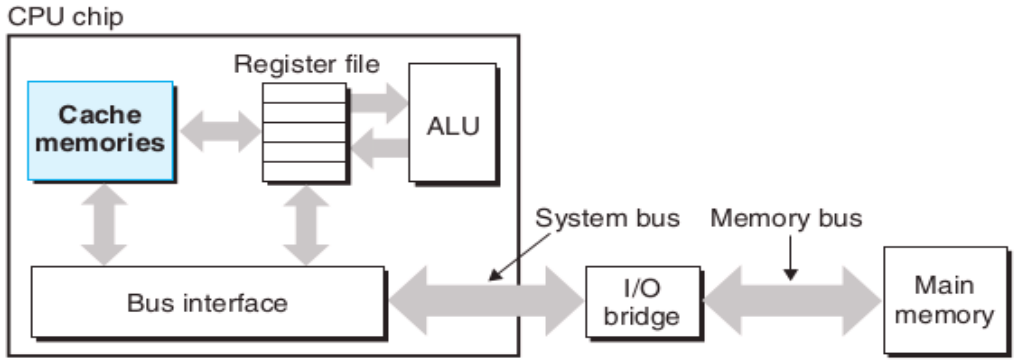
A Tour of Computer Systems

Caches

- From a programmer's perspective, Copying is overhead that slows down the "real work" of the program.
- System designers include smaller faster storage devices called **cache** memories.
- Caches serve as temporary staging areas for information that the processor is likely to need in the near future.
- An **L1 cache** on the processor chip holds tens of thousands of bytes and can be accessed nearly as fast as the register file.
- A larger L2 cache with hundreds of thousands to millions of bytes is connected to the processor by a special bus.



Memory hierarchy.

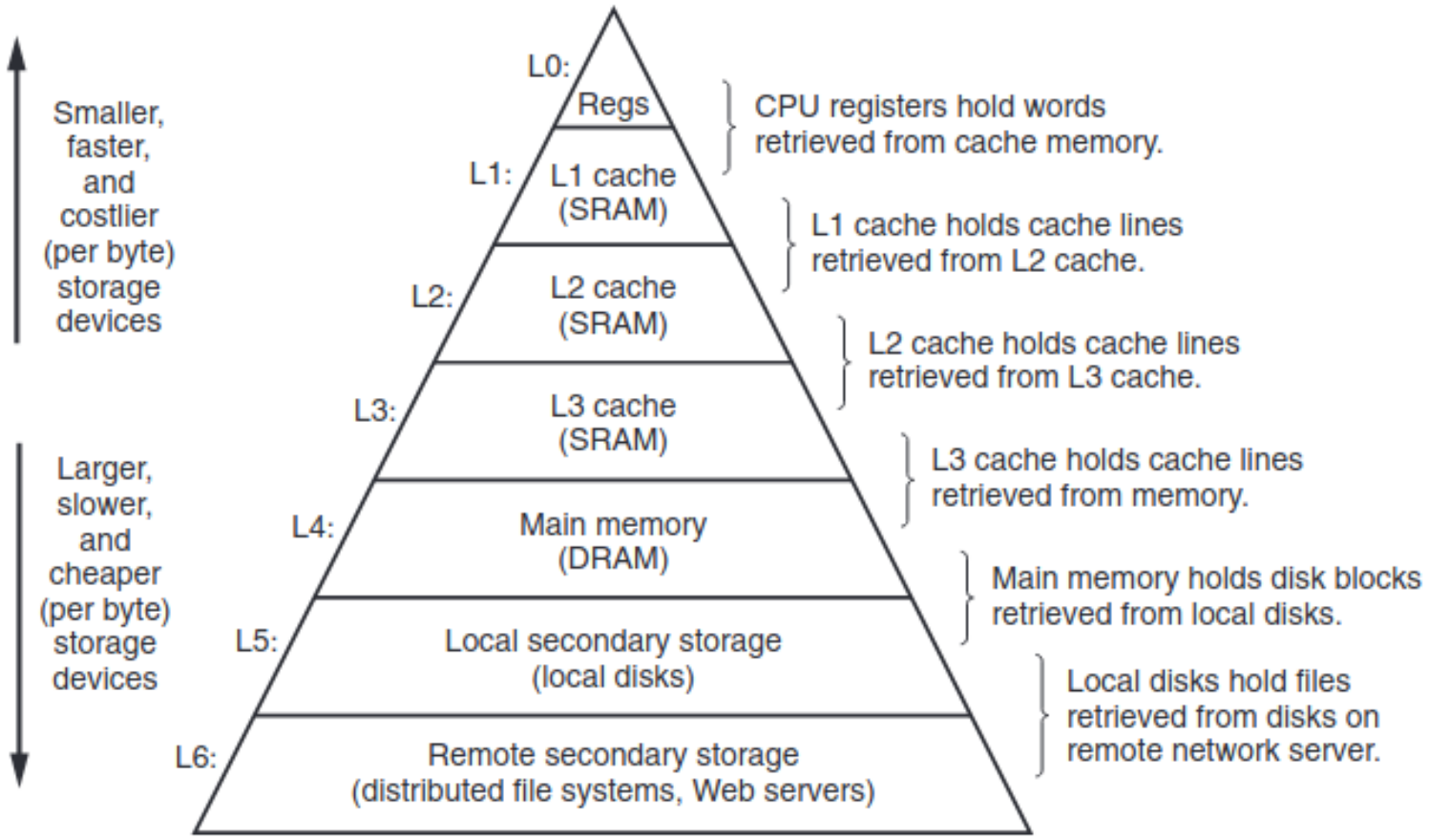
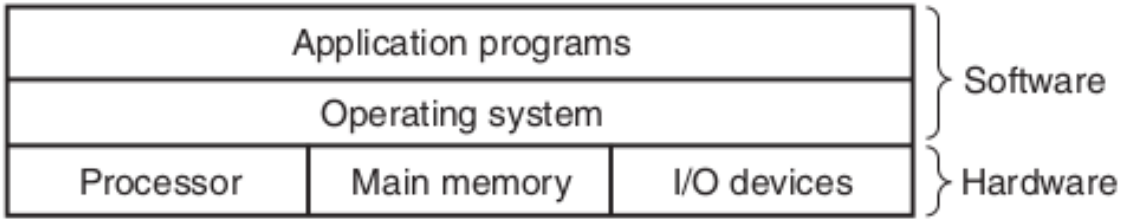


