COMPUTER ORGANIZATION AND ARCHITECTURE

Organization and Architecture

- Computer architecture refers to those attributes of a system visible to a programmer or, put another way, those attributes that have a direct impact on the logical execution of a program
- Computer organization refers to the operational units and their interconnections that realize the architectural specifications.
- Architectural attributes include the instruction set, the number of bits used to represent various data types (e.g., numbers, characters), I/O mechanisms, and techniques for addressing memory.
- Organizational attributes include those hardware details transparent to the programmer, such as control signals; interfaces between the computer and peripherals; and the memory technology used.

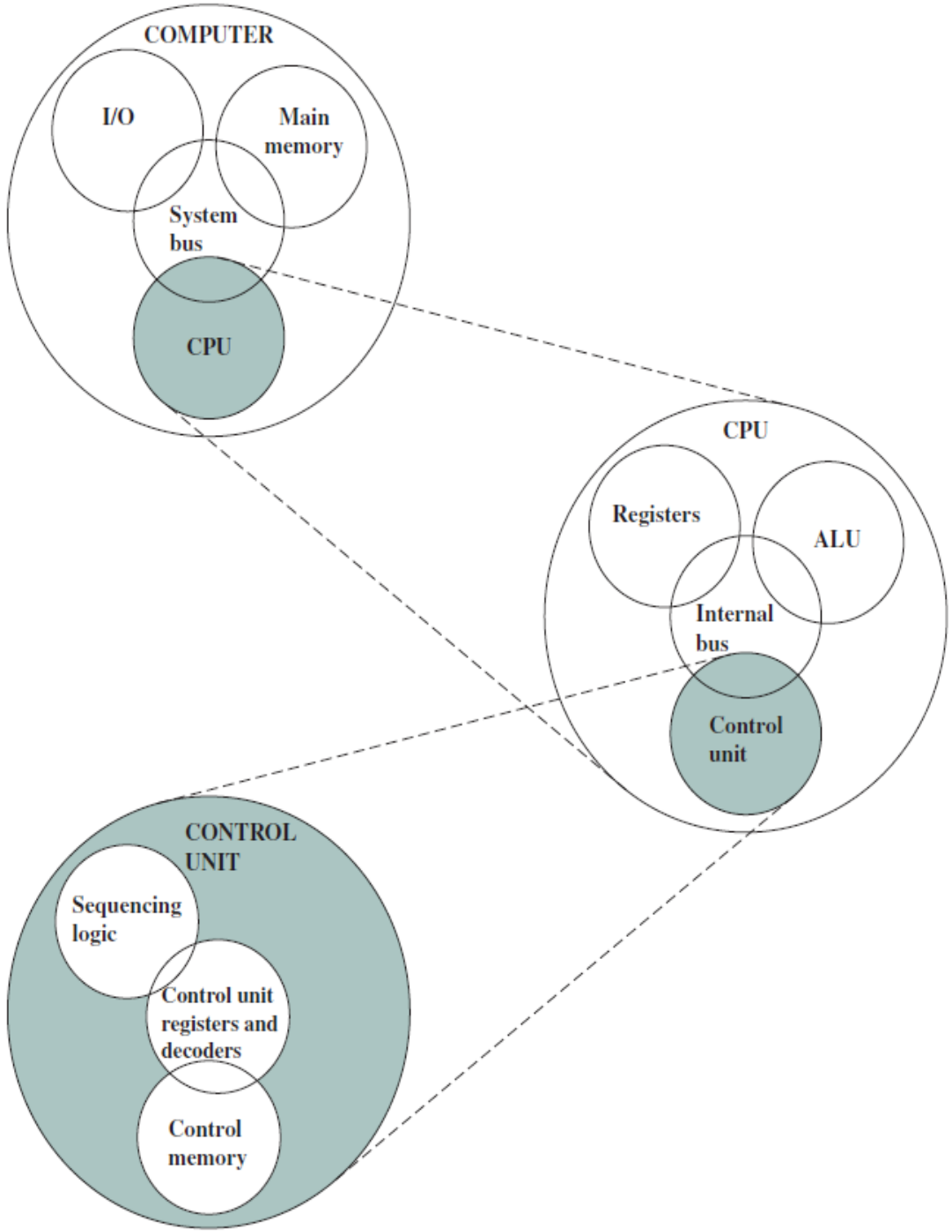
Structure and Function

- Structure: The way in which the components are interrelated.
- Function: The operation of each individual component as part of the structure.

