Computer Evolution

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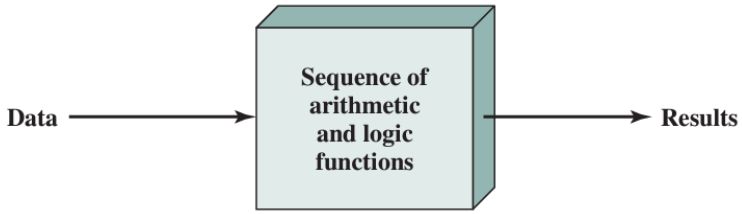
Announcements

- There is no lab today
- Our first lab is next week
- The lab venue has changed to ITD415
- I will update the course outline
- My website is not yet up due to technical issues
- Course material will continue being online

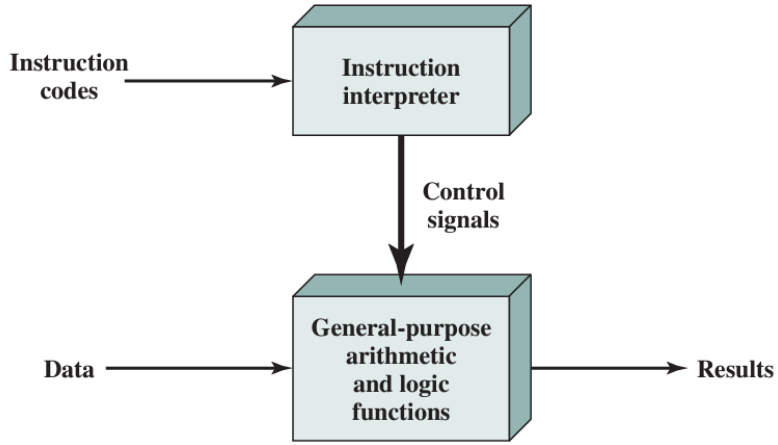
Computer Functions

- A computer has storage, processes any stored data and moves it around either in main memory and/or IO devices
- A configuration of computer components designed to achieve a specific computation is basically *programming*
- Programming can be achieved in either *hardware* or *software*
- Programming in hardware involves creating customized hardware for a specific program
- Programming in software requires new control signals for a new program, hence requiring no hardware rewrite

Hardware vs. Software Programming Respectively



- Data as input and produces results
- Hardware rewrite is needed for new programs
- The arithmetic and logic functions are not general purpose



- A sequence of codes which are instructions
- Instruction interpretation hardware to generate control signals for each code
- General-purpose arithmetic and logic functions

Types of Computer Components

There are two main types of devices:

- **Gates:** implement boolean and logical functions
- **Memory cells:** store 1 bit of data.
- **Interconnection:** connects the gates and memory cells

Mapping to the Core Functions

- **Data Storage:** memory cells
- **Data Processing:** gates
- **Data Movement:** interconnection between components to move data; memory to memory and memory to gates to memory
- **Control:** interconnection between components can have control signals eg. a gate can have two inputs and a control signal that activates the gate

Program Execution

- A computer program is a sequence of instructions
- Arithmetic and logic functions act on each step of the program
- Control signals are required
- Each instruction is processed in two steps:
  - Fetch
  - Execute
- **Instruction Cycle:** the processing required for a single instruction

