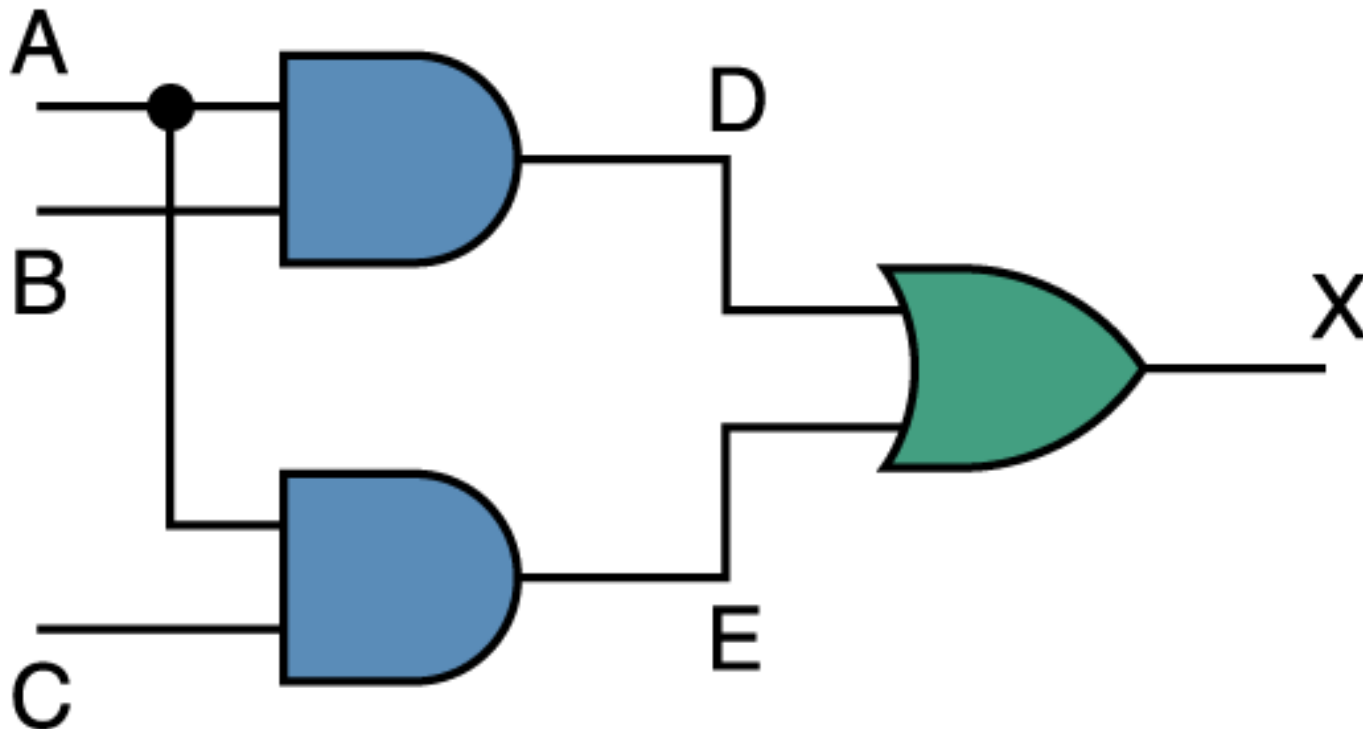


# Combinational Circuits

- Gates are combined into circuits by using the output of one gate as the input for another



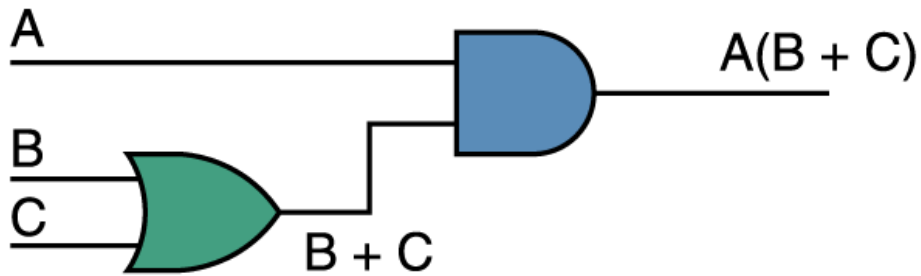
# Combinational Circuits

A	B	C	D	E	X
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1
1	1	1	1	1	1

- Because there are **three inputs** to this circuit, eight rows are required to describe all possible input combinations
- This same circuit using **Boolean algebra** is  $(AB + AC)$

# Now let's go the other way; let's take a Boolean expression and draw

- Consider the following Boolean expression  $A(B + C)$



A	B	C	$B + C$	$A(B + C)$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

- Now **compare** the final result column in this truth table to the truth table for the previous example
  - They are **identical**

# Now let's go the other way; let's take a Boolean expression and draw

- We have therefore just demonstrated **circuit equivalence**
  - That is, **both circuits** produce the **exact same output** for each input value combination
- **Boolean algebra** allows us to apply provable mathematical principles to **help us design logical circuits**