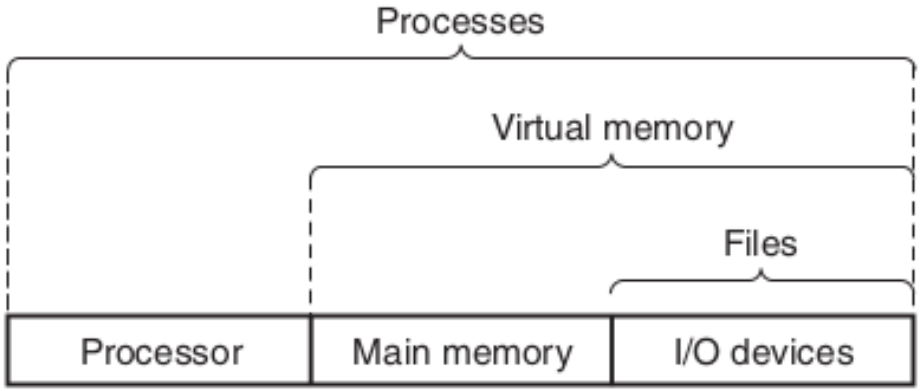
Figure 1.9 An example of a memory hierarchy.

Ref: Bryant and O'Hallaron, Computer Systems: A Programmer's , Third Edition

The Operating System Manages the Hardware

- **Operating system :** A layer of software interposed between the application program and the hardware.
- **Fundamental abstractions of OS**
  - **Processes, virtual memory, and files.**

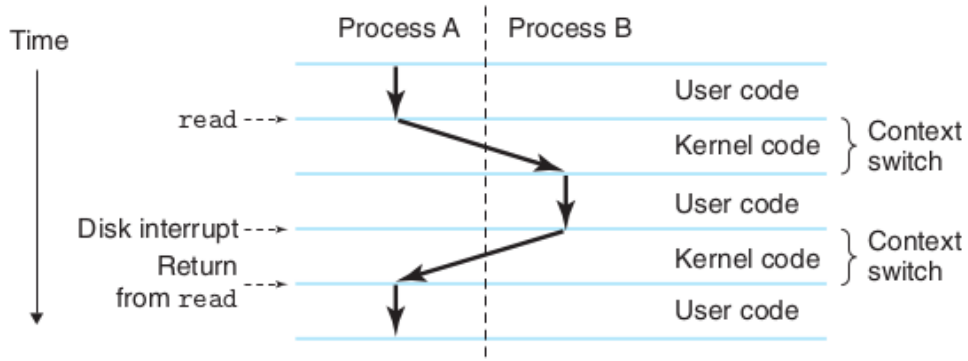




The Operating System Manages the Hardware

Processes

- A **process** is the operating system's abstraction for a running program.
- **Multiple processes** can run concurrently on the same system, and each process appears to have exclusive use of the hardware
- Uniprocessor system containing a single CPU.