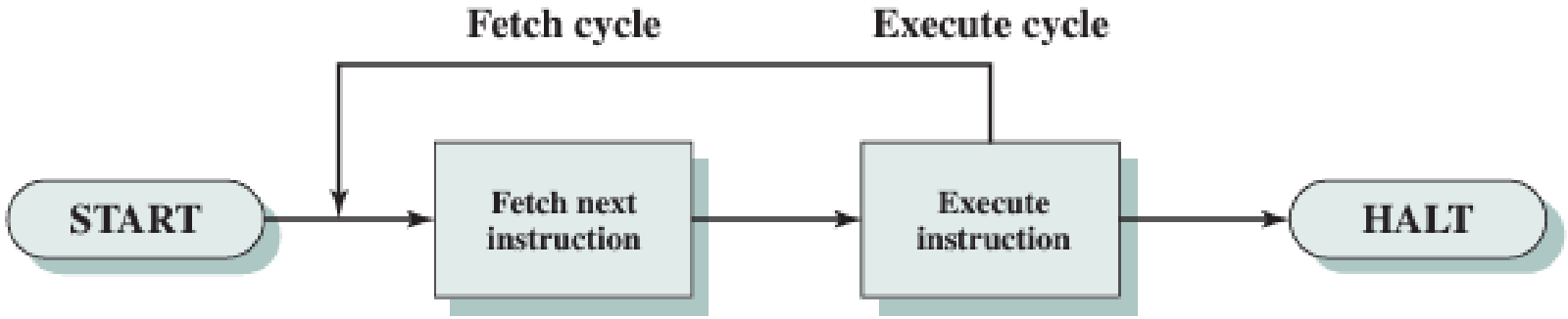
The Instruction Cycle

Fetch cycle: reads instructions from memory one at a time

- Reads the next instruction from the program counter (PC) register
- Loads it in the instruction register (IR)

Execute cycle: interprets the instruction and performs the required action

- Each instruction has a bit that specifies the action
- This action is one of the core functions of the computer like control, processing etc



Prehistory and Early Developments

- Charles Babbage is regarded as the father of computing