# Homework

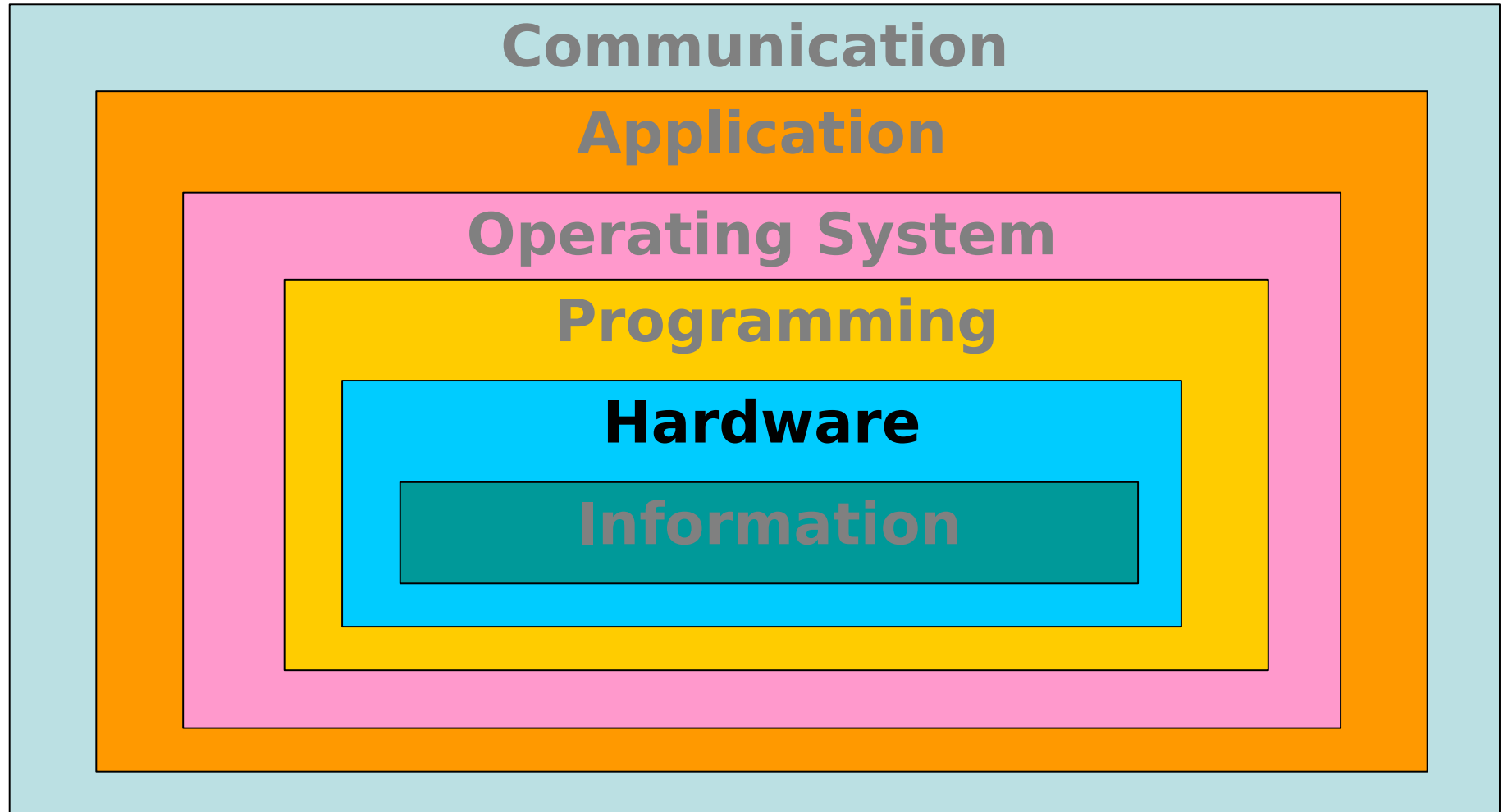
- **Read Chapter Four, Sections 4.4 – 4.7**
- **Exercise: P119-120, 55 & 59**

# Chapter 5

## Computer Components



# Layers of a Computing System



# Chapter Goals

- Read an ad for a computer and **understand the jargon**
- List the components and their function in a **von Neumann machine**
- Describe the **fetch-decode-execute cycle** of the von Neumann machine



# Chapter Goals

- Describe how **computer memory** is organized and accessed
- Name and describe different **auxiliary storage devices**
- Define **three alternative parallel computer configurations**

# Computer Components

- Consider the following ad

## Dell Dimension 4600 Series

**Exceptional Performance, Small Design**

- Intel® Pentium® 4 Processor at 3.06GHz
- 512MB Dual Channel shared SDRAM at 333MHz
- 80GB Ultra ATA/100 Hard Drive
- 17" Flat-Panel Display
- Integrated Intel® Extreme Graphics 2
- 2X DVD+R/+RW Drive with CD-RW
- Integrated 5.1 Audio with Dolby Digital 5.1 capability
- Roxio Easy CD Creator®
- Altec Lansing® ADA745 4.1 Surround Sound Speakers with Subwoofer
- 56K PCI Data/Fax Modem
- WordPerfect® Productivity Pack with Quicken New User Edition
- 6 months of America Online Membership included

# Sizes in Perspective

- Admiral Grace Murray Hopper
  - A coil of wire nearly 1,000 feet long
    - Distance traveled by an electron along the wire in the space of a **microsecond**
  - A short piece of wire
    - In the space of a **nanosecond**
  - A bag containing grains of pepper
    - In the space of a **picosecond**

# Sizes in Perspective

Power of 10	Power of 2	Value of Power of 2	Prefix	Abbreviation	Derivation
$10^{-12}$			pico	p	Spanish for little
$10^{-9}$			nano	n	Greek for dwarf
$10^{-6}$			micro	$\mu$	Greek for small
$10^{-3}$			milli	m	Latin for thousand
$10^3$	$2^{10}$	1024	kilo	K	Greek for thousandth
$10^6$	$2^{20}$	1,048,576	mega	M	Greek for large
$10^9$	$2^{30}$	1,073,741,824	giga	G	Greek for giant
$10^{12}$	$2^{40}$	not enough room	tera	T	Greek for monster
$10^{15}$	$2^{50}$	not enough room	peta	P	Greek prefix for five