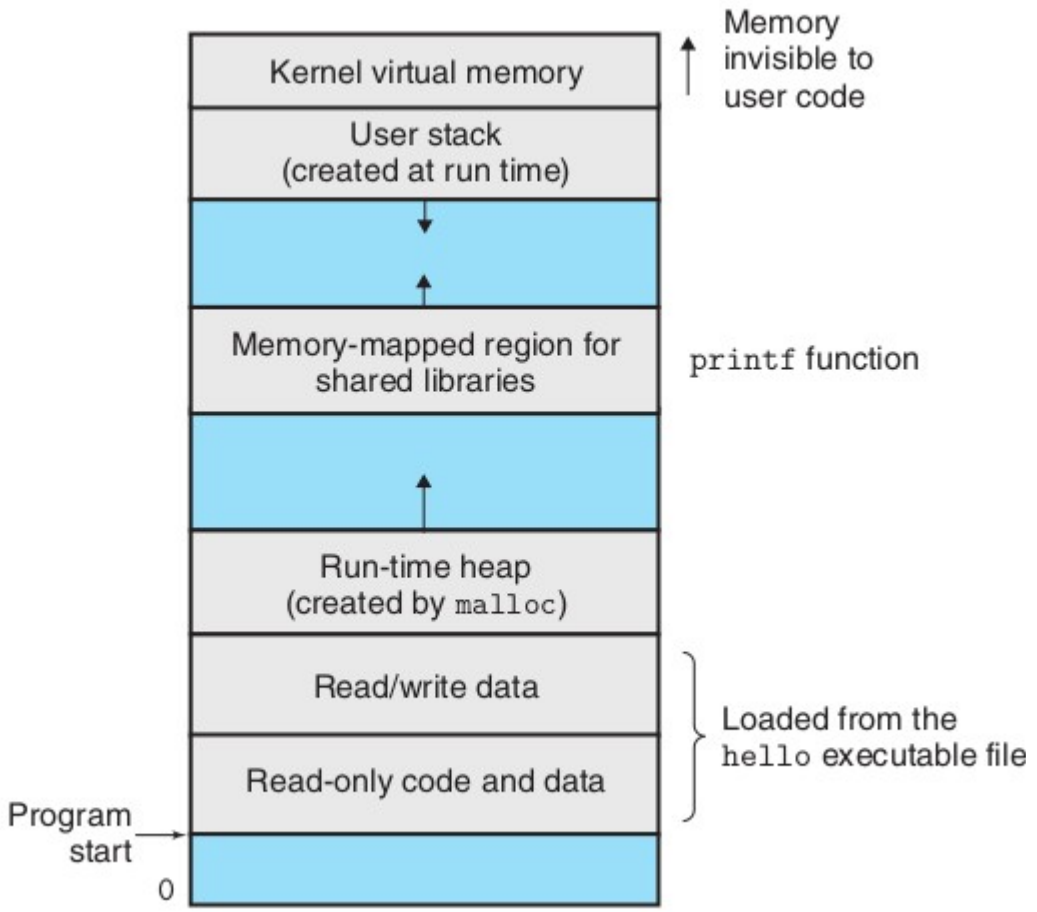
- **Multicore** processors can execute several programs simultaneously
  - single CPU can appear to execute multiple processes concurrently.
- A uniprocessor system can only execute the code for a single process.
- Transfer control from the current process to some new process is **context switching**

Ref: Bryant and O'Hallaron, Computer Systems: A Programmer's , Third Edition

The Operating System Manages the Hardware

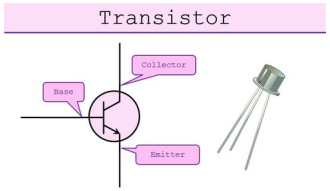
- **Threads**
  - Thread is an execution unit that is part of a process.
  - A process can have multiple threads, all executing at the same time.
  - A thread is lightweight

- **Virtual Memory:**
  - abstraction that provides each proce with the illusion that it has exclusive of the main memory
  - Program code and data
  - Heap.
  - Shared libraries
  - Stack
  - Kernel virtual memory.