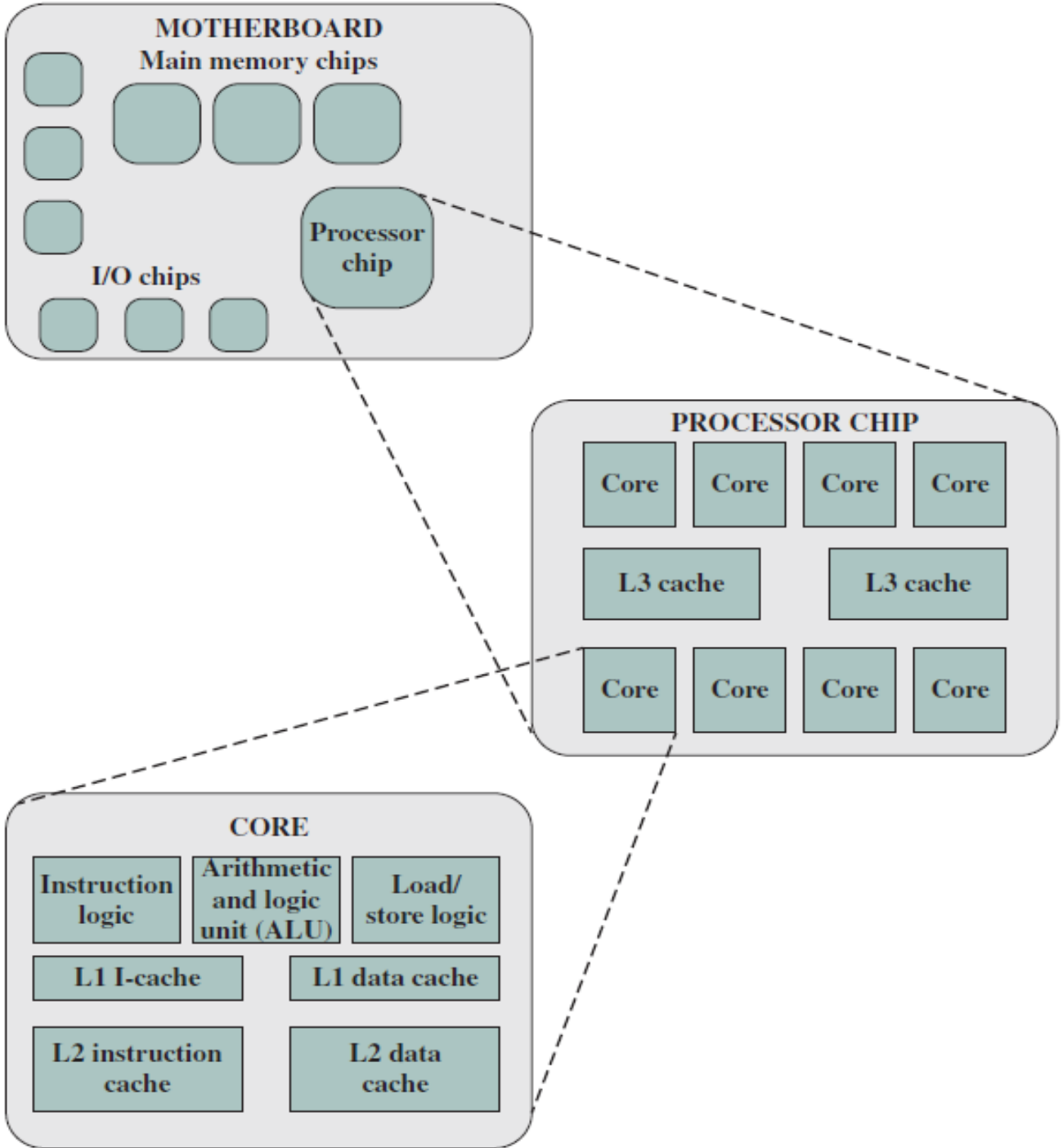
Function

- There are only four basic functions that a computer can perform:
- Data processing: Data may take a wide variety of forms, and the range of processing requirements is broad. However, we shall see that there are only a few fundamental methods or types of data processing.
- Data storage: Even if the computer is processing data on the fly (i.e., data come in and get processed, and the results go out immediately), the computer must temporarily store at least those pieces of data that are being worked on at any given moment. Thus, there is at least a short-term data storage function. Equally important, the computer performs a long-term data storage function. Files of data are stored on the computer for subsequent retrieval and update.
- Data movement: The computer's operating environment consists of devices that serve as either sources or destinations of data. When data are received from or delivered to a device that is directly connected to the computer, the process is known as input–output (I/O), and the device is referred to as a peripheral. When data are moved over longer distances, to or from a remote device, the process is known as data communications.
- Control: Within the computer, a control unit manages the computer's resources and orchestrates the performance of its functional parts in response to instructions.

Structure


COMPUTER
I/O
Main memory
System bus
CPU
CPU
Registers
ALU
Internal bus
Control unit
CONTROL UNIT
Sequencing logic
Control unit registers and decoders
Control memory

