Process

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CS31202 / CS30002

This lecture

- What is a process?
- Structure of a process
- Process states
- Process control block
- Context switch

What is a process?

- A process is a program in execution
  - Recall multitasking
  - Several processes may be in various stages of execution at same time

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  - Recall multitasking
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- CPU switches rapidly between several processes
  - We say that processes are executing concurrently
  - CPU multiplexed

Program vs. Process

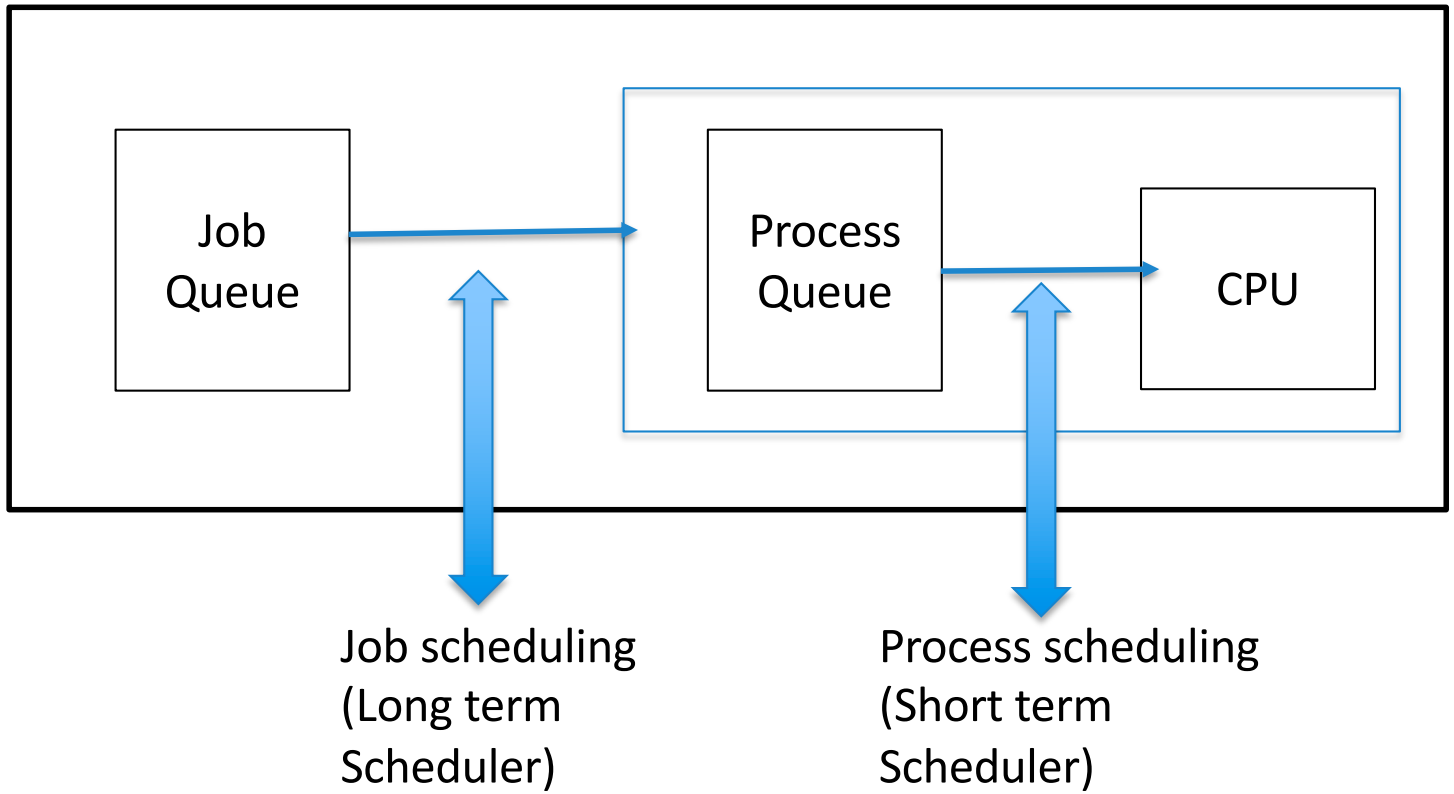
- Program is a passive entity
- Process is an active entity
  - Program becomes process when the code is loaded in the memory and ready to execute
- Each execution instance of the same program is a separate process

Job scheduling and process scheduling

- Job scheduling
  - In batch processing or multiprogramming, user programs are called jobs
  - Long term scheduler – loaded jobs into memory

- Process scheduling
  - Short term scheduler – allocated CPU to jobs

Job scheduling and process scheduling



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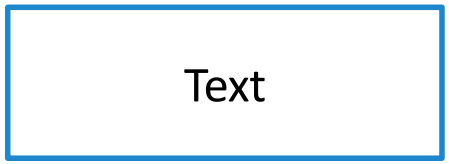
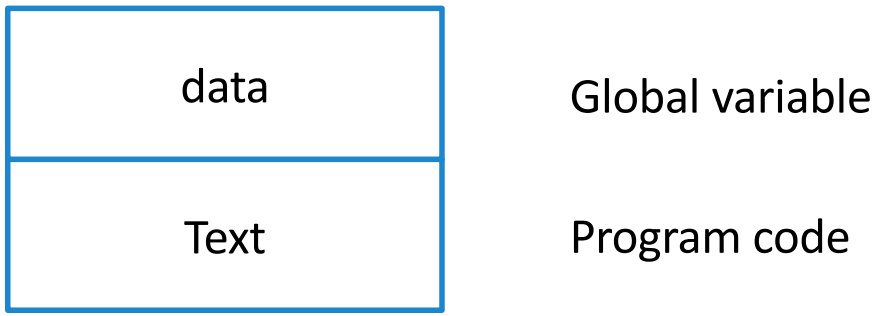
What are parts of a process (in memory)?



Program code

What are parts of a process?



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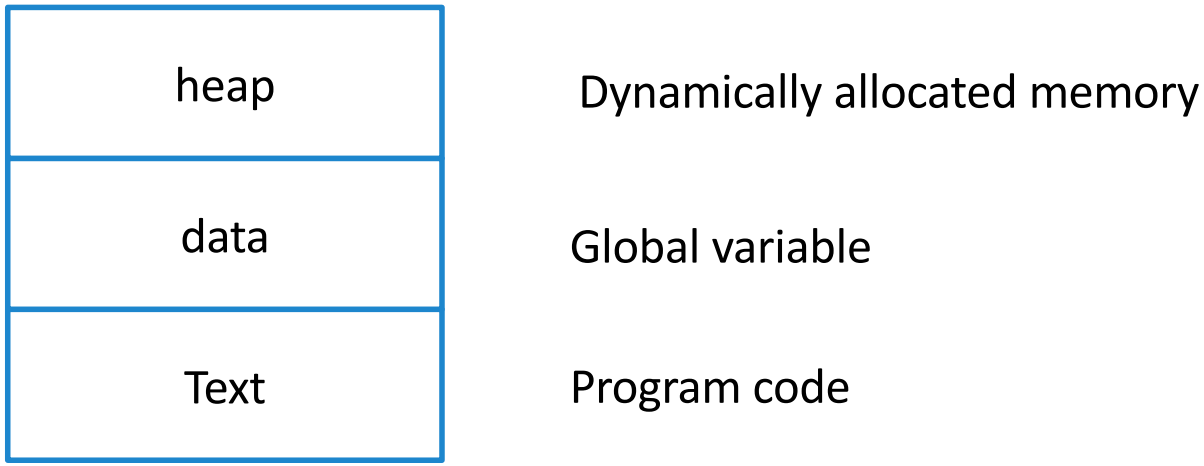