- Built a machine to compute mathematical tables (1823), difference engine
- Then the first general purpose computer idea conceived, analytic engine (1842)
- Babbage's work and influence was expanded by others like Ada Byron (first programmer)
- Then gave rise to the ENIAC[1] (1943 - 45)
- The EDVAC[2] which was the first computer based on the stored-program concept (1945)

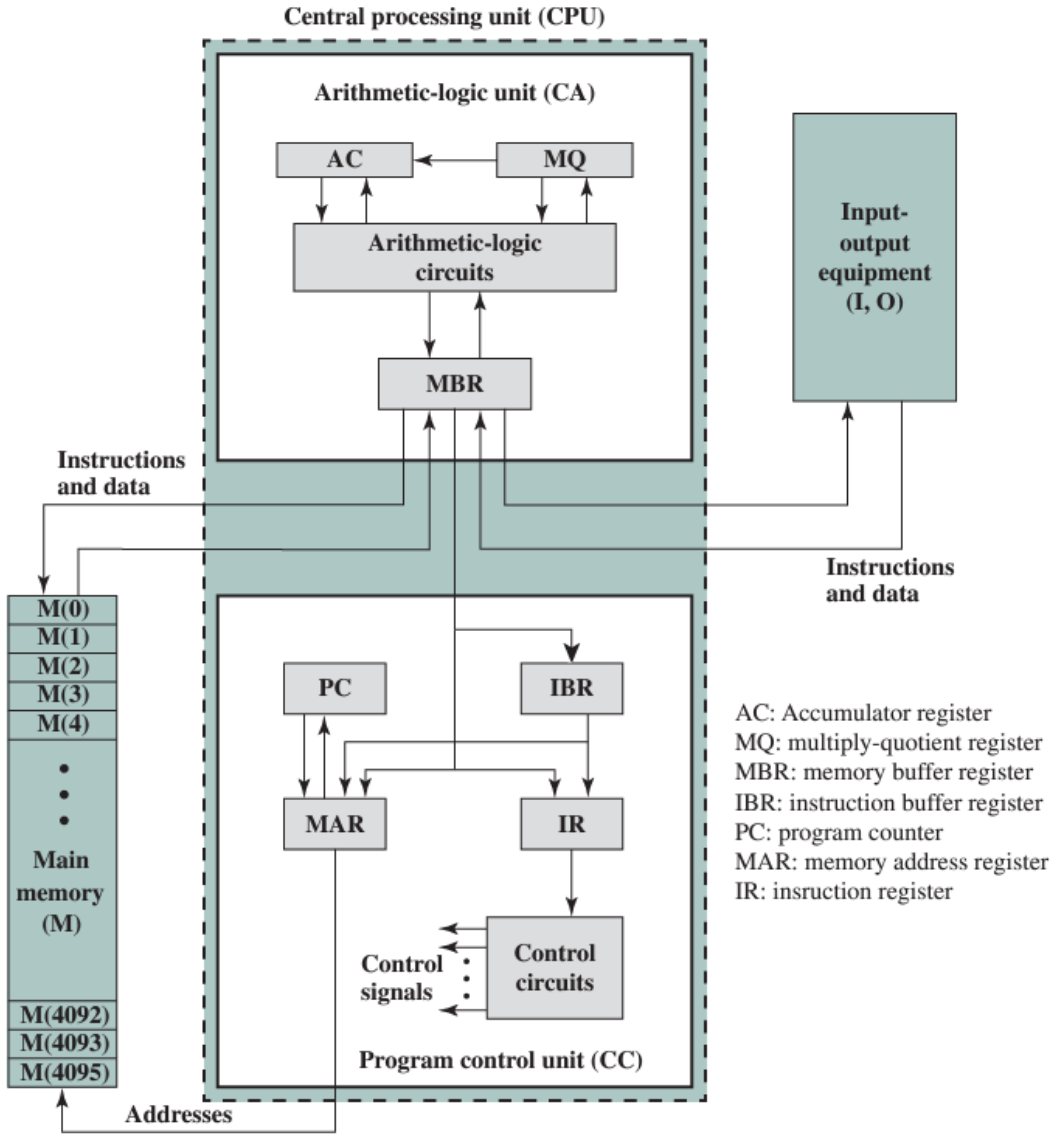
[1] Electronic Numerical Integrator and Computer
[2] Electronic Discrete Variable Automatic Computer

