Introduction to Telecommunications and Computer Engineering

Unit 1: *Engineering and Computer Systems*

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Acknowledgements

These notes contain material from the following sources:

[1] *Number and Computer Systems*, by R.Palit, CSE Department, North South University, 2006.

[2] *Computer Systems, Processors, etc.*, Wikipedia the Free Encyclopaedia, wikipedia.org, 2007.

[3] *Introduction to Electrical and Computer Engineering*, C.B.Fleddermann & M.D. Bradshaw, Pearson Education, 2003.

Engineering

Engineering is the application of science and mathematics to produce useful systems and devices.

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Scientists study nature and try to discover the fundamental laws discovering nature whereas **engineers** are more concerned with how to use/apply scientific knowledge. **Technicians** are charged with building devices, running experiments, recording experimental data, maintaining devices etc. A person may perform a combinations of these functions and may not serve as exactly one of engineering/scientist/technician.

Example Engineering Fields

- Computer Engineering
- Electrical Engineering
- Telecommunications Engineering
- Mechanical Engineering
- Civil Engineering
- Aerospace Engineering
- Chemical Engineering
- Nuclear Engineering
- Manufacturing Engineering
- Biomedical Engineering
- And many others

Computer Systems

A computer is an electromechanical device that processes or manipulates data to produce information.

Five key elements computers integrate five key elements

- **Hardware** – computer's hardware consists of electronic devices; the parts you can see and touch.
- **Software** – consists of organized sets of instructions for controlling the computer.
- **Data** - a representation of facts, concepts.
- **Users/People** – people are the operators, also known as users.
- **Procedures** – steps to follow for processing data.

A brief history (1)

1946 AD – J. Presper Eckert, John Mauchley and a team of 50 complete the ElectronicNumerical Integrator and Computer (Eniac), the first large-scale electronic digital computer, at the University of Pennsylvania's Moore School. Weighing 2 tons, standing 2 stories and covering 15,000 square feet, Eniac operates at 357 multiplications per second. Cost: US$ 500, 000

1950 AD – Von Neumann's EDVAC is finally complete. Having lost the distinction as the first stored-program computer, it is still the first to use binary or digital mathematics.

1954 AD – Fortran, or Formula Translation programming language, is developed by John Bakus at IBM.

1960 AD – The first modern computer generation ends as vacuum tubes, punched cards and machine codes give way to second generation transistors, magnetic tape and procedural languages in computer design and operation.

A brief history (2)

1965 AD – Beginner's All-purpose Symbolic Instruction Code (BASIC) language is created by Tom Kurtz and John Kemeny of Darmouth.

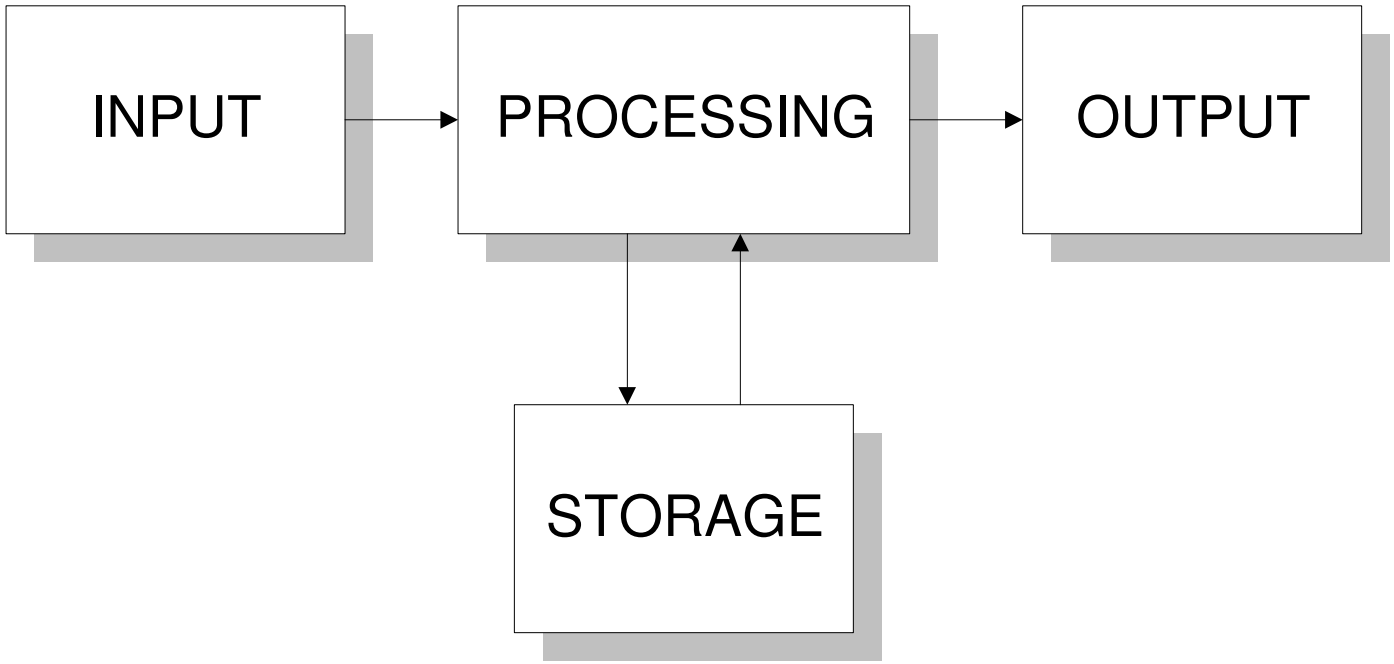
1971 AD – Intel markets the 4004 microprocessor, which paves the way for the micro revolution.

