (so running, suspended, etc. is simply a field in the PCB).



pointer

process state

process number

program counter

registers

memory limits

list of open files

•
•
•

Scheduling Components

The act of **Scheduling** a process means changing the active PCB pointed to by the CPU. Also called a **context switch.**

A context switch is essentially the same as a process switch - it means that the memory, as seen by one process is changed to the memory seen by another process.

See Figure on Next Page (4.3)

SCHEDULING QUEUES:

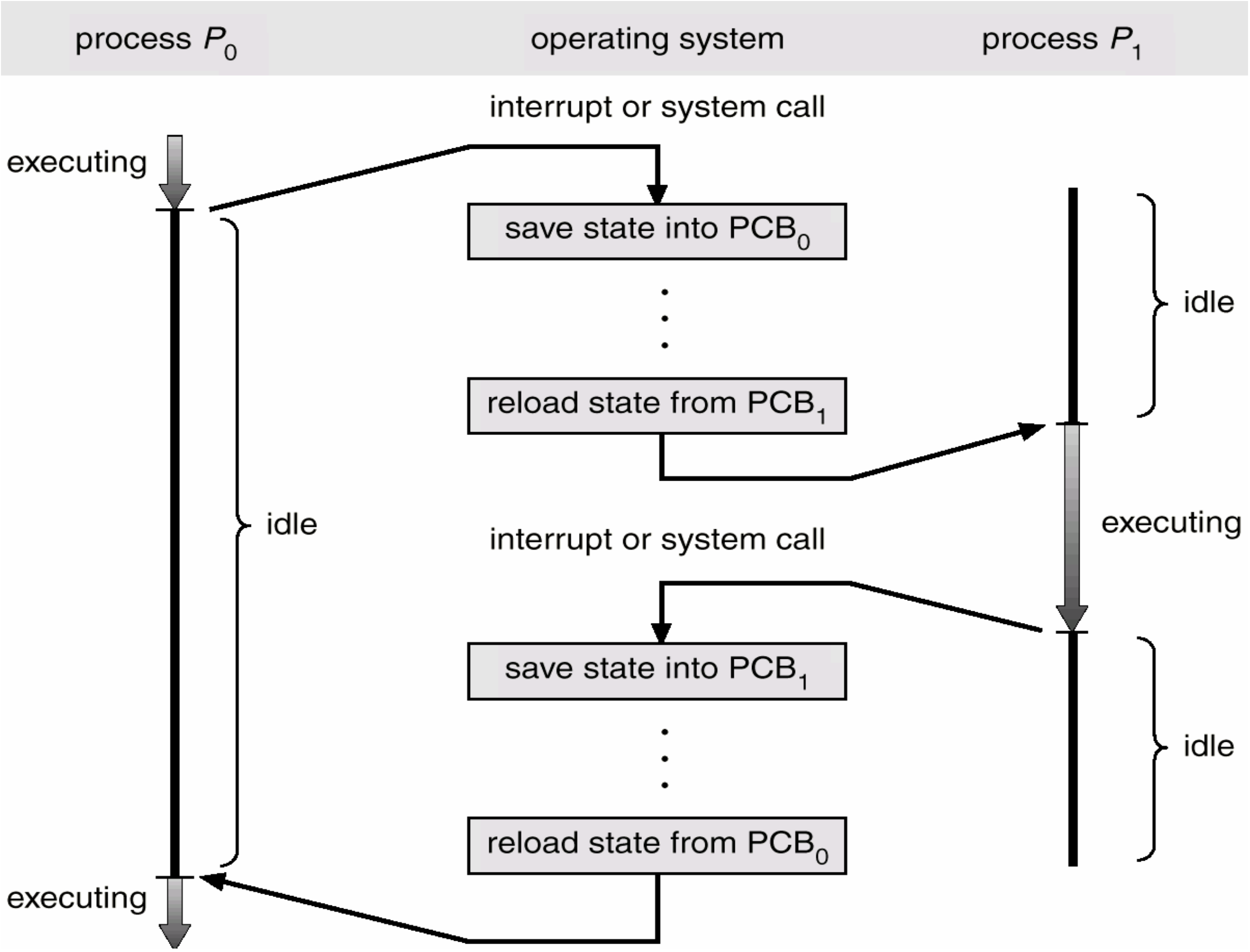
(Process is driven by events that are triggered by needs and availability)

- Ready queue = contains those processes that are ready to run.
- I/O queue (waiting state) = holds those processes waiting for I/O service.

