computer science
illuminated

Computing Components

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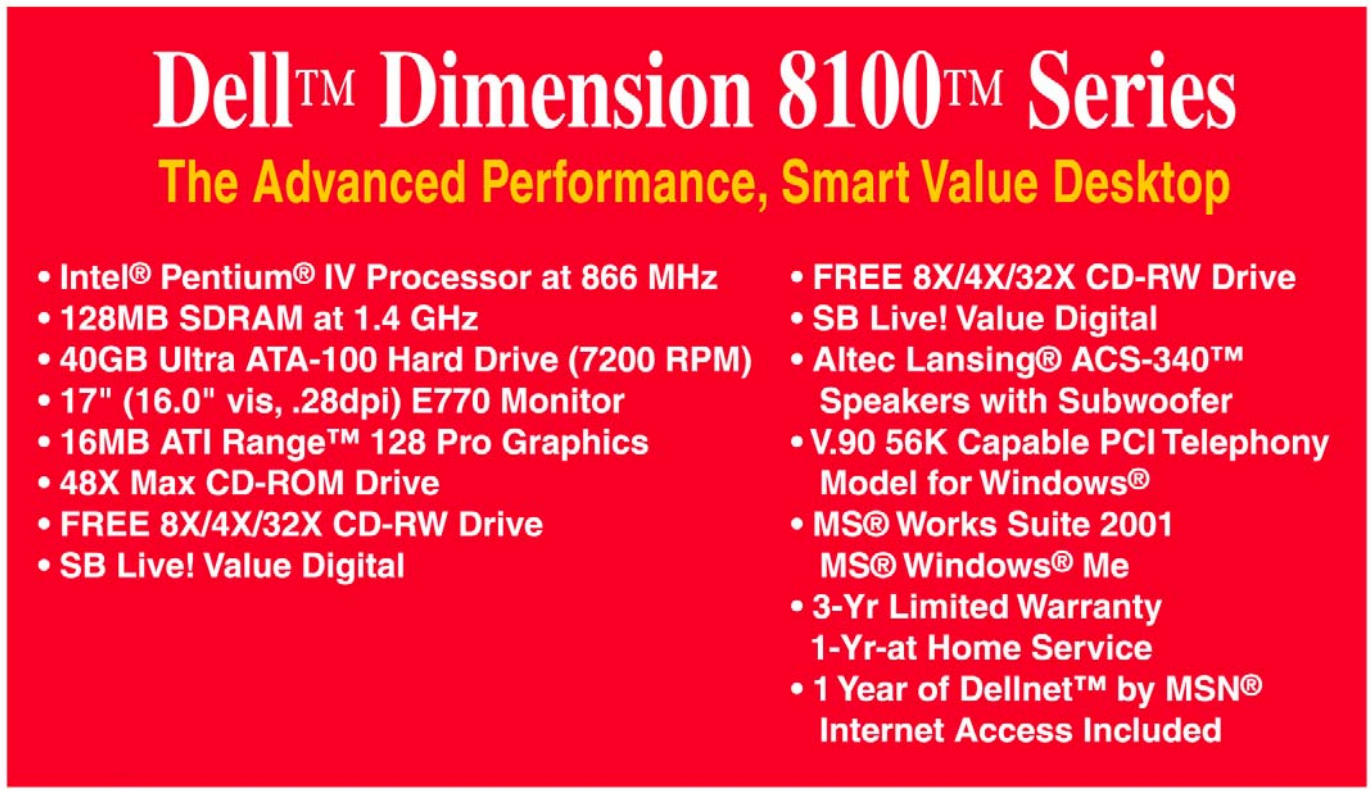
(adaptation by Michael Goldwasser)