# Stored-Program Concept

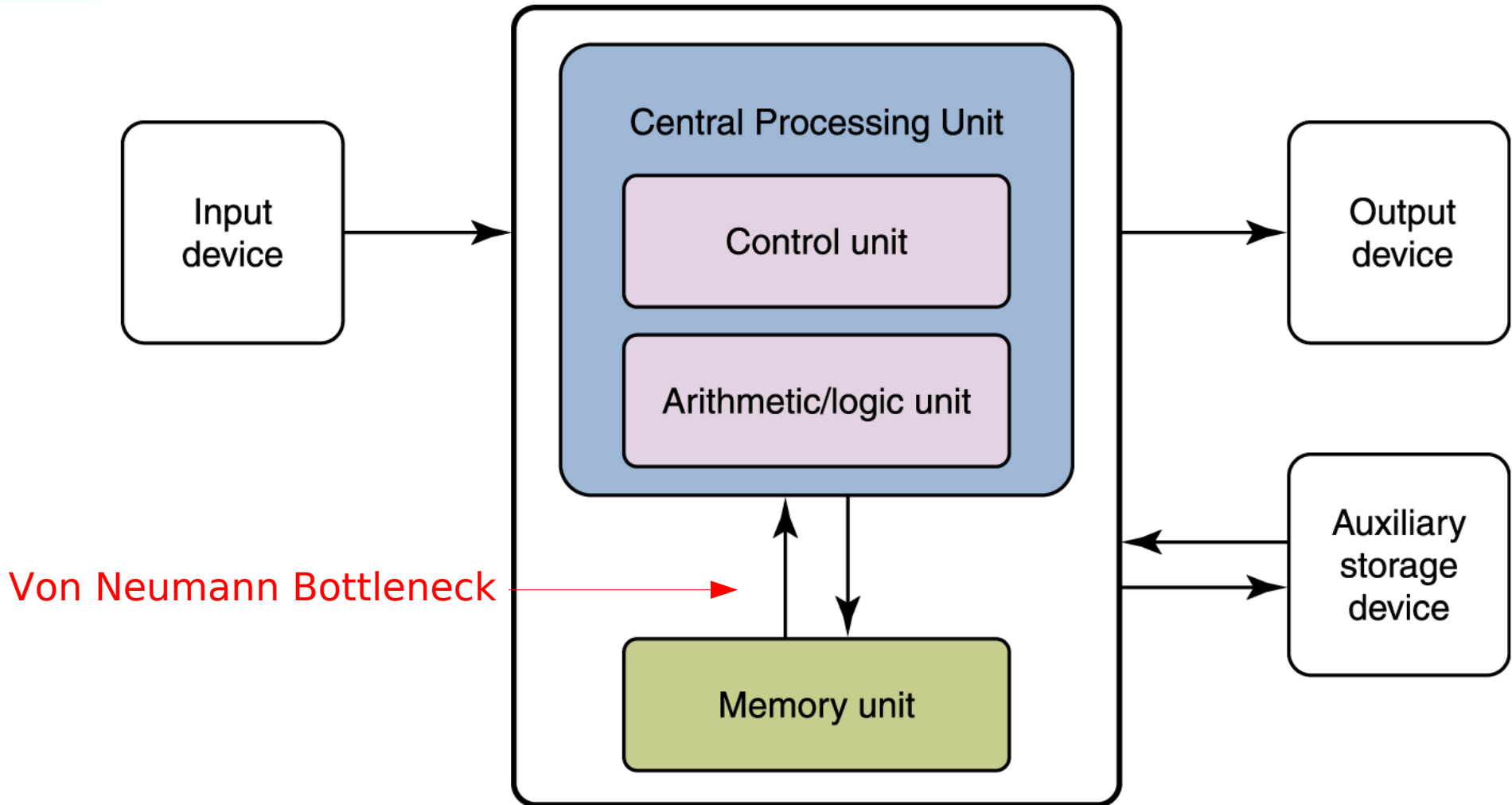


Figure 5.1 The von Neumann architecture

# John von Neumann

- Hungarian born mathematician
- Original member of Institute of Advanced Studies at Princeton where he met Alan Turing
- Member of the Manhattan Project
- Responsible for modern computer design – the “stored – program computer”
- Fly and the Train Problem!



# Memory

- Memory is a collection of **cells**, each with a **unique physical address**

**Address**

00000000

00000001

:

.

11111100

11111101

11111110

11111111

**Contents**

11100011

10101001

:

.

00000000

11111111

10101010

00110011

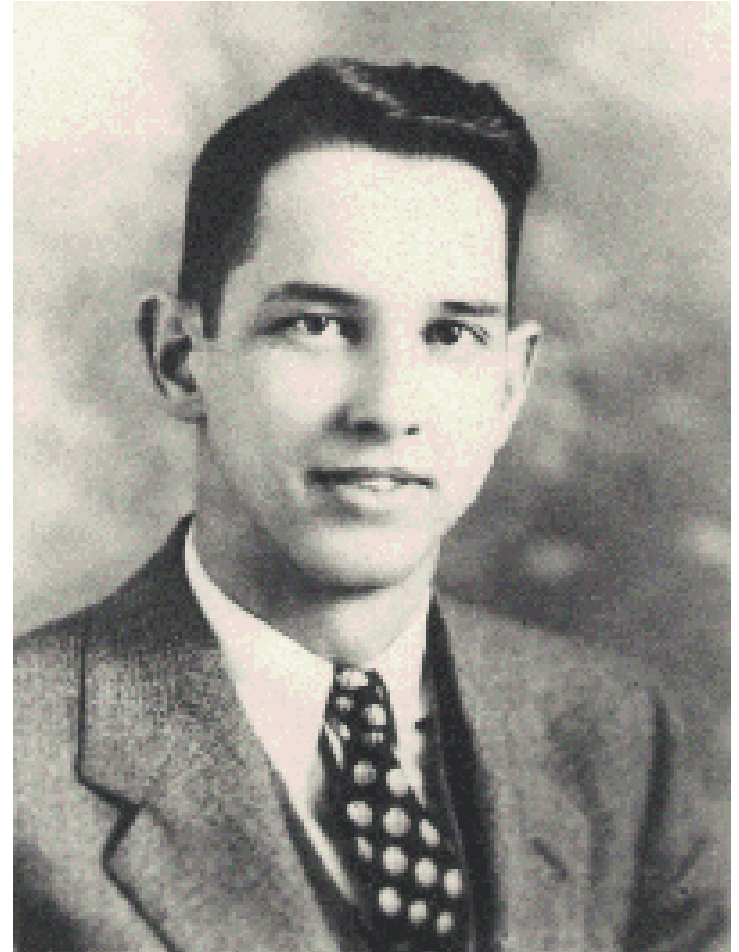
# Arithmetic/Logic Unit

- 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**



# John Vincent Atanasoff

- Native of Hamilton, NY
- Envisioned a computer device that was “digital”
- The idea of building an electronic digital computer came to him while he was sitting in a tavern – first computer insomniac
- 1939, the Atanasoff Berry Computer (ABC) at University of Iowa
- Forgotten “Father of the Computer”