1981 AD – The IBM Personal Computer debuts, and Microsoft's S-DOS becomes its standard operating software.

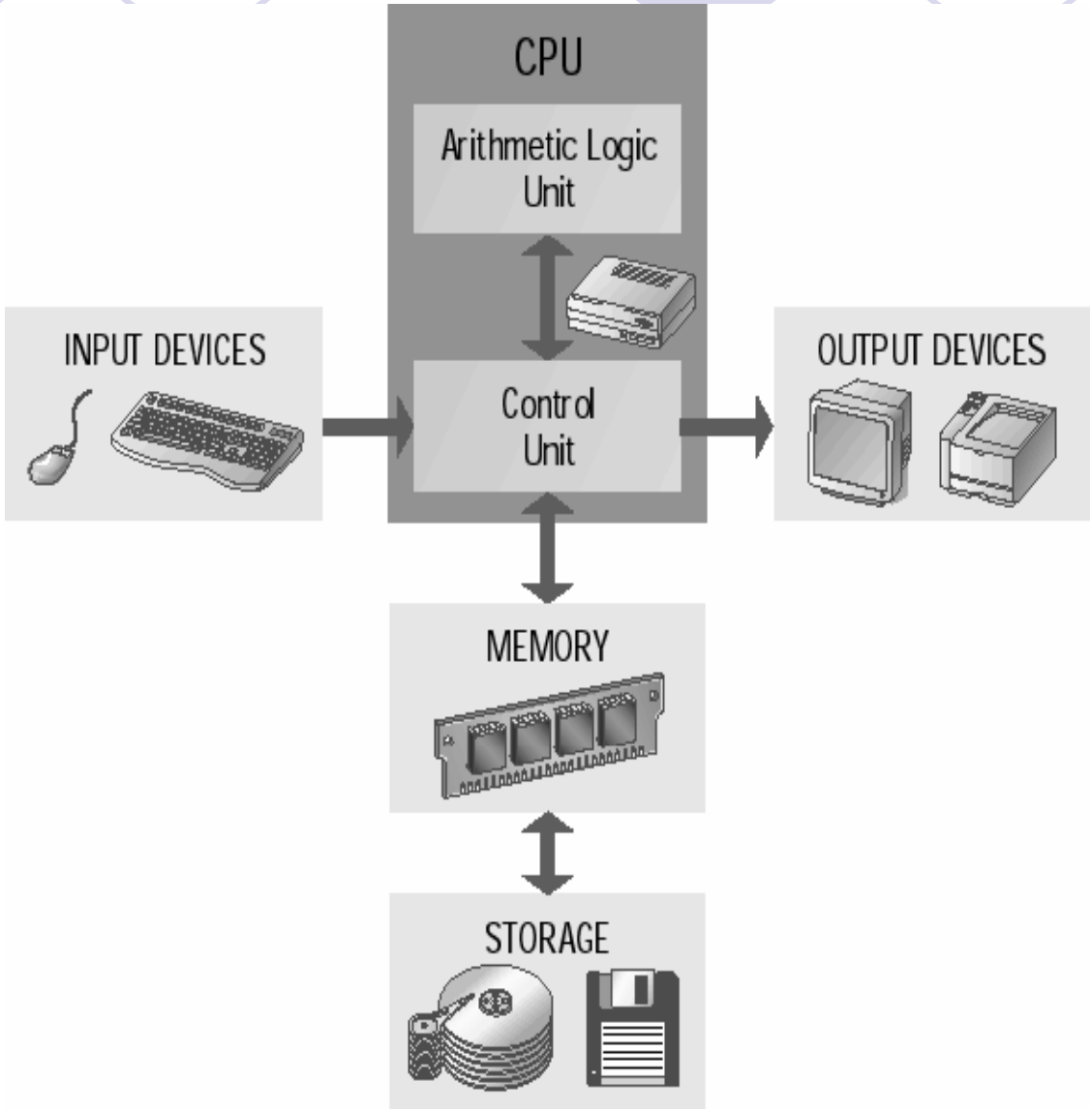
1990 AD – Computers containing a million processors are set to work solving complex problems.

