Overview of a System

Systems Programming

(CST-210)

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Outline

- **Revisit C Compilation**
- Tour of a Computer System
- Running a C program
- Cache Memory
- Storage Hierarchy
- Operating System Concepts

Revisit C Compilation

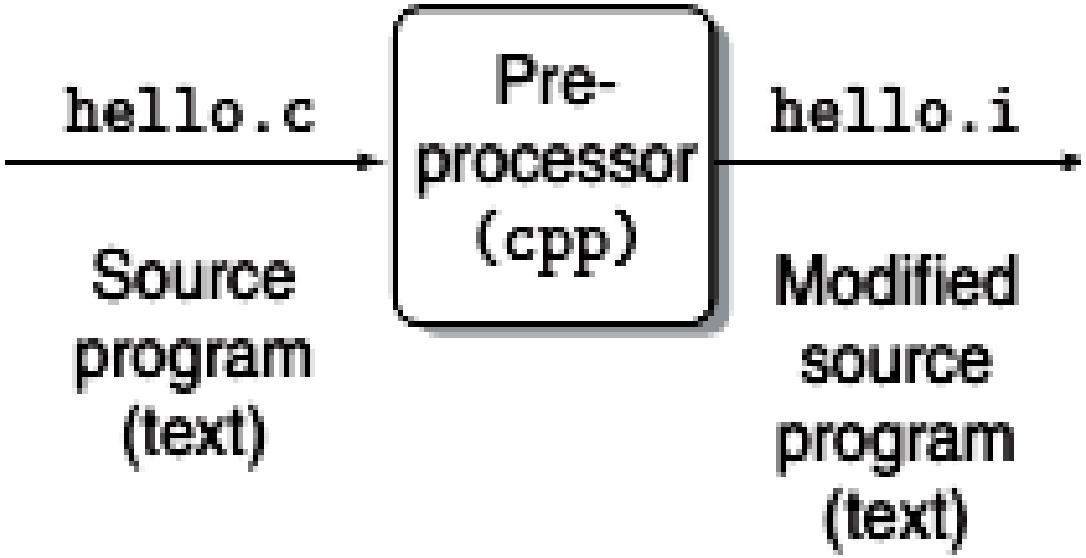
- A very simple C program:

```
#include<stdio.h>
void main() {
    printf("Hello World \n");
}
```

- We stored the program in ***hello.c***

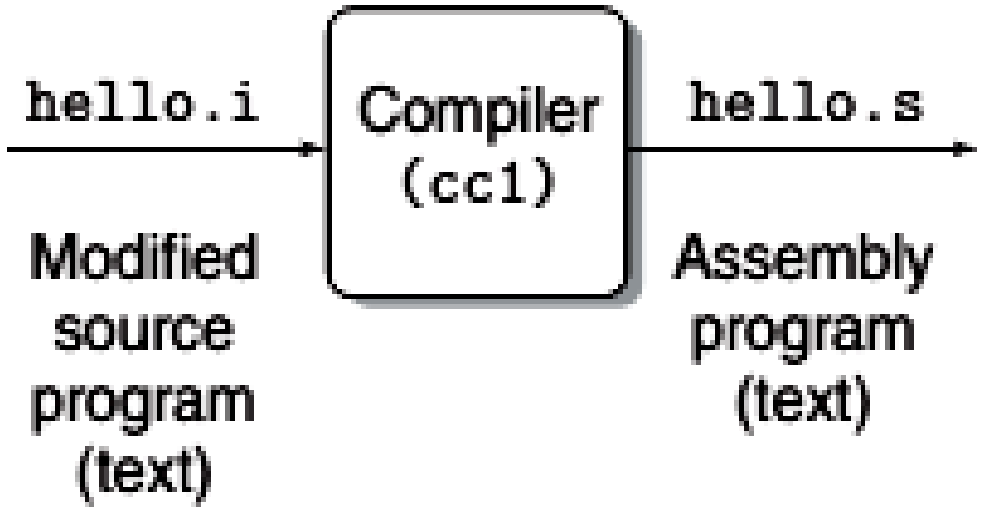
Revisit C Compilation (contd.)

- STEP 1:



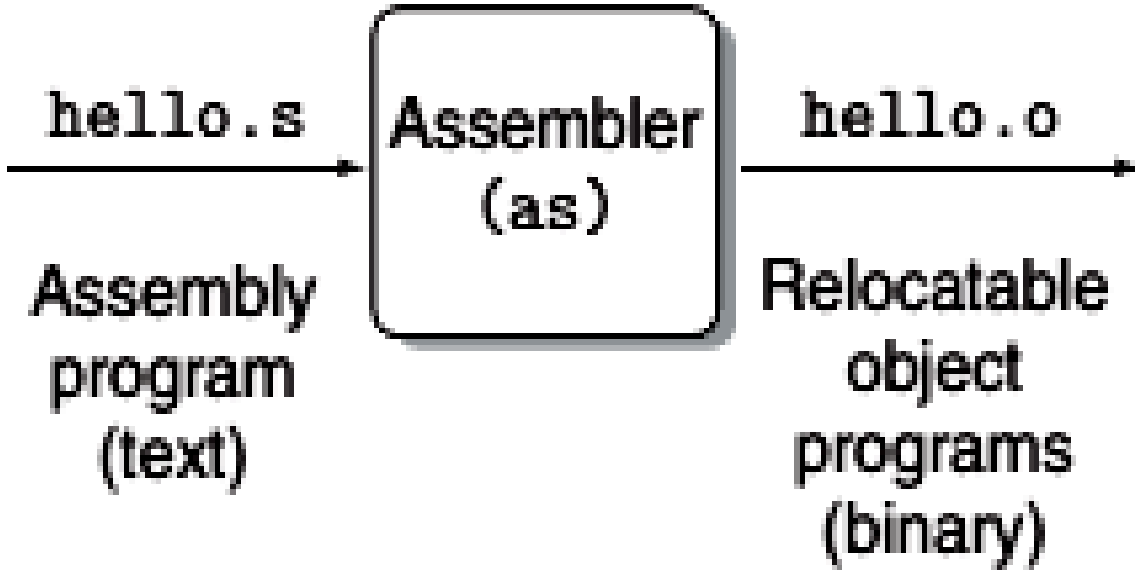
Revisit C Compilation (contd.)

- STEP 2:



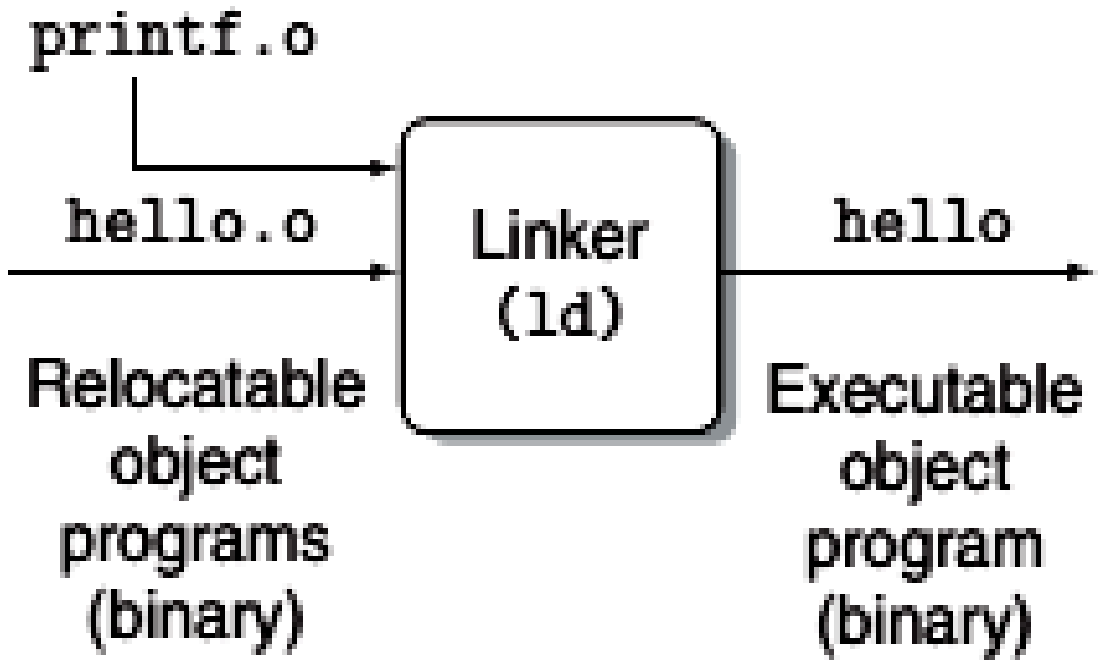
Revisit C Compilation (contd.)

- STEP 3

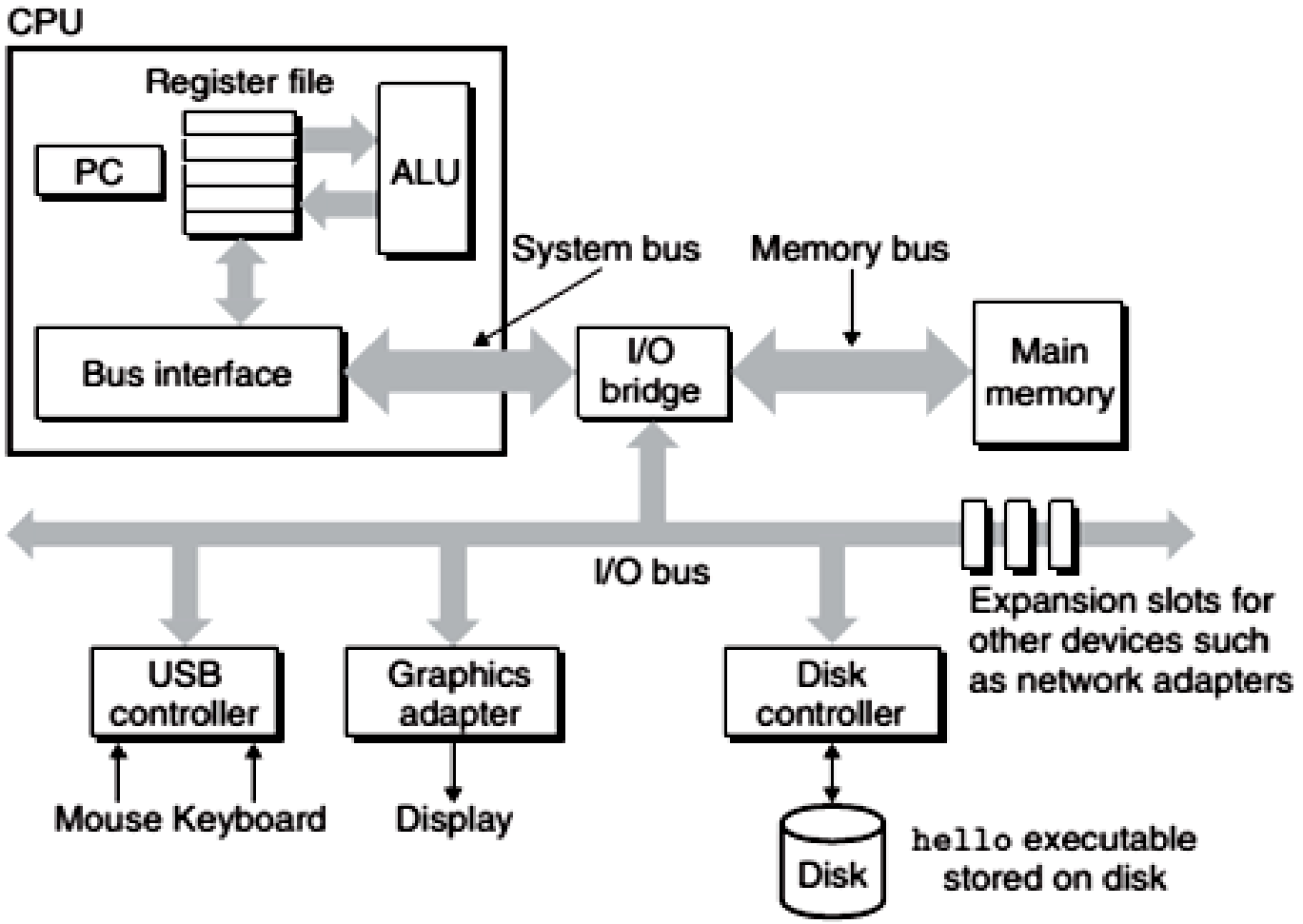


Revisit C Compilation (contd.)