History

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

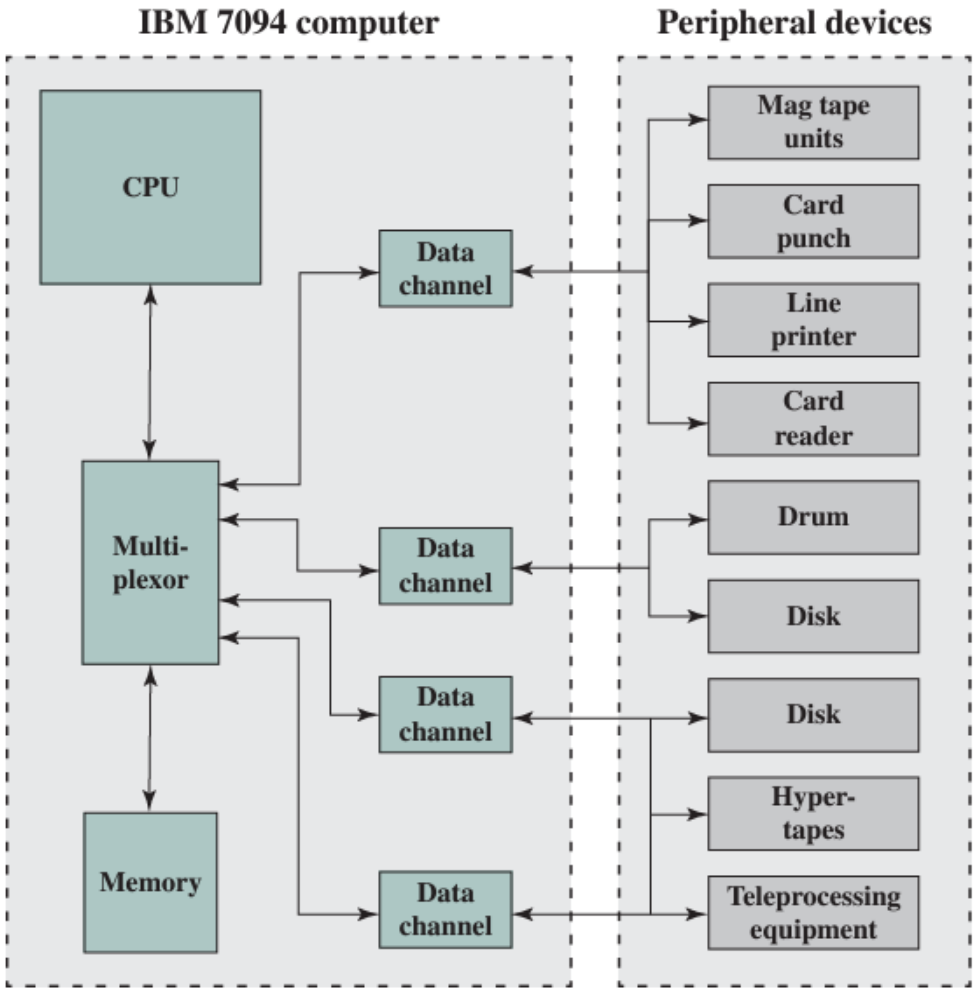
First Generation

- Uses **a vacuum tube** for digital logic elements and memory
- The most famous computer is the IAS from Princeton
- It is based on the **stored-program concept**
- And is the prototype of all subsequent general-purpose computers



Second Generation

- Uses **the transistor**, a solid-state device made of silicon
- Introduces more complex ALUs and control units
- Uses high-level programming languages
- Provides system software
- More features:
  - Speed
  - Data channels
  - Multiplexor