Computer Components

- Consider the following ad



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Stored-Program Concept

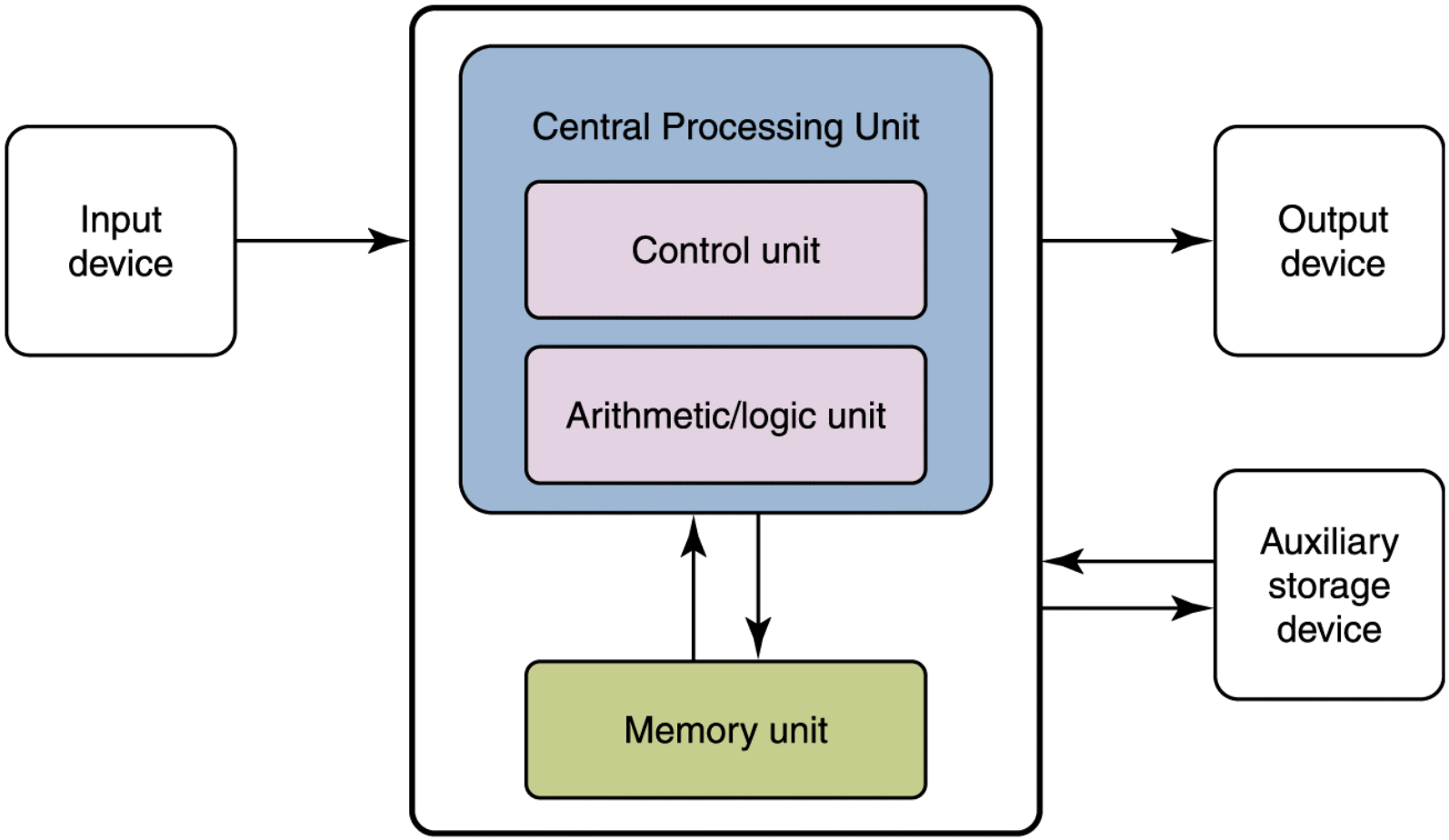

Figure 5.1 The von Neumann architecture

Memory

- Memory is a collection of cells, each with a unique physical address
- (analogy: numbered parking spots)
- **With 8 bit addresses we can only reference $2^8 = 256$ distinct memory addresses**

Address	Contents
00000000	11100011
00000001	10101001
⋮	⋮
11111100	00000000
11111101	11111111
11111110	10101010
11111111	00110011

Sizes in Perspective

Multiple of ten	Prefix	Abbreviation	Derivation
10^{-12}	pico	p	Spanish for little
10^{-9}	nano	n	Greek for dwarf
10^{-6}	micro	μ	Greek for small
10^{-3}	milli	m	Latin for thousand
2^{10} ~~10^{3}~~ =1024	kilo	K	Greek for thousandth
2^{20} ~~10^{6}~~	mega	M	Greek for large
2^{30} ~~10^{9}~~	giga	G	Greek for giant
2^{40} ~~10^{12}~~	tera	T	Greek for monster