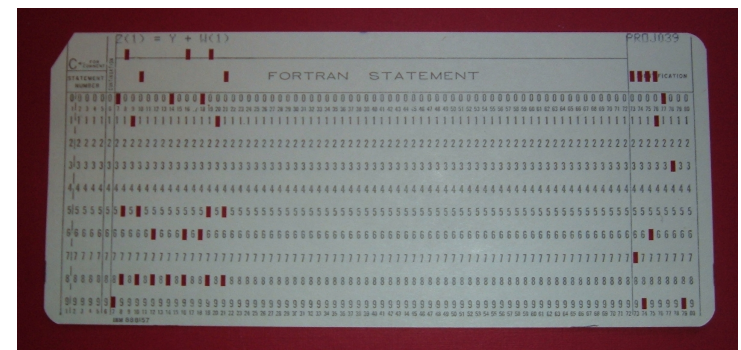
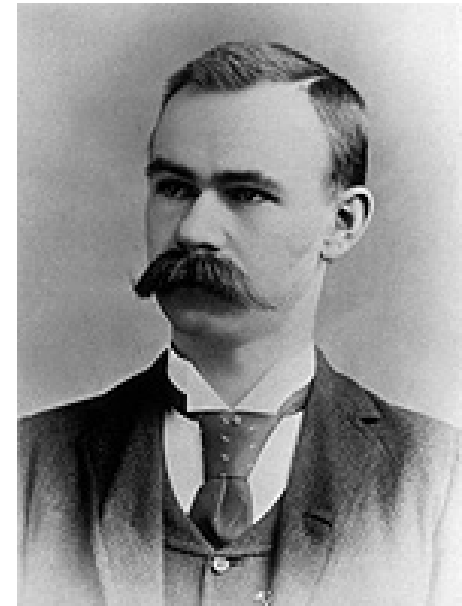


# Input/Output Units

- **Input Unit** A device through which data and programs from the outside world are entered into the computer
  - Keyboard, the mouse, and scanning devices
- **Output unit** A device through which results stored in the computer memory are made available to the outside world
  - Printers and video display terminals

# Herman Hollerith

- Developed calculating method for 1890 census
- Based on Hollerith code using card with holes punched in them
- 1896 founded the Tabulating Machine Company
- 1911 merged with another company to form the Computing Tabulating Recording (CTR) company, with [Thomas J Watson](#) president
- 1924 company renamed **IBM**