- STEP 4:



Tour of a Computer System



Running a C program

- Compile:

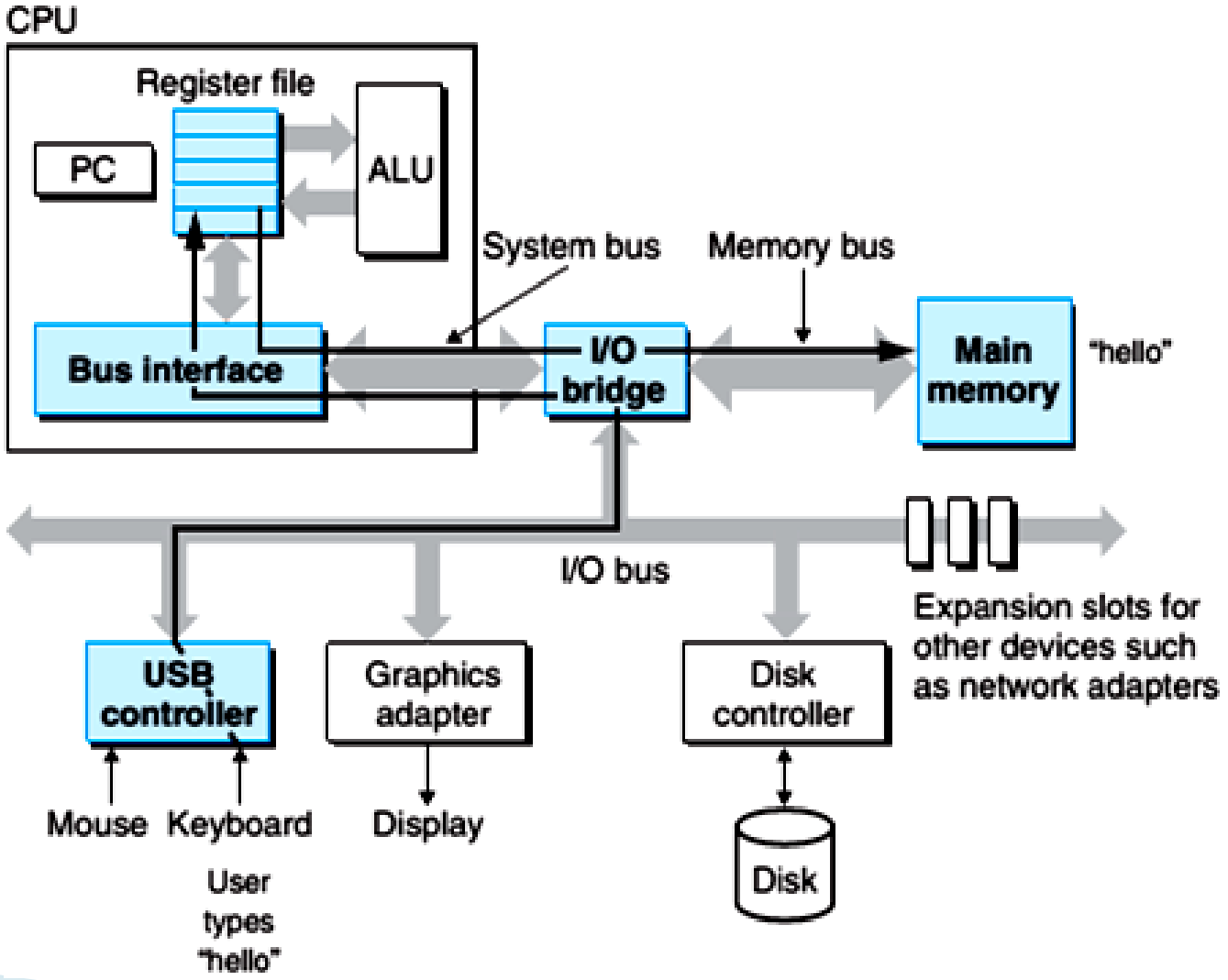
  $ **gcc –o hello hello.c**

- Run

  $ ./hello
  Hello World
  $ _

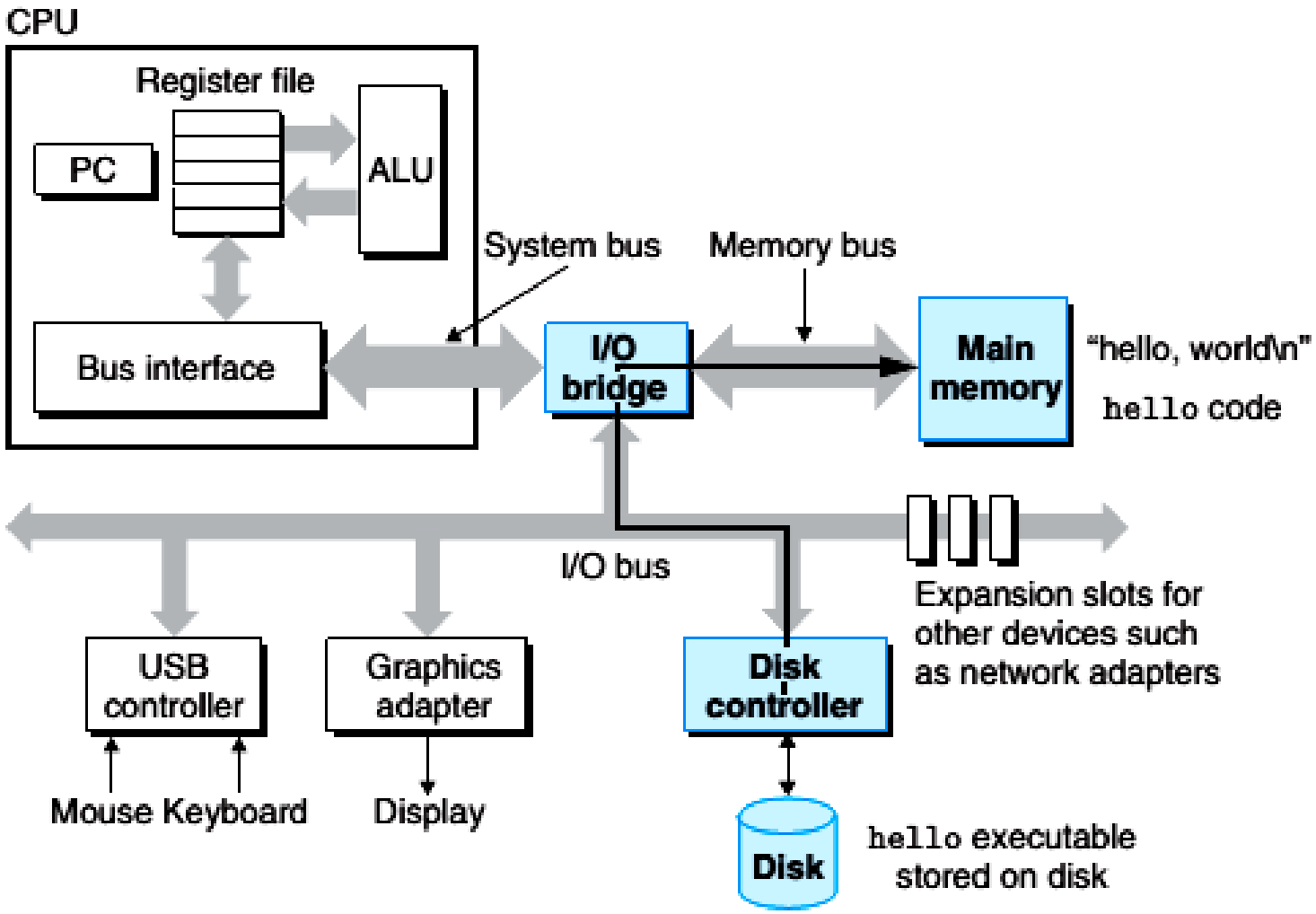
Running a C program (contd.)