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Note: for quantities of bits, we use powers of two

Arithmetic/Logic Unit

- Performing basic arithmetic operations such as adding
- Performing logical operations such as AND, OR, and NOT
- Most modern ALUs have a small amount of special storage units called **registers**

Input/Output Units

- An **input unit** is a device through which data and programs from the outside world are entered into the computer
  - Keyboard, the mouse, and scanning devices
- An **output unit** is a device through which results stored in the computer memory are made available to the outside world
  - Printers and video display terminals

Control Unit

- **Control unit** is the organizing force in the computer
- There are two registers in the control unit
  - The **instruction register** (IR) contains the instruction that is being executed
  - The **program counter** (PC) contains the address of the next instruction to be executed
- ALU and the control unit called the **Central Processing Unit**, or CPU

Flow of Information

- The parts are connected to one another by a collection of wires called a bus

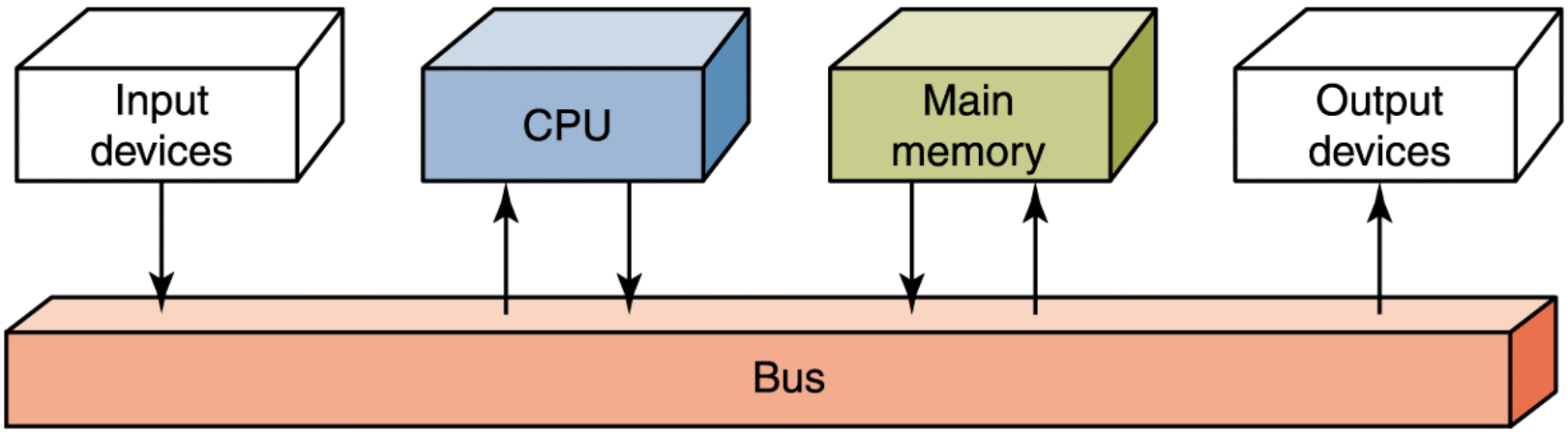
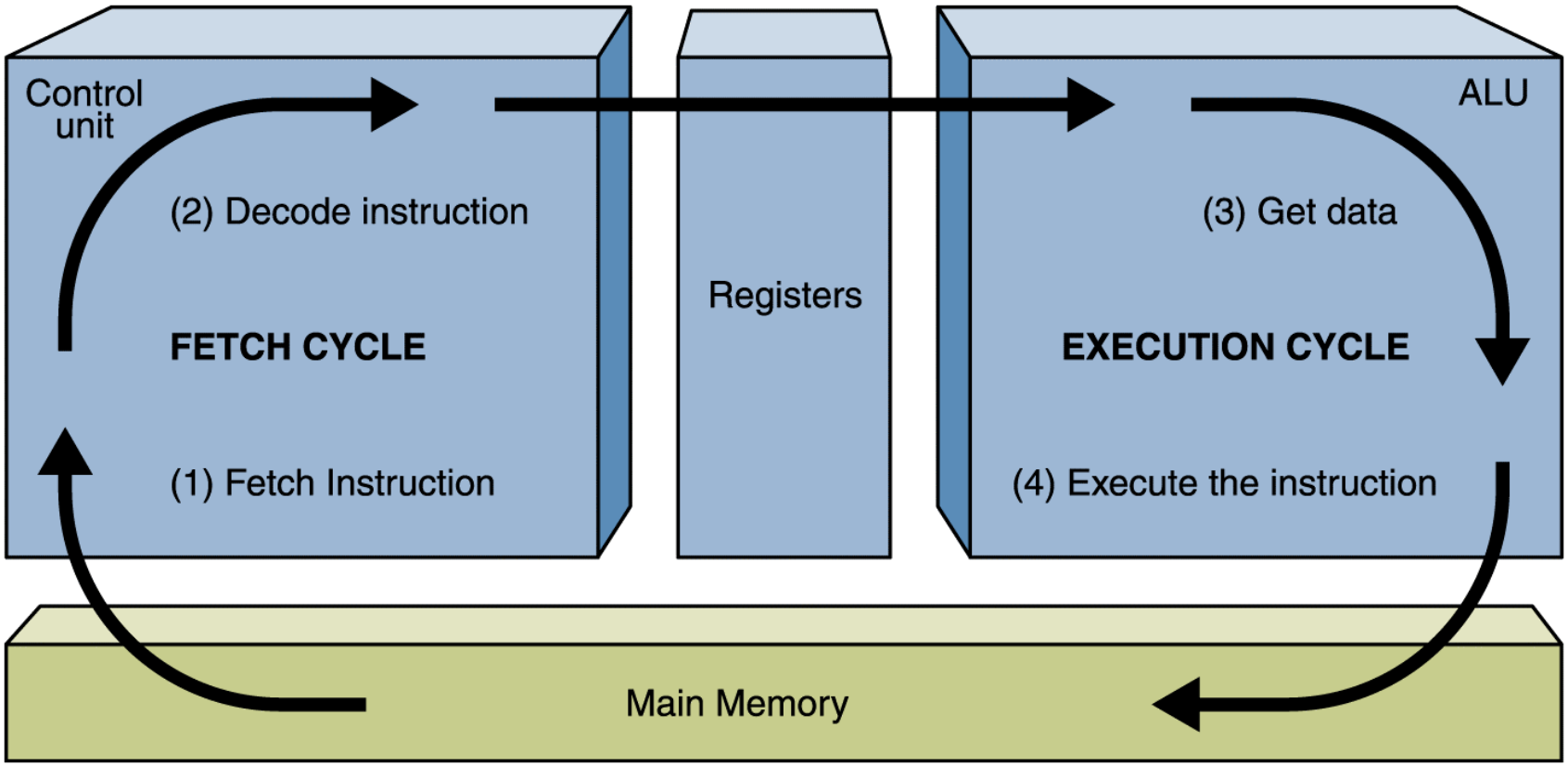


