CMP 1203:
COMPUTER ORGANISATION AND ARCHITECURE.

Who Am I

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Send **ALL** communication through class prefect

About the Course

- Course work (40%)
- Exam (60 %)
- Participate **actively** in class. You can earn up-to 5 bonus points for each assignment.
- Ask questions
- Discuss
- Prepare for the lecture in advance
- Late submission of course work is not tolerated
- A lot of material. Study hard and try to UNDERSTAND the material. Avoid memorizing the texts/slides.

Computers

- Seemingly complex but evolve from simple fundamental concepts
- Execute complex algorithms that simplify several tasks
- Some algorithms may not work with current hardware or may run too slowly: need to understand how a program runs through a computers “eyes”: How does a computer work?
- Need understanding of hardware to effectively optimize computer programs/systems.
- How does hardware interact with software? How do different components fit together to make a working computer system?

Computer Architecture Vs. Computer Organization?

ASSIGNMENT ONE!

Computer Organization

- We shall see computers as a series of layers that constitute a hierarchy: from low level hardware to high level software – OS and assemblers
- Computer Organization focuses on this hierarchy, aspects of how we partition these levels and how each level is implemented.
- How do various circuits and components fit together to make a working system? How does a computer work?
- Aspects: control signals, signaling, types of memory, interfaces

Computer Architecture

- Architecture focuses on the interface between hardware and software, with emphasis on the structure and behavior of the system
- Logical and abstract aspects of the system implementation as seen by the programmer: these attributes have direct impact on the execution of a program
- Hardware + Instruction Set Architecture
- ISA is agreed upon interface between all software that runs on the machine and the hardware that executes it. This is how you talk to the computer.
- How do we design computers?
- Aspects: instruction sets and formats, operation codes, data types, registers, addressing modes, memory access, I/O methods etc

Computer Components

- Algorithms implemented in languages e.g. C++, Java…
- What makes algorithms run? Other algorithms and so on until the basic machine level ➔ algorithm implemented as an electronic circuit.
- **Principle of Equivalence of Hardware and software**: Any task done by software can also be done using hardware and vice versa

Hardware Vs. Software

- There is always a choice between the two. How do we make appropriate choice considering other factors: cost, speed, function ? --- computer organization and architecture.
- Computer Hardware:

1. Processor : interpret and execute programs
2. Memory : store data and programs
3. Mechanism to transfer data to and from the outside world

Understanding the basic components of computer is key to understand what its doing at any time and how we can change its behavior

Jargon

Comparison Criteria Show differences only	 Apple MacBook MNYK2HN/A Ultrabook (Core M3 7th	 Dell Latitude E6330 Laptop
SUMMARY		
Display	12" (30.48 cm) display, 1920 x 1080 px	-
Storage	256 GB SSD	500 GB HDD, SATA, 7200 RPM
Processor	Intel Core M3 (7th Gen) Processor	-
Ram	8 GB LPDDR3 RAM	-

PERFORMANCE		
Clockspeed	1.2 Ghz	2.6 Ghz
Graphic Processor	Intel HD 615	Intel HD 4000
Processor	Intel Core M3-7Y30 (7th Gen)	HD 4000Core i5 3rd Gen2.6 GhzIntelIntel HD 4000Intel QM77 ExpressIntel Core i5-3320MIntel3320M
MEMORY		
Memory Layout	1 x 8 Gigabyte	1 x 4 Gigabyte
Ram Type	LPDDR3	DDR3
Memory Slots	1	2 DIMM
Ram Speed	1866 Mhz	1600 Mhz
Capacity	8 GB	4 GB

Source: https://www.gadgetsnow.com/compare-laptops/Apple-MacBook-MNYK2HNA-Ultrabook-Core-M3-7th-Gen8-GB256-GB-SSDmacOS-Sierra-vs-Dell-Latitude-E6330-Laptop