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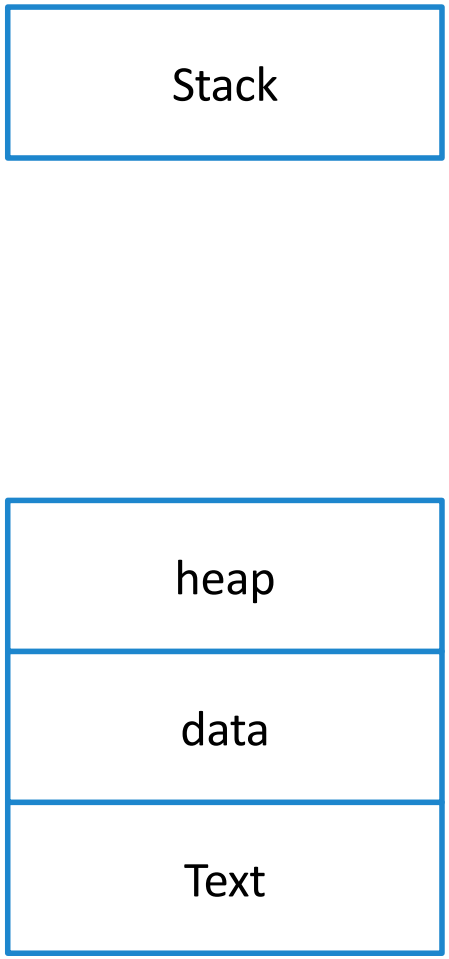

Temporary data,
function parameters,
local variables, return addresses

Dynamically allocated memory

Global variable

Program code

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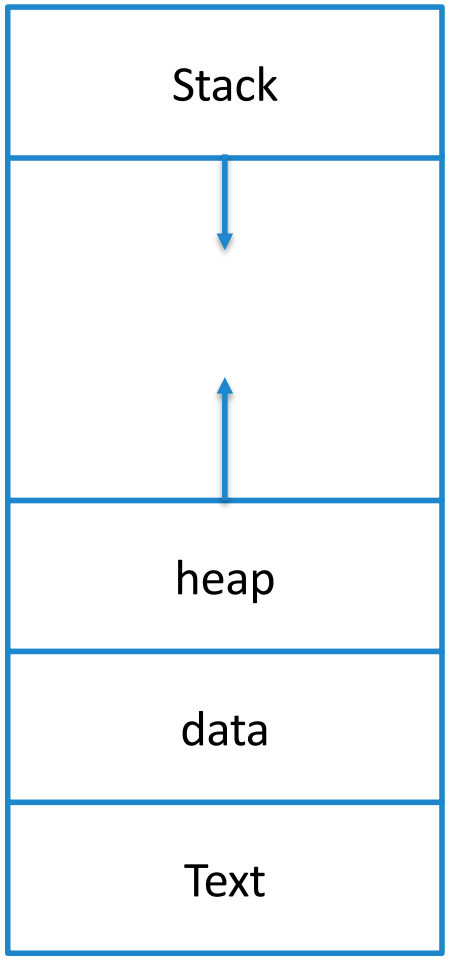

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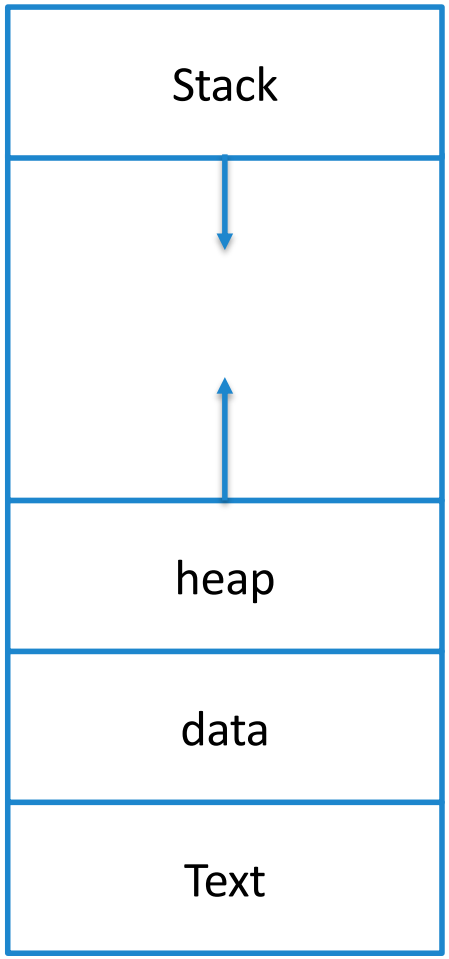

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Dynamically allocated memory

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Program code

Also
Program
counter (PC),
CPU registers,
open files

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A process has different states

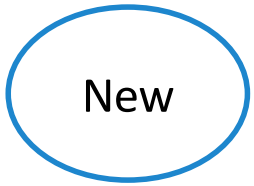
- At a particular point of time, a process may be in one of several states
- Processes change state based on certain events
- You can think of process execution as an automata

States of a process

- States
  - **new:** The process is being created
  - **ready:** The process is waiting to be assigned to a processor
  - **running:** Instructions are being executed on the CPU
  - **waiting:** The process is waiting for some event to occur
  - **terminated:** The process has finished execution

- Note: there is a separate area in the disk: “swap space”
  - Swap-out and swap-in between main memory and disk

Process state diagram



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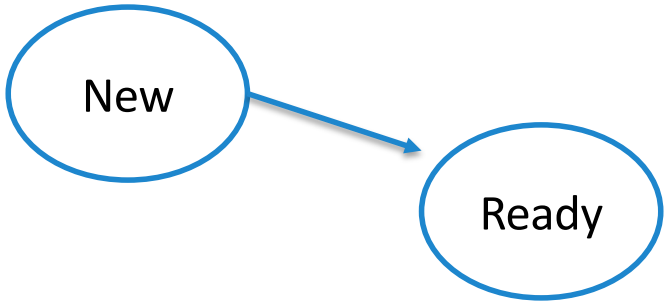

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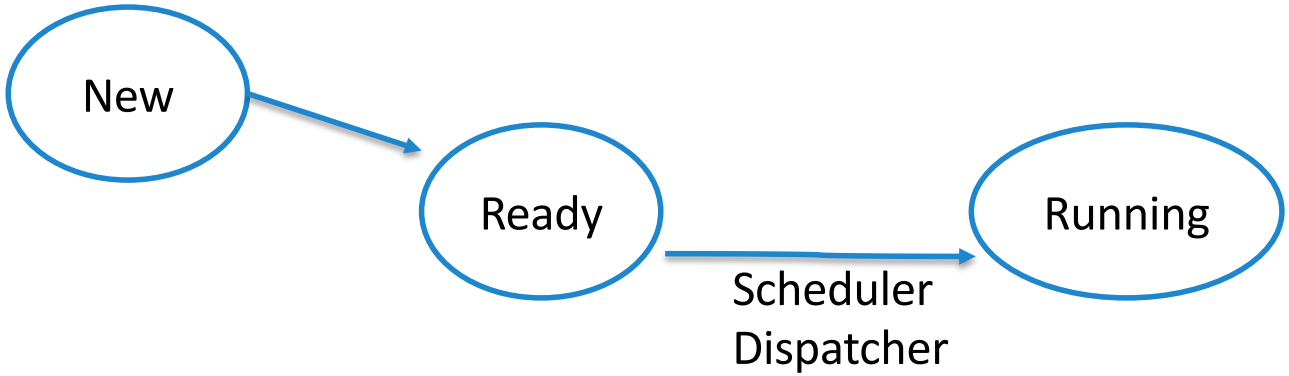