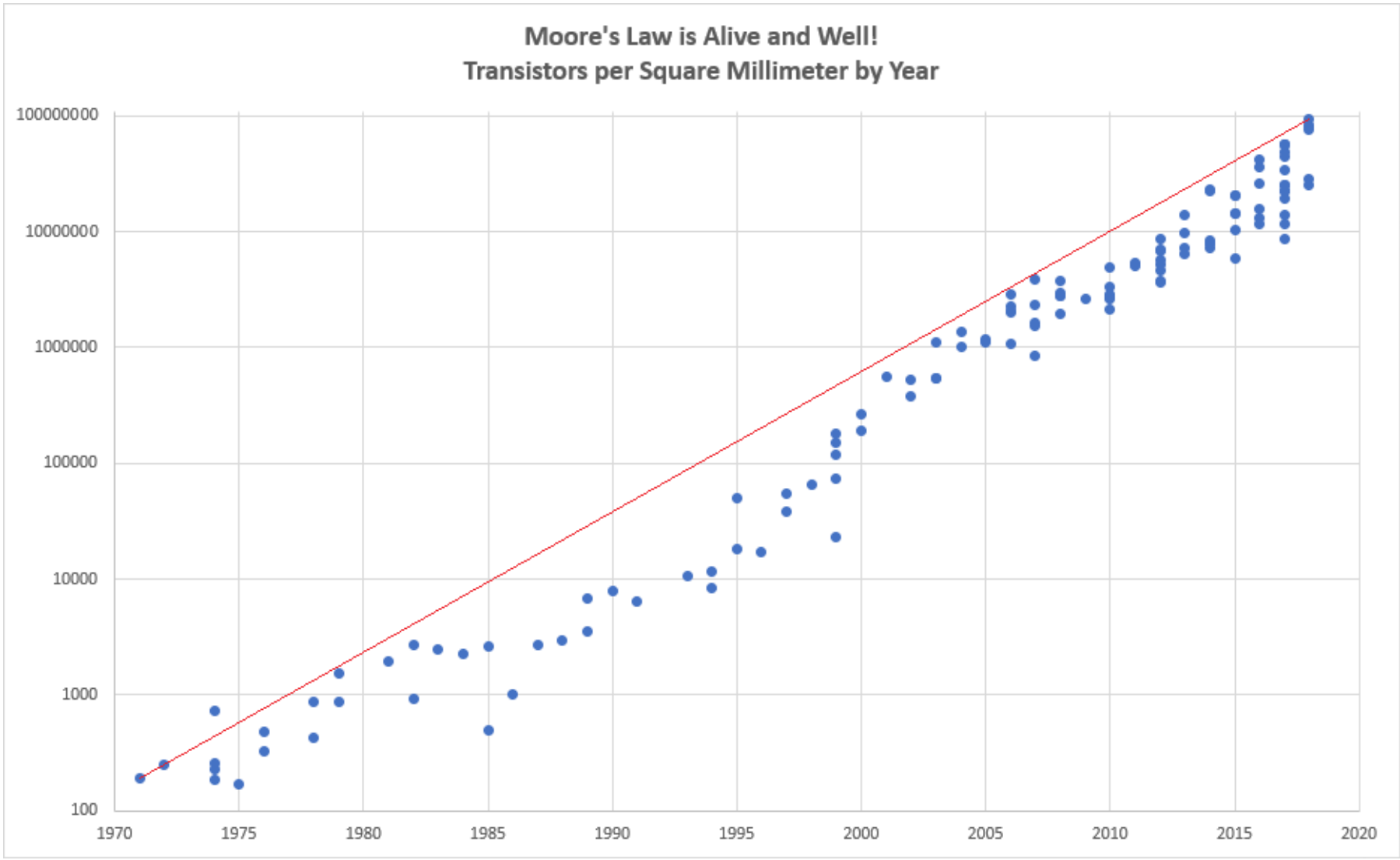


Third Generation

- Started the invention of **integrated circuits**
- Moving away from assembled discrete components
- To fabricating the entire circuit on a tiny piece of silicon
- Many transistors have continued be produced on a single silicon
- As predicted by Moore's law:

Moore observed that the number of transistors that could be put on a single chip was doubling every year, and correctly predicted that this pace would continue into the near future.

Moore’s Law


Moore's Law is Alive and Well!
Transistors per Square Millimeter by Year
100000000
10000000
1000000
100000
10000
1000
100
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

Later Generations

Mainly characterized by advanced integrated cicuit technology:

- **Large scale integration (LSI):** more than 1,000 components
- **Very-large-scale integration (VLSI):** achieved more than 10,000 components
- **Ultra-large-scale integration (ULSI):** can contain more than one billion components

It also came with two more major developments:

- **Semiconductor Memory:** integrated circuit technology moved to the construction of memory
- **Microprocessors:** contain all components of a CPU on a single chip

Evolution of the Intel x86 Architecture

- 4004: 1971, 4-bit microprocessor
- 8008: 1972, 8-bit microprocessor
- 8080: 1974, 8-bit microprocessor - Standandized
- 8085: 1976, 3 MHZ
- 8086: 1976, 5 MHZ
- 8088: 1979
- 80186: 1980, 10 MHZ
- 80286: 1982, 16 MB memory instead of 1 MB

Evolution of the Intel x86 Architecture

- 80386: 1985, 32-bit machine
- 8008: 1991
- Pentium: 1993, 60 MHZ
- Pentium II: 1997
- Pentium III: 1999 (1.3GHZ)
- Pentium IV: 2001
- Pentium M: 2003

Evolution of the Intel x86 Architecture

- Core 2 Duo: 2006, 1.86 GHZ
- Core 2 Quad: 2007, 2.4 GHZ
- Core i3 (dual): 2010, 2.93 GHZ
- Core i5 (quad): 2010, 3 GHZ
- Core i7 (quad): 2010
- Core i7 extreme (Octa): 2012, 4 GHZ