- Reading **./hello**



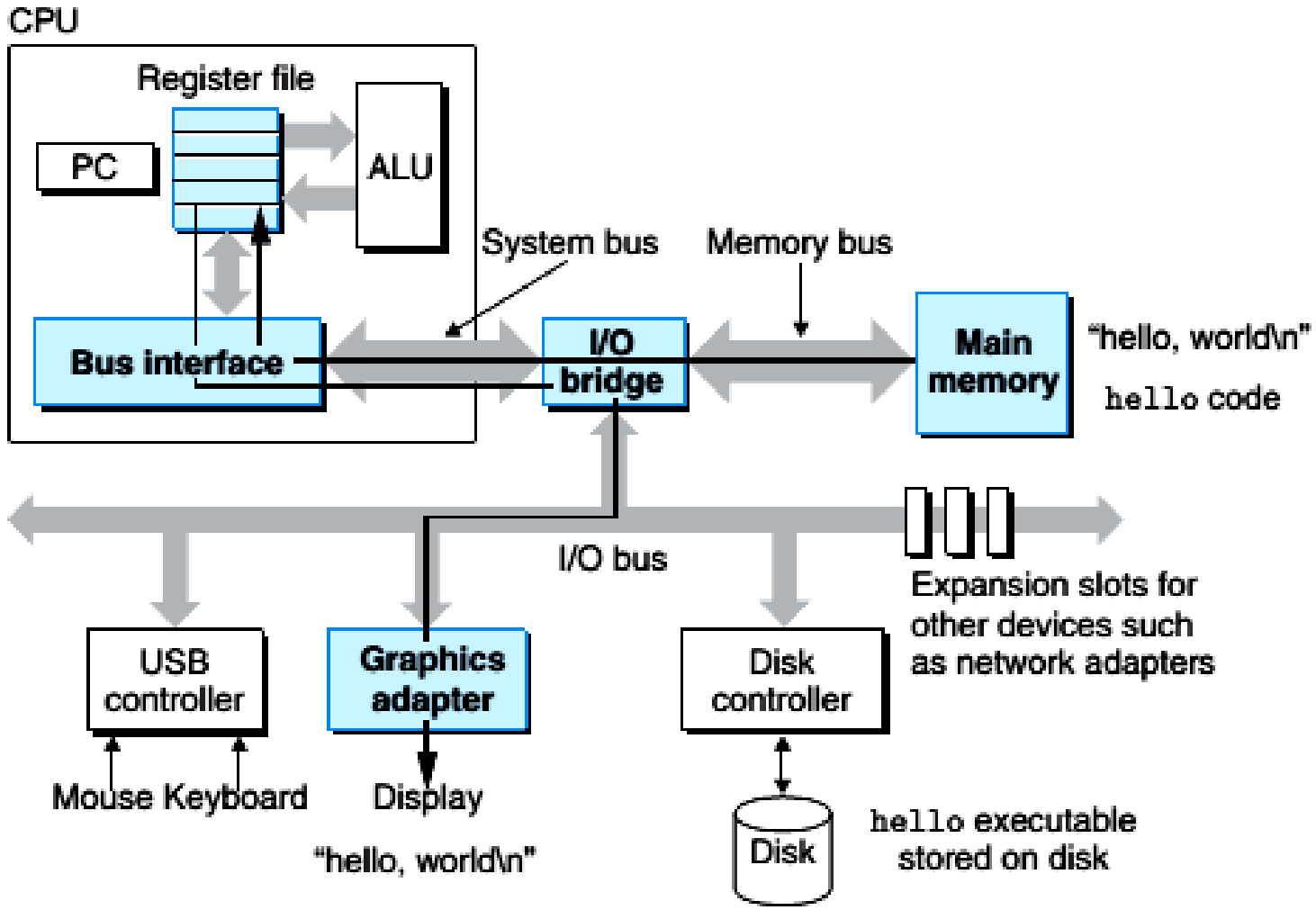
Running a C program (contd.)

- Loading the executable

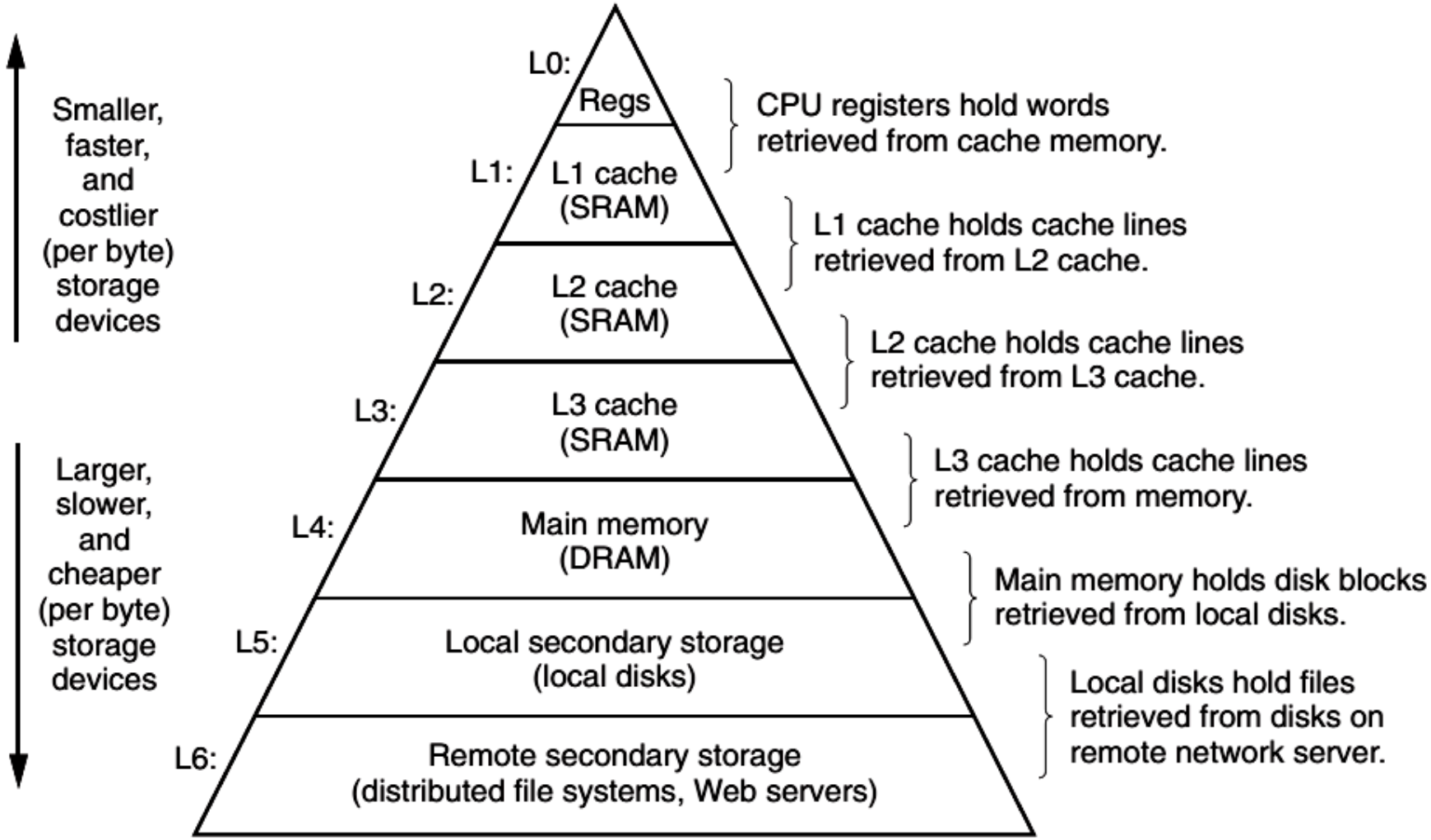


Running a C program (contd.)

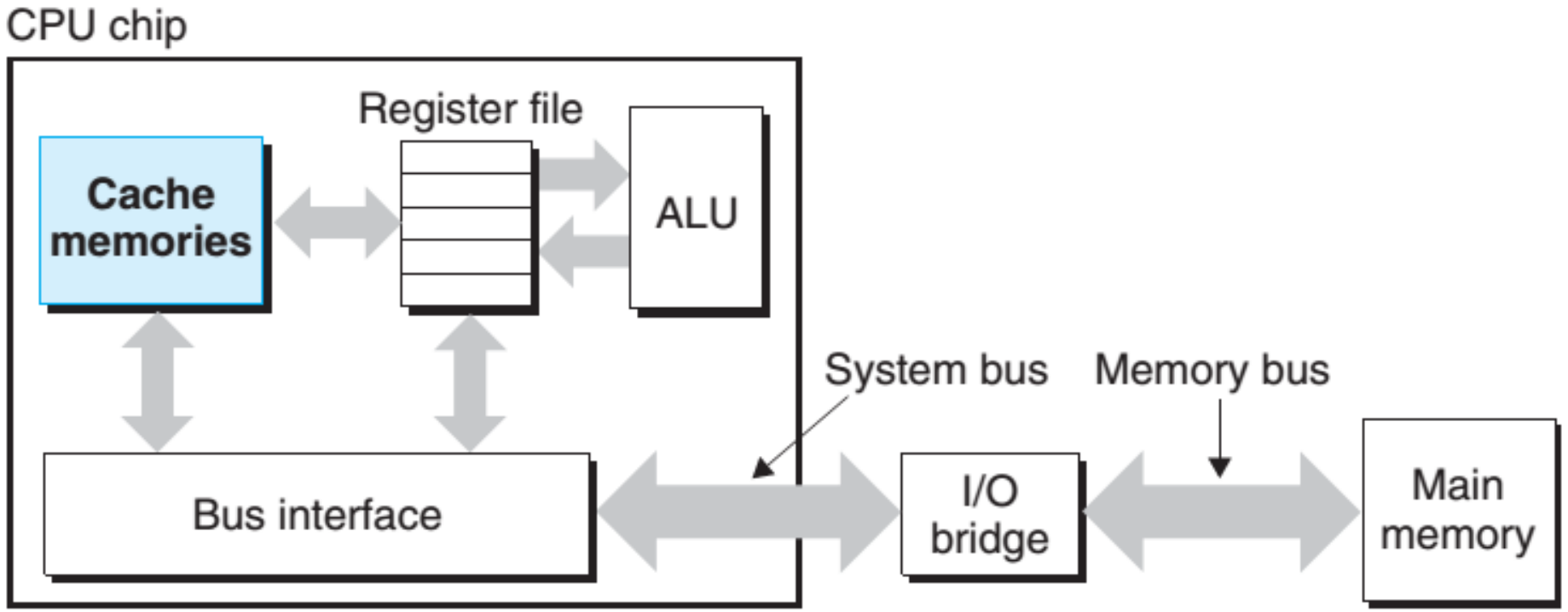
- Writing output “String”