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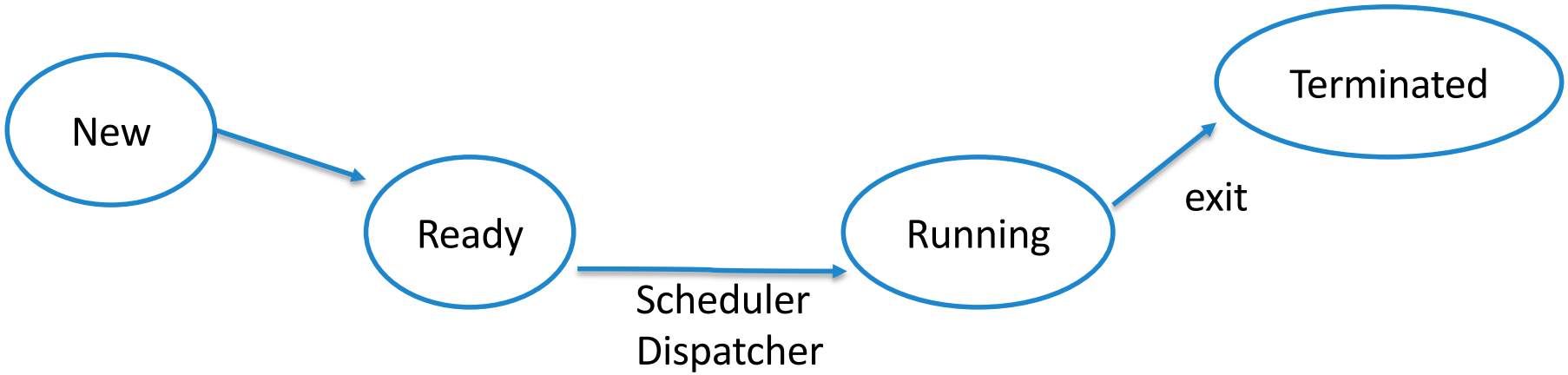

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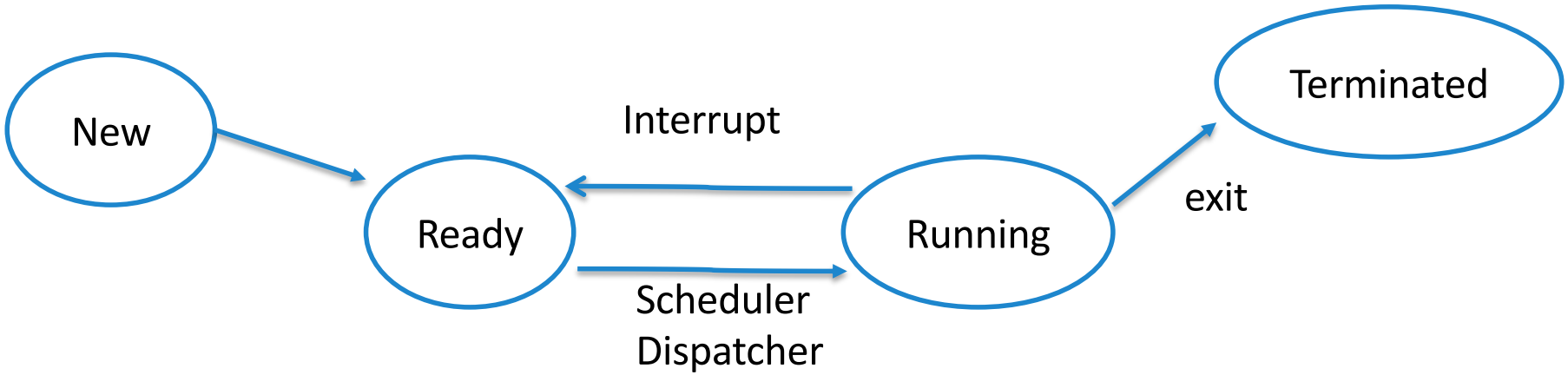

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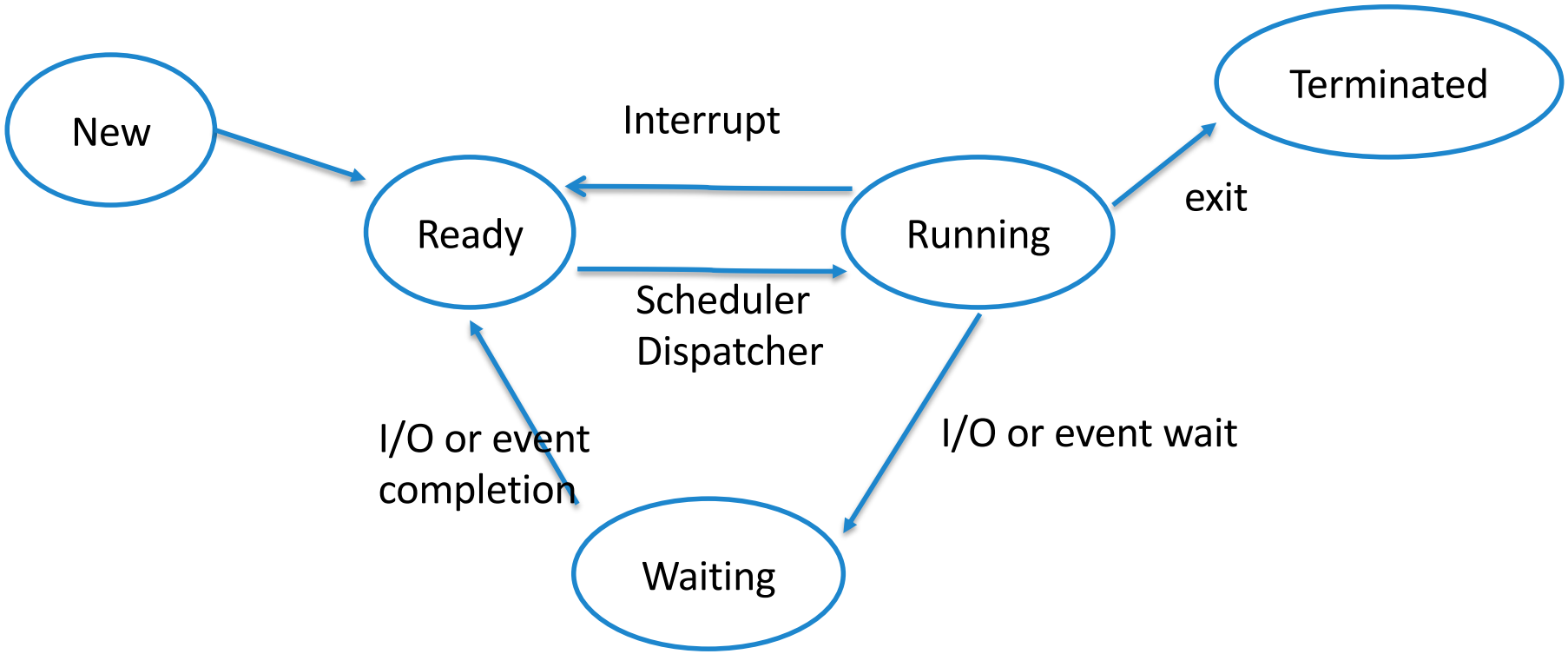