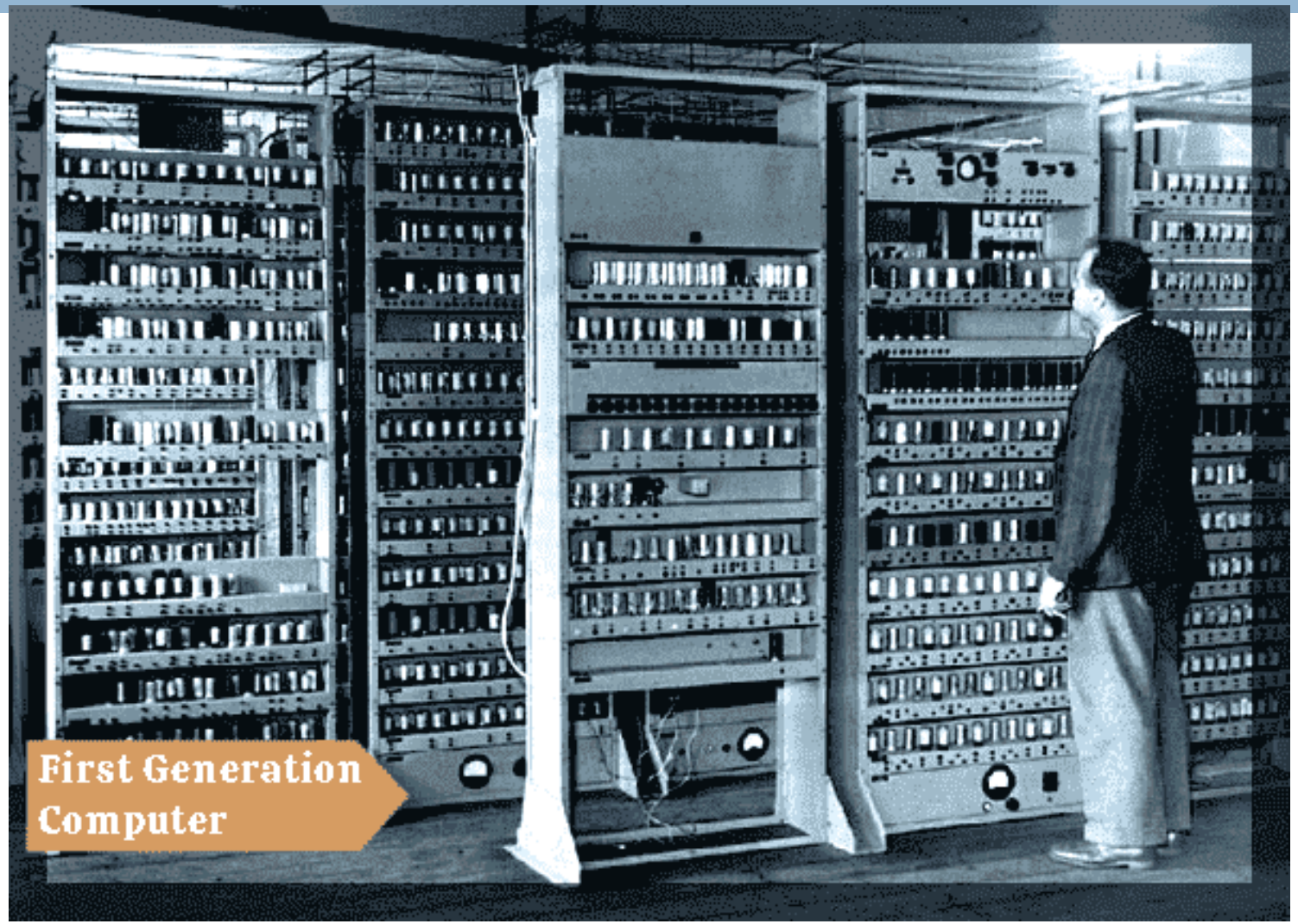
Structure


MOTHERBOARD
Main memory chips
Processor chip
I/O chips
PROCESSOR CHIP
Core
Core
Core
Core
L3 cache
L3 cache
Core
Core
Core
Core
CORE
Instruction logic
Arithmetic and logic unit (ALU)
Load/ store logic
L1 I-cache
L1 data cache
L2 instruction cache
L2 data cache