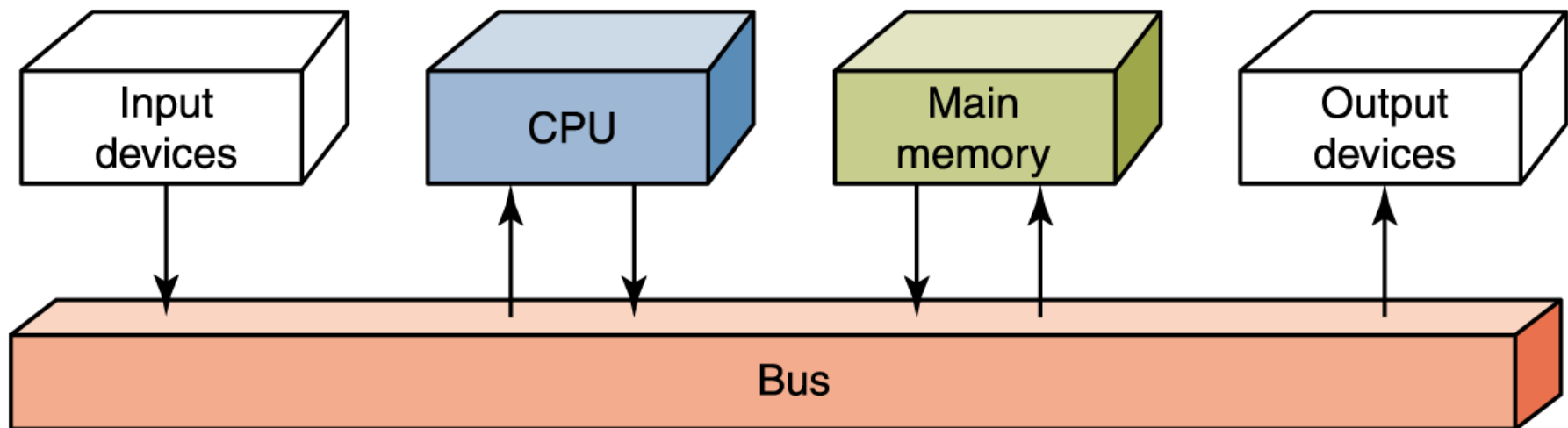


# Control Unit

- **Control unit** 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**

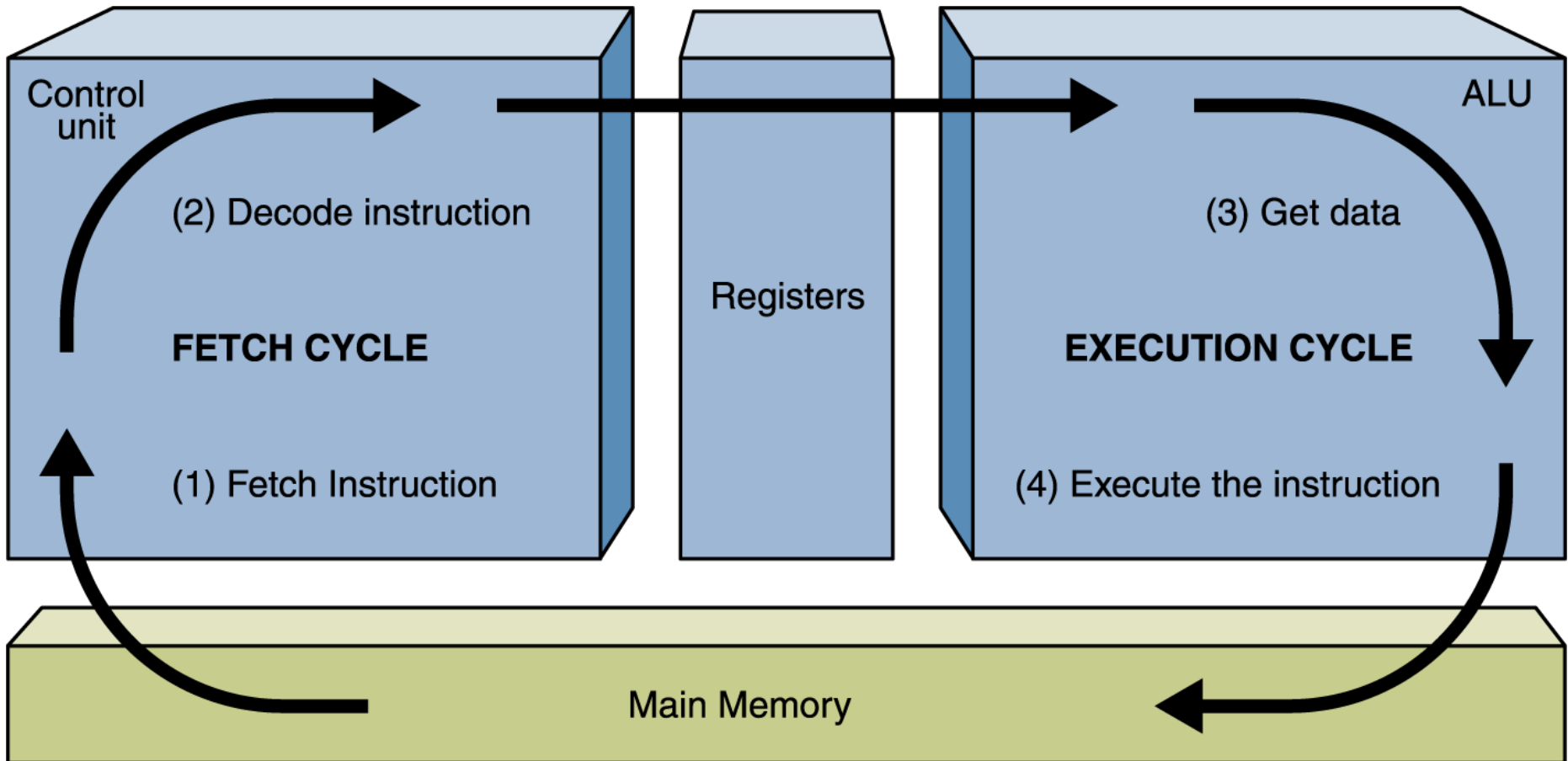


**Figure 5.2** Data flow through a von Neumann architecture

# 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 **volatile**, ROM is not
  - This means that RAM does not retain its bit configuration when the power is turned off, but ROM does