Storage Hierarchy

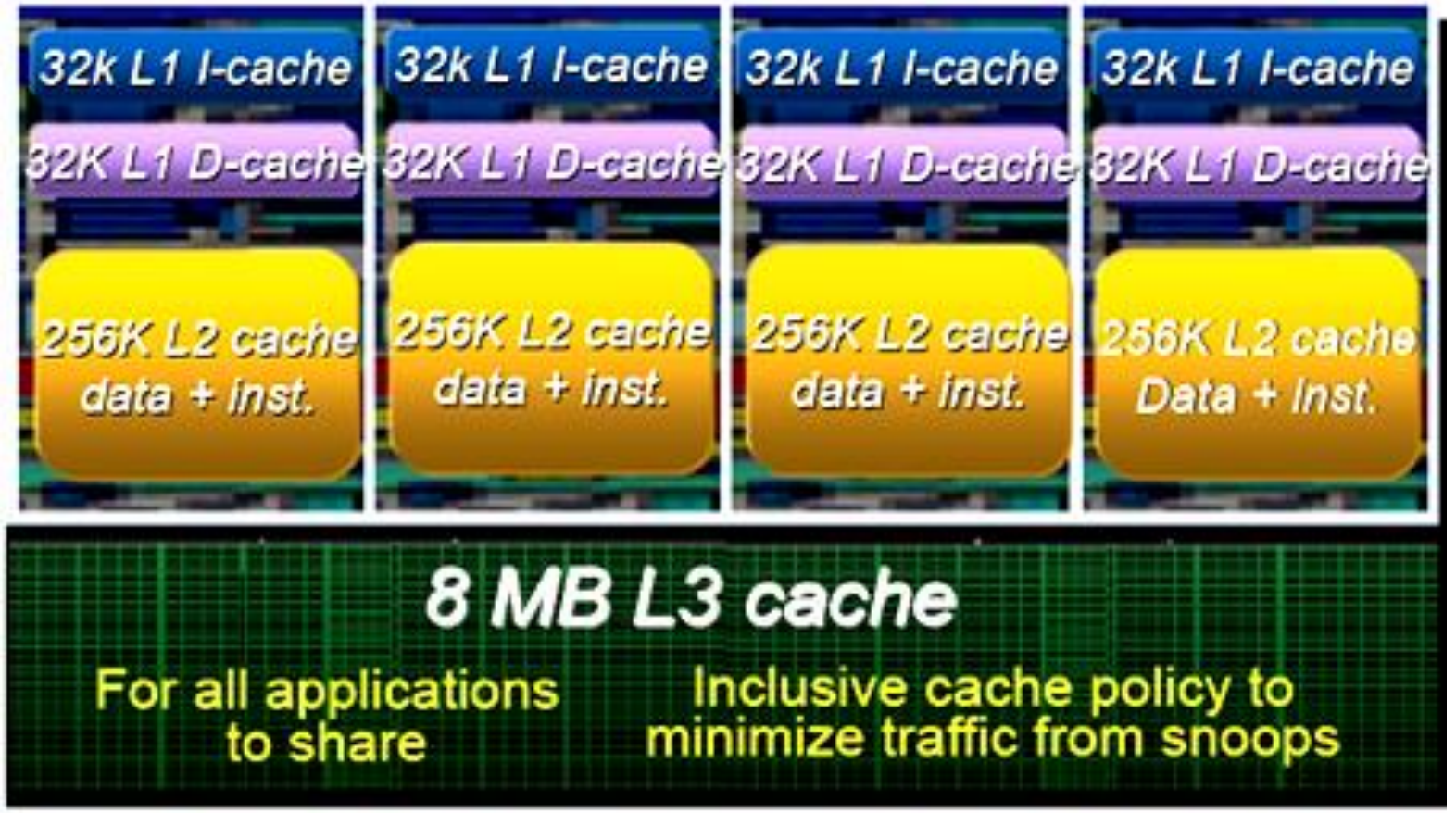


Cache Memory



Cache Memory (contd.)

- Intel Core i7



Cache Memory (contd.)

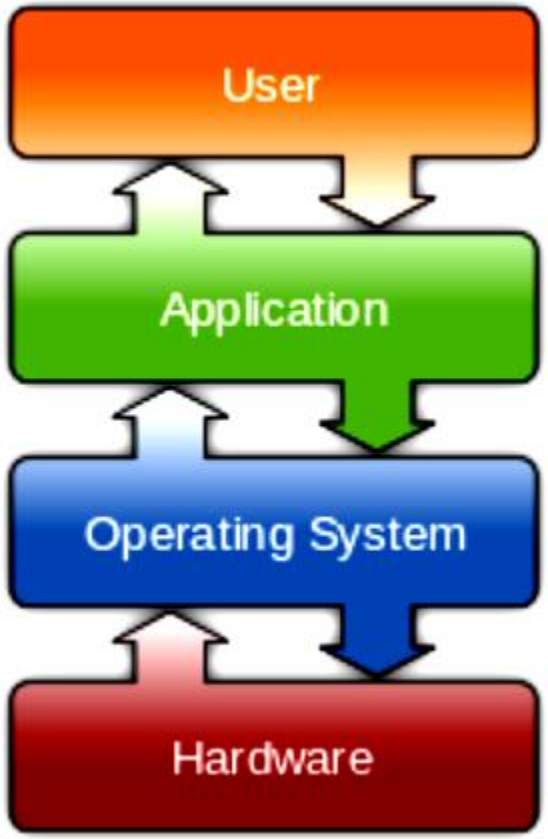
- Cache: L1
  - As fast as the Registers
- Cache: L2
  - 5-10 times faster than main memory
- Cache: L3
  - About 2-times faster

- All types are implemented using SRAM

Operating System Concepts

- A software layer that abstracts away the messy details of hardware into a useful, portable, powerful interface
  - Modules:
    - File-system, virtual memory management, network stack, protection system, scheduler
    - Each of these “subsystems” is a major system of its own!
- Design and implementation has many engineering tradeoffs
  - e.g., speed vs. portability, maintainability, simplicity etc.

Operating System Concepts



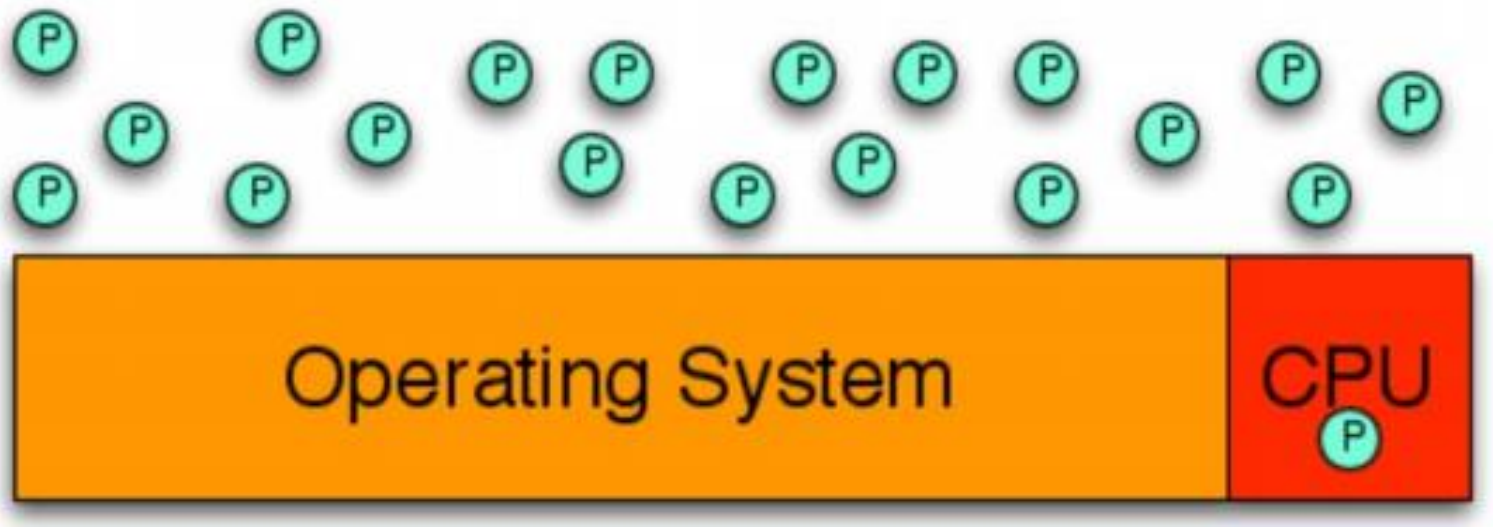
Operating System Concepts (contd.)

- Single-Tasking
- Multi-Tasking
- Multi-User / Time-Shared
- Real-Time
- Distributed
- Embedded

Operating System Concepts (contd.)

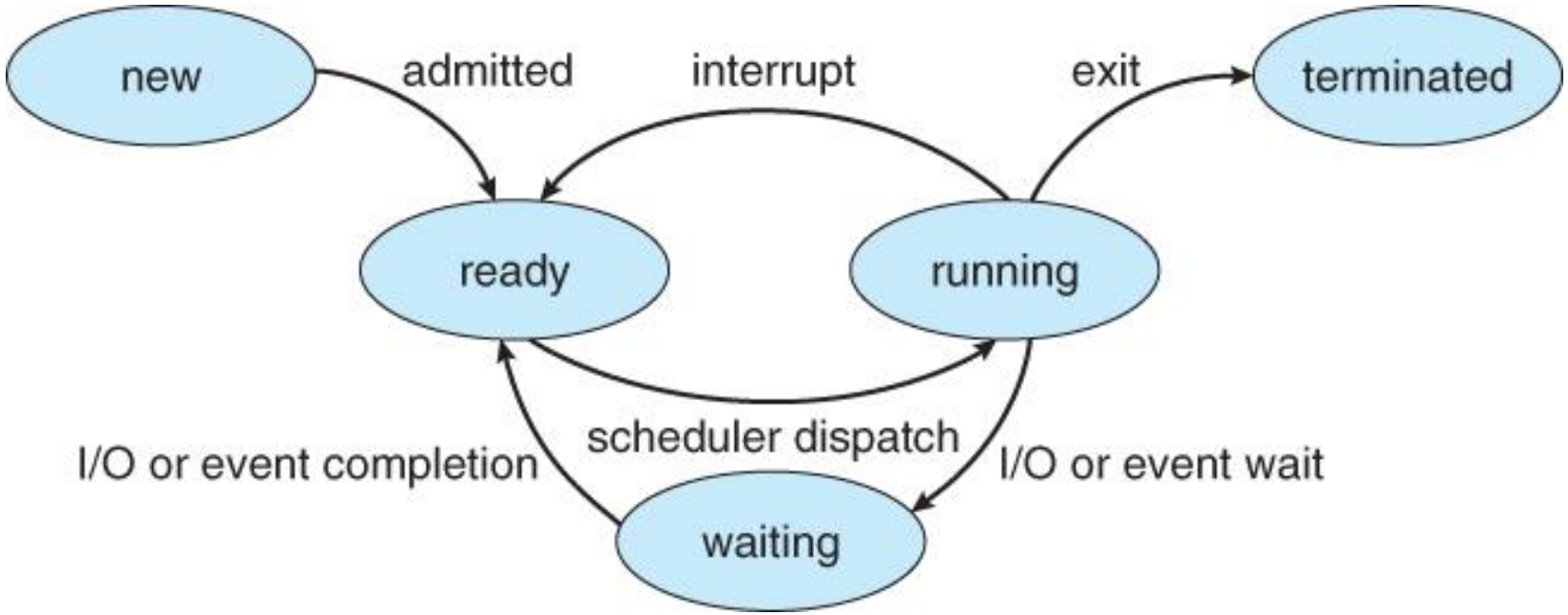
- Process: *Program in Execution*
- Processes are independent programs running concurrently within the operating system