Evolution of Computers

Image source: pocketables.com

Evolution of Computers- Storage

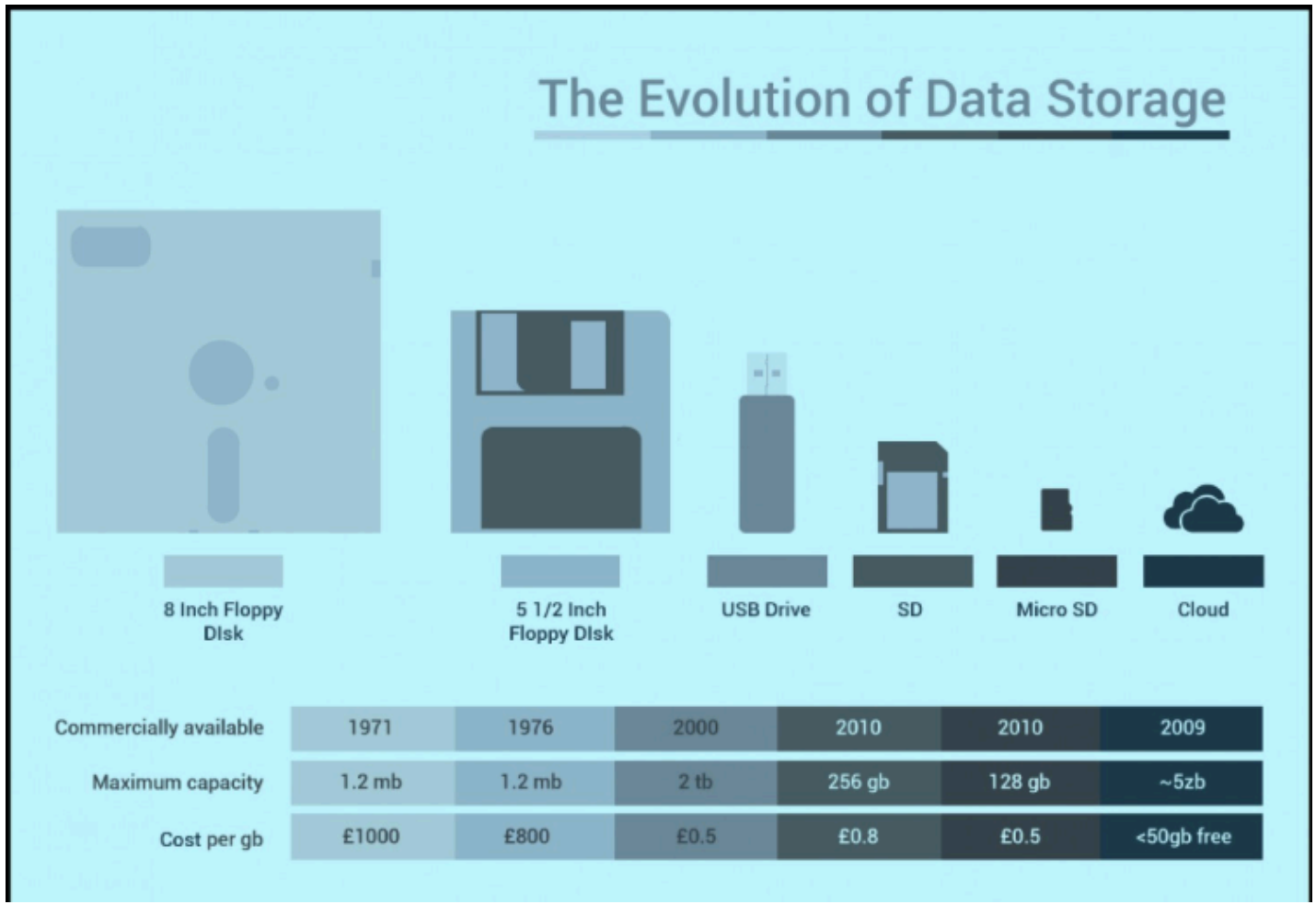
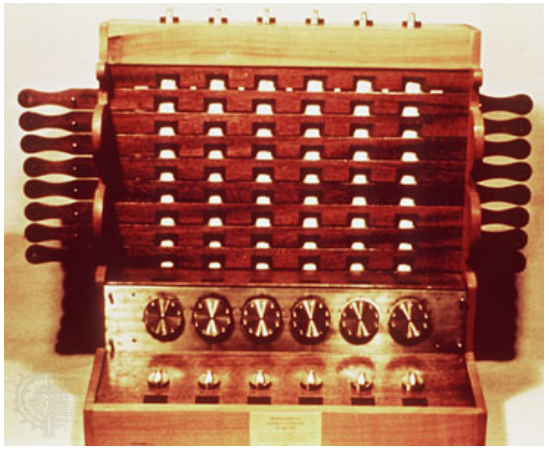