Figure 5.2 Data flow through a von Neumann architecture

The Fetch-Execute Cycle

- Fetch the next instruction
- Decode the instruction
- Get data if needed
- Execute the instruction

Figure 5.3 The Fetch-Execute Cycle



RAM and ROM

- RAM stands for **Random Access Memory**
  - Inherent in the idea of being able to access each location is the ability to change the contents of each location
- ROM stands for **Read Only Memory**
  - The contents in locations in ROM cannot be changed
- RAM is (generally) volatile, ROM is (generally) not
  - This means that RAM does not retain its bit configuration when the power is turned off, but ROM does

Secondary Storage Devices

- Because most of main memory is volatile and limited, it is essential that there be other types of storage devices where programs and data can be stored when they are no longer being processed
- Secondary storage devices can be installed within the computer box at the factory or added later as needed

Magnetic Tape

- The first truly mass auxiliary storage device was the magnetic tape drive

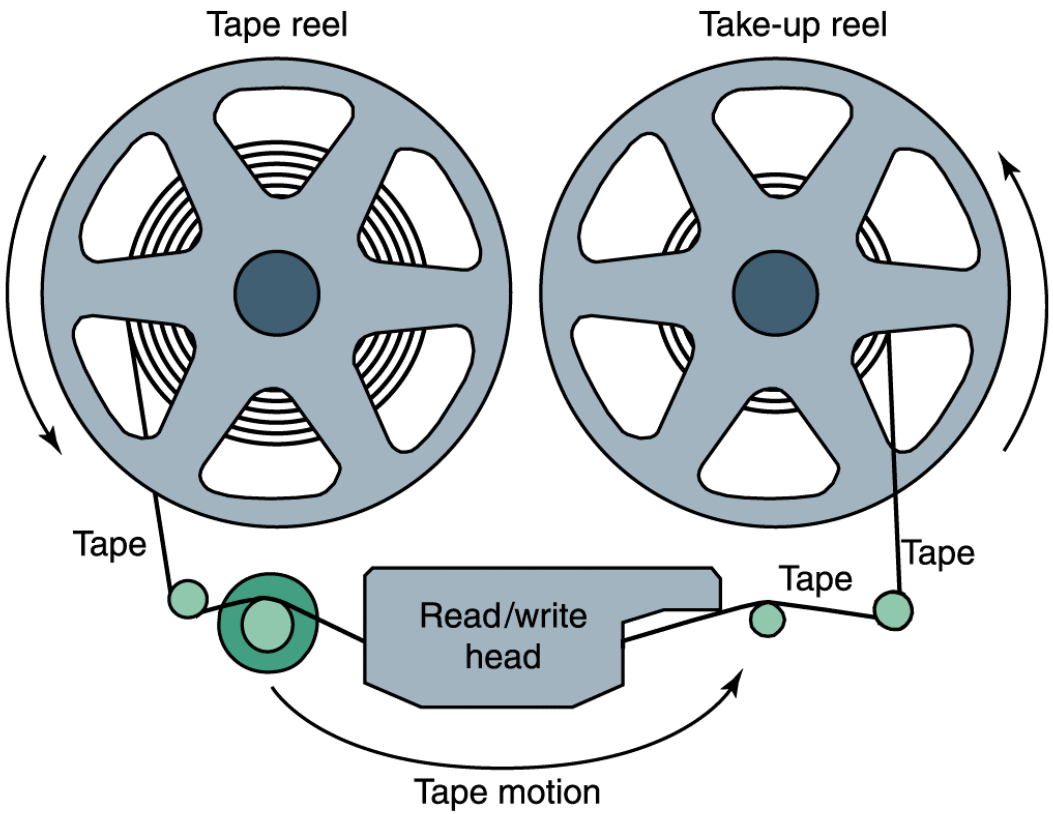


Figure 5.4 **A magnetic tape**

Magnetic Disks

- A read/write head travels across a spinning magnetic disk, retrieving or recording data

