Computer Systems

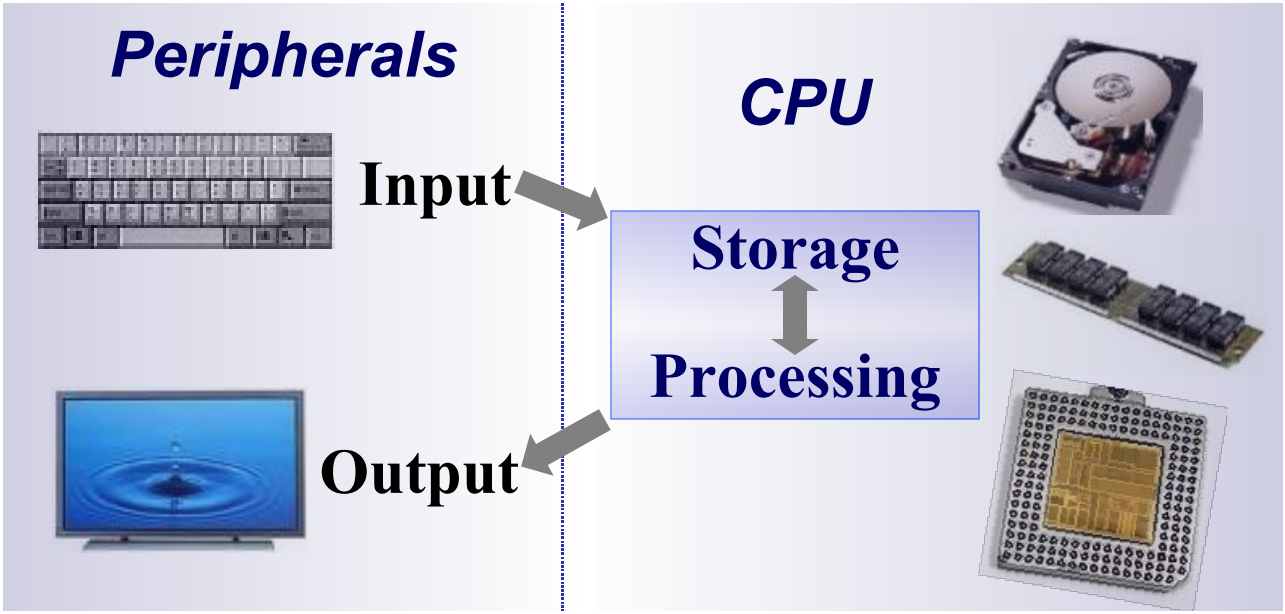
Computers are useful machines,
but they are generally **useless** by themselves.

Computers are usually part of a **system** –
a computer **system** includes:

- **Hardware** (machines)
- **Software** (programs, applications)
- **Communication** (networks, radio links)
- **Meatware** (people, users – don't forget them)

Hardware

Computer **hardware** includes many **components.**



The **traditional** view is divided into 4 sections:

Input → Storage ← → Processing →Output

Peripherals

Peripherals are the devices **attached** to the CPU. Some are **input** devices, others are **output** devices. They are commonly attached to a **USB port** (Universal Serial Bus). Some common peripherals are:

Input	*Output*
Keyboard , Mouse	**Monitor (VDU, CRT, LCD)**
Scanner (OCR), Graphic Tablet	**Printer , Plotter**
Light Pen , Bar-Code Reader	**Speaker (music, warnings)**
Optical Mark Recognition	**LED (light emitting diode)**
Magnetic Ink Character Recog.	**Motors (robots, machines)**
Digital Camera, Video Camera	**----------**
Sensors (temperature, light)	**Force-Feedback Joystick**
Microphone (voice recognition)	**Smart Board, Touch Screen**
Joystick (game pad), VR Glove	

System Unit

The **System Unit** contains the motherboard, disk-drives, power supply, and ports (connectors). In a PC, all these things are contained inside the **box.**
We divide the contents into two areas:

Storage	**Processing**
RAM, ROM, flash disk drive(s) tape drive	mainboard, busses microprocessor controller chips, cache

Storage

3.2.5-6

Storage is divided into 2 types:

- **Primary Memory** – RAM, ROM, cache – contains programs and data being used currently, and is **directly accessible** to the CPU
- **Secondary Storage** – disk, tape, flash memory – **permanent** storage for software and data, access requires **I/O operations**

- **Backup –** extra storage, usually not directly accessible – requires **mounting** the media – includes **robotic** warehouses and **networks**

Data Representation

Data is stored as **digital numbers**. These are stored in **binary (1's and 0's)** using transistors and other **bipolar** devices. The following issues are important:

- **number systems** – binary, hexadecimal  3.5.1-5
- **bits** and **Bytes** – kilo, mega, giga, tera  3.2.2
- **analog** vs **digital** – ADC, DAC, sampling  3.5.6-8
- **error detection** – parity bit, check-sum  3.6

Architecture

Architecture describes the most basic features and functions of a computer. A **32-bit** architecture means that all the **busses** and **chips** can process 32-bits of data at a time. Architecture issues include:

3.2.1-4

3.2.7

- **Microprocessor (CPU) –** Pentium, AMD, Motorola
- **Word-Size & Bus-Width** – 32-bit, 64-bit
- **Speed –** MegaHertz, GigaHertz
- **Band-width** – bits-per-second (bps)
- **Memory Size** – MegaBytes, GigaBytes
- **Motherboard** – contains all the chips, including the **controller chipset**