Image source: https://visual.ly/community/infographic/technology/evolution-data-storage

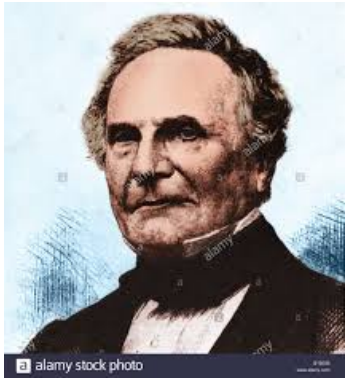
Generation Zero: Mechanical Calculating Machines (1642- 1945)

- **Wilhelm Schickard (1592 – 1635):** The Calculating clock- add and subtract numbers up to 6 digits
- **Blaise Pascal (1623 – 1662):** Pascaline in 1642 - addition with carry and subtraction
- **Gottfried Wilhelm von Leibniz (1646 – 1716):** Stepped Reckoner - add, subtract, multiply and divide
- *none could be programmed, had no memory

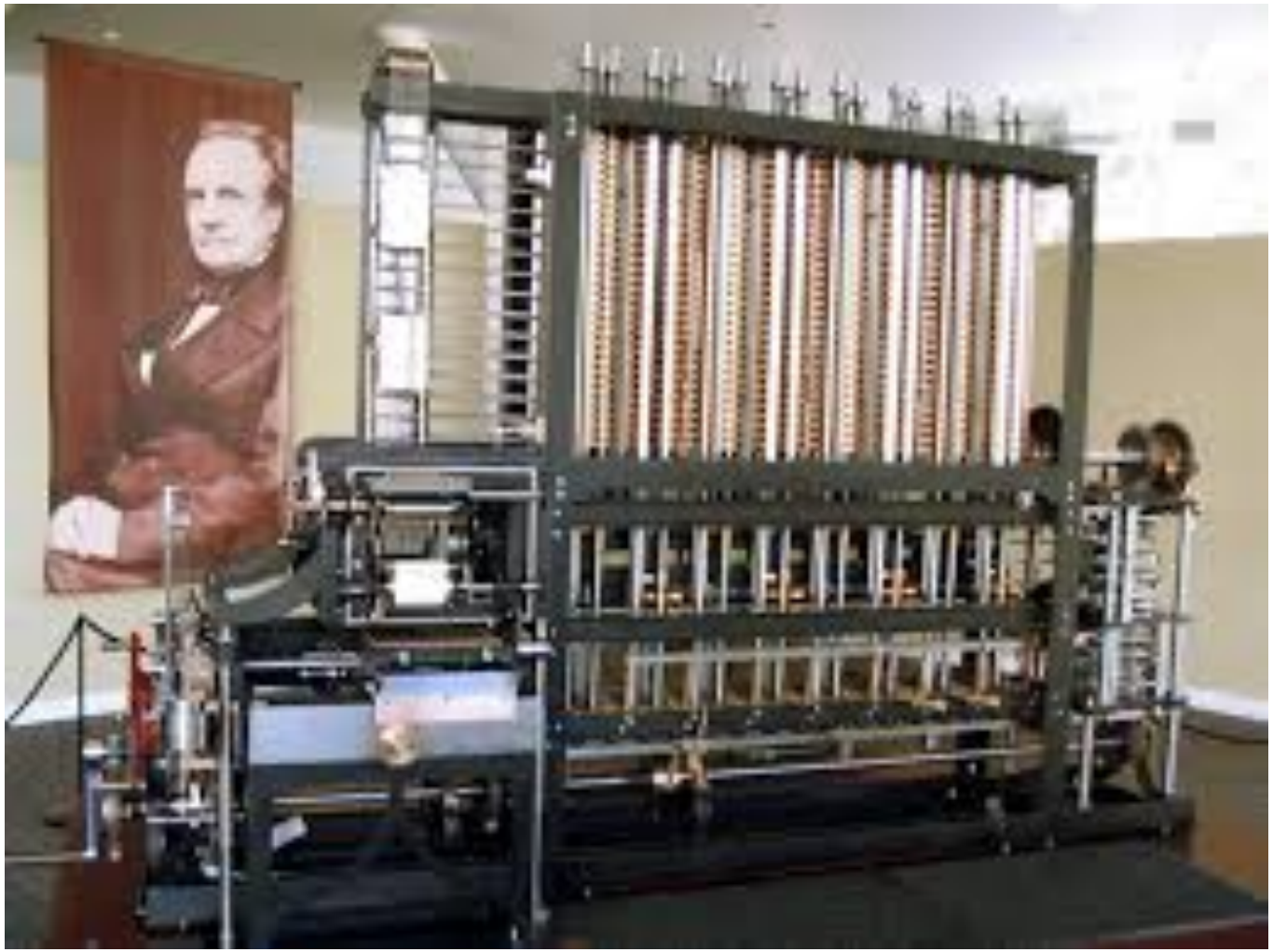


Generation Zero

- Charles Babbage (1791 – 1871) : “father of computing”
- Built difference engine in 1872: mechanized solution of polynomials
- Designed Analytical Engine: capable of performing any mathematical calculation
- Died before it could be built
- It had basic building blocks of computer: arithmetic processing unit(the mill), a memory (store), I/O devices