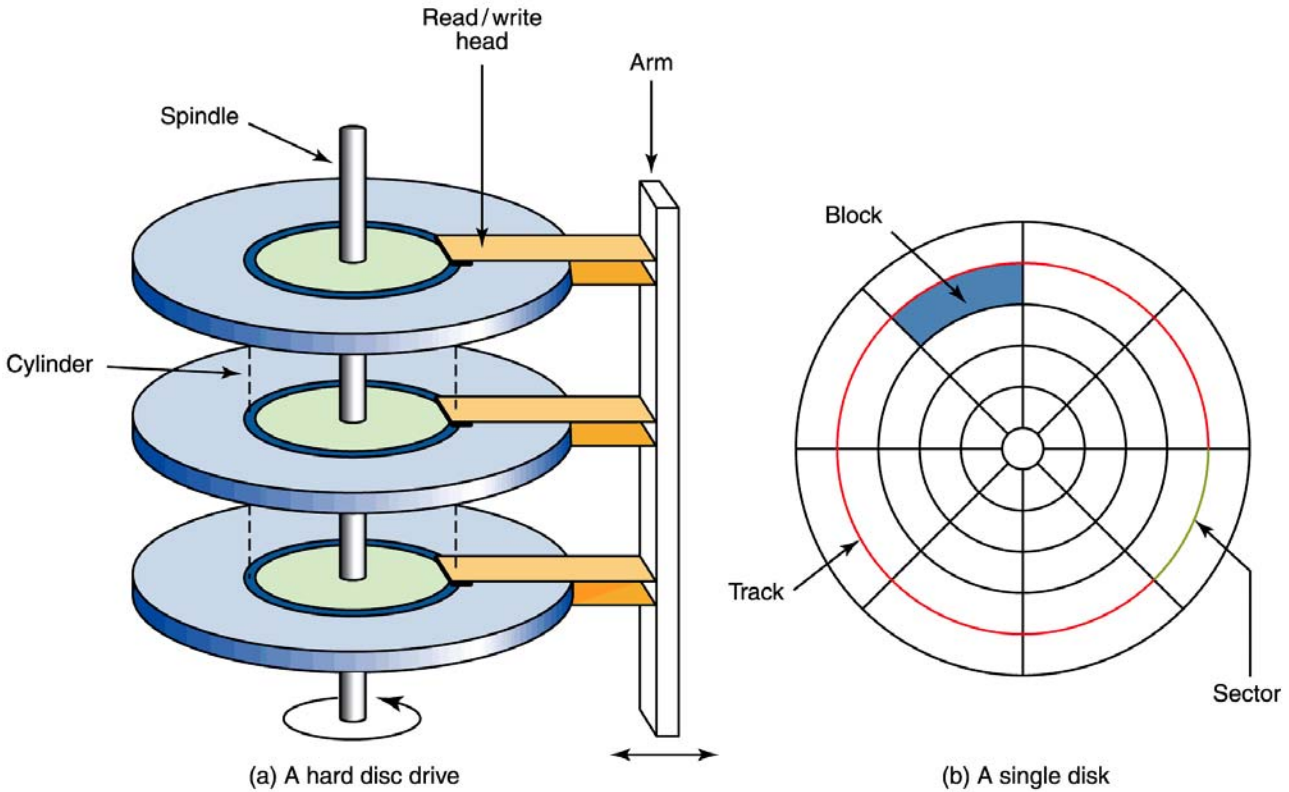
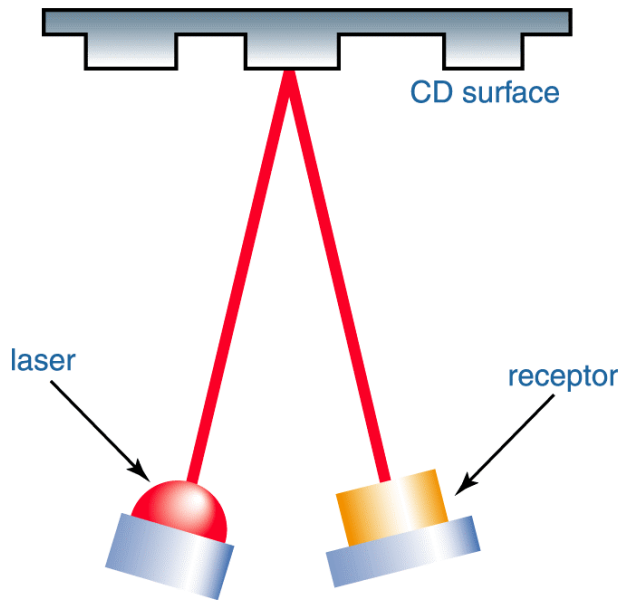


Figure 5.5
The organization of a magnetic disk

Compact Disks

- A CD drive uses a laser to read information stored optically on a plastic disk
- CD-ROM is Read-Only Memory
- DVD stands for Digital Versatile Disk



Synchronous processing

- One approach to parallelism is to have multiple processors apply the same program to multiple data sets

