

Informally: Process is a program in execution.

States of a process:

New Process is being created

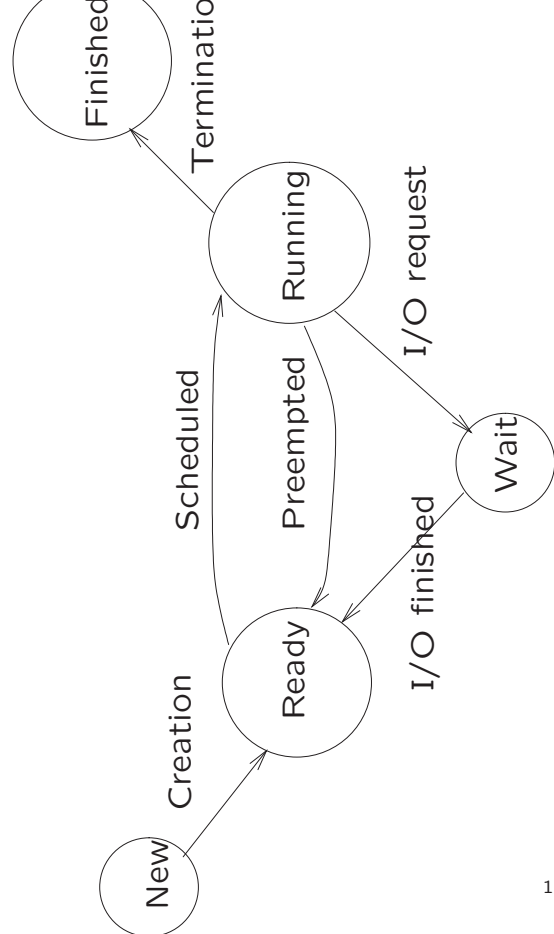
Running Instructions are being executed

Waiting Process waiting for an event to occur (I/O; signal)

Ready Process waiting for processor only

Terminated Process has finished execution

12



13

Process Control Block

OS allocates one **Process Control Block (PCB)** per process to **store all relevant information**, e.g.,

- Process state
- Program counter
- CPU-registers
- CPU-scheduling information
- Memory management information
- Accounting information
- I/O-status information

PCB used to identify process

14

Resource Queues

Ready-state associated with a **queue of processes** waiting to be executed
Scheduler picks one from the queue according to some criteria (later)

Instance of **general principle**:

Whenever we have a shared resource (here: processor), **collect all waiting processes in a queue** and use scheduler to decide who is next

15

Changing running process requires **saving state of old one and loading state of new one**
⇒ **significant** overhead involved (upto 1 ms).

Amount of work increases with complexity of OS

⇒ has become a **real performance bottleneck**

Will discuss one possible remedy (**Threads**) later

16

Special **system call** for this (**fork** in UNIX)

Creating process is called **parent**, created process **child**.

Several possibilities for **relation between parent and child**:

- Concurrent execution vs. parent waiting for children
- Child is duplicate of parent or has separate code

Often all **variants can be realised** (UNIX).

17

Threads

Problem: **Context switch takes too long**
⇒ Can we reduce amount of material to be stored and re-fetched?

Solution: differentiate between

- **data**: memory, file pointers ...
- **processor information**: program counter, register set, stack

Processes manage all these data
introduce **Threads**, which are **activity carriers together with processor information**

18

User-level vs. kernel-level threads

Two possibilities for implementation of threads:

- **User-level**: **OS doesn't know about them**, only have a library. ⇒ Minimal overhead, but one blocked thread of process blocks whole process
- **kernel-level**: **implementation done in OS**: slower, but fairer allocation of resources possible

Some OS (e.g. Solaris) provide both versions.

Threads require good handling of concurrent processes.

19