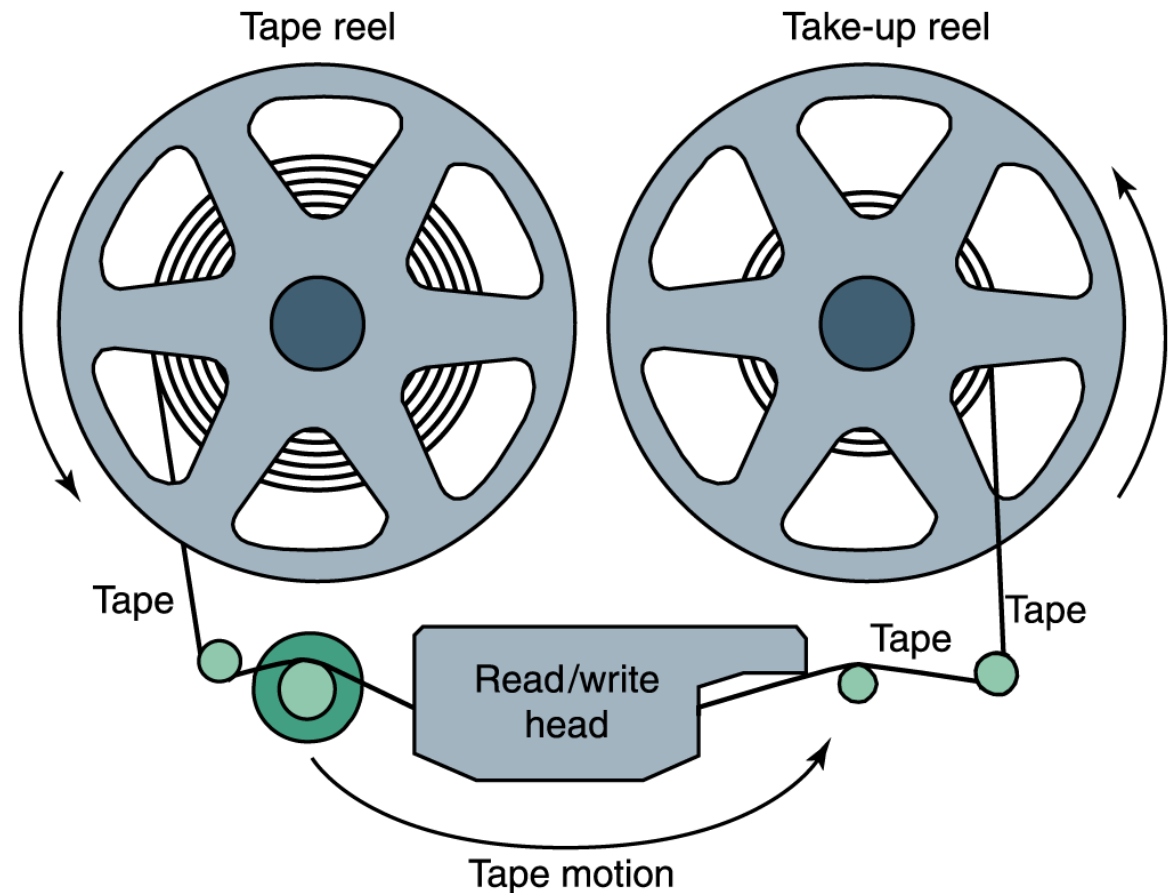


# Secondary Storage Devices

- 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

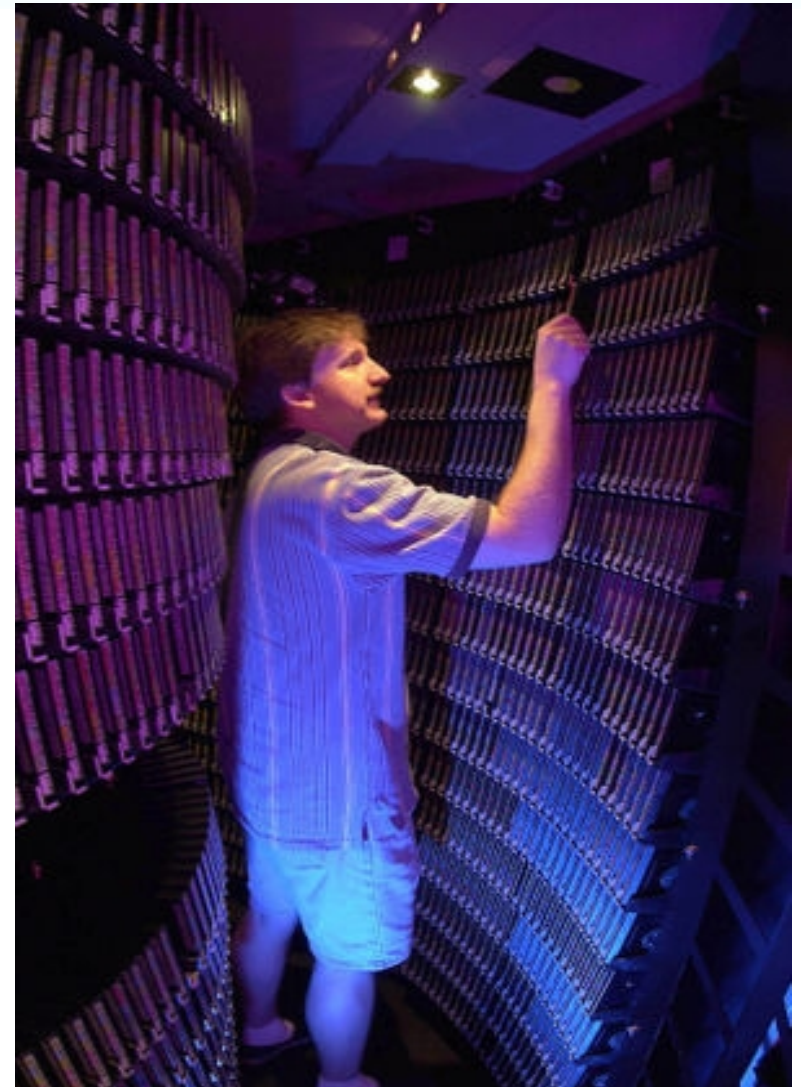


A magnetic tape storage mechanism

**Figure 5.4** A magnetic tape

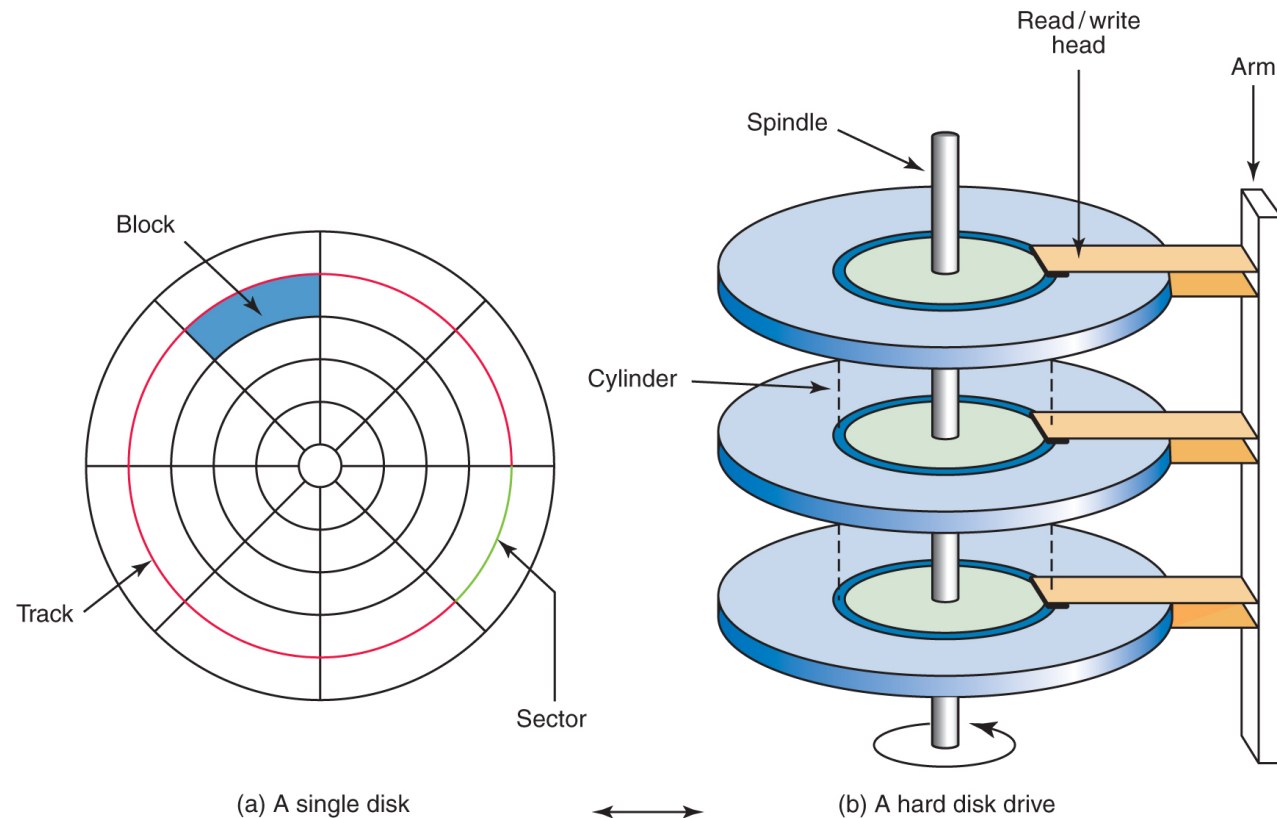
# Tape Silo

- Handled by a robot
- Travels 80 mph



# 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

# A Hard Drive In Action

- **Inside A Hard Drive** - Simple operations performed by a hard drive with no cover, so that you can see what it looks like inside. This experiment was performed on an old hard drive, do not try this with newer expensive hard drives, it is a bit risky. -from [digg.com](http://digg.com)
- **What Happens When You Drop A Disk - Or Two!**

# 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

# USB Drive

- Flash Drive is a form of non-volatile memory
- Stores information in an array of floating gate transistors, called "cells"



# Touch Screens

- **Touch screen** A computer monitor that can respond to the user touching the screen with a stylus or finger
- There are four types
  - Resistive
  - Capacitive
  - Infrared
  - Surface acoustic wave (SAW)