What do the queues look like? They can be implemented as single or double linked. **See Figure Several Pages from Now (4.4)**

PROCESSES

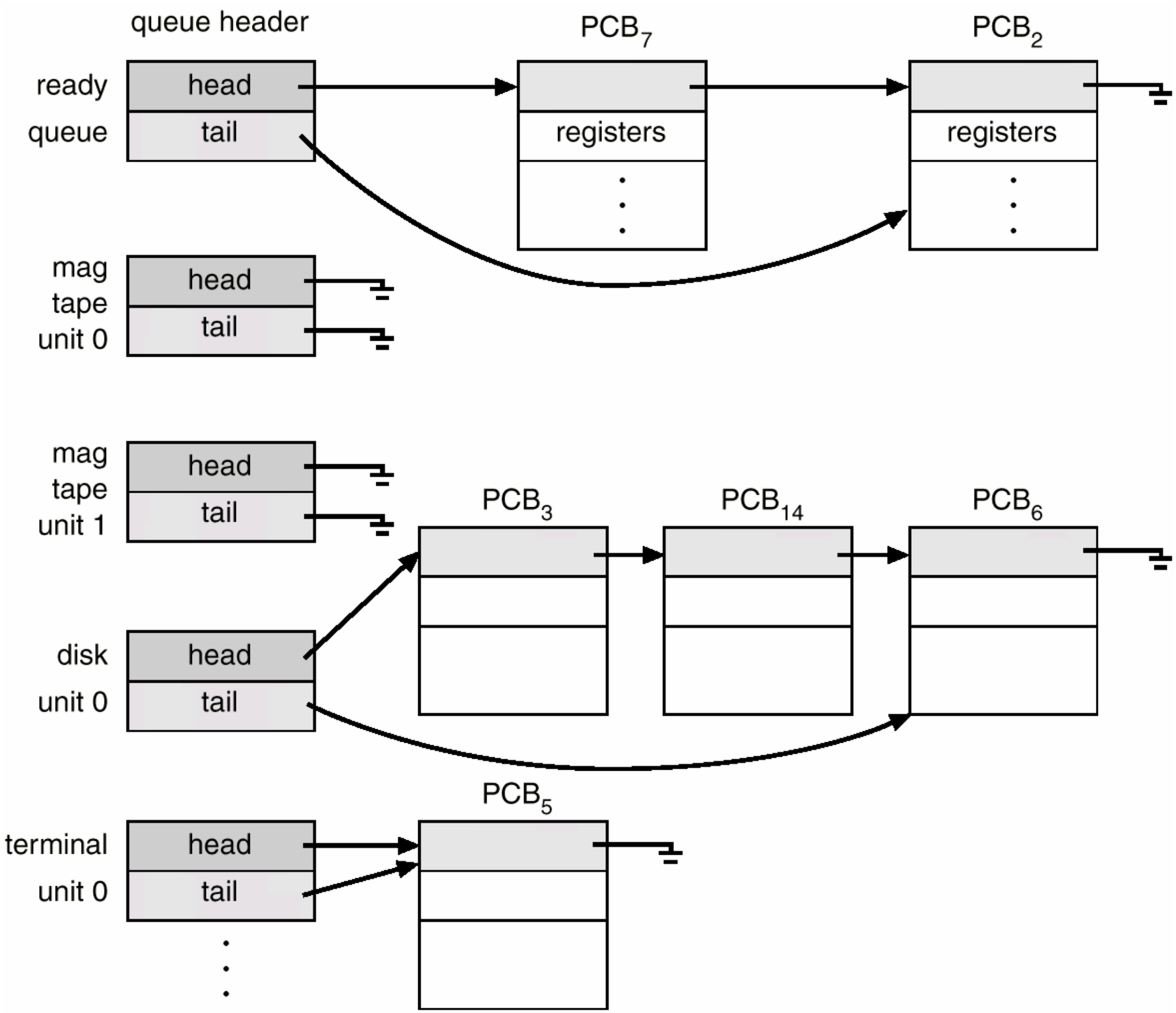
Scheduling Components



The CPU switching from one process to another.

PROCESSES

Scheduling Components



Ready Q And IO Q's

Figure 4.4

PROCESSES

Scheduling Components

LONG TERM SCHEDULER

- Run seldom (when job comes into memory)
- Controls degree of multiprogramming
- Tries to balance arrival and departure rate through an appropriate job mix.

SHORT TERM SCHEDULER

Contains three functions:

- Code to remove a process from the processor at the end of its run.
  a)Process may go to ready queue or to a wait state.
- Code to put a process on the ready queue –
  a)Process must be ready to run.
  b)Process placed on queue based on priority.

PROCESSES

Scheduling Components

SHORT TERM SCHEDULER (cont.)

- Code to take a process off the ready queue and run that process (also called **dispatcher**).
  a) Always takes the first process on the queue (no intelligence required)
  b) Places the process on the processor.

This code runs frequently and so should be as short as possible.