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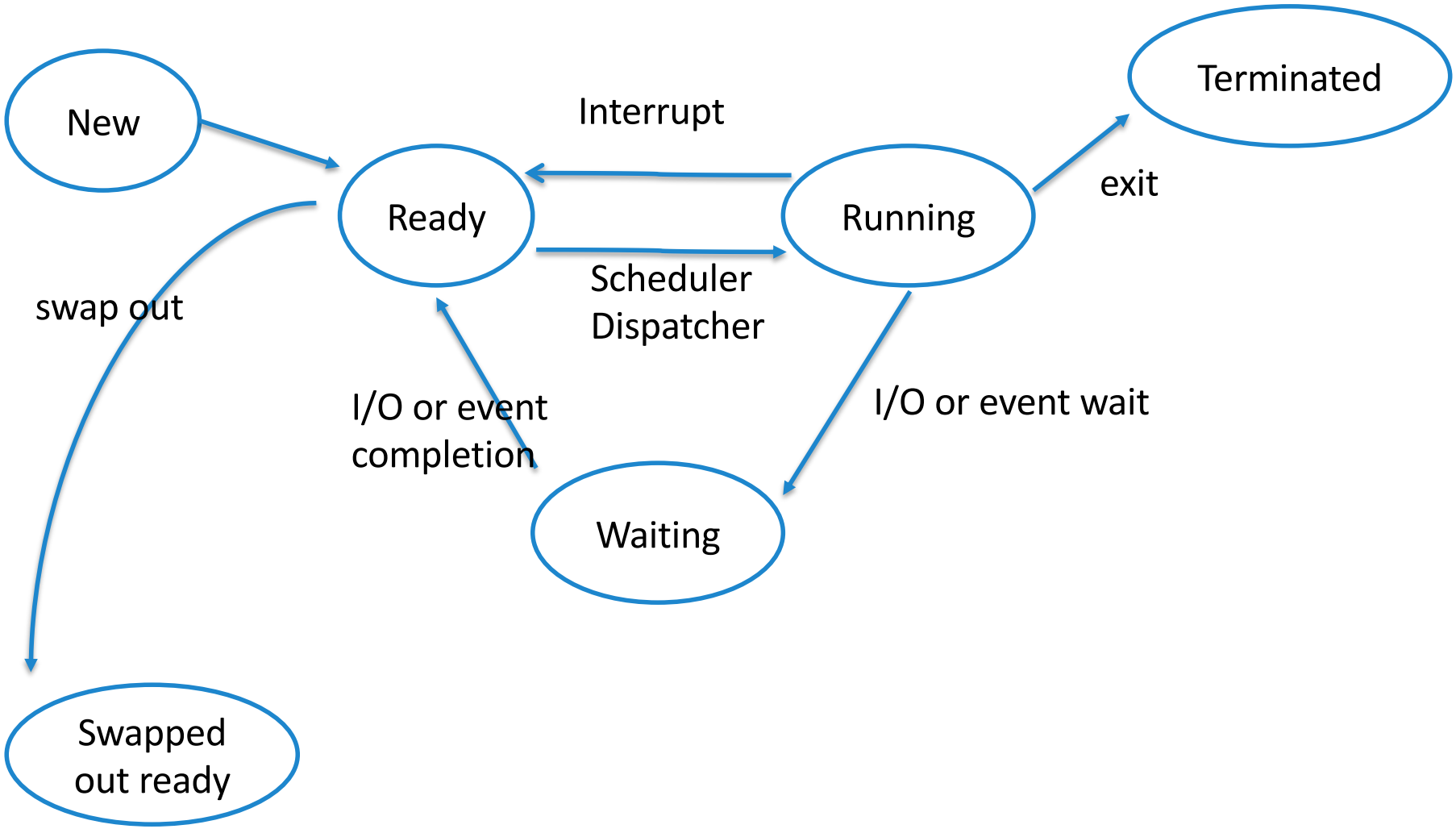

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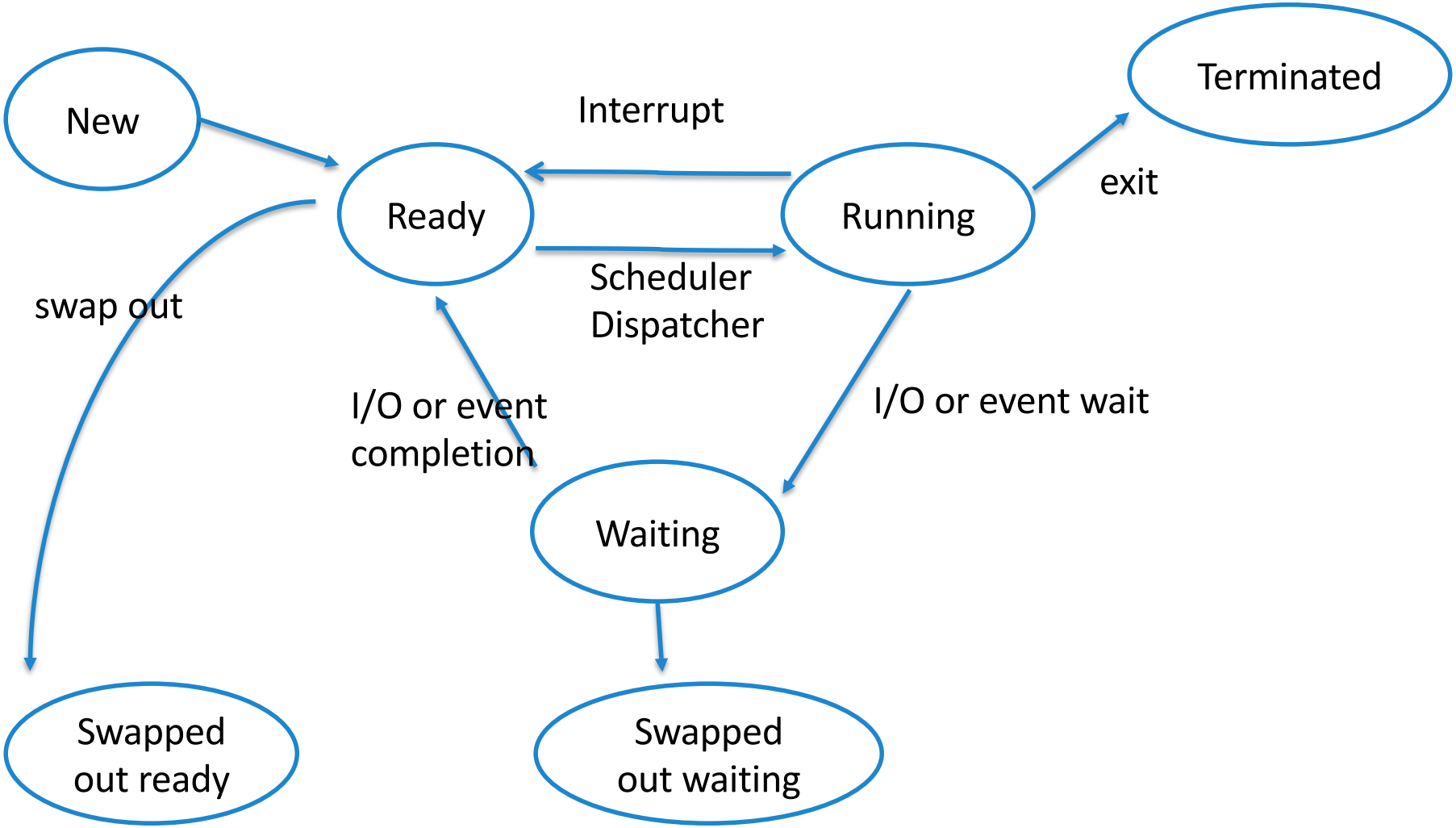