- to see what processes are running on a UNIX system, use the **ps** command



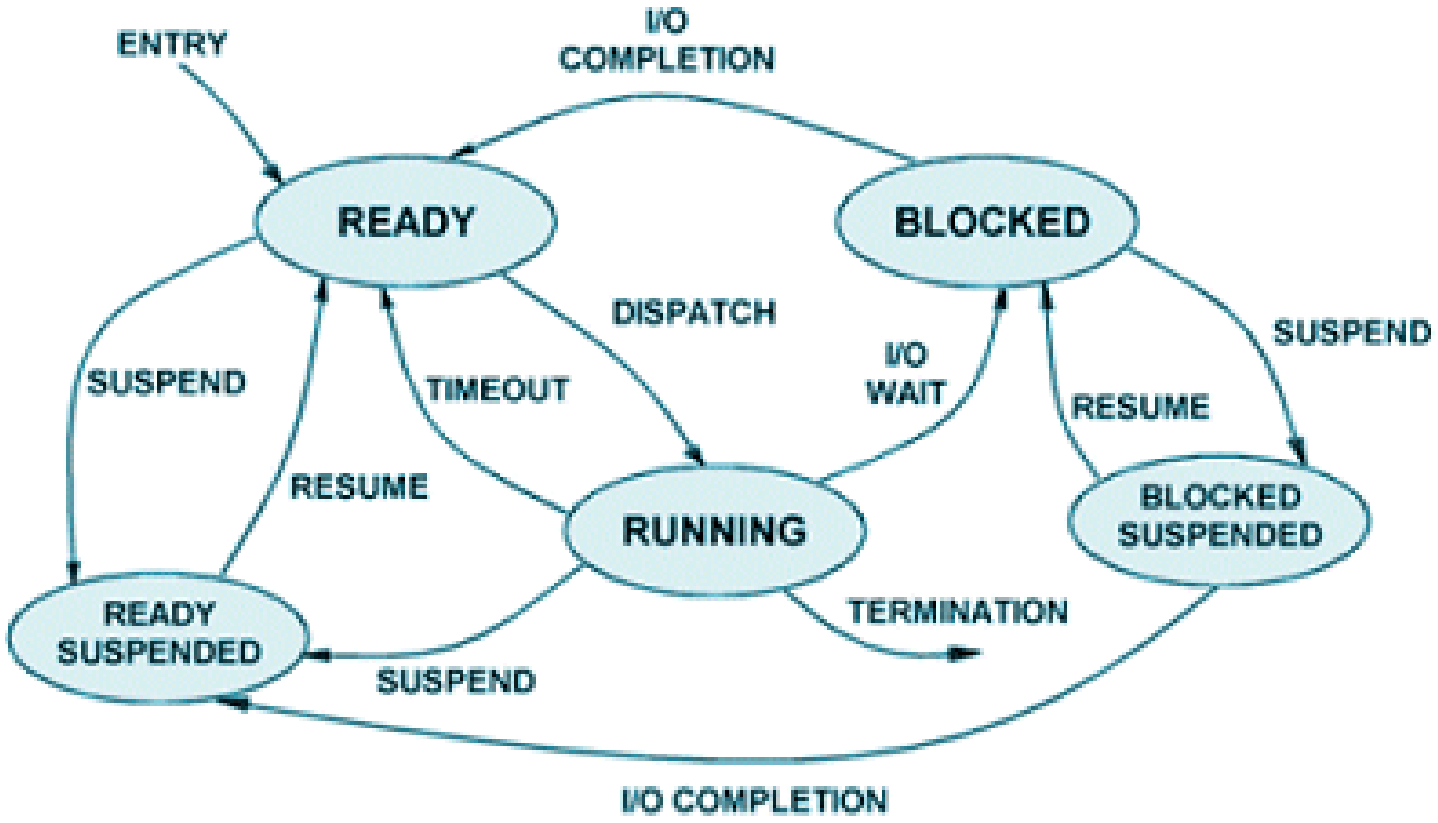
Operating System Concepts (contd.)

- Process States

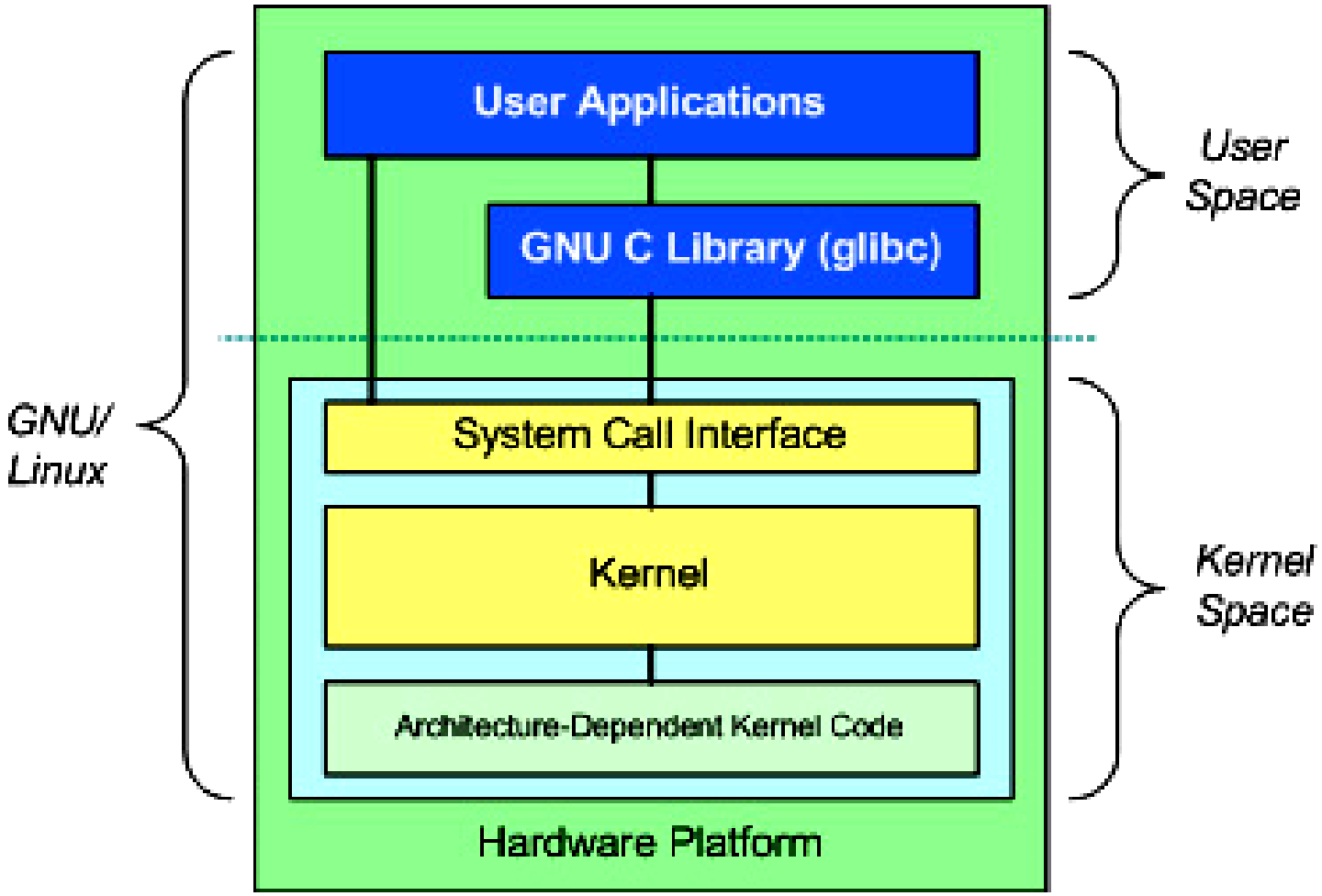


Operating System Concepts (contd.)

- Process States (advanced)

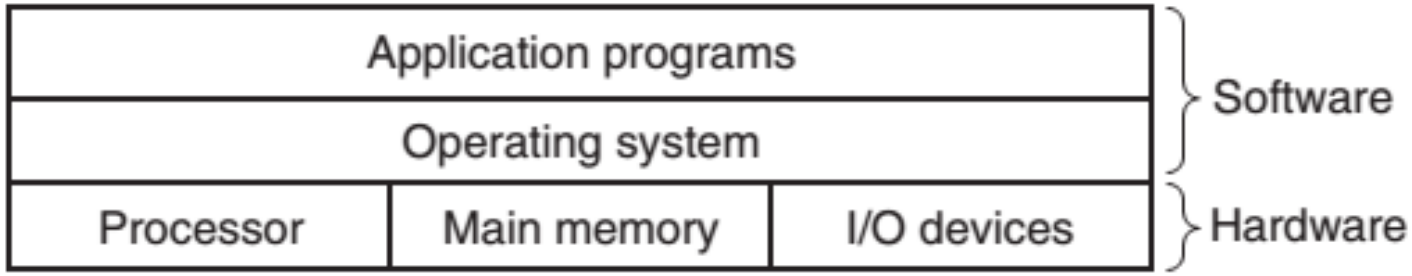


Operating System Concepts (contd.)

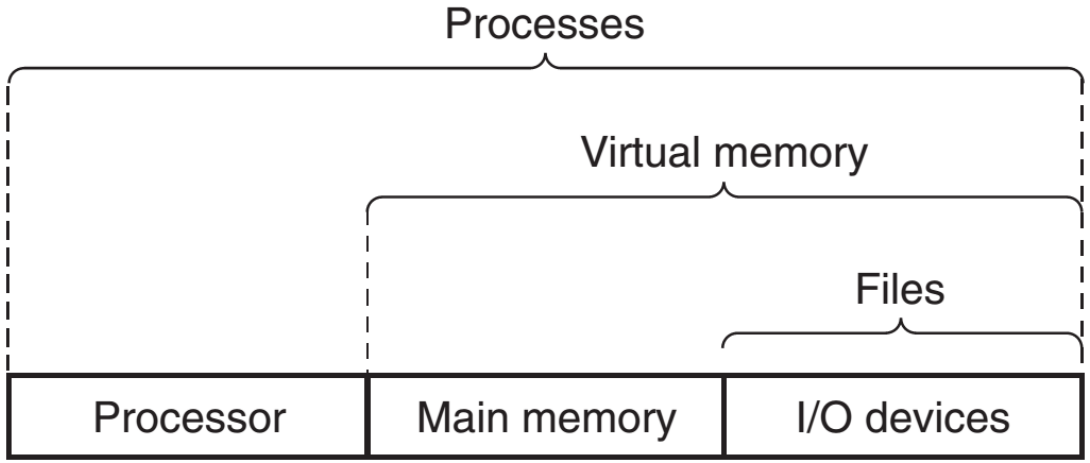


Operating System Concepts (contd.)