# Touch Screens

- **Resistive touch screen** A screen made up of two layers of electrically conductive material.
  - One layer has vertical lines, the other has horizontal lines.
  - When the top layer is pressed, it comes in contact with the second layer which allows electrical current to flow.
  - The specific vertical and horizontal lines that make contact dictate the location on the screen that was touched.

# Touch Screens

- **Capacitive touch screen** A screen made up of a laminate applied over a glass screen.
  - The laminate conducts electricity in all directions, and a very small current is applied equally on the four corners.
  - When the screen is touched, current flows to the finger or stylus.
  - The location of the touch on the screen is determined by comparing how strong the flow of electricity is from each corner.

# Touch Screens

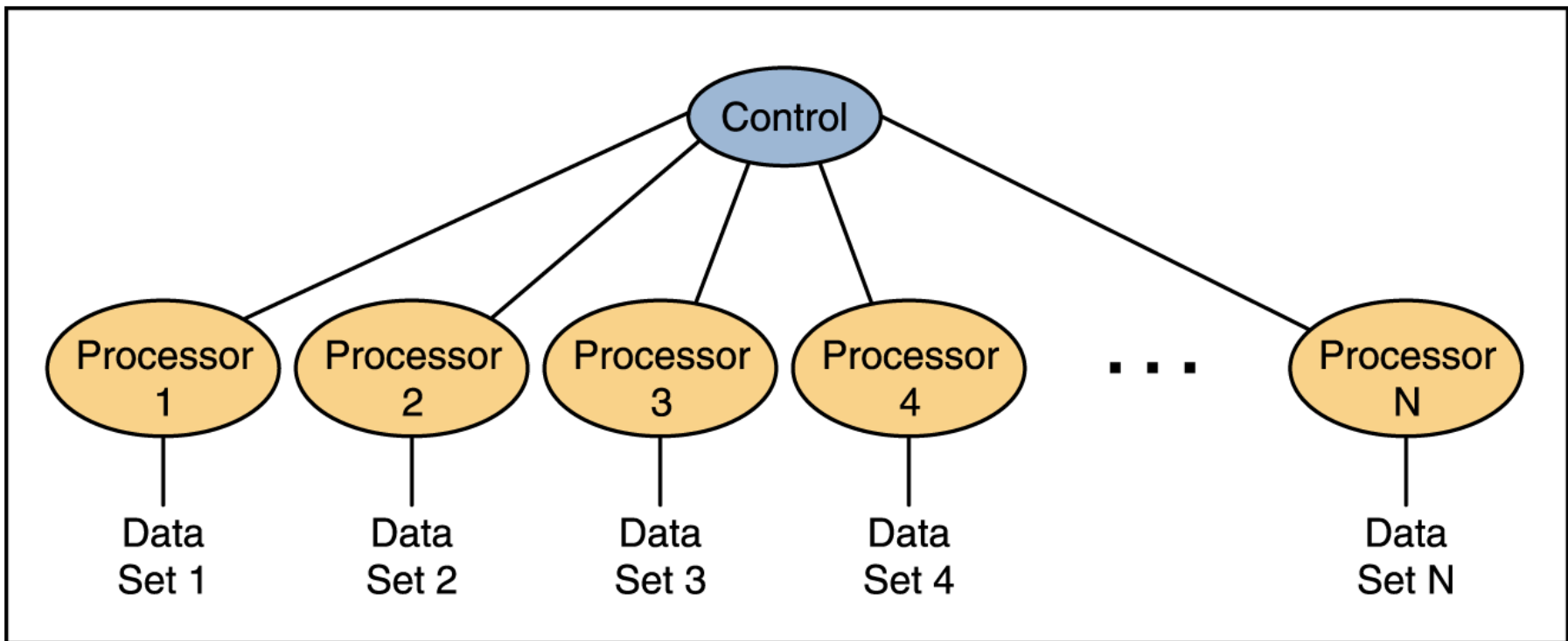
- **Infrared touch screen** A screen with crisscrossing horizontal and vertical beams of infrared light
  - Sensors on opposite sides of the screen detect the beams.
  - When the user breaks the beams by touching the screen, the location of the break can be determined.