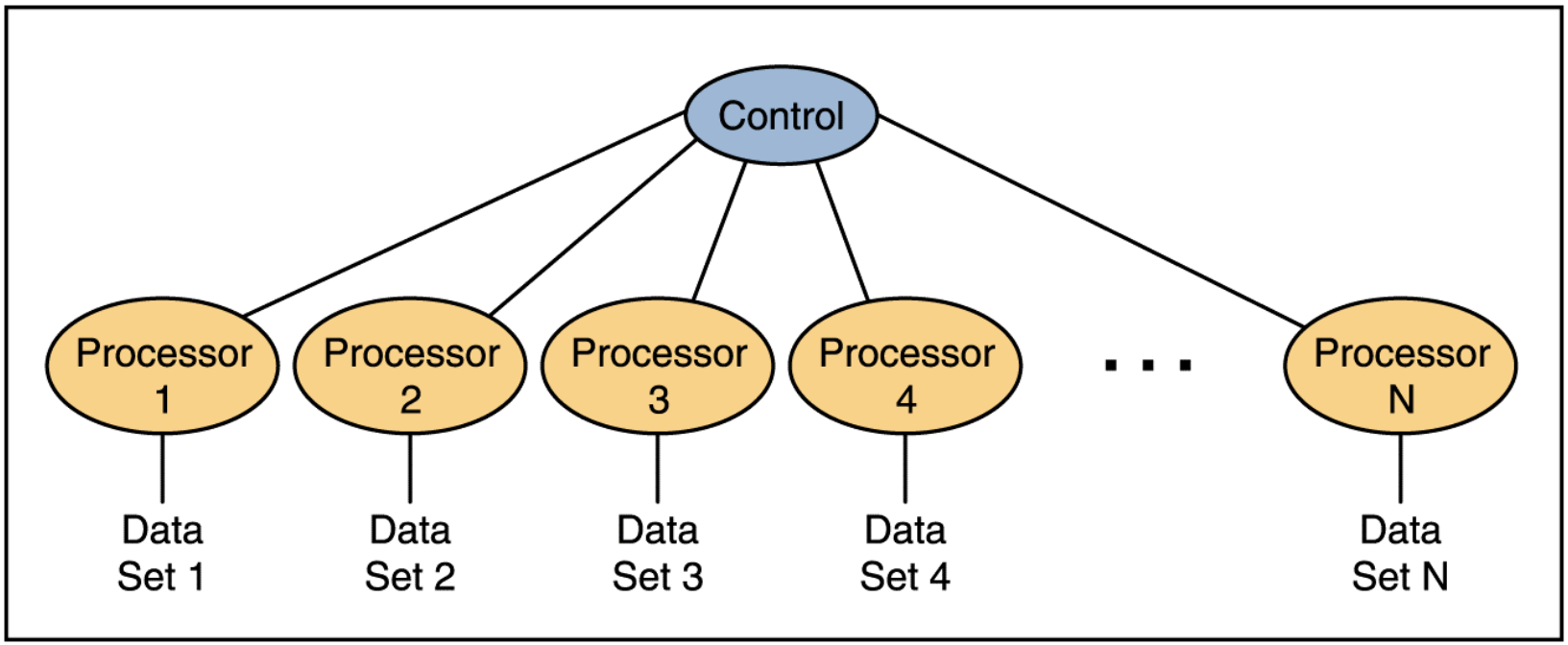


Figure 5.6 **Processors in a synchronous computing environment**

Pipelining

- Arranges processors in tandem, where each processor contributes one part to an overall computation

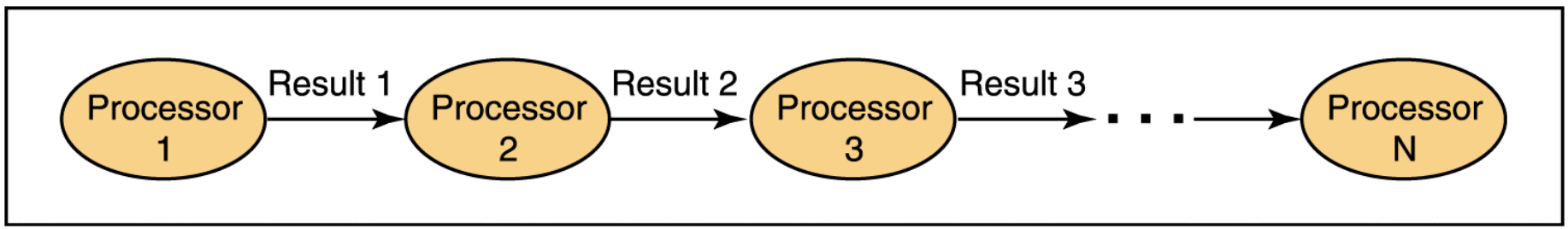


Figure 5.7 **Processors in a pipeline**