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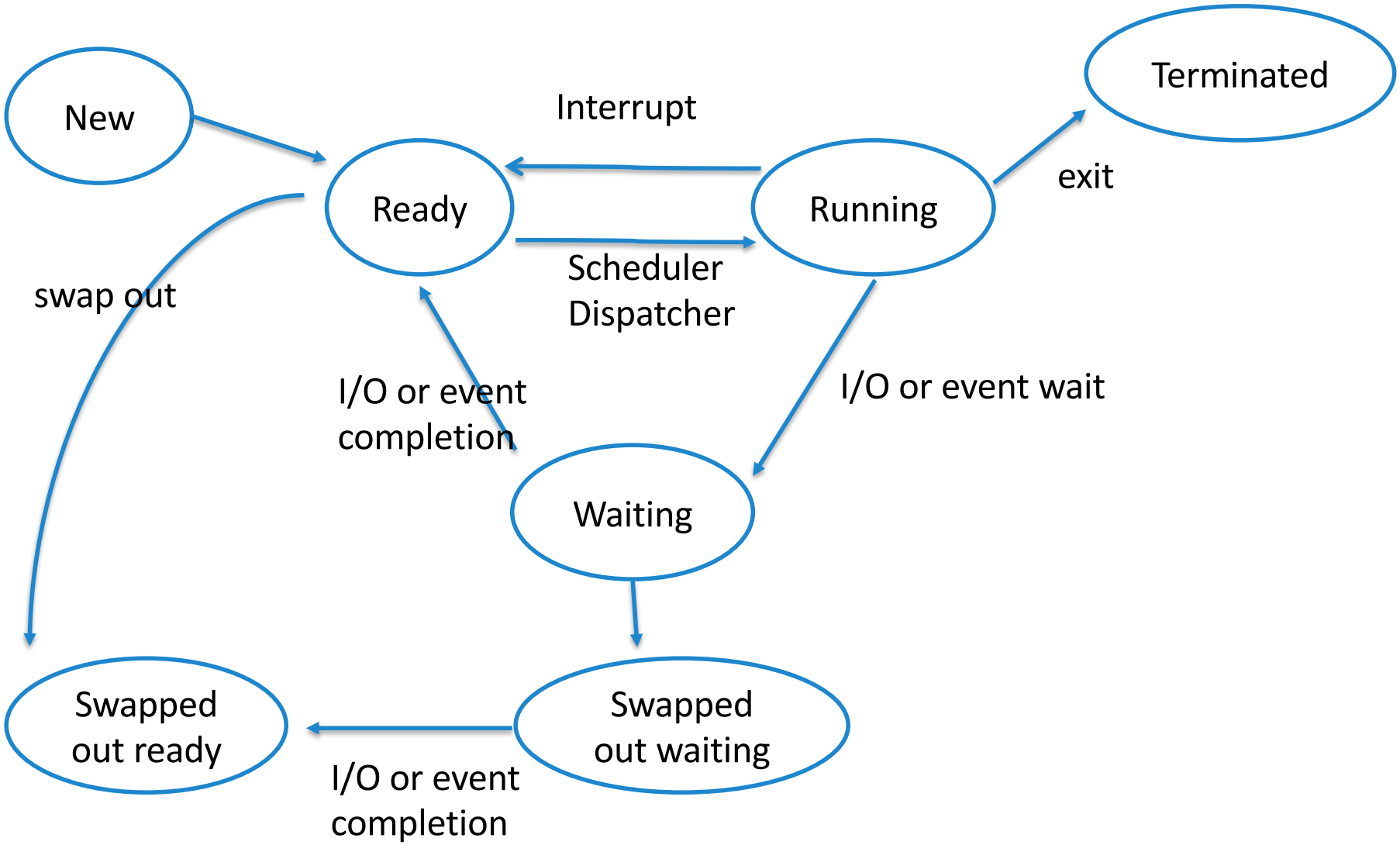

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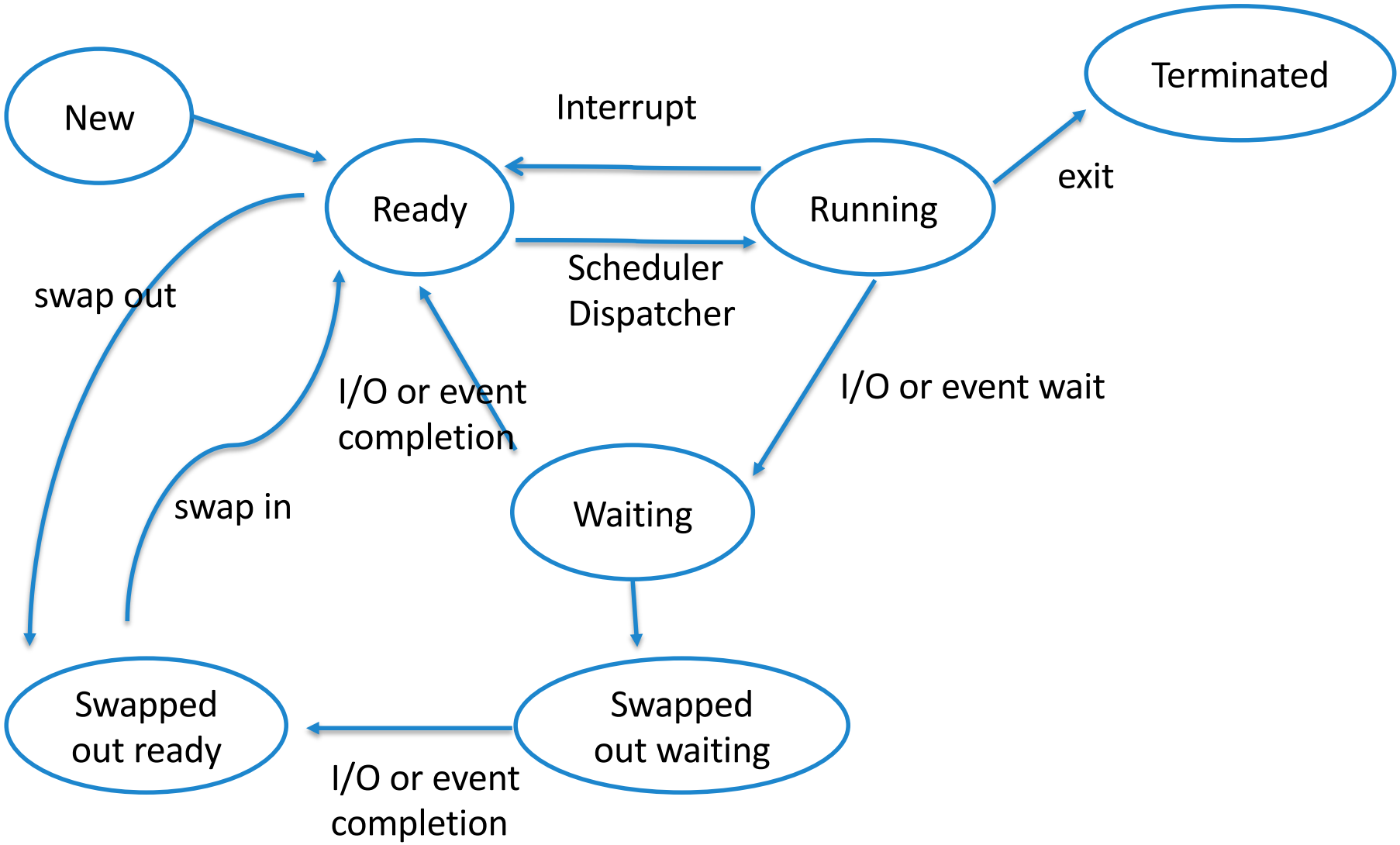