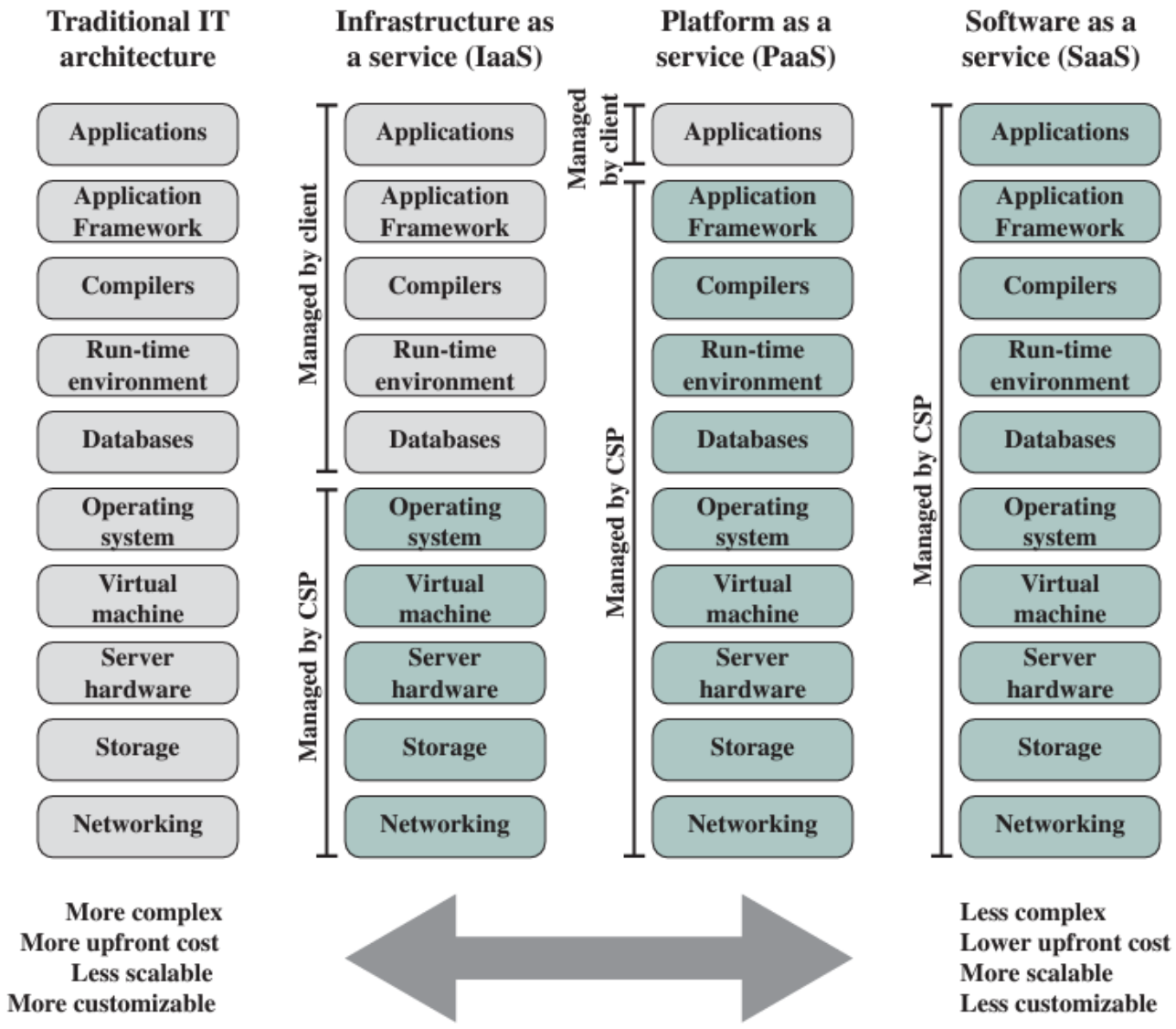
Cloud Computing

- **Cloud Computing:** a model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable computing resources
- **Cloud networking:** refers to the networks and network management functionality that must be in place to enable cloud computing.
- **Cloud Storage:** consists of database storage and database applications hosted remotely on cloud servers

Cloud Service Models

- **Software as a Service (SAAS):** provides service to customers in the form of software, specifically application software, running on and accessible in the cloud
- **Platform as a Service (PAAS):** provides service to customers in the form of a platform on which the customer applications can run
- **Infrastructure as a Service (IAAS):** provides virtual machines and other abstracted hardware and operating systems, which may be controlled through a service application programming interface (API)

Cloud Computing Benefits



IT = information technology
CSP = cloud service provider

More Reading Resources

- Embedded Systems