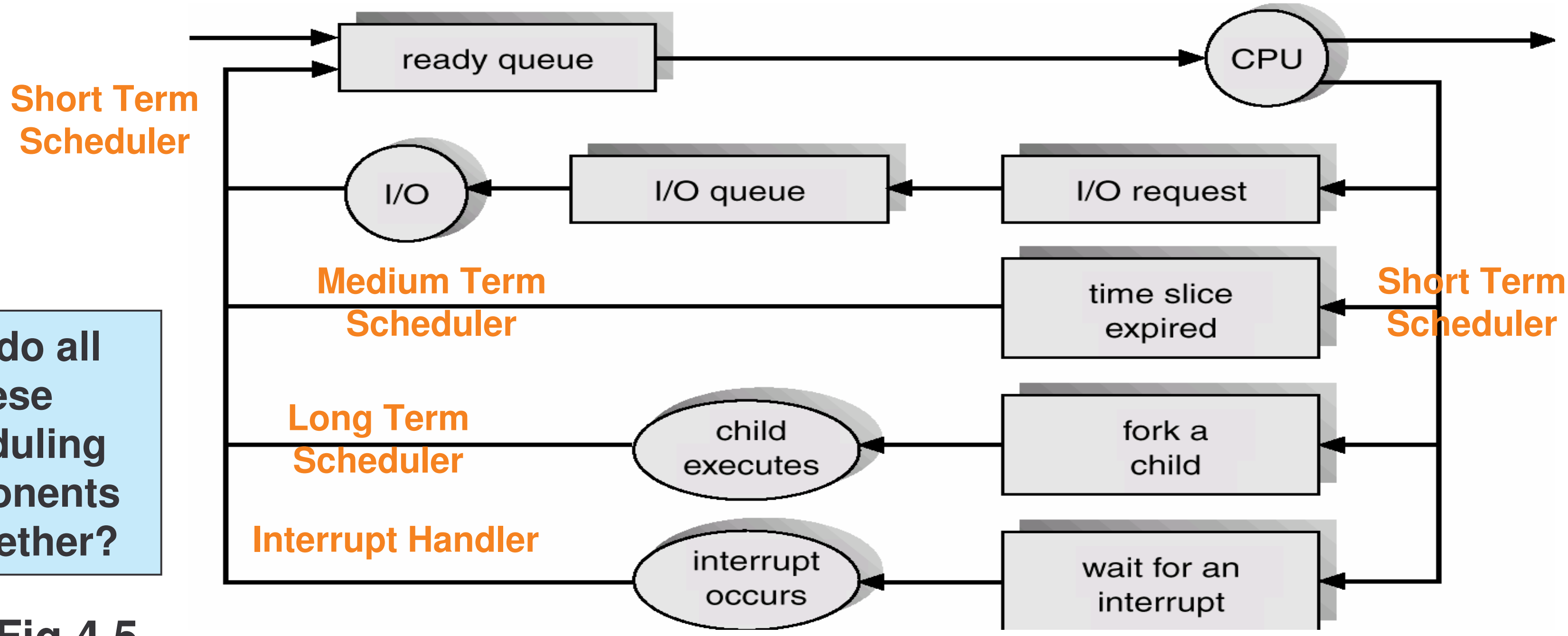
MEDIUM TERM SCHEDULER

- Mixture of CPU and memory resource management.
- Swap out/in jobs to improve mix and to get memory.
- Controls change of priority.

Scheduling Components

INTERRUPT HANDLER

- In addition to doing device work, it also readies processes, moving them, for instance, from waiting to ready.



How do all these scheduling components fit together?