- **Files:**
  - A file is a sequence of bytes.
  - Every I/O device, including disks, keyboards, displays, and even networks, is modeled as a file.

Technologies for Building Processors and Memory

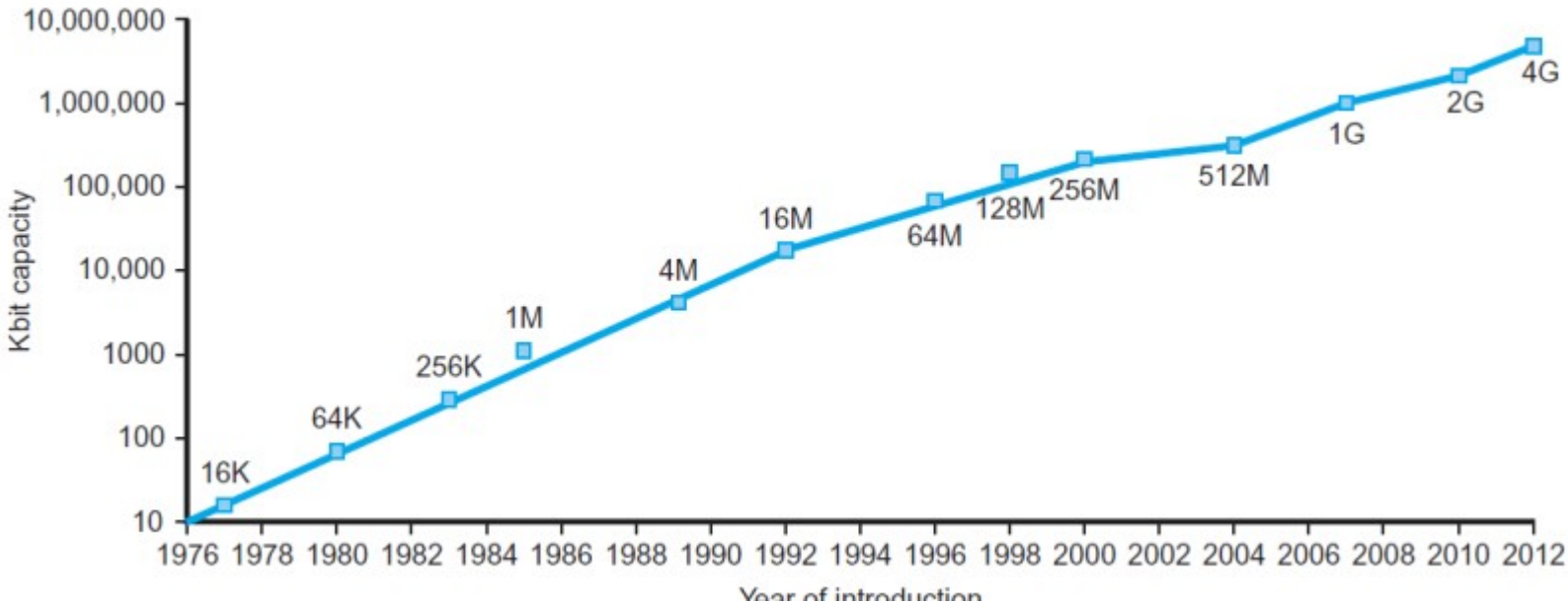


- **Electronics technology continues to evolve**
  - Increased capacity and performance
  - Reduced cost
- A transistor is simply an on/off switch controlled by electricity
- The integrated circuit (IC) combined dozens to hundreds of transistors into a simple chip.
- Very large-scale integrated (VLSI) circuit: A device containing hundreds of thousands to millions of transistors

Core i7-= (1.750 billion)Ttransistors

Year	Technology	Relative performance/cost
1951	Vacuum tube	1
1965	Transistor	35
1975	Integrated circuit (IC)	900
1995	Very large scale IC (VLSI)	2,400,000
2013	Ultra large scale IC	250,000,000,000

Ref: Bryant and O'Hallaron, Computer Systems: A Programmer's , Third Edition



Ref: Bryant and O'Hallaron, Computer Systems: A Programmer's , Third Edition