Dispositivi di calcolo I

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computing

What do we mean with computing?

The term *computing* comes from the Latin *computare*.
A word, composed by the union of *cum* (with) and *putare* (to evaluate in quantitative sense).

Together they mean to “evaluate quantitatively things”, strict synonymous of *calculating*, another Latin originated word that we will consider later on. So, based on this understanding, we could say that computing something has to do with dealing with the **quantitative aspects of things.**

A number represents a feature of specific properties of ensembles of things.

For example: a bunch of cookies in a basket comes with some properties. They are sweet, they may be warm or cold, they may be light or heavy, they may be few or many. These properties are evaluated here qualitatively but, if we want to be more precise we could specify how much these properties are in place.

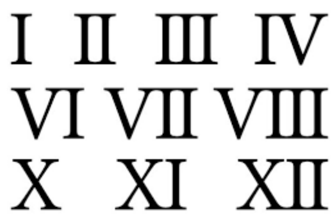
Computing with devices

Fingers, stones, writing…

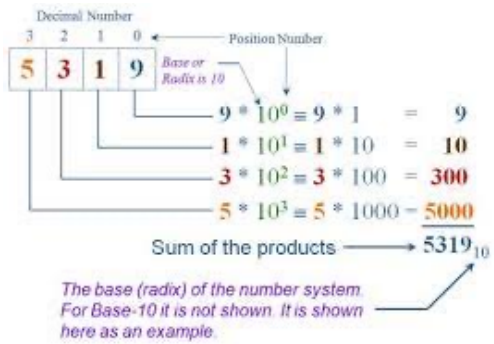
One simple solution, instead of using fingers, is to use small stones. Small stones can come in large quantities, are available for free and can be easily carried around. They can be employed very much like fingers, by associating a stone to each unit that we want to count. By accumulating stones into a basket, we can promptly count cookies, sheep, and all sort of ensembles.

Numeration systems

By looking at the general features of numeration systems we can identify two main classes: positional and non-positional systems. A good example of non-positional system is the Roman numeration.



Positional number system. The role of «0».



Computing with devices

Slide rule

Non è degno di uomini eccellenti perdere ore come schiavi e faticare su calcoli che potrebbero essere affidati a chiunque se venissero usate le macchine.

Gottfried Wilhelm Leibnitz

Describing, in 1685, the value to astronomers of the hand-cranked calculating machine he had invented in 1673.

Che cos'è un computer?

Computer = Calcolatore (dal latino *computare*)

A computer is a machine that performs automatically some calculations.

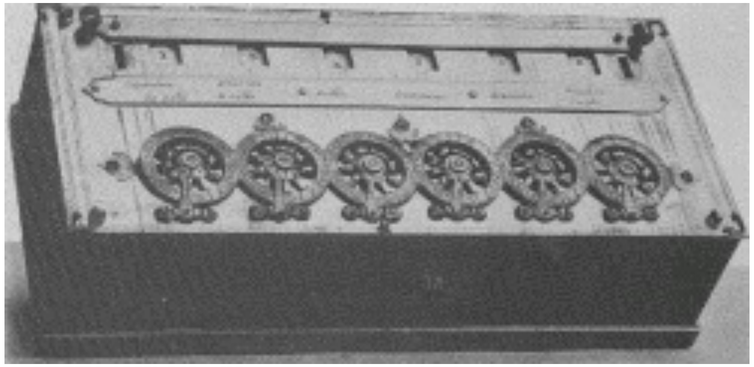
a computer is a **device** that processes information, entered in the form of **numerical data** in order to achieve a result whose achievement is obtained through a sequence of **preordained operations**.

Different kind of computers

Nome	**Dimensioni fisiche**	**costo**
Supercomputer	10 m	10^6 €
Mainframe	2 m	10^5