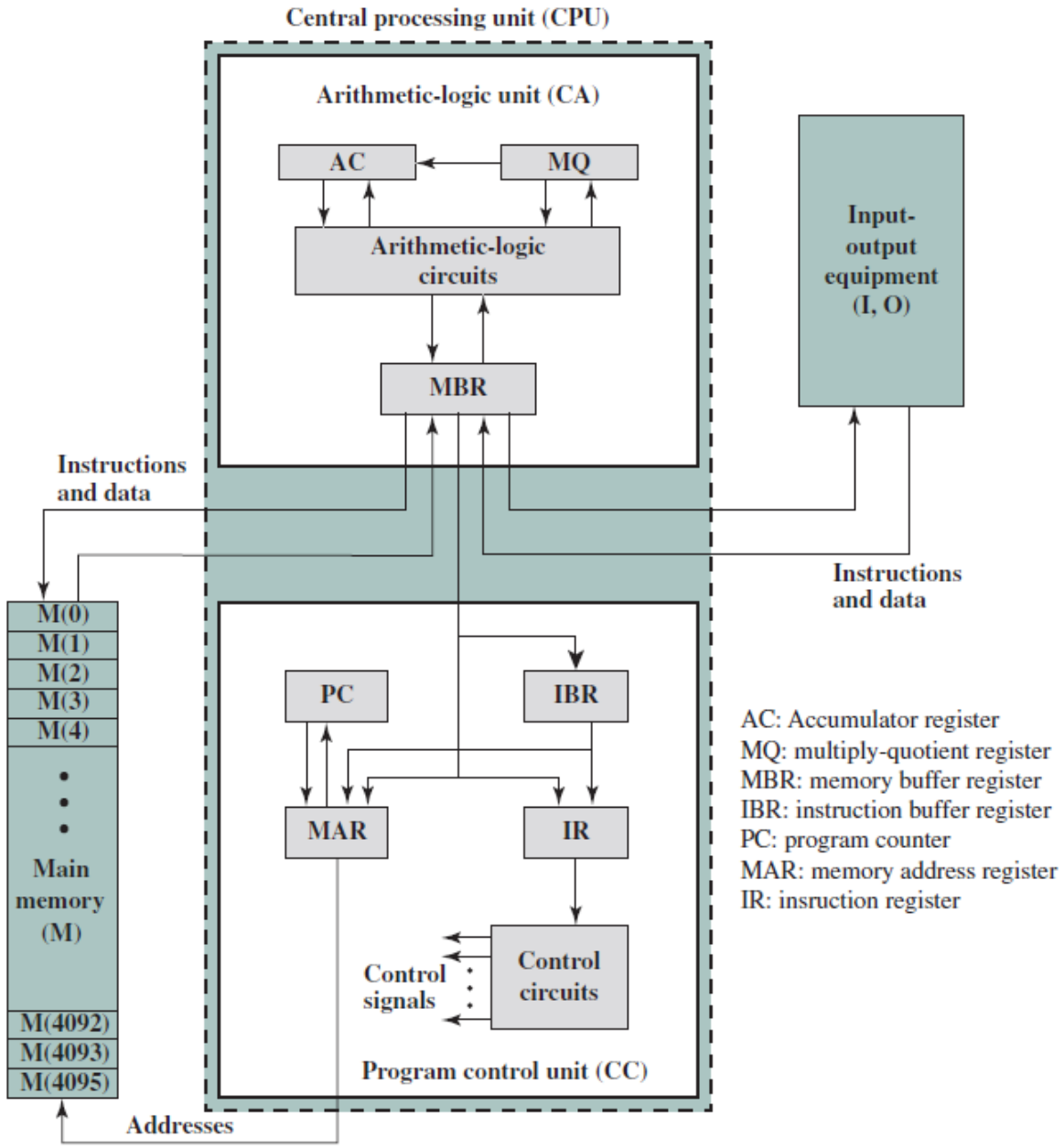
A Brief History of Computers

- The First Generation: Vacuum Tubes
- The Second Generation: Transistors
- The Third Generation: Integrated Circuits
- Fourth Generation Computers: Micro-processors