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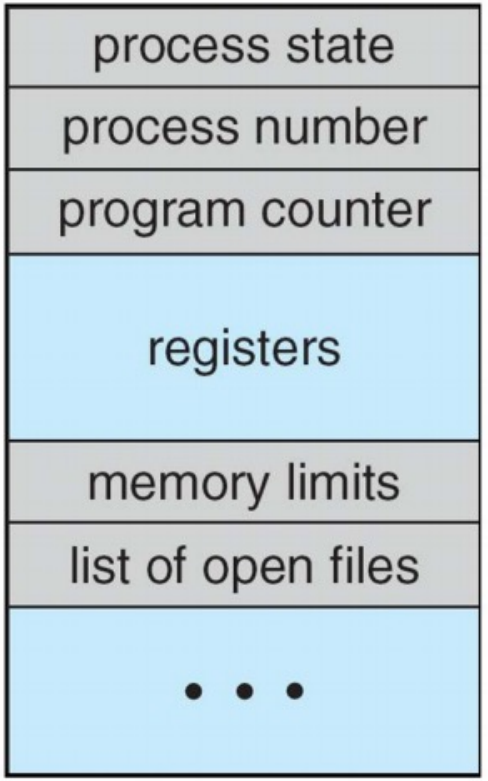
Process control block (PCB)

- Each process is represented in the kernel as a PCB
  - Also called task control block
  - Contains many pieces of information associated with a specific process

Structure of a PCB

- Process state – running, waiting, etc
- Program counter (PC) – location of instruction to next execute
- Content of CPU registers
- CPU scheduling information- priorities, scheduling queue pointers
- Memory-management information –Base and limit registers, page tables
- Accounting information – CPU used, clock time elapsed since start, time limits, pid
- I/O status information – I/O devices, allocated to process, list of open files



Process representation in Linux

Represented by the C structure task_struct

```
pid t pid;    // process identifier

long state;    // state of the process

unsigned int time slice      // scheduling information

struct task struct *parent;   // this process's parent

struct list head children;    // this process's children

struct files struct *files;    // list of open files

struct mm_struct *mm;    // address space of this pro
```

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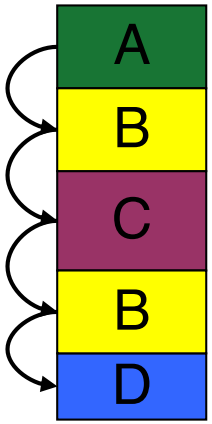
CPU runs multiple processes

- Multiprogramming of four programs
- Conceptual model
  - 4 independent processes
  - Processes run sequentially
- Only one program active at any instant!
  - That instant can be very short…

CPU runs multiple processes

CPU's point of view



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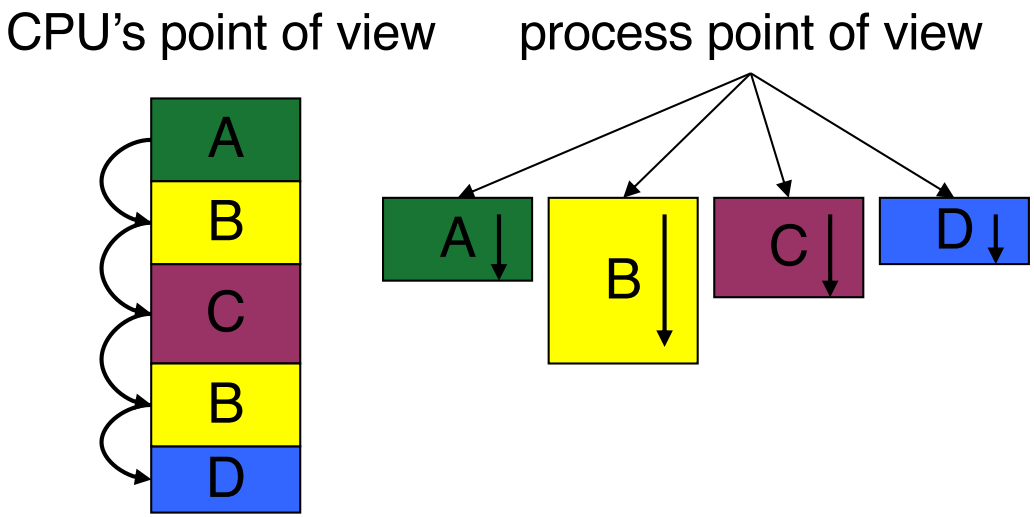

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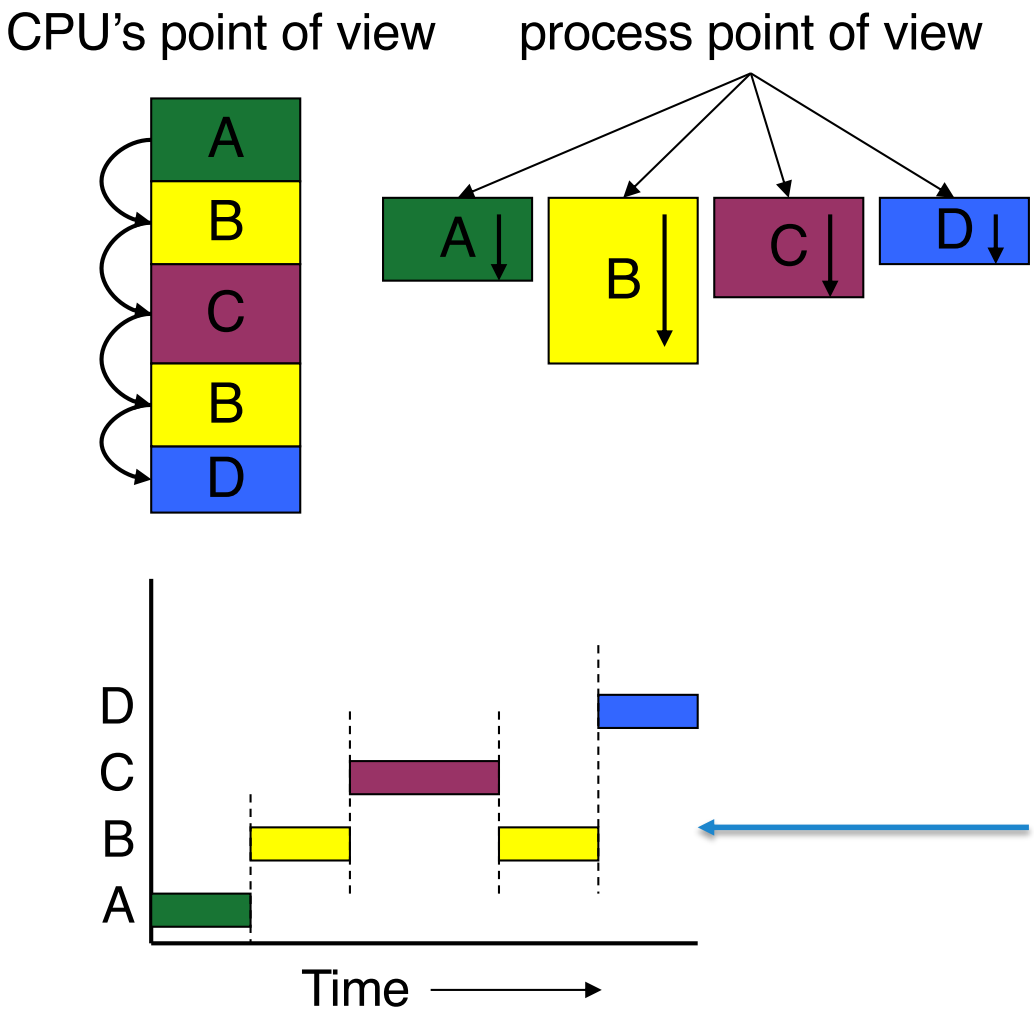