- Used a punch card system for input and programming
- Ada (countess of Lovelace) suggested Babbage write a plan for how the machine would perform calculations : First computer program



Difference Engine



First Generation: Vacuum Tube Computers (1945- 1953)

- Konrad Zuse (1910 – 1955): The Z1 computer
- Improved Babbages design
- Used electromechanical relays instead of hand cranked gears
- Programmable, had memory, arithmetic unit and a control unit
- Designed to use vacuum tubes

but he could not afford them

https://en.wikipedia.org/wiki/File:Zuse_Z1-2.jpg

First Generation: Vacuum Tube Computers (1945- 1953)

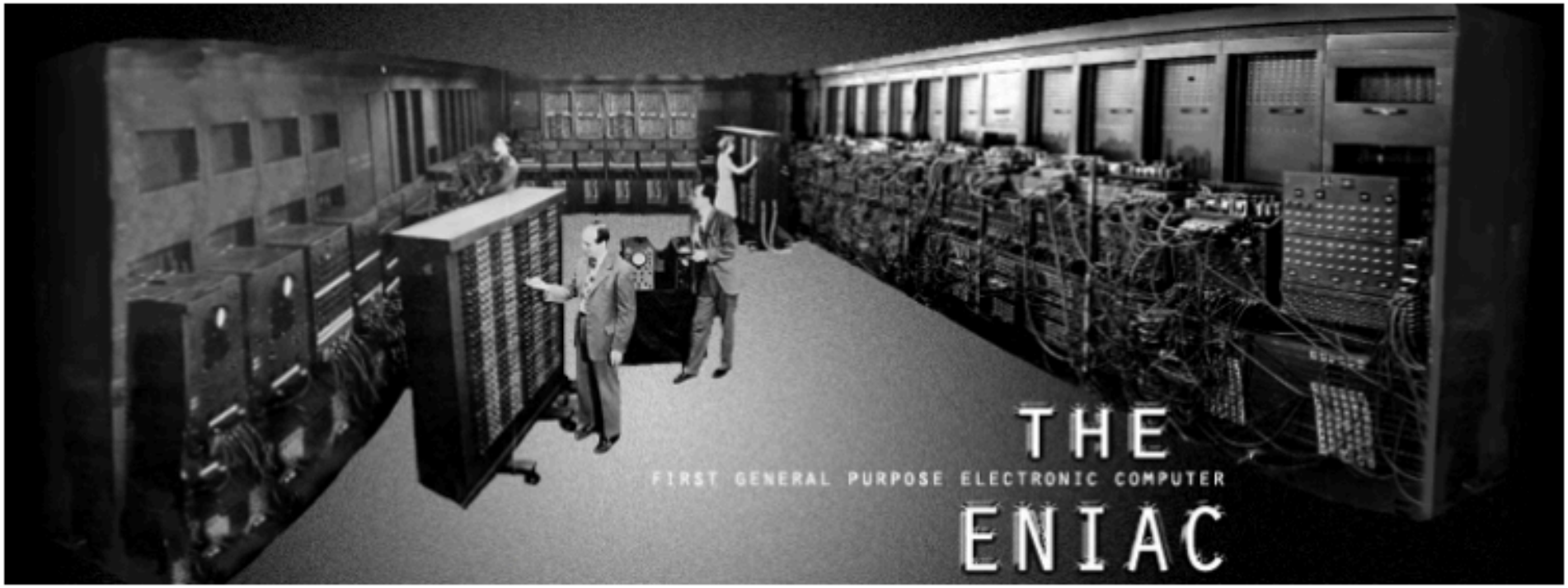
- Digital computers really took off in the 1930s and 40s
- John Atanassoff (1904 -1995) credited with building first completely electronic computer: The Atanassoff Berry Computer (ABC)