The First Generation: Vacuum Tubes



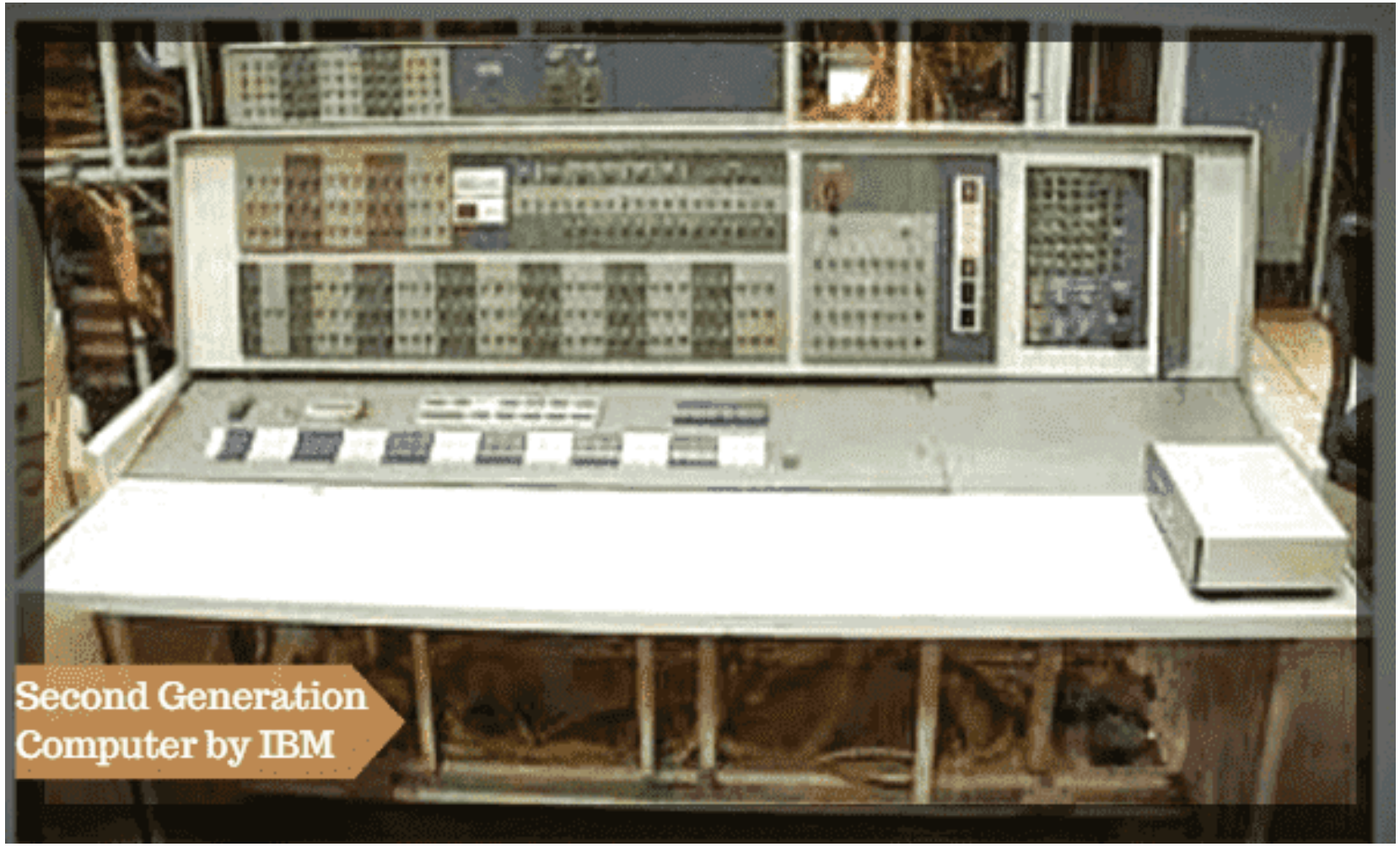
Von Neumann Machine



The First Generation: Vacuum Tubes

- A fundamental design approach first implemented in the IAS computer is known as the stored-program concept. This idea is usually attributed to the mathematician John von Neumann.
- The ENIAC pc was terribly serious and huge. Its size was a 50-foot-long basement area and Its weight was 30 tons. It had over 17,000 vacuum tubes. Vacuum Tube Computers used tons of electricity. ENIAC consumed a 150 kilowatts of power, during which 80 kilowatts were used for heating tubes, 45 kilowatts for DC power provides 20 kilowatts for ventilation blowers, and 5 kilowatts for punched-card electronic equipment.
- ENIAC was capable of doing 5000 additions per second.
- To differ its program implied essentially reworking it, with punch cards and switches in wiring plugboards. It might take a team 2 days to reprogram the machine.

The Second Generation: Transistors



The Second Generation: Transistors

- The Second generation of computers are much smaller in size than the first-generation computers.
- The main change is the use of transistors in place of vacuum tubes(Vacuum tubes are used in first generation of computers).
- The second generation of computers requires less amount of energy (i.e. electricity) compared to the first generation of computers and produces less heat than the first-generation computer.
- Assembly language is used instead of Machine Language(used in first-generation computers) for programming in computers.
- Calculation of data could be done in microseconds.
- The cost of Second-generation computers is reduced in comparison to first-generation computers.

The Third Generation: Integrated Circuits

The Third Generation: Integrated Circuits