Platforms

3.3.3-4

Computers come in many different sizes and shapes, for different **tasks** (applications):

- **Personal Computer (PC) –** for office work, personal use, public terminals, for **single user**
- **Mainframe** – big expensive machines for large databases, accessible by **many users**
- **Portable -** very small, battery powered, limited storage, portable data access communication
- **Supercomputer** – usually large, very expensive, very fast calculations for scientific simulations

Developments

The **history** of the **digital computer** is less than 70 years old. New technologies develop at exponential speeds – according to **Moore's Law**, computer power is **doubling** every 18-24 months. Reasons include:

3.2.9

- **parallel** processing – parallel pipelines, dual-core processors
- **reduced circuit size** – portable devices, increased transistor density
- **new technologies** – optical storage, flash memory
- **expansion** – wireless communications, global networks

Software

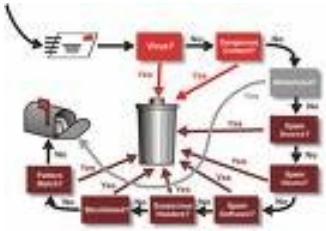
Software is programs and applications **controlling**:

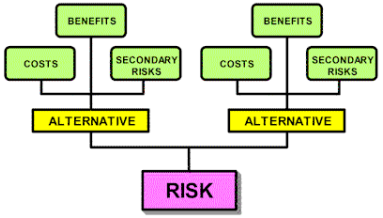
- **user-interface**
  (operating system)

- **hardware drivers**
  (for peripherals)

- **calculations**
  (processing data)

- **logic of operations**
  (business rules)





Operating System

The **OS** provides an **interface** between the **hardware devices** and the **software.** Common examples are:

Windows, Linux, Unix, Mac OS

3.3.1-2

A modern OS provides:

- **hardware control** (interrupts, device drivers)
- **software execution** (load and run programs)
- **User Interface** (command line, GUI)
- **resource allocation** (disk & memory management)
- **multi-tasking** (task manager)
- **communication service** (interrupts, LAN, WAN)
- **security** (accounts, passwords)

Utilities

3.7

Modern OS's include **utilities** for adjusting and improving operations, including:

- **file maintenance** – search, copy, delete, etc
- **backups** – automatically make backup copies
- **disk maintenance –** format, partition, defragment
- **compression –** archives (.zip)
- **security –** account and password management, virus scanner

Applications

Recall that a computer **system** includes **people**.
The users have **reasons** (goals) for using the system.

They accomplish **tasks** for specific **applications**.
Some common **application areas** are:

3.4.9

- **network apps –** e-mail, browser, conferencing, e-commerce
- **word-processing** (secretaries, office-workers)
- **inventory management** (stores, warehouses)
- **banking** (money and property records)
- **games** and **entertainment**
- **scientific research** and **simulation**
- **machine control** (airports, hospitals, factories)

Types of Processing

Not all computer systems work like a PC.
PC applications use **interactive** processing – the user is directly involved all the time.
We identify 3 different **processing types:**


3.3.5-7

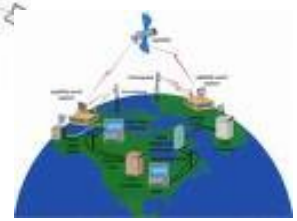
- **Interactive (online)** – the user is involved all the time – word-processing, web-browsing, games, streaming video
- **Batch processing** – data is collected over time and submitted in a big **batch**, all at once – bank cheques, backups, downloading music or programs
- **Real-time** – the computer controls machines or reacts to sensors at the same speed as the real world – robots, air-traffic control, medical sensors, live broadcasts

** **Reliability** is an important issue and may effect the choice of processing type.


3.3.8

Communication

Earlier computer systems were **stand-alone** – they existed in **one place** and functioned in **isolation.** Now **communication** is normal for computers, through **networks** and **wireless** links, including:



- **LANs**
  (intranets, home networks)
- **WANs**
  (Internet, large business networks)
- **Telecommunications**
  (phones, broadcasts)

- **Multimedia** (video, audio)

LAN

3.4.1-2

Local Area Networks use cables (or wireless) to connect lots of **workstations** (PCs), **servers**, and **peripherals** (printers, scanners, etc). This allows many users to **share** data and peripheral devices.

The **architecture** (organization) of the LAN involves:

- **topology** – bus, star, ring
- **connectors** – hubs, switches, cables
- **network OS** – the program that "runs" the network

WAN

Wide Area Networks use **public** communication (telephone) to connect widely-separated **nodes**. The **Internet** is only one example – international corporations can create their own WANs without using the Internet, although this is less common.

Some important issues for WAN's are:

- **Compatibility** – protocol, platforms
- **Speed** – actually **bandwidth**

3.4.3-4

- **Security –** encryption, encoding, privacy
- **Reliability** – error-rates, error-detection, error-prevention, error-recovery

3.4.5-8

People

People play a crucial role in **computer systems**. They have various **roles** and **responsibilities**:

- **Producers** (engineers, programmers)
- **Technicians** (installation, support, repairs)
- **Professional Users** (office workers, authors)
- **Personal Users** (home, recreation, games)