# Touch Screens

- **Surface acoustic wave (SAW)** A screen with crisscrossing high frequency sound waves across the horizontal and vertical axes.
  - When a finger touches the surface, the corresponding sensors detect the interruption and determine the location of the touch.

# Synchronous processing

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



**Figure 5.7** Processors in a synchronous computing environment

# Pipelining

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

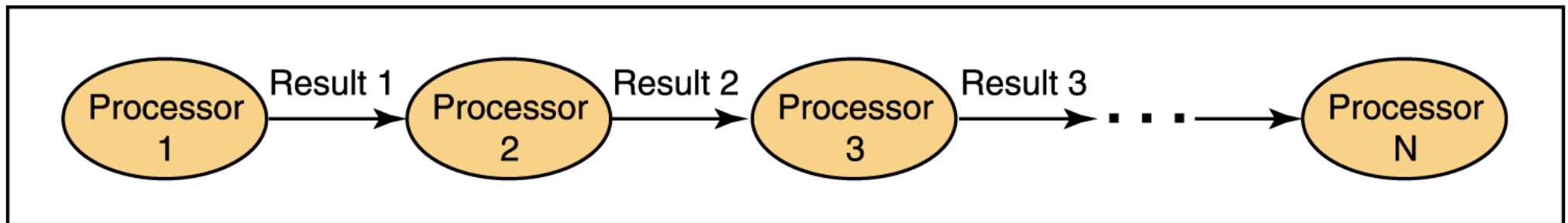
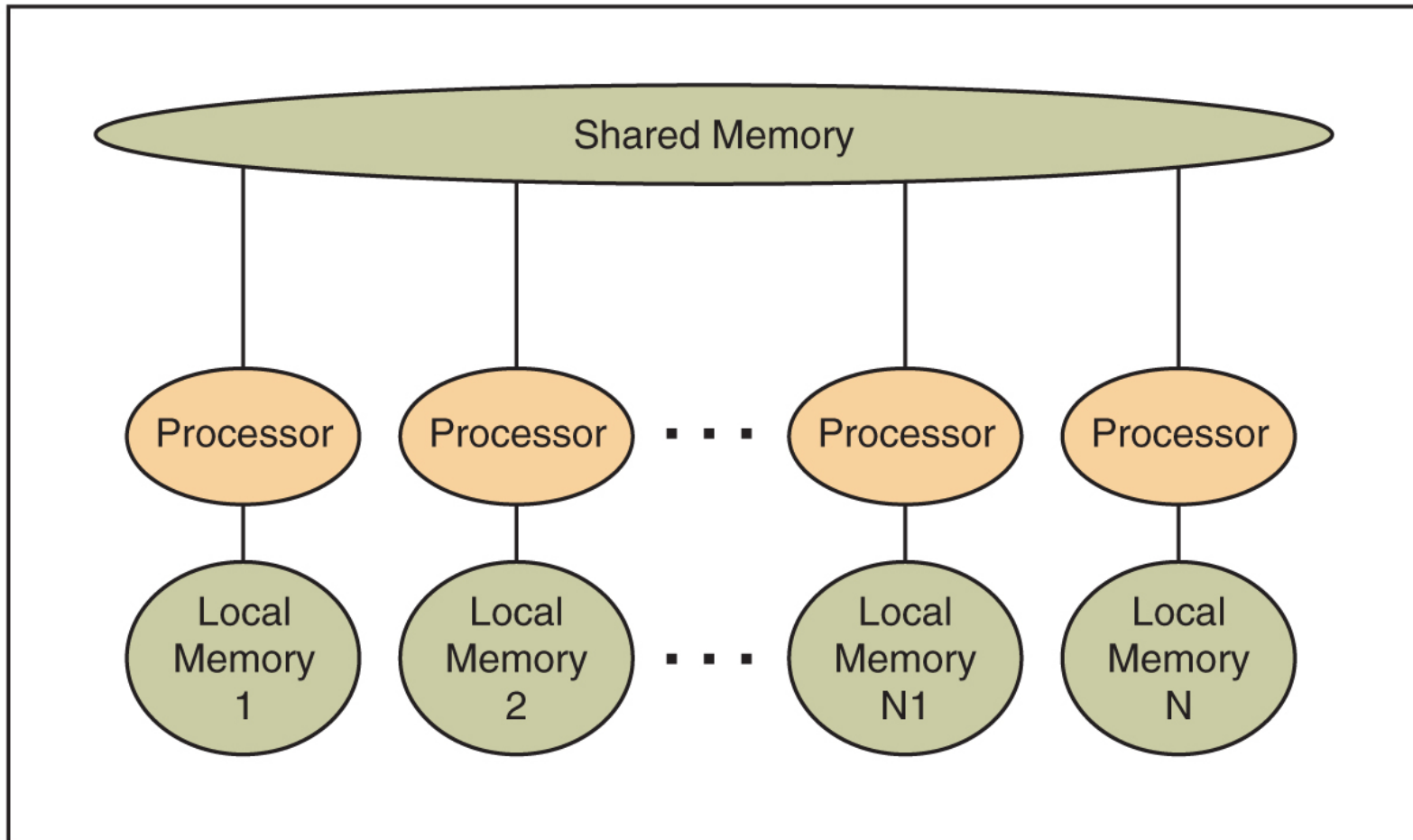


Figure 5.8 Processors in a pipeline

# Independent Processing with Shared Memory



**Figure 5.9** A shared-memory configuration of processors

# Assignment One

- **Let Me Know If I Can Publish On Web Site**
- **There Is No Obligation**



# Homework

- **Read Chapter Five, All Sections**

# Mid-Term

- Take Home Exam – Non-Trivial (think!)
- Cover Chapters 1-5 & 16 & Anything Covered In Class
- Given Out: Oct 11
- Due Back: Oct 18
- No Lateness!!!

# Good Night and Good Dreams!