- Layered view

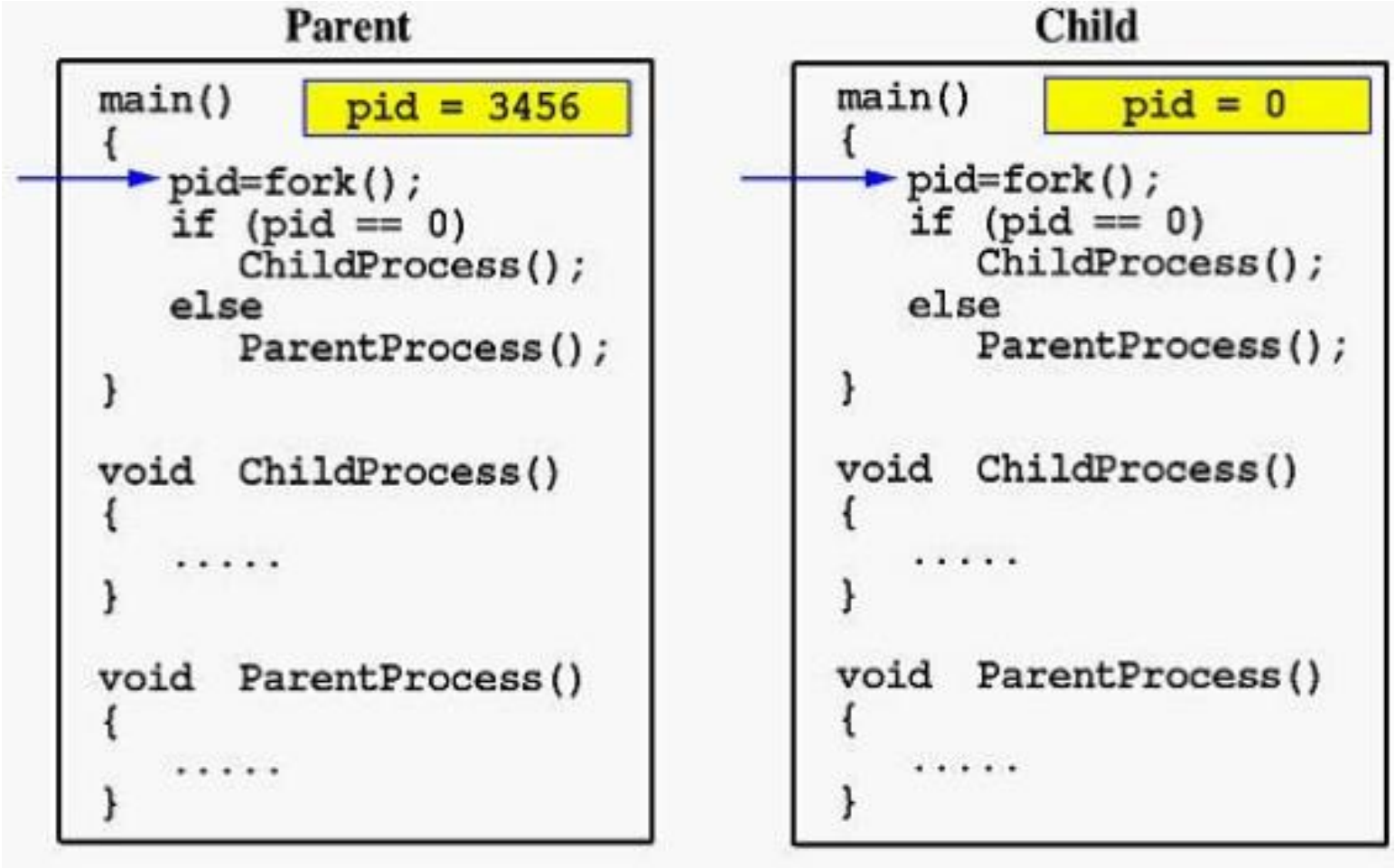


- Abstraction view



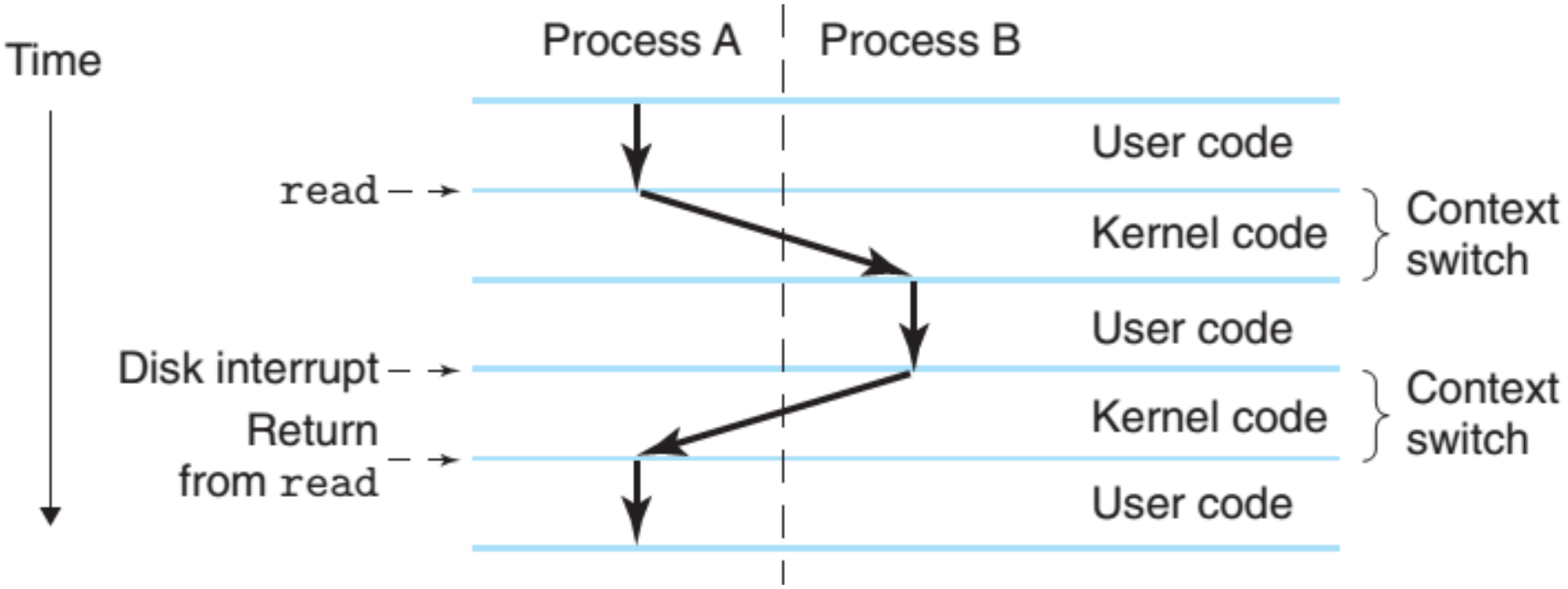
Operating System Concepts (contd.)

Process Creation



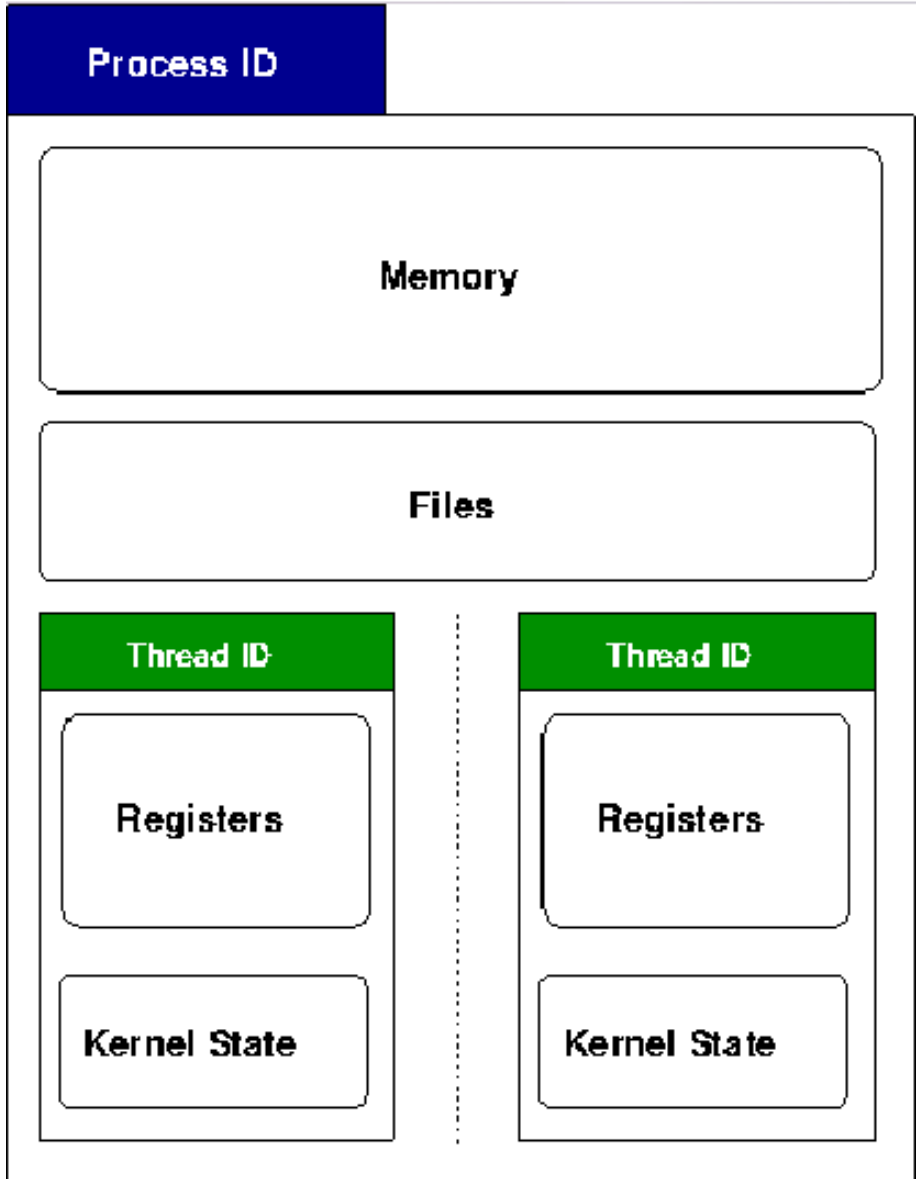
Operating System Concepts (contd.)

Context Switching



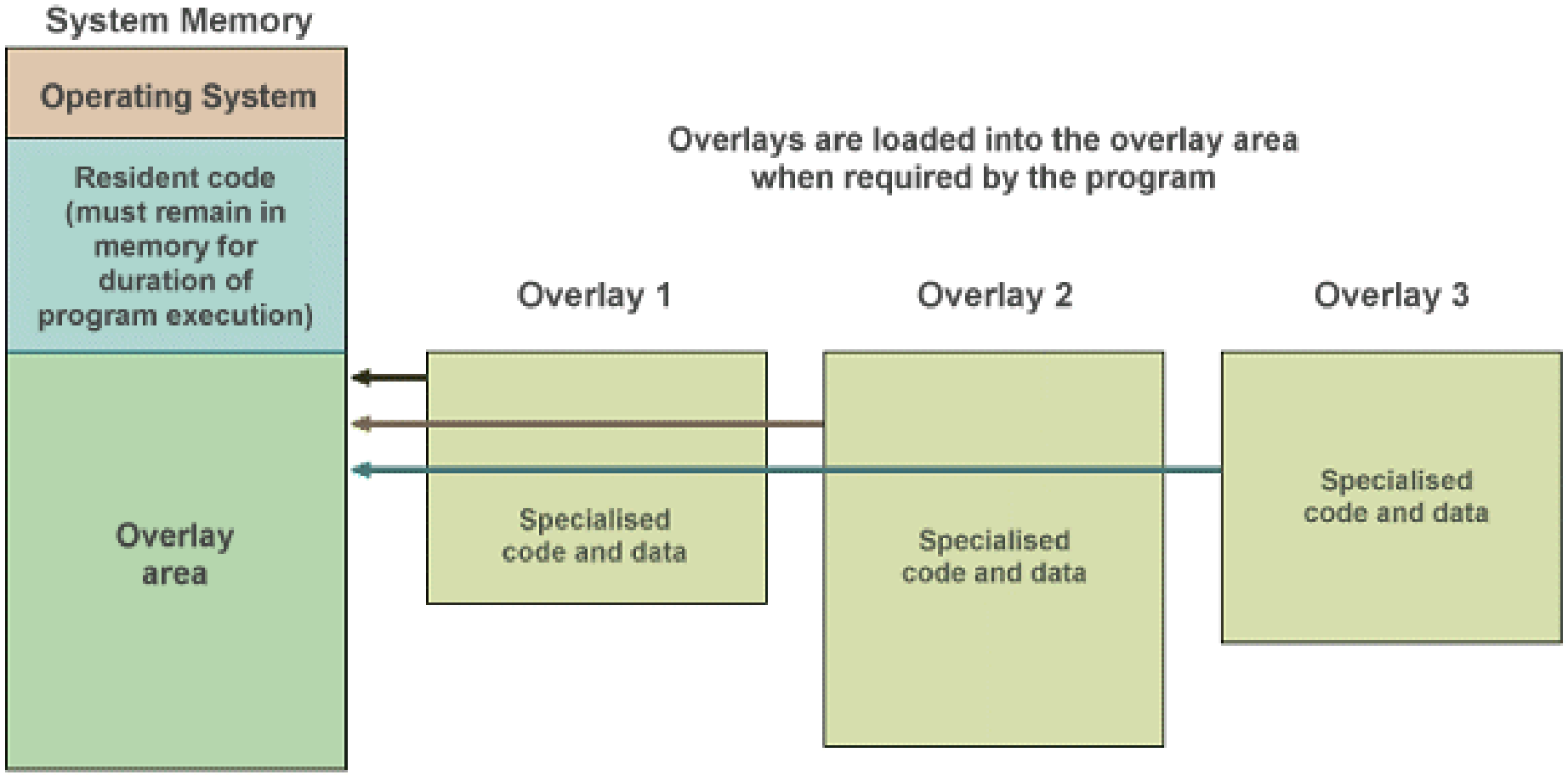
Operating System Concepts (contd.)