2000 AD – Computers containing a billion processors exceed the power of the human brain

The IPOS Cycle



Von Neumann Architecture



From [2]

Input, Output and Storage

Input Devices

- Keyboards
- Mouse
- Pens
- Touch Screens
- Game Controllers
- Bar Code Readers
- Scanners
- Optical Character Reader
- Microphones
- Digital Cameras

Output Devices

- Monitors
  - o CRT, LCD Monitors
- Digital Light Projectors
- Speakers
- Printers
  - o Dot matrix, Ink Jet, Laser
- Plotters

Storage Devices

- Magnetic drive
- Optical dives (CD ROM, DVD)

Central Processing Unit (CPU)

The two main parts of a CPU are the **control unit** and the **arithmetic logic unit** (ALU).

The **control unit** directs the flow of data through the CPU, and to and from other devices. It stores the CPU's microcode, which contains the instructions for all the tasks the CPU can perform.

The **ALU** can perform arithmetic and logic operations. The ALU is connected to a set of **registers**—small memory areas in the CPU, which hold data and program instructions while they are being processed.

Types of Processors

A **complex instruction set computer** (***CISC***) is a microprocessor instruction set architecture in which each instruction can execute several low-level operations, such as a load from memory, an arithmetic operation, and a memory store, all in a single instruction. Examples include Intel's 80x86 line of processors (including the Pentium), AMD and Cyrix processors used today.

Reduced instruction set computers (***RISC***) have processors that use smaller instruction sets. This enables them to process more instructions per second than (CISC) chips. RISC processors are found in Apple's PowerPC systems, as well as many Handheld PCs (H/PCs), workstations, minicomputers, and mainframes.

Main Memory: RAM and ROM

Computers use **RAM** (**Random Access Memory**) to hold the program code and data during computation. A defining characteristic of RAM is that all memory locations can be accessed at almost the same speed. Many types of RAM are volatile, which means that unlike some other forms of computer storage such as disk storage and tape storage; they lose all data when the computer is powered down. Modern RAM generally stores a bit of data as either a charge in a capacitor, as in "dynamic RAM,“ (needs to be periodically refreshed), or the state of a flip-flop, as in "static RAM“ (retains memory as long as power is on). Examples of DRAM:

EDO DRAM, SIMM, DIMM, SDRAM, DDR SDRAM etc.

Because data stored in **ROM** (**Read Only Memory**) cannot be modified (at least not very quickly or easily), it is mainly used to distribute **firmware** (software very closely tied to specific hardware, and unlikely to require frequent updates). However, more modern types such as EPROM and flash EEPROM can be erased and re-programmed multiple times.

Cache Memory

Cache Memory is fast memory that serves as a buffer between the processor and main memory.

1. Processor's internal memory/registers
2. L1 Cache contained usually in the processor
3. L2 Cache usually on the motherboard (nowadays located on the processor chip)
4. L3 Cache usually on the motherboard
5. The Main Memory (RAM) itself
6. Part of the Hard Disk used by O/S called virtual memory

Types of Computers

- Microcomputers
- Minicomputers
- Mainframe Computers
- Supercomputers

Types of Computers

A **microcomputer** is a computer that has a microprocessor chip as its CPU. They are often called **personal computers (PC)** because they are designed to be used by one person at a time. Personal computers are typically used at home, at school, or at a business. **Laptop** or **notebook** computers are small and lightweight enough to be carried around with the user. **Desktop computers** are larger and not meant to be portable.