- The third-generation computers were more reliable, fast, efficient, less expensive, and smaller in size.
- In third generation computers, high-level programming languages were used such as BASIC, PASCAL, ALGOL-68, COBOL, FORTRAN – II, PASCAL PL/1.
- The punch cards were replaced with mouse and keyboards.
- The integrated circuit technology replaces the use of individual transistors.
- The computers have high storage capacity.
- Computer required less space due to the use of integrated circuits (IC). A single integrated circuit (IC) contains transistors, resistors, condensers, condensers, etc. on a piece of the silicon semiconductor substrate.
- It produces less heat and required less energy during operations.
- The computers were portable and offer better speed.

Fourth Generation Computers: Micro-processors

Fourth Generation Computers: Micro-processors

- Very Large Scale Integrated (VLSI) circuits are used in a microprocessor-based system.
- Handheld computers have grown in popularity and cost.
- Networking between systems was invented and became commonplace.
- The quantity of memory and other storage devices available has expanded dramatically.
- The processing power, or speed, has skyrocketed.
- With the expansion of storage systems' capacity, huge programs began to be used.
- Great advancements in hardware aided in the improvement of the screen, paper, and other output.
- Multiple high-level languages, such as BASIC, PASCAL, COBOL, FORTRAN, and C, were developed in the fourth generation.

Computer Generations

Generation	Approximate Dates	Technology	Typical Speed (operations per second)
1	1946–1957	Vacuum tube	40,000
2	1957–1964	Transistor	200,000
3	1965–1971	Small- and medium-scale integration	1,000,000
4	1972–1977	Large scale integration	10,000,000
5	1978–1991	Very large scale integration	100,000,000
6	1991–	Ultra large scale integration	>1,000,000,000