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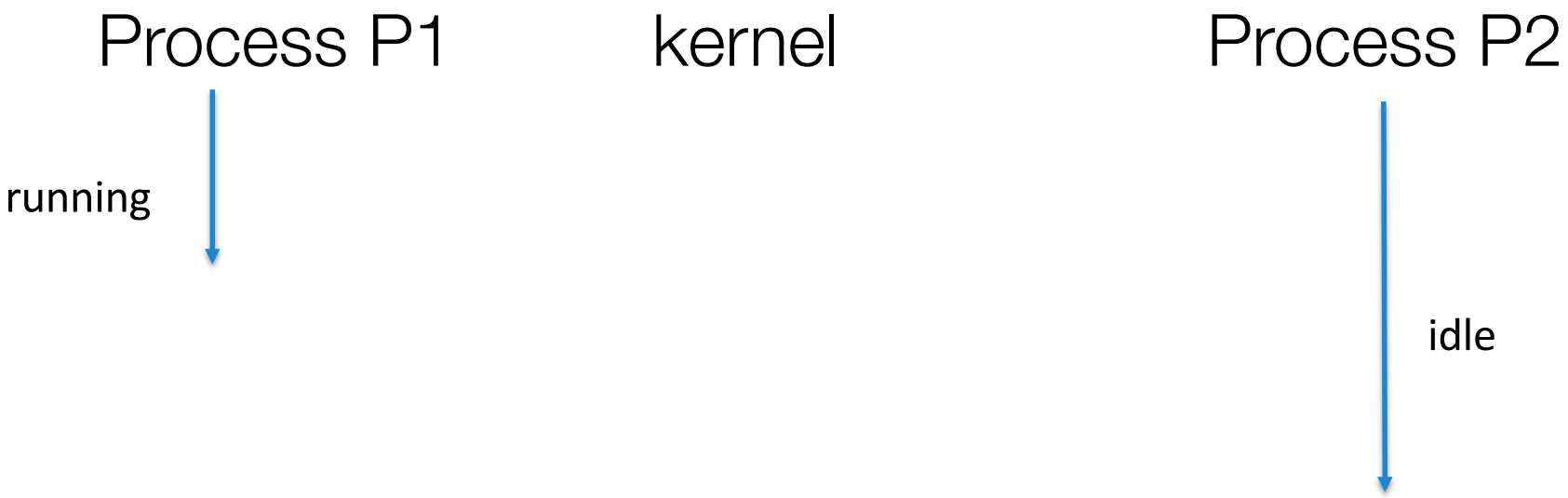
Gantt chart for multiprogramming

How to interleave processes?

- CPU switches to another process
  - The kernel saves the state of the old process and loads the saved state for the new process via a context switch
  - Context of a process == PCB
  - More complex the OS and PCB, longer to switch

Context switch



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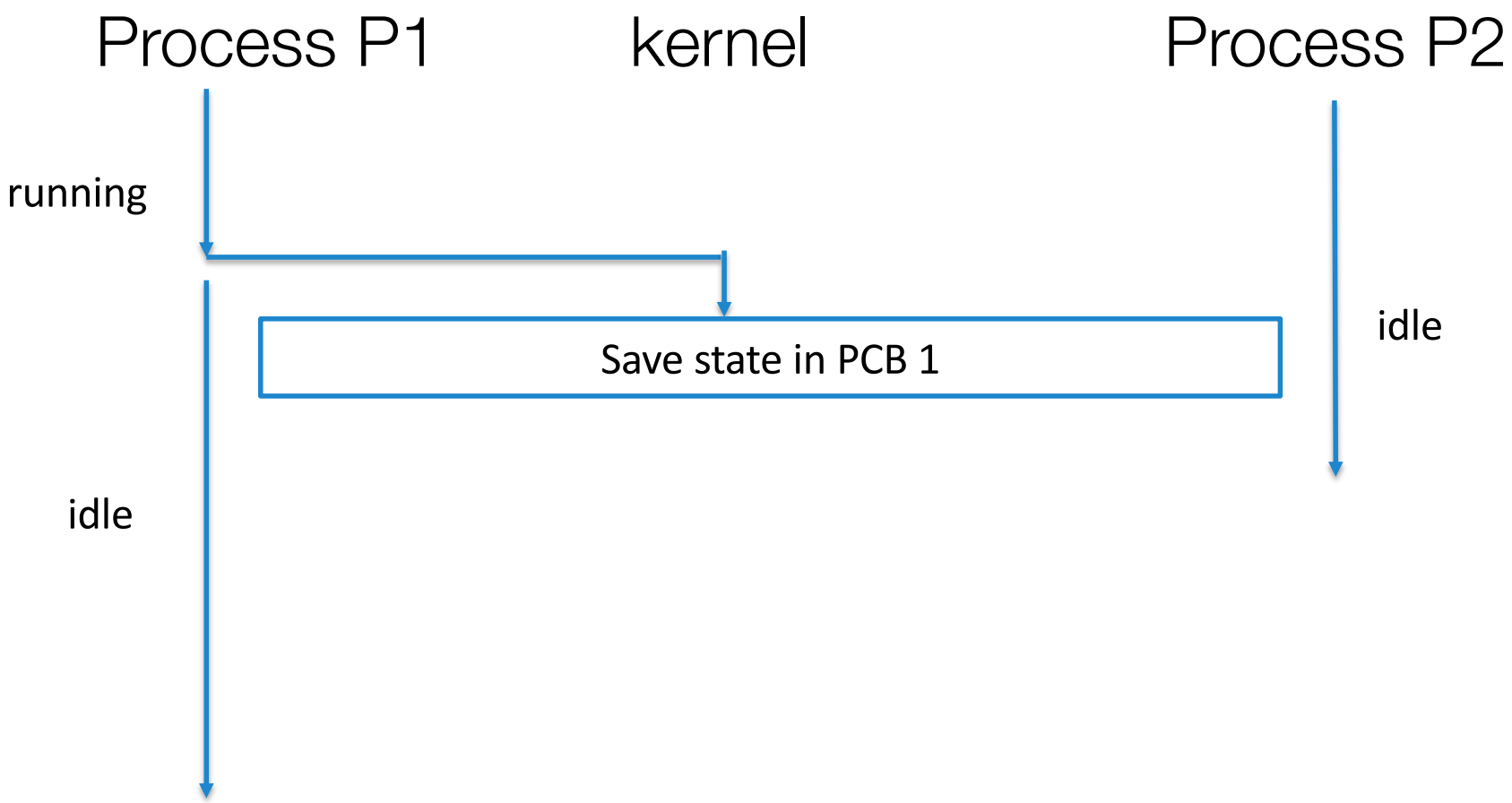