Fig 4.5

Scheduling Processes and Threads

What needs to be done on a process schedule?

What needs to be done on a thread schedule?

What is a context switch?

PROCESSES

Process Relationships

Parent can run concurrently with child, or wait for completion.

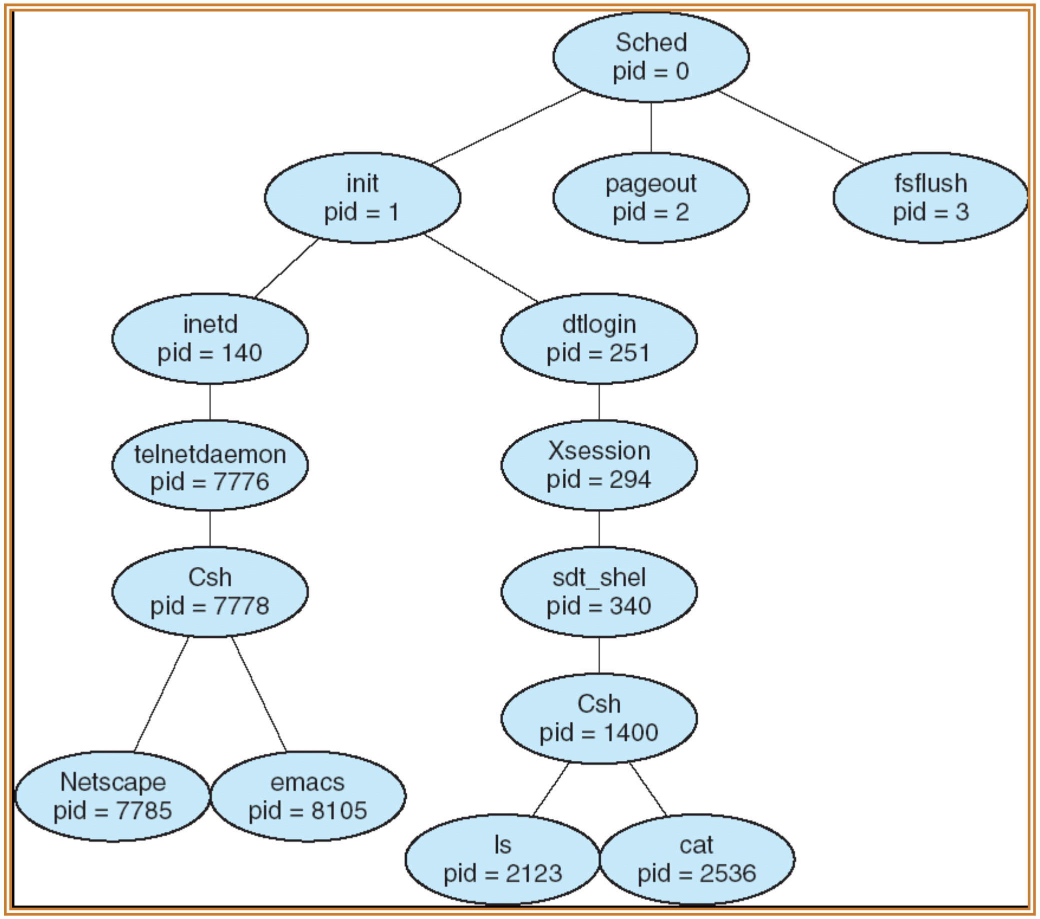
Child may share all (fork/join) or part of parent's variables.