A **Personal Digital Assistant** (**PDA**) is a handheld microcomputer that trades off power for small size and greater portability. They typically use a touch-sensitive LCD screen for both output and input. A **palmtop** or **handheld PC** is a very small microcomputer that also sacrifices power for small size and portability.

A **workstation** is a powerful, high-end microcomputer. They contain one or more microprocessor CPUs. A **dumb terminal** on a network is NOT a microcomputer since it does not have independent processing power.

Types of Computers

A **mainframe** computer is a large, powerful computer that handles the processing for many users simultaneously (up to several hundred users). A (dumb) **terminal** is a device that has a screen and keyboard for input and output, but it does not do its own processing. The processing power of the mainframe is time-shared between all of the users.

A **minicomputer** is a multi- user computer that is less powerful than a mainframe. This class of computers became available in the 1960's when large scale integrated circuits made it possible to build a computer much cheaper than the then existing.

Types of Computers

A **supercomputer** is mainframe computer that has been optimized for speed and processing power. Supercomputers are used for extremely calculation-intensive tasks such simulating nuclear bomb detonations, aerodynamic flows, around global weather patterns. A supercomputer typically costs several million dollars.

Types of Software

- **System software** helps run the computer hardware and computer system. It includes operating systems, device drivers, diagnostic tools, servers, windowing systems, utilities and more.

- **Programming software** usually provides tools to assist a programmer in writing computer programs and software using different programming languages in a more convenient way. E.g. integretaed development environments (such as Eclipse for Java)

- **Application software** allows humans to accomplish one or more specific (non-computer related) tasks. Typical applications include industrial automation, business software, educational software, medical software, databases and computer games.

Operating Systems

An operating system (OS) is an essential software program that manages the hardware and software resources of a computer. The OS performs basic tasks, such as controlling and allocating memory, prioritizing the processing of instructions, controlling input and output devices, facilitating networking and managing files.

- The User Interface
- Running Programs
- Managing Files
- Managing Hardware
- Utility Software

The lowest level of any operating system is its kernel. This is the first layer of software loaded into memory when a system boots or starts up. The services of the kernel include, but are not limited to: disk access, memory management, task scheduling, and access to other hardware devices.

Example Operating Systems

IBM PC compatible - Microsoft Windows and smaller Unix-variants (like Linux and BSD)

Apple Macintosh - Mac OS X, Windows, Linux and BSD

Mainframes - A number of unique OS's, sometimes Linux and other UNIX variants

Embedded systems - a variety of dedicated OS's, and limited versions of Linux or other OS's

Programming Languages

The first widely used high-level programming language was FORTRAN, developed during 1954–57 by an IBM team led by John W. Backus. Some programming languages widely used today include Java, C++, C#, MATLAB, Visual Basic etc. A computer program may be compiled or interpreted in order to be run.

An **interpreter** parses a computer program and executes it directly. In contrast, a **compiler** translates the program into machine code – the native instructions understood by the computer's processor. Some "interpeters" actually use a just- in-time compiler, which compiles the code to machine language immediately before running it.

Programming Languages

A **high-level programming language** is a programming language that, in comparison to low-level programming languages, may be more abstract, easier to use, or more portable across platforms.

A **low-level programming language** is a language that provides little or no abstraction from a computer's microprocessor.

"High-level" and "low-level" are also used relatively; a Java programmer might consider C to be a comparatively low-level language. Whereas a C programmer might consider machine code to be of a lower level.

Bits, Bytes and Words

Computer memory consists of a large number of 'two-state devices' (flip-flops). We can think of them as switches, which can be 'On' or 'Off'. If the switch is 'On' it is storing the digit 1. If the switch is 'Off' it is storing the number 0. Hence the binary system of numbers is used, which consists only of numbers containing 0s and 1s.

- 8 bits (b) = 1 byte (B)
- 1024 bytes = 1 kilobyte (KB)
- 1024 kilobytes = 1 megabyte (MB)
- 1024 megabytes = 1 gigabyte (GB)
- 1024 gigabytes = 1 terabyte (TB)

A bit may be called a “binary digit”. A word is the number of bits that the CPU can handle at a time (usually 16, 32, 64 or 128). When we say 32 bit processor, the word size is 32 bits.