

Process

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CS39002

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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

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

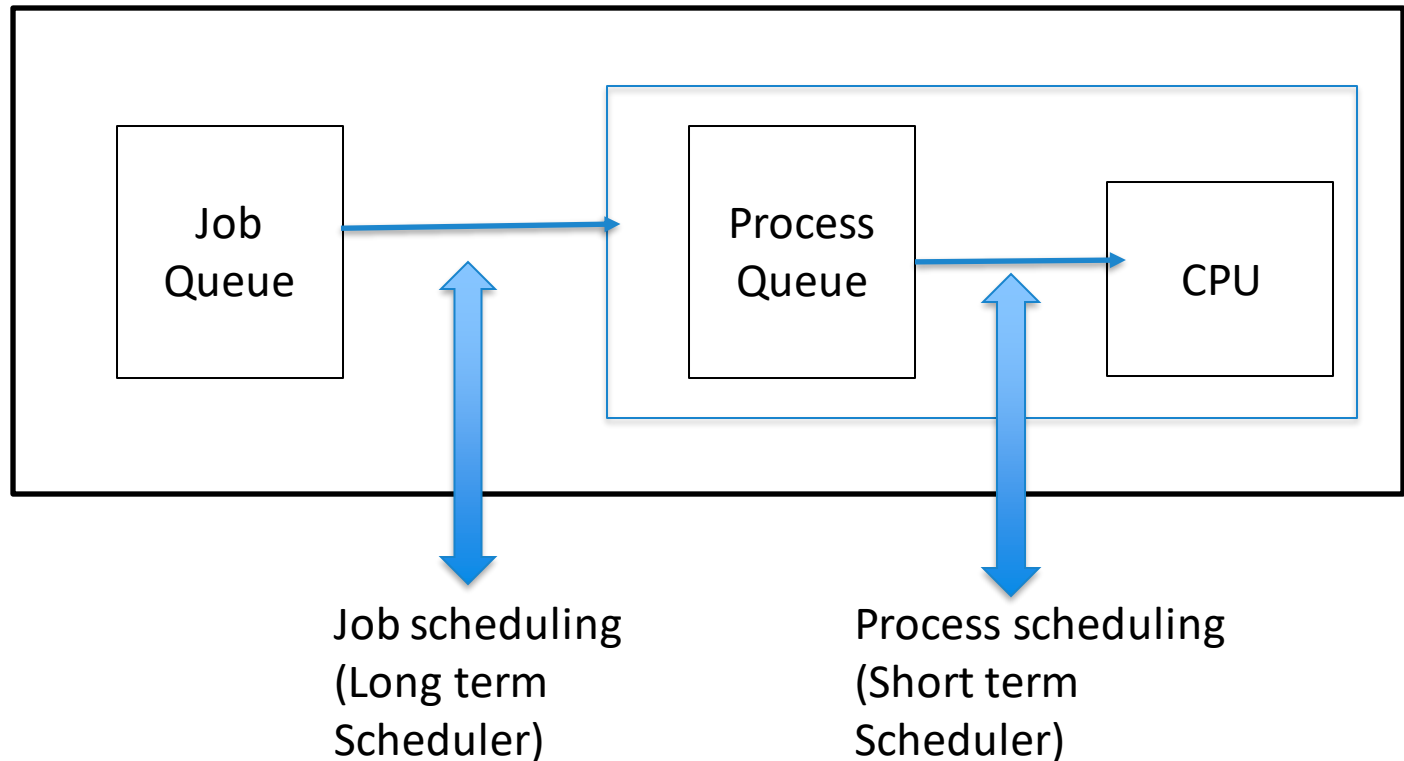
Program vs. Process

- 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



This lecture

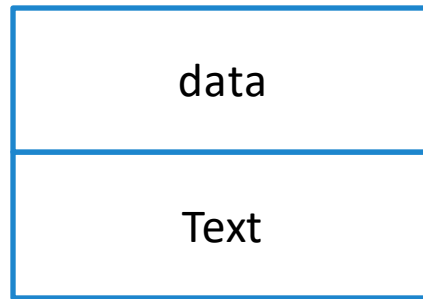
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What are parts of a process (in memory)?



Program code

What are parts of a process?



Global variable

Program code

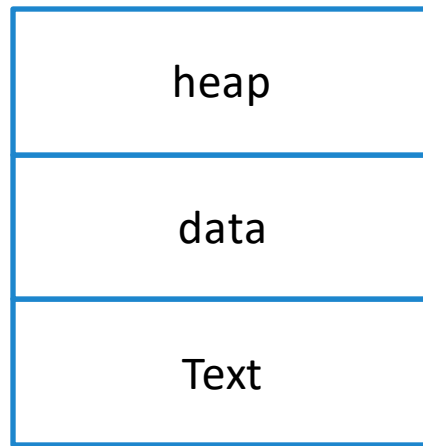
What are parts of a process?

heap	Dynamically allocated memory
data	Global variable
Text	Program code

What are parts of a process?



Temporary data,
function parameters,
local variables, return addresses

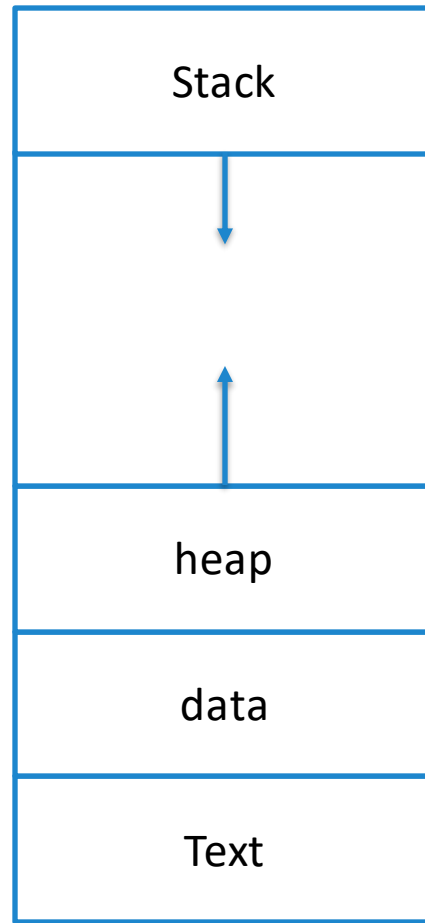


Dynamically allocated memory

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What are parts of a process?