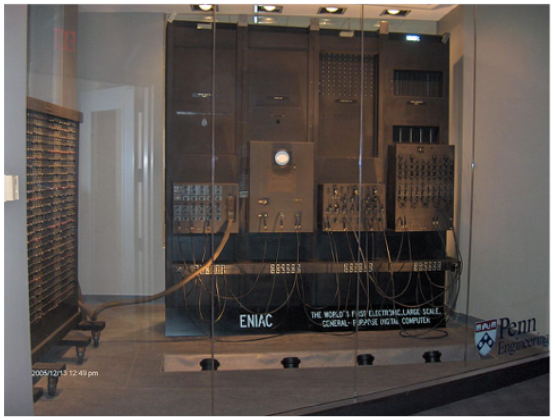
- Binary machine built from vacuum tubes
- Specifically developed to solve systems of linear equations: cant be called a general purpose computer
- There were some similarities with the ENIAC however: led to several controversies concerning patents and credits

The ENIAC

- Electronic Numerical Integrator and Computer
- John Mauchly (1907-1980) and J Presper Eckert (1929 -1995)
- Introduced to public in 1946
- First all electronic, general-purpose digital computer
- 17,468 vacuum tubes, occupied 1800 square feet of floor space, weighed 30 tons and consumed 174 kilowatts of power
- Memory capacity of 1000 information bits (about 20 10-digit decimal numbers)
- Used punch cards to store data

THE ENIAC





For more info: http://eniacprogrammers.org/

Second Generation: Transistorized Computers (1954-1965)

- Followed development of the transistor: Circuitry smaller and more reliable because transistors were smaller, more reliable and consumed less power
- 2G computers still bulky and very expensive
- Many computer makers emerged e.g. IBM, Univac, DEC marketing different computers e.g. the 7094 and 1401, 1100 ,PDP
- CDC built the worlds first super computer the CDC 6600

IBM 7094

CDC 6600

Third Generation: Integrated Circuit Computers (1965 – 1980)

- Real explosion in computer development
- Dozens of transistors could be made on a single chip
- Faster, smaller and cheaper computers increasing processing power
- IBM System /360 was first commercially available system built from solid state devices
- All computers in this line used same assembly language enabling users to upgrade their computers without rewriting all their software
- IC usage also introduced multiprogramming (use of a single computer by multiple people at a time)

IBM 360

Image source: ibm.com

Fourth Generation: VLSI computers: (1980 onwards

- VLSI: more than 10,000 components per chip
- Intel created first microprocessor, the 4004: 4-bit system that run at 108 KHz and the RAM chip accommodating 4 kilobits of memory on a single chip
- Microcomputers developed: The Altair 8800, Apple I and Apple II, PET, Vic 20 and finally in 1981 IBM's PC

Image source: wikipedia

Altair 8800 Apple I Apple II IBM PC

Fifth Generation??

- What will mark the 5th generation?
- Parallel processing? Quantum computing? Neural networks? Optical computing systems? Artificial Intelligence?
- Or have we already surpassed the fifth generation?
- What do you think?