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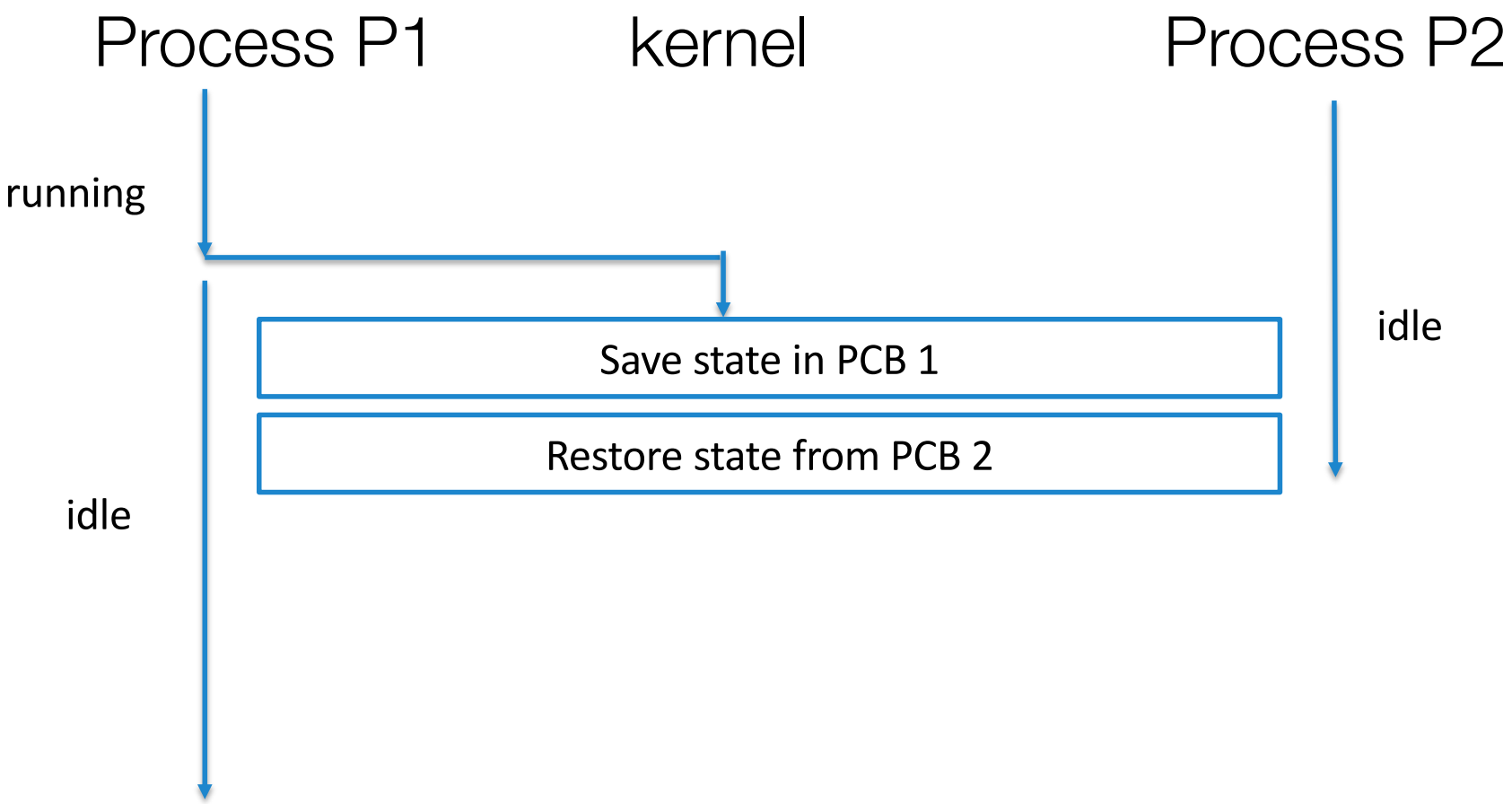

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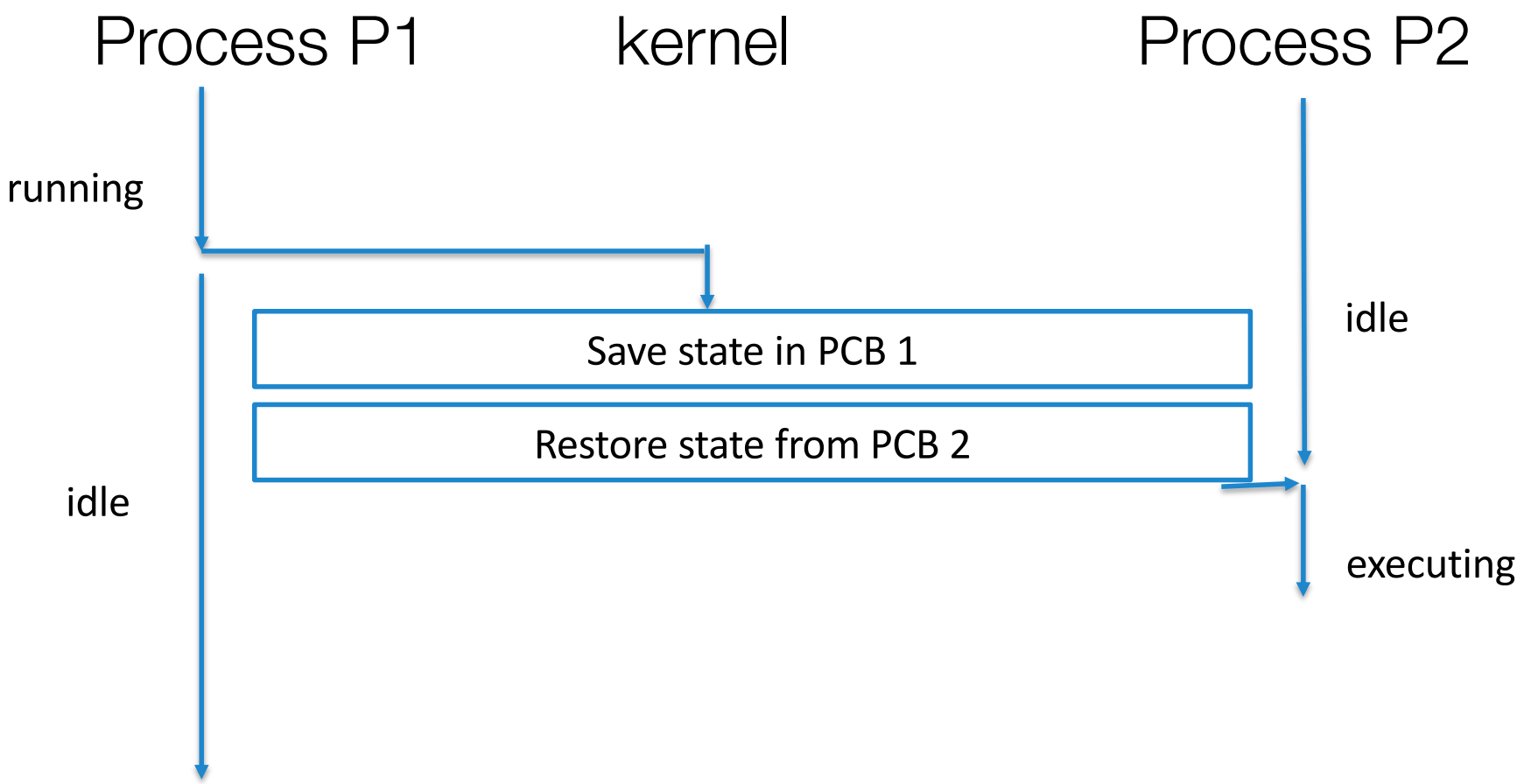

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