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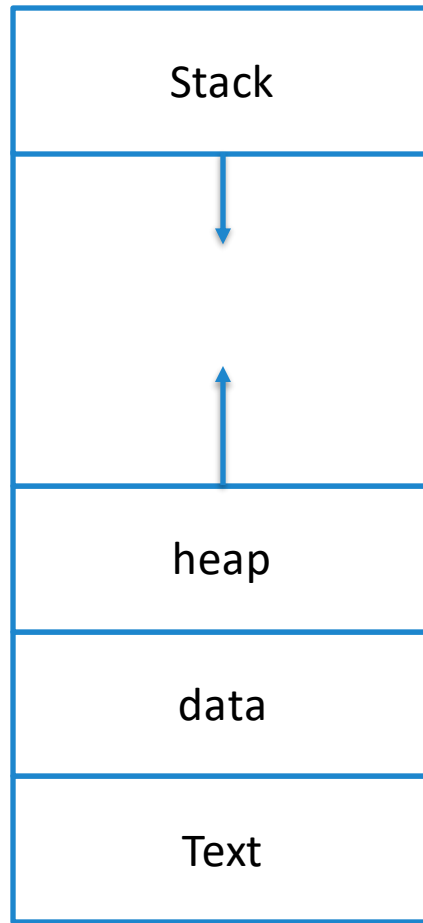
Dynamically allocated memory

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Program code

What are parts of a process?

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



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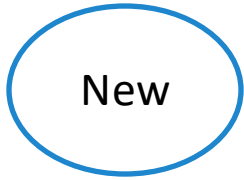
A process has different states