- Threads



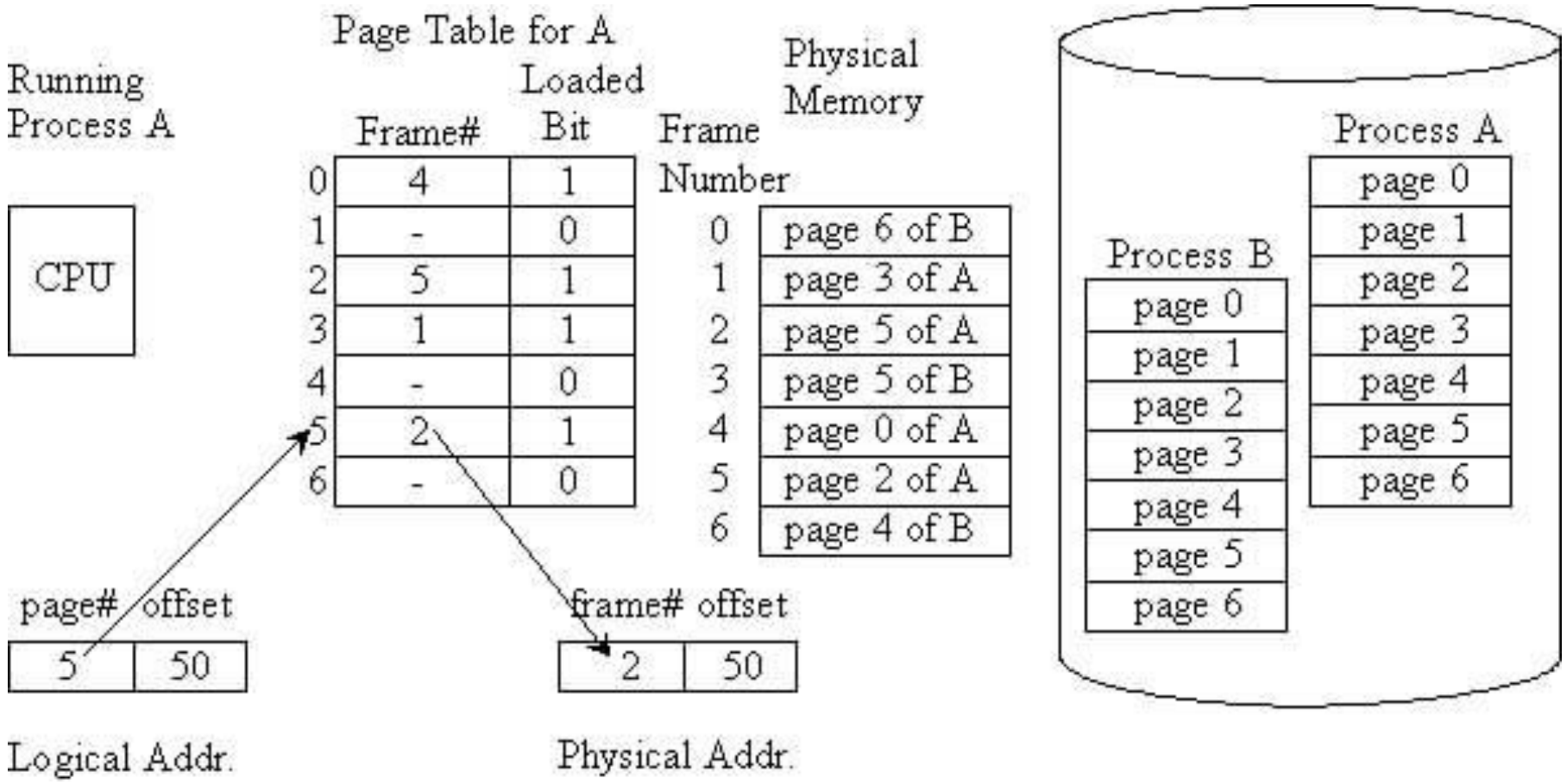
Operating System Concepts (contd.)

Overlays



Operating System Concepts (contd.)

Paging



Operating System Concepts (contd.)

Virtual Memory

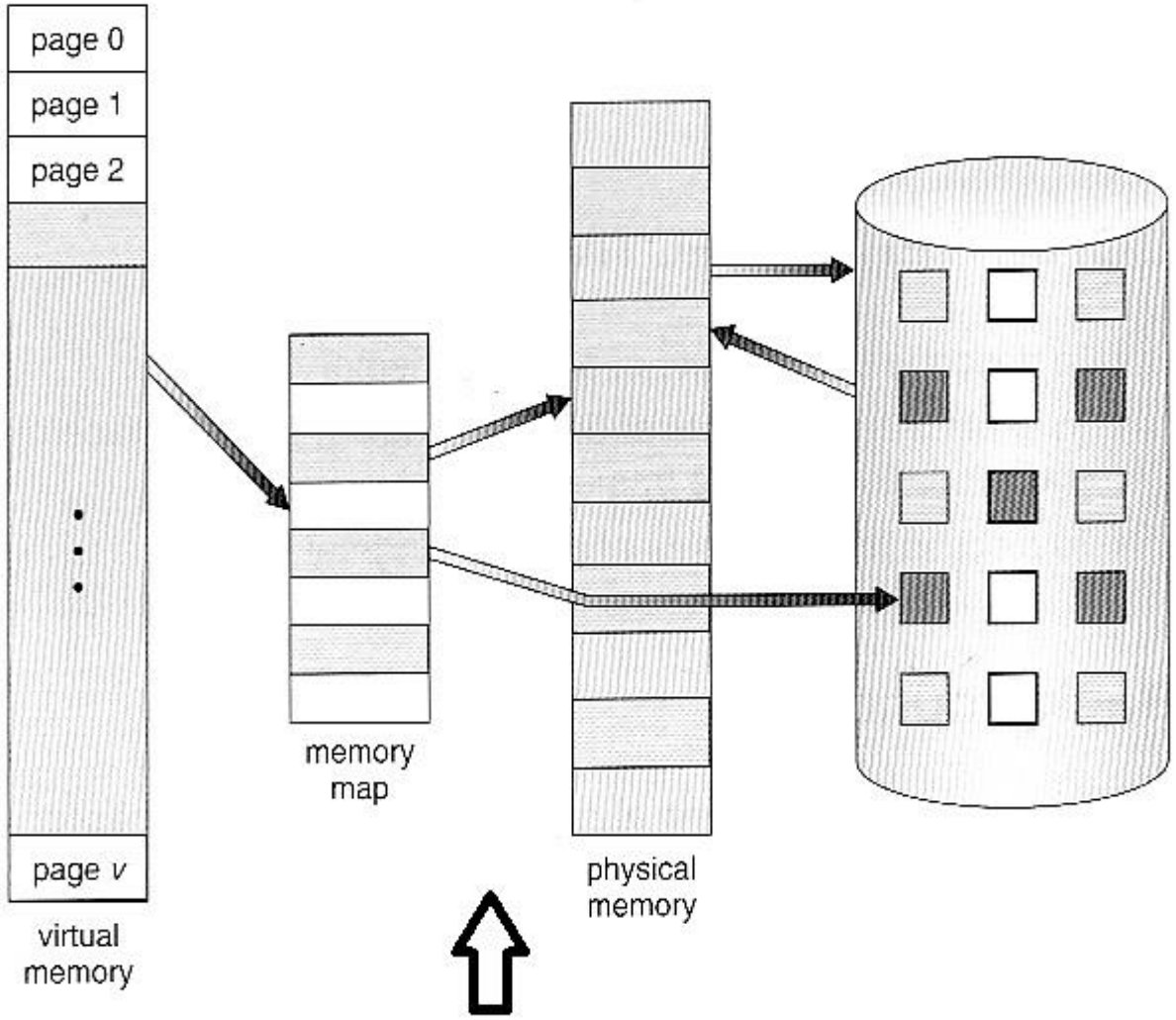
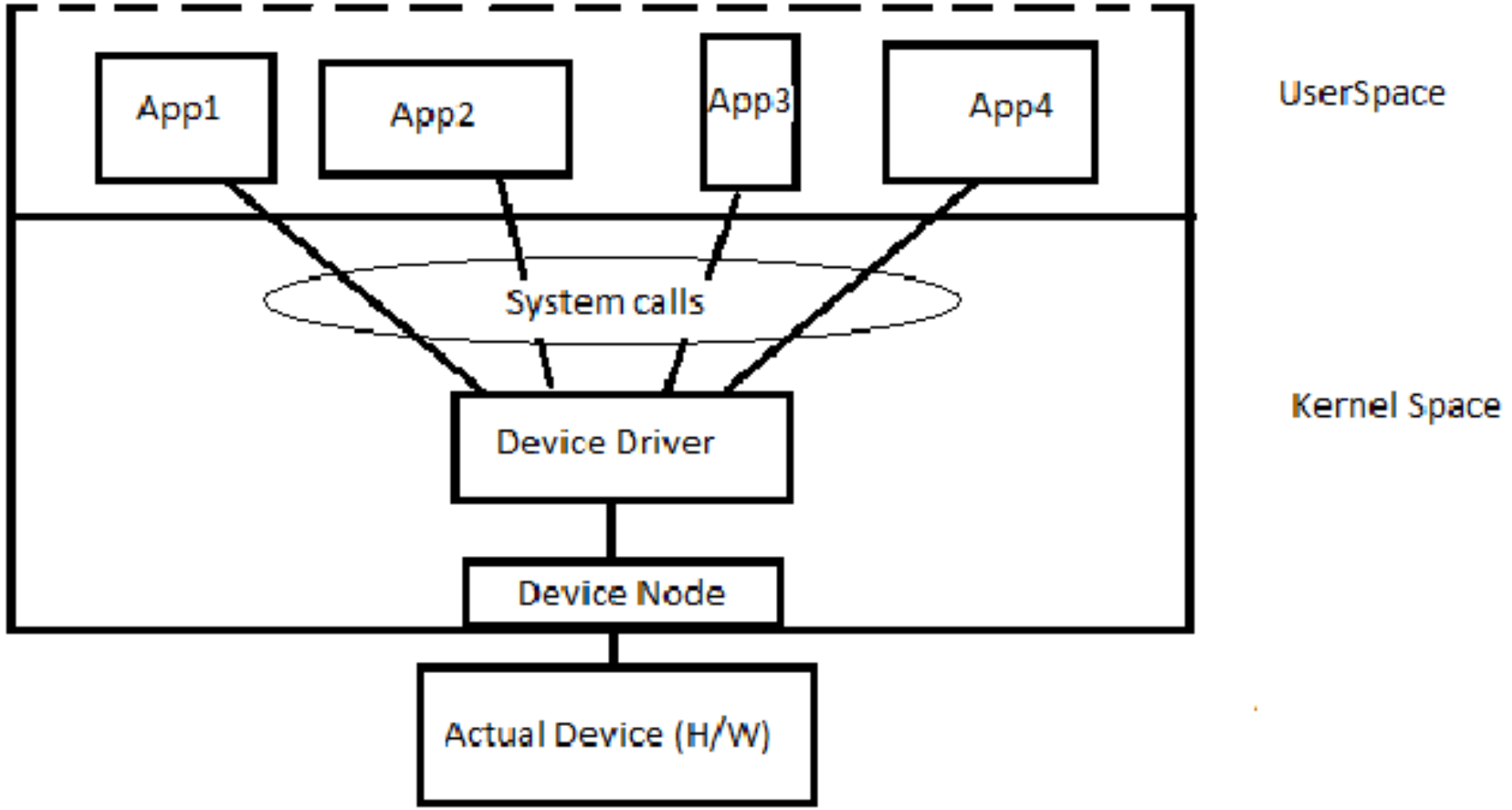