Moore's Law and Rock's Law

- How far can miniaturization go?
- *The density of transistors in an IC will double every year* - Moore's Law: currently the density of silicon chips doubles every 18 months
- But with current technology it cant hold forever: physical and financial constraints. Cost may ultimately dictate
- *The cost of capital equipment to build semiconductors will double every four years* - Rock's law: cost of new chip facilities has escalated from USD 12,000 to USD 3 billion in 2005!
- Both on a collision course

Moore's Law/ Computer Evolution

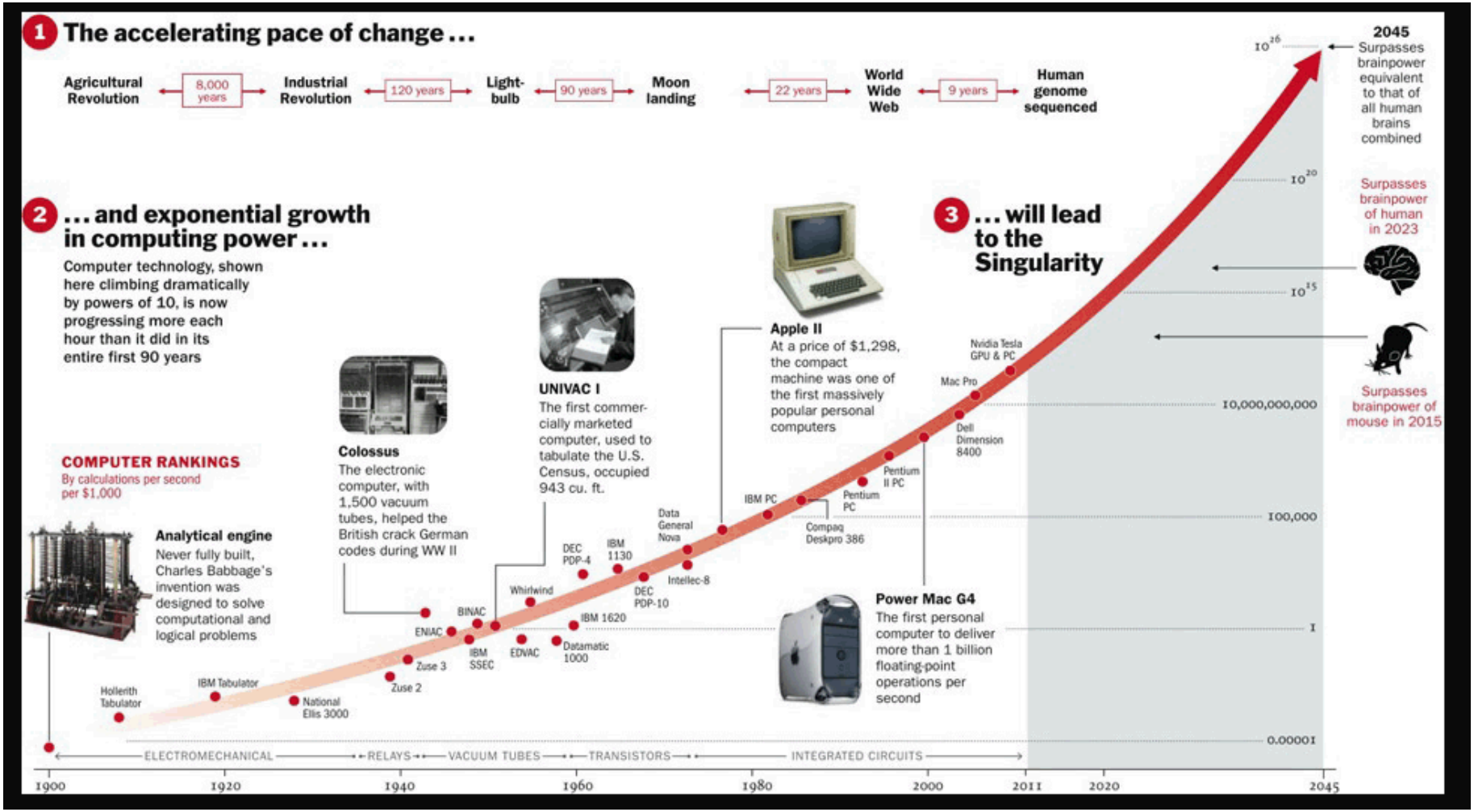


Image source: https://humanswlord.files.wordpress.com/2014/01/moores-law-graph-gif.png

References/ Further Reading

- Linda Null, Julia Lobur, “The Essentials of Computer Organization and Architecture” , 4 ed, chapter 1.
- William Stallings, Computer Organization and Architecture, 9th Ed. , chapter 0 - 2.1