- 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

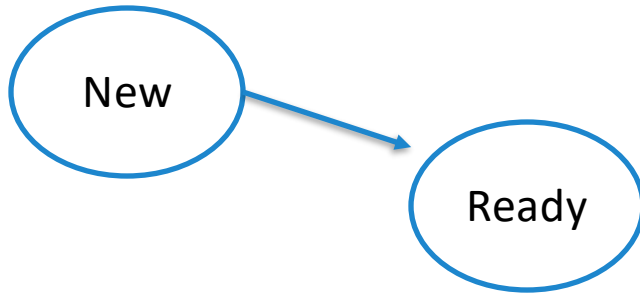
States of a process

- 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

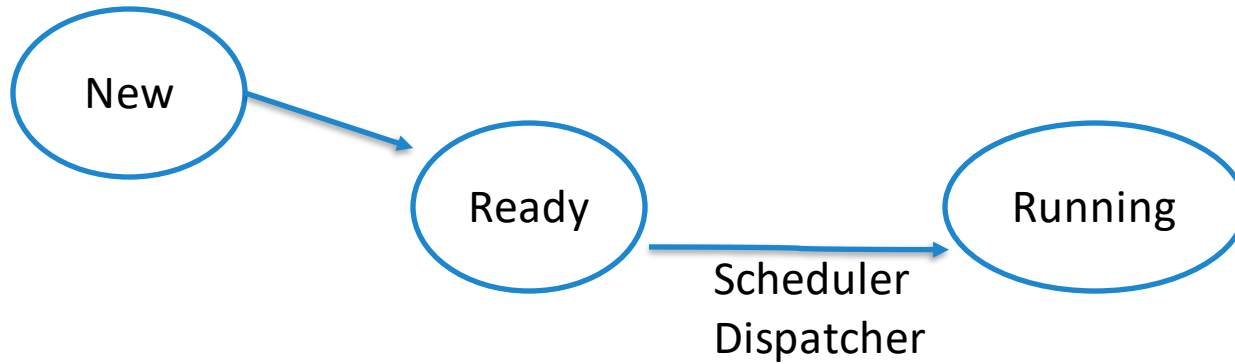
Process state diagram



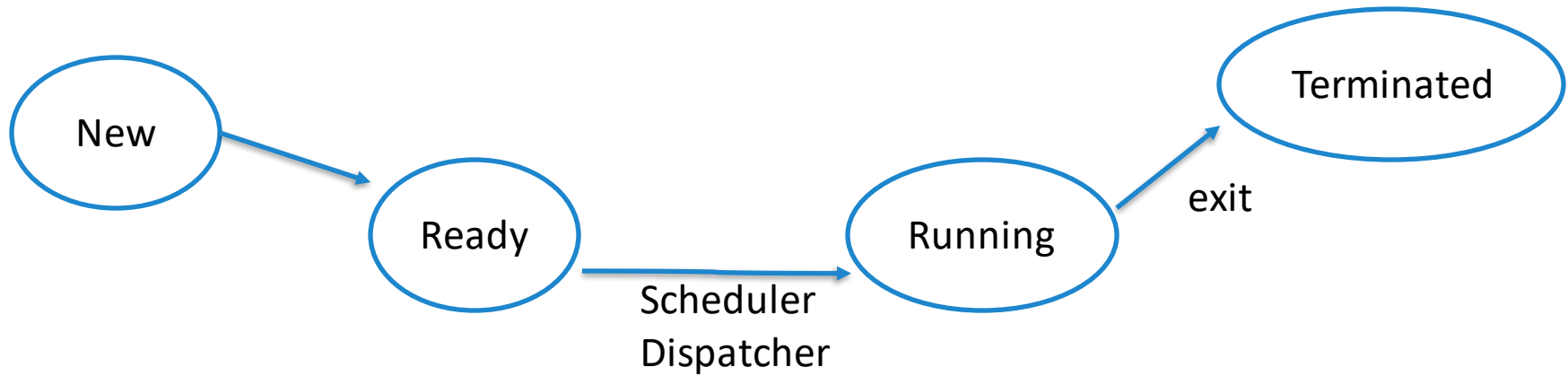
Process state diagram



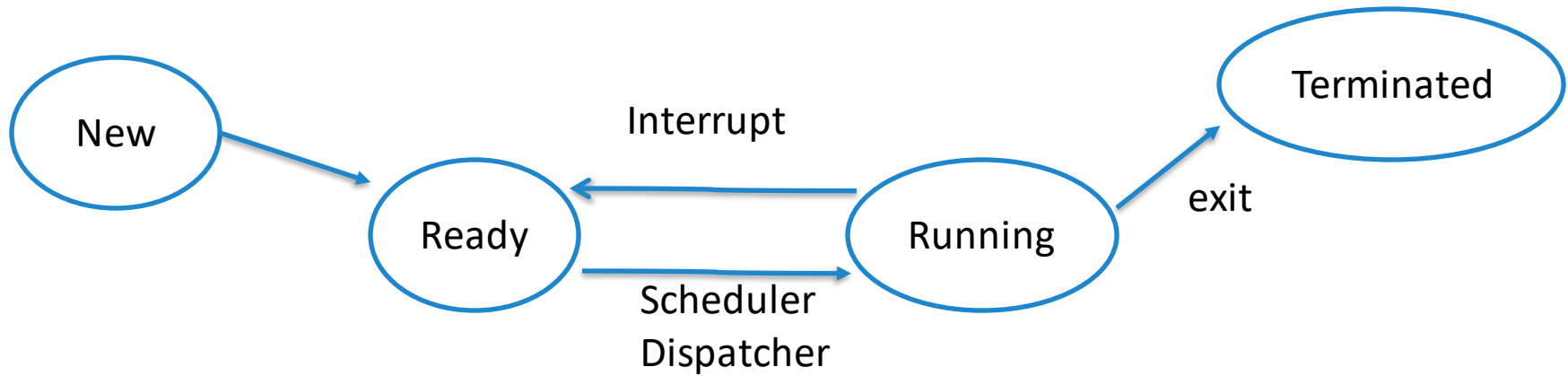
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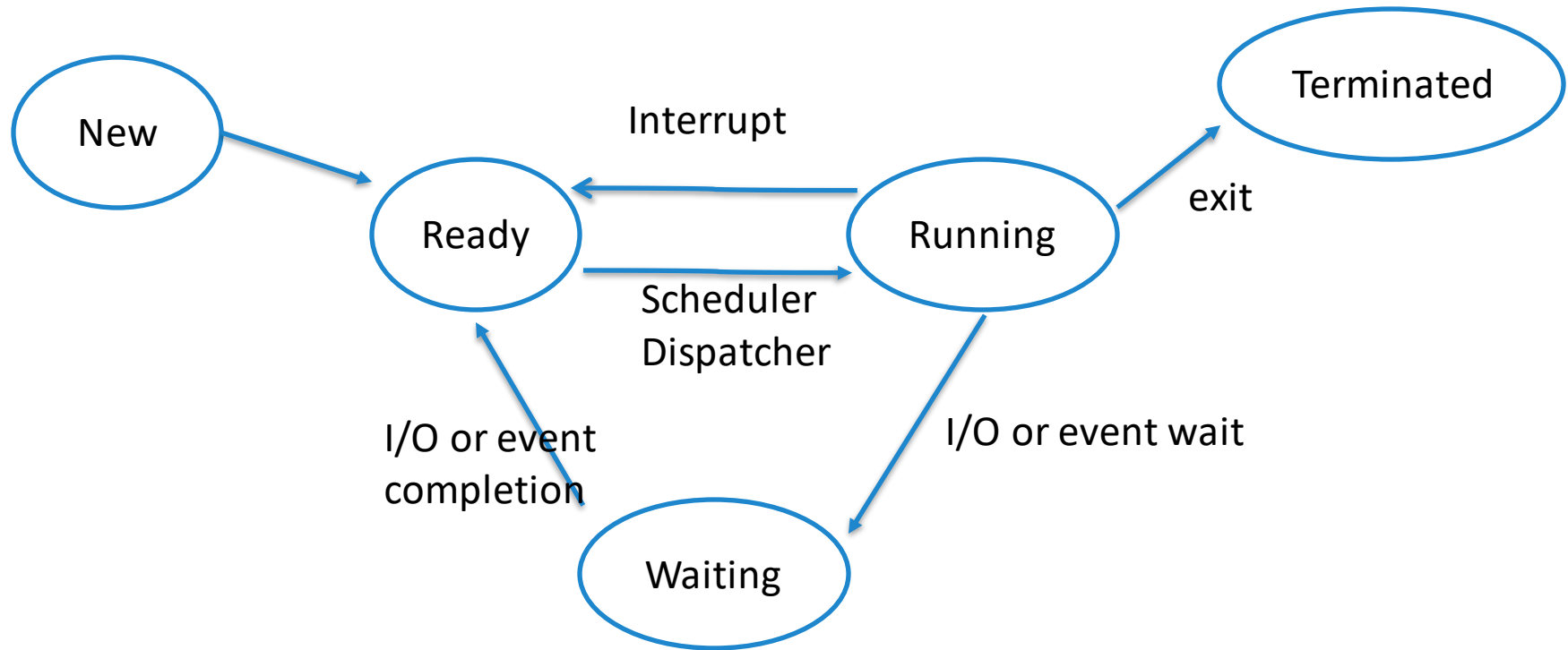
Process state diagram



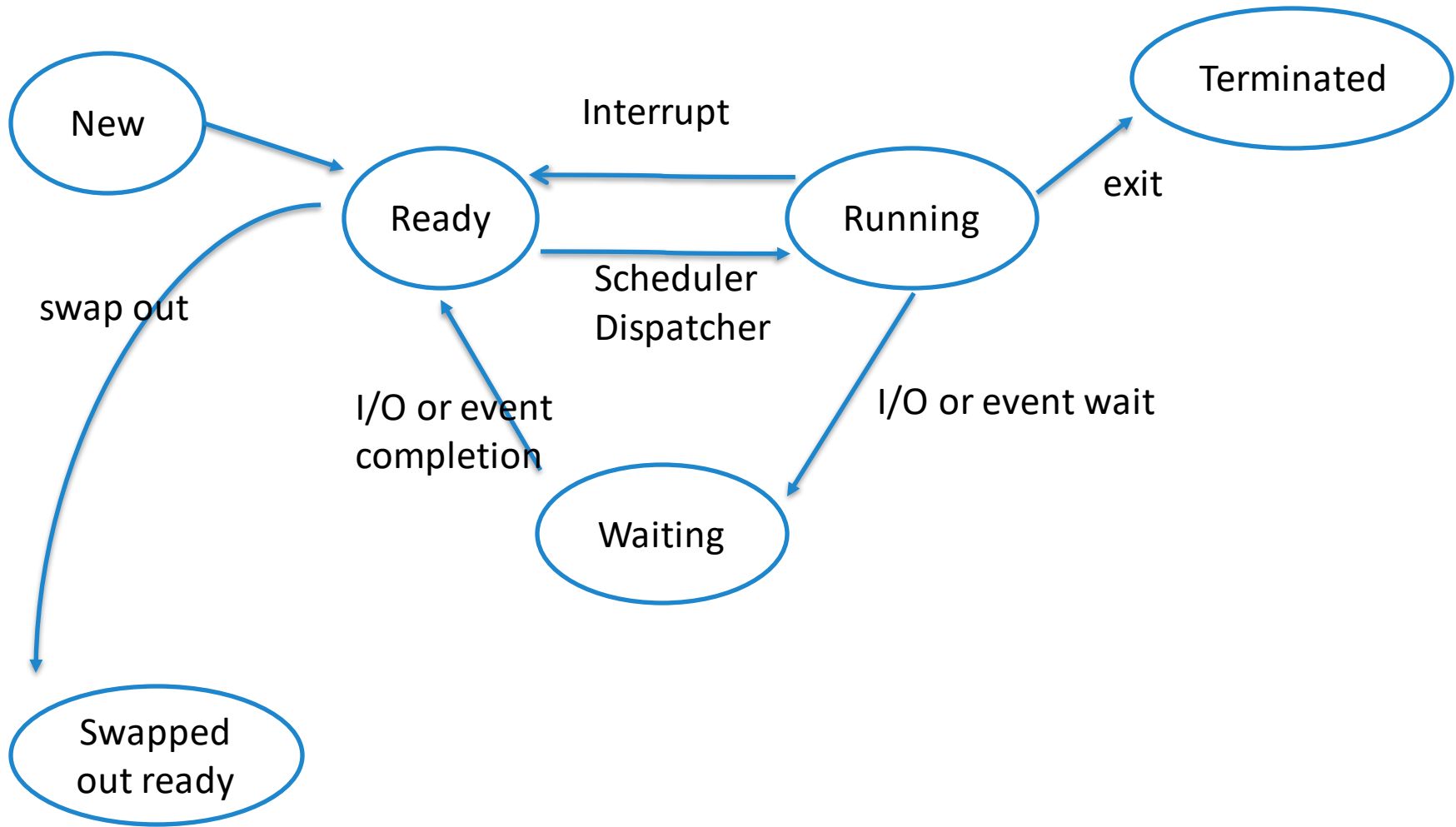
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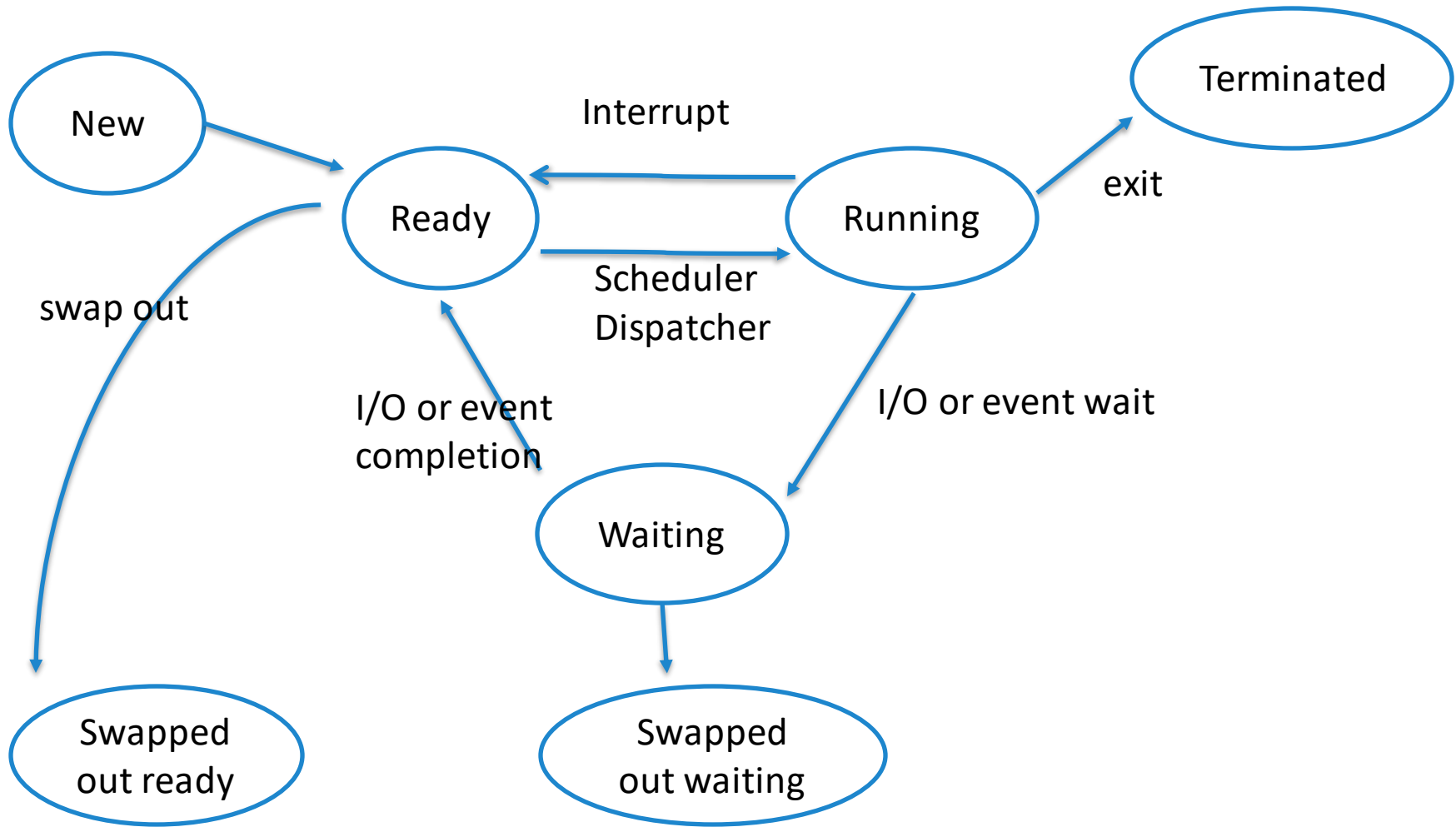
Process state diagram



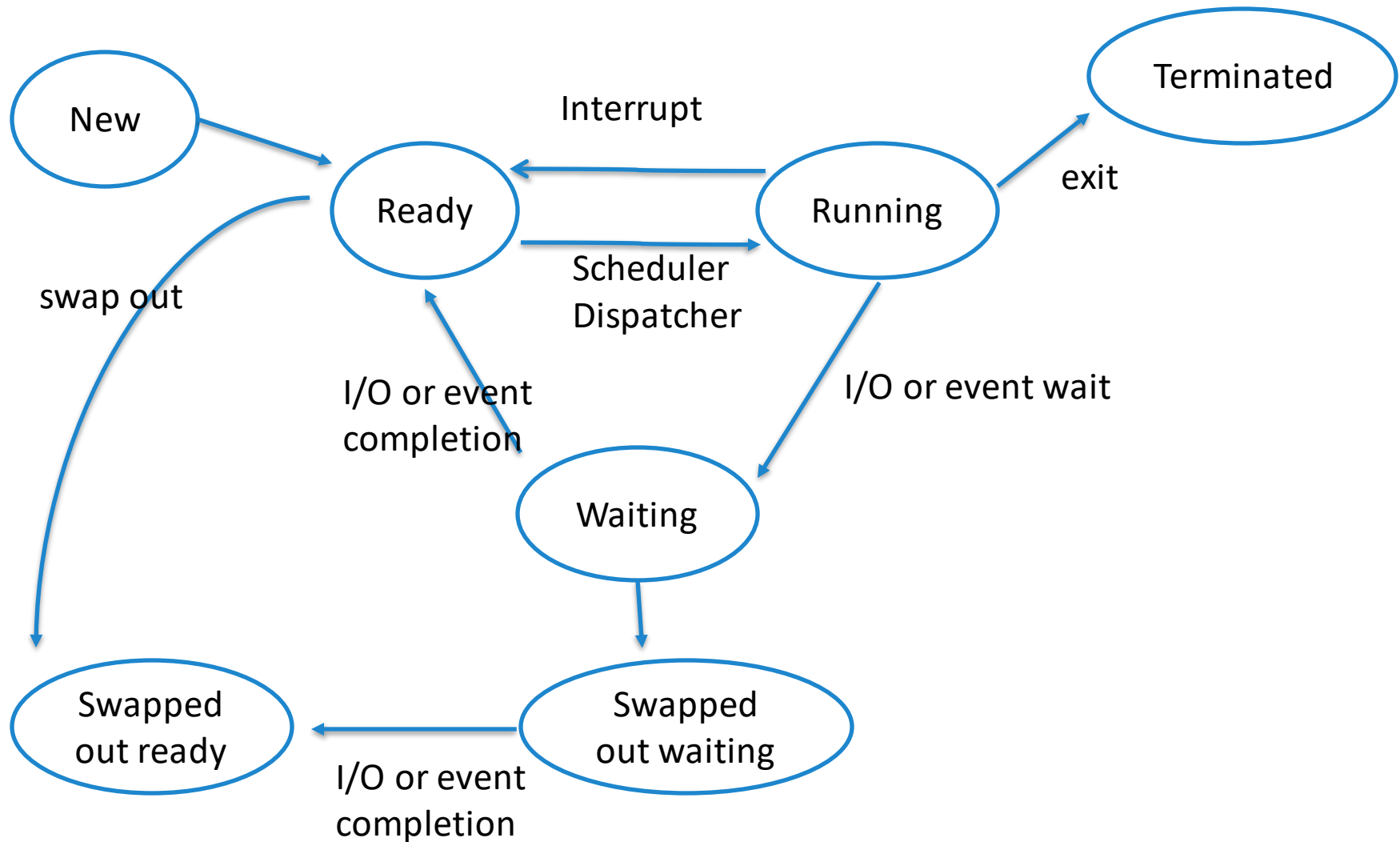
Process state diagram



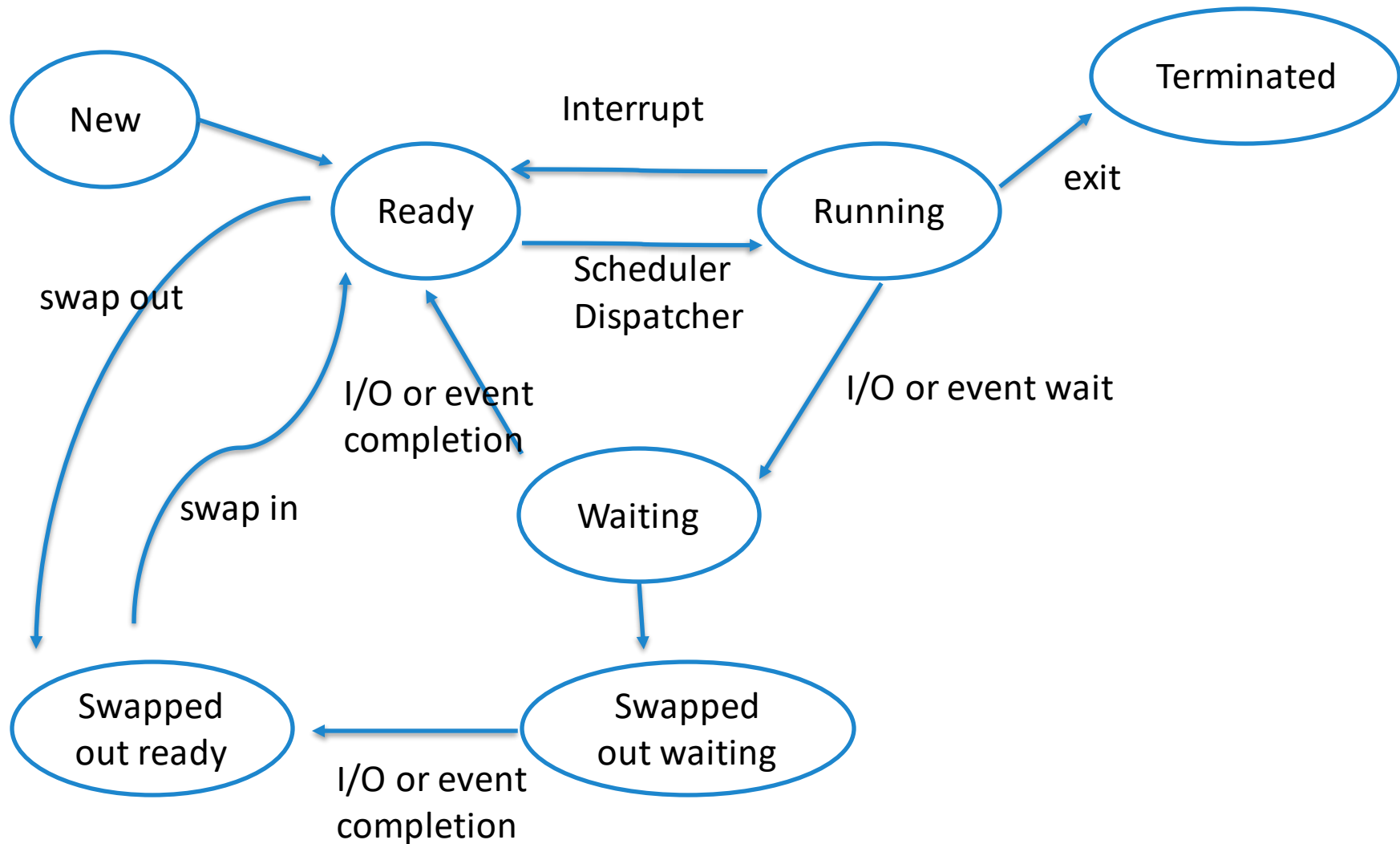
Process state diagram



Process state diagram



Process state diagram



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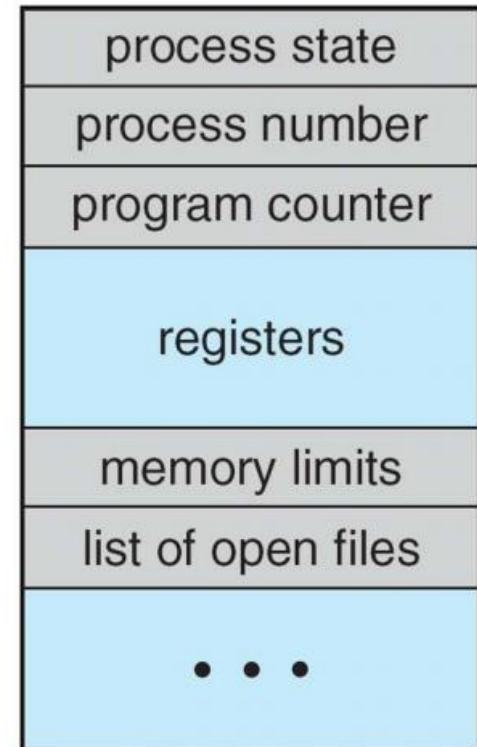
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Process control block (PCB)

- 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
```

This lecture

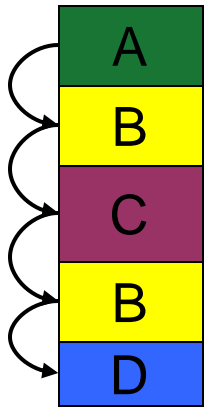
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CPU runs multiple processes

- 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...

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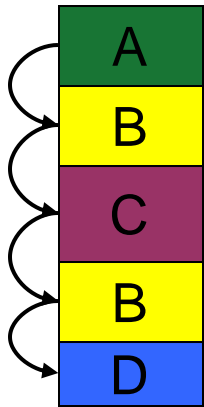
CPU's point of view



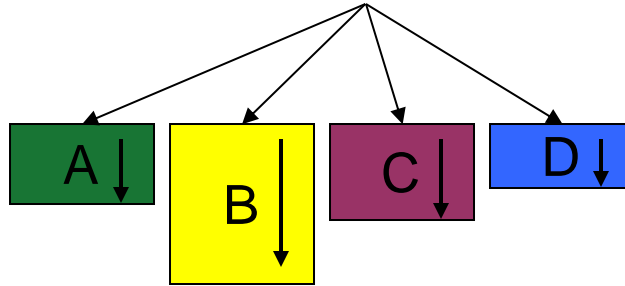
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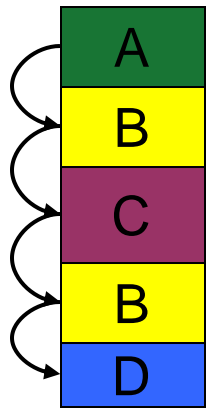
process point of view



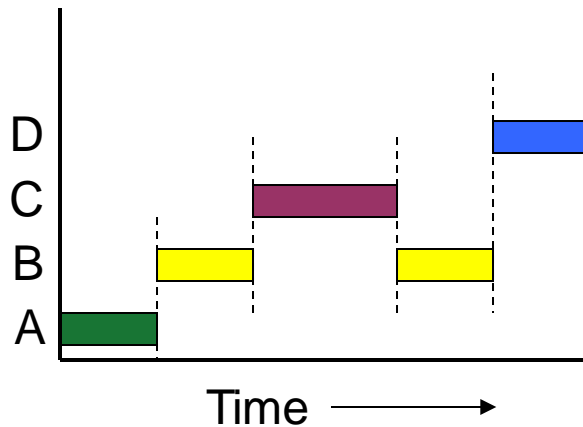
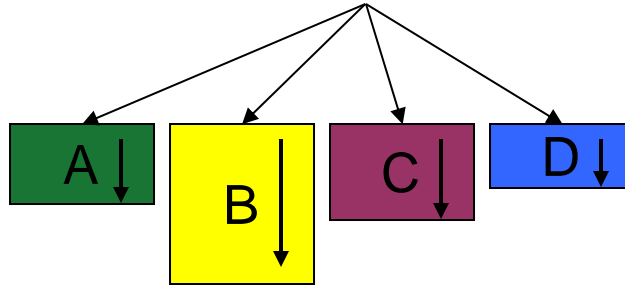
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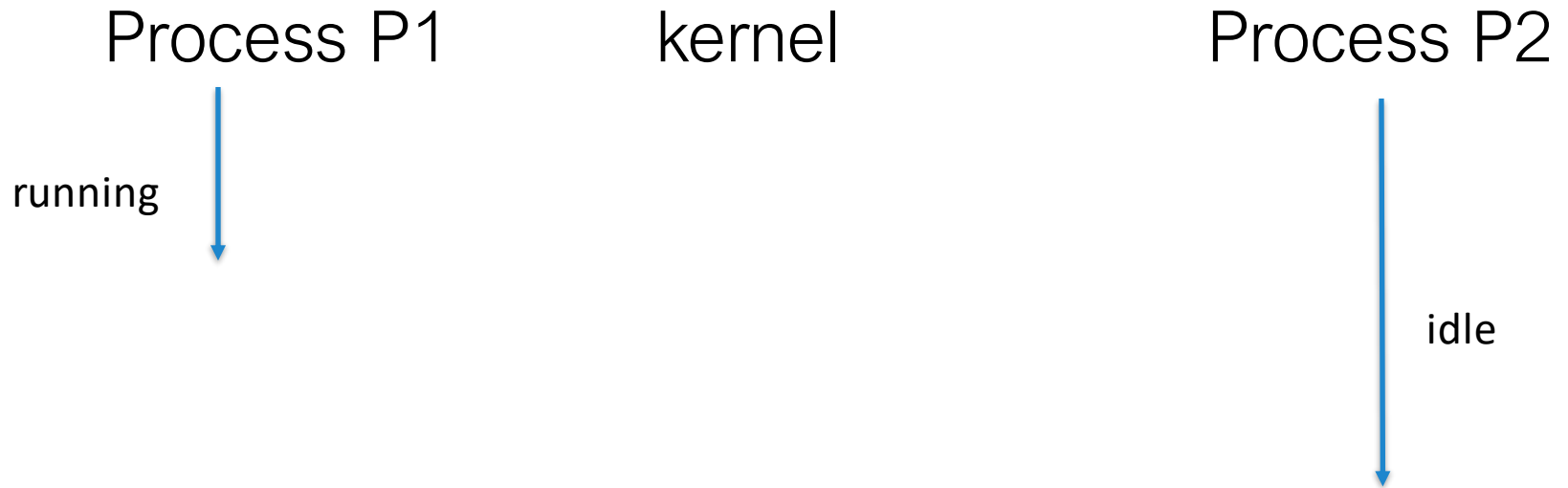
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Gantt chart for multiprogramming

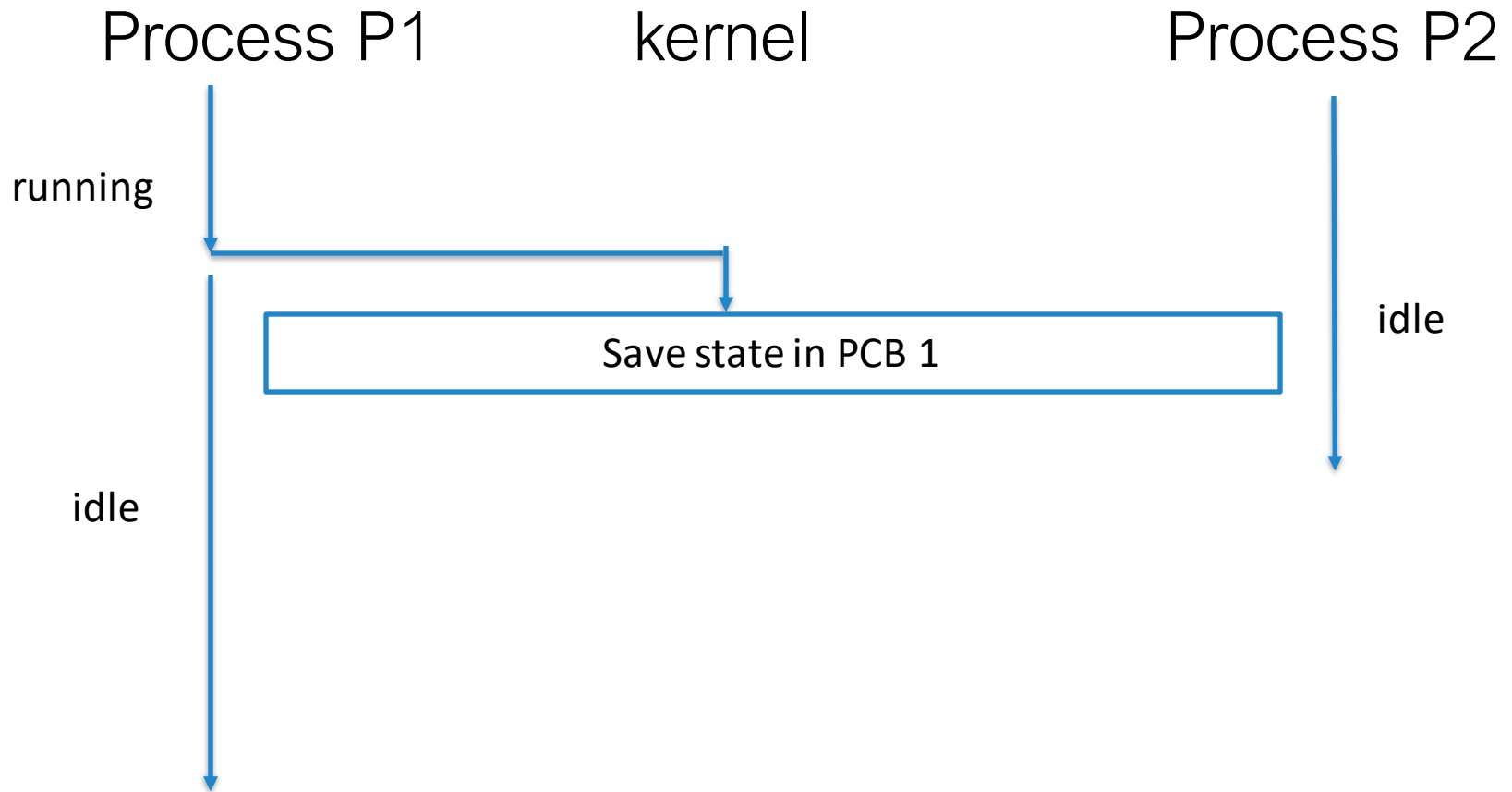
How to interleave processes?

- 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

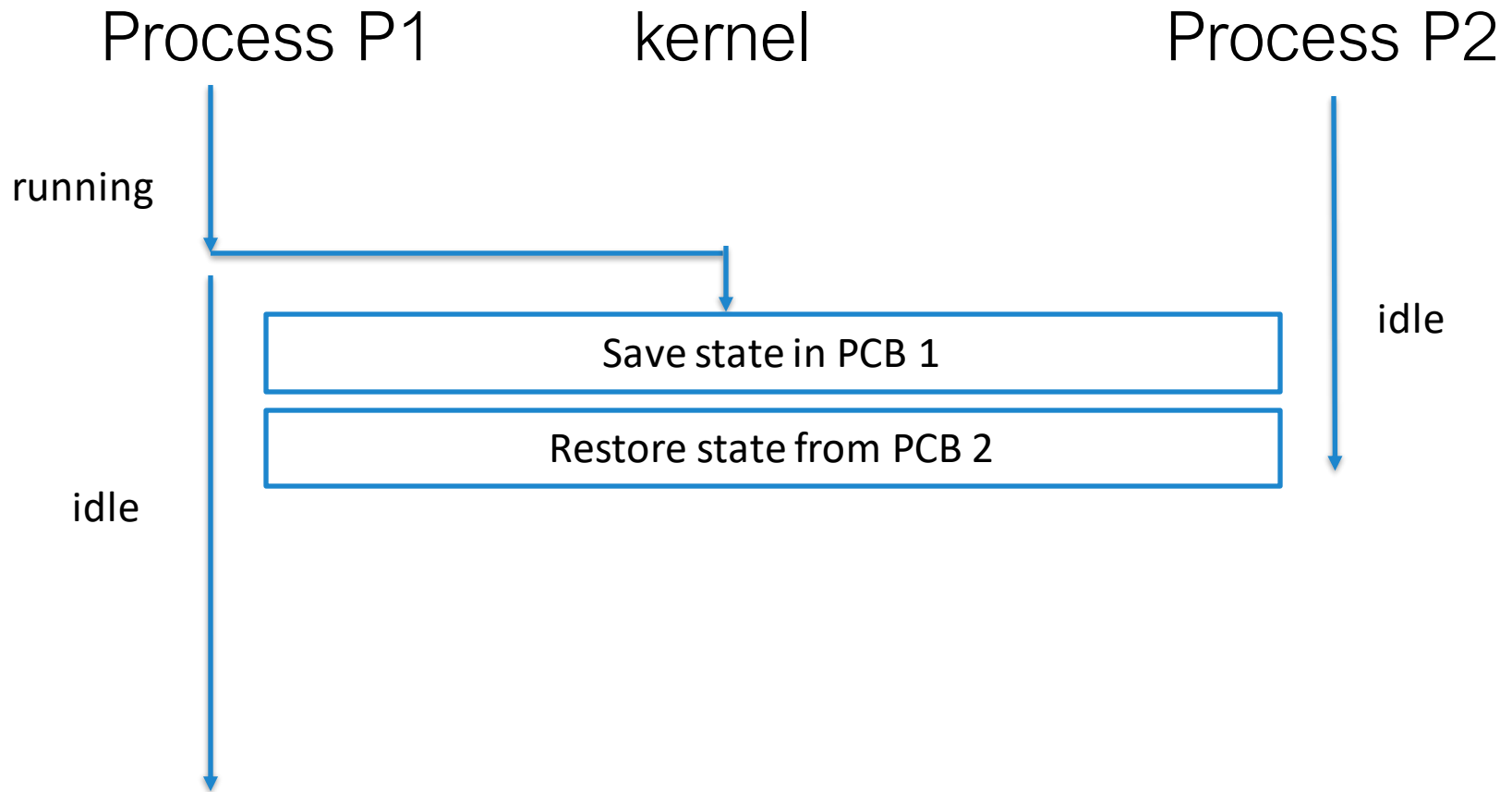
Context switch



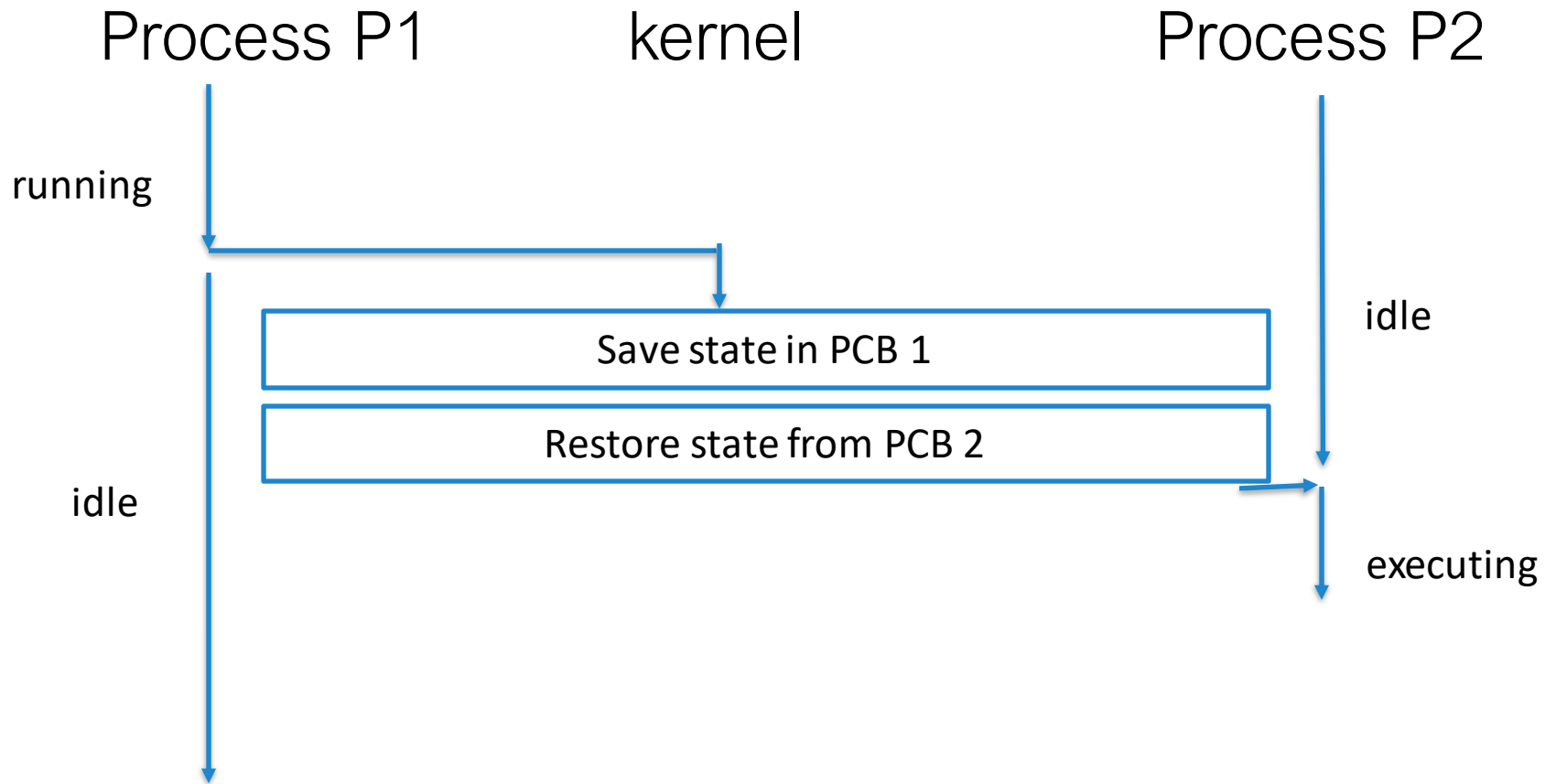
Context switch



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