Diagram showing virtual memory that is larger than main memory

Operating System Concepts (contd.)

Files:

- Files are **FILES**
- Folders are **FILES**
- Devices are also **FILES**



Operating System – Tasks

- Memory management
- Device management
- Processor management
- I/O programs
- File systems
- Searching / sorting
- Scheduler
- Libraries

Other System Software

- Compiler-compiler
- Cross compiler
- Cross assembler
- Emulator
- Preprocessor
- Macro-processor
  - MASM, NASM, TASM, VAX

Programming Considerations

- Development and Production environments
- Making Software Portable
- Software over Internet
- Programs as Components
- Quick-and-Dirty Programming
- Dynamic/Flexible/Adaptive Software

Take Away

- Concurrency
  - Multiple simultaneous activities
- Parallelism
  - Concurrency to make systems run faster

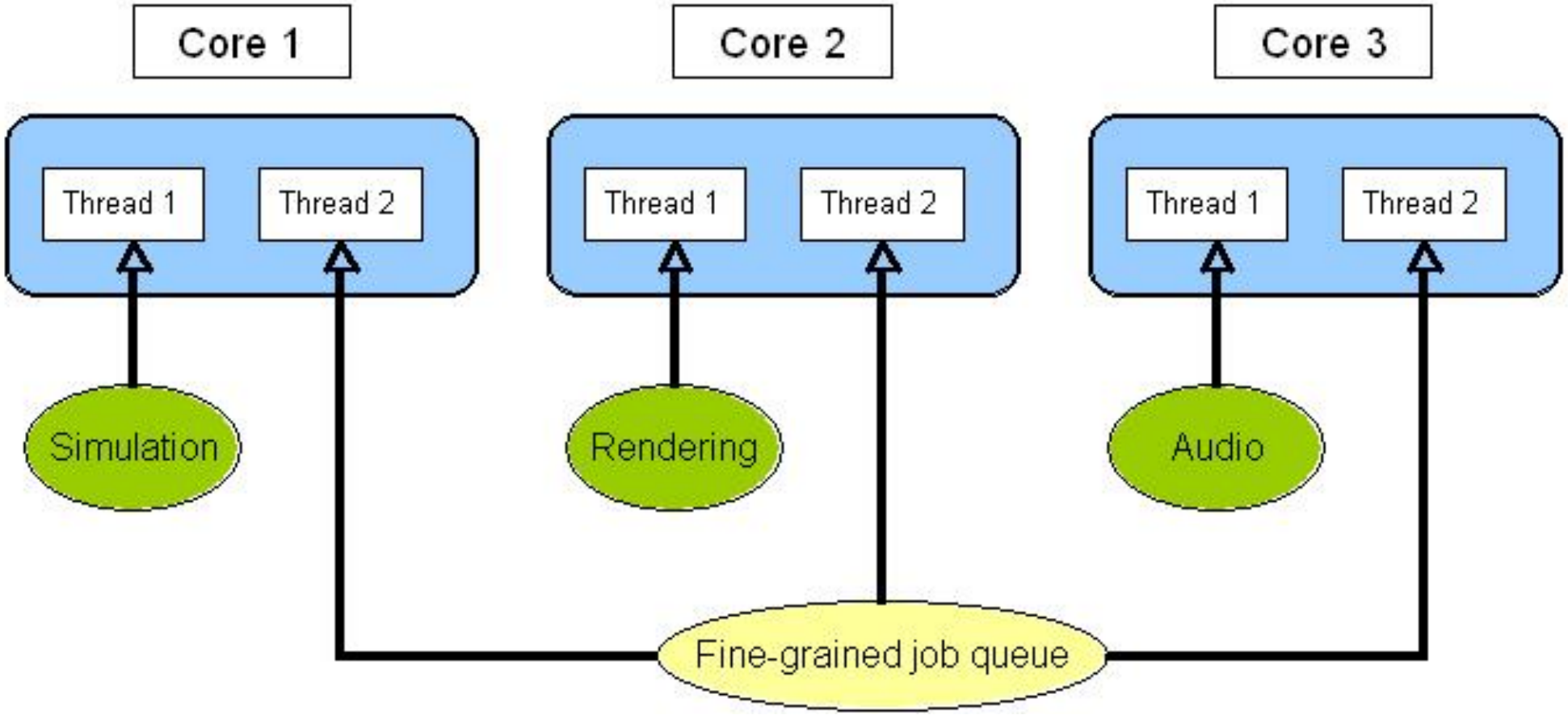
Take Away (contd.)

Hardware Threads:

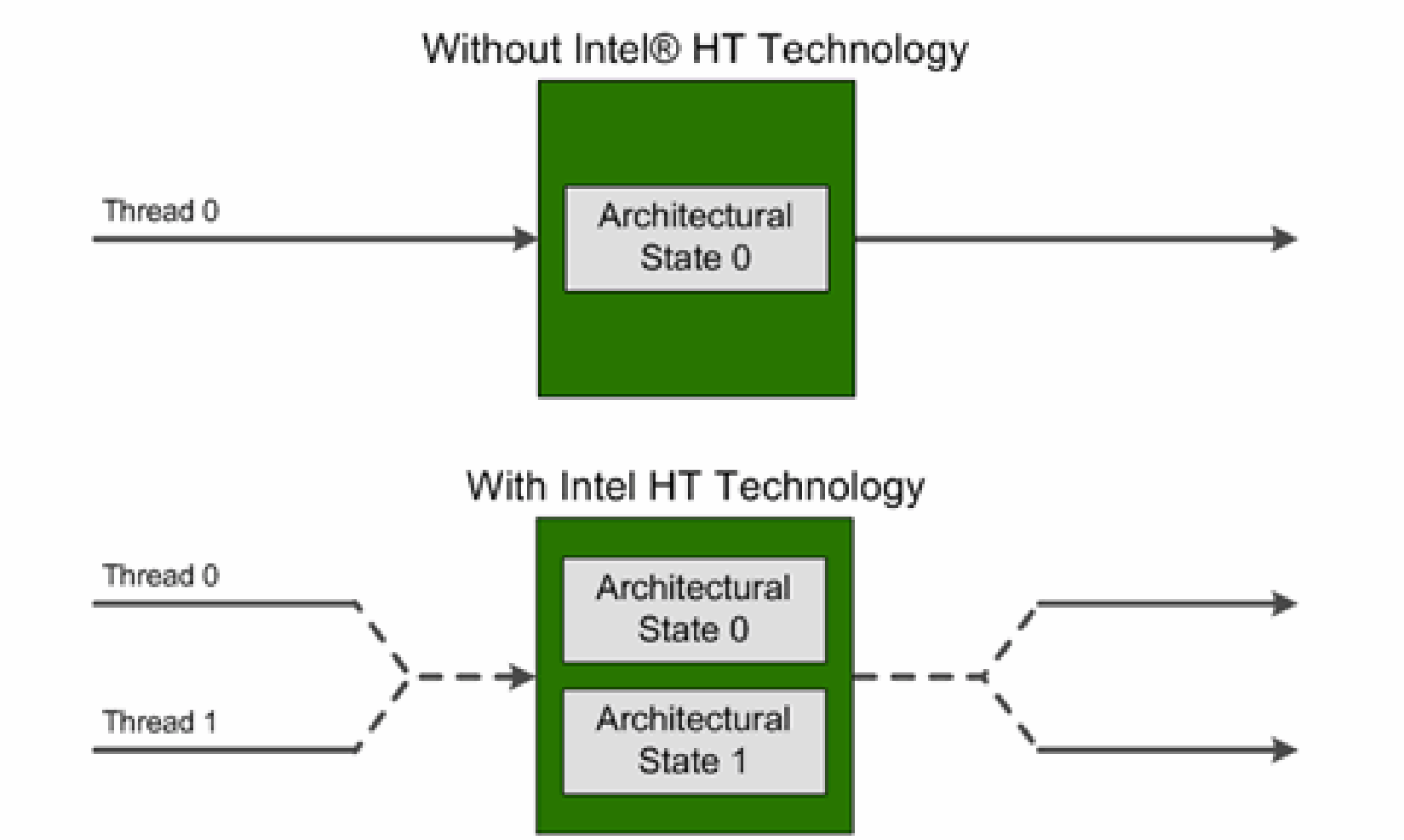
- **Thread-level Concurrency**
  - Uni-processor
  - Multi-processor

- Hyper-threading
  - Simultaneous multithreading
  - Multiple: PC, other registers
  - Single: ALU, FPU

Take Away (contd.)



Take Away (contd.)



Take Away (contd.)

Instruction-level Concurrency:

- Previous Systems:
  - 1 instruction takes 3-4 Machine Cycles
- Superscalar
  - System that can execute more than ONE instructions per Cycle