Death of parent may force death of child.

Processes are static (never terminate) or dynamic (can terminate).

Independent Execution is deterministic and reproducible. Execution can be stopped/ started without affecting other processes.

Cooperating Execution depends on other processes or is time dependent. Here the same inputs won't always give the same outputs; the process depends on other external states.



Interprocess Communication

This is how processes talk to each other.

There are basically two methods:

Shared memory (with a process "kick") -- fast/ no data transfer.

Message Passing -- distributed/ better isolation.

FUNCTIONALITY OF COMMUNICATION LINKS:

- How are the links formed?
- How many processes on each link?
- How many links per pair of processes?
- Capacity - buffer space - can messages be enqueued.
- Message formats and sizes
- Uni- or bidirectional

METHODS OF IMPLEMENTATION:

- Direct or indirect - to process or mailbox.
- Symmetric or asymmetric?
- Buffering mechanism
- Send by copy or by reference?
- Fixed or variable size messages?

Interprocess Communication

DIRECT COMMUNICATION:

Need to know name of sender/receiver. Mechanism looks like this:

send (Process_P, message) ;

receive (Process_Q , message);

receive (id, message) <-- from any sender

The Producer/Consumer Problem is a standard mechanism. One process produces items that are handed off to the consumer where they are "used".

```
repeat
    produce item
    send( consumer,  nextp)
until false
```

```
repeat
    receive( producer,   nextp )
    consume item
            until false
```

Interprocess Communication

Other properties of Direct Communication:

- Link established automatically (when send or receive requested.)
- Only two processes in this form.
- One link per pair of processes.
- Generally Bi-directional
- Receiver may not need ID of sender.

Disadvantage of Direct Communication:

- The names of processes must be known - they can't be easily changed since they are explicitly named in the send and receive.

Interprocess Communication

INDIRECT COMMUNICATION

- Processes communicate via a named mailbox rather than via a process name. Mechanism looks like this:

  open(mailbox_name);
  send (mailbox_name, message);
  receive (mailbox_name, message);

- Link is established if processes have a shared mailbox. So mailbox must be established before the send/receive.
- More than two processes are allowed to use the same mailbox.
- May cause confusion with multiple receivers - if several processes have outstanding receives on a mailbox, which one gets a message?

Interprocess Communication

BUFFERING:

Options include:

- **Zero** -- sender must wait for recipient to get message. Provides a rendezvous.
- **Bounded** -- sender must wait for recipient if more than n messages in buffer.
- **Unbounded** -- sender is never delayed.

MESSAGE FORMAT:

- Fixed, Variable, or Typed (as in language typing) size messages.
- Send reference rather than copy (good for large messages).
- Suspended vs. unsuspended sends.

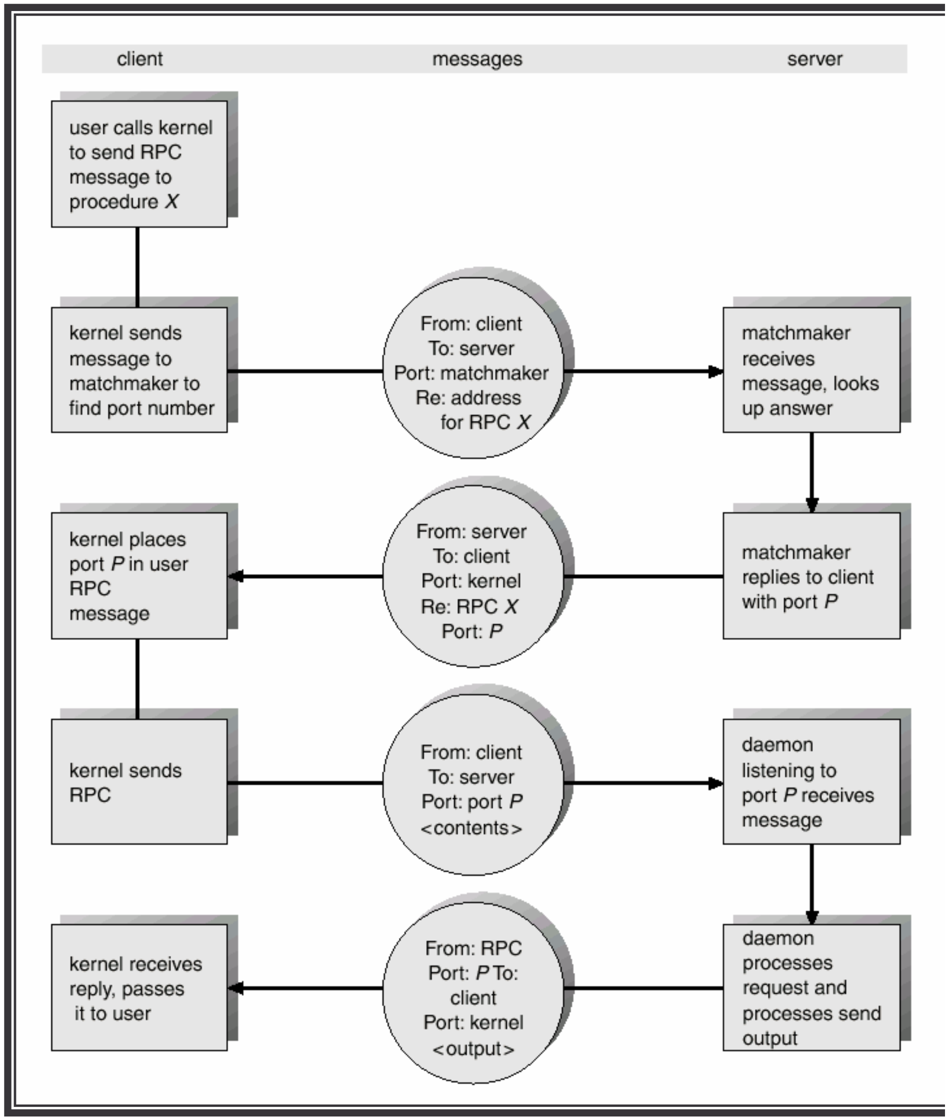
Interprocess Communication

Remote procedure call (RPC) abstracts procedure calls between processes on networked systems.

Stubs – client-side proxy for the actual procedure on the server.

The client-side stub locates the server and *marshalls* the parameters.

The server-side stub receives this message, unpacks the marshalled parameters, and peforms the procedure on the server.



client

messages

server

user calls kernel to send RPC message to procedure *X*

kernel sends message to matchmaker to find port number

From: client
To: server
Port: matchmaker
Re: address for RPC *X*

matchmaker receives message, looks up answer

matchmaker replies to client with port *P*

From: server
To: client
Port: kernel
Re: RPC *X*
Port: *P*

kernel places port *P* in user RPC message

kernel sends RPC

From: client
To: server
Port: port *P*
<contents>

daemon listening to port *P* receives message

daemon processes request and processes send output

From: RPC
Port: *P* To: client
Port: kernel
<output>

kernel receives reply, passes it to user

PROCESSES

WRAPUP

We've looked in detail at how processes work. Specifically we've

- Seen how they get scheduled (and studied schedulers in doing so),
- Visited the actions that can be performed on objects,
- Examined the extension of processes called threads,
- Looked at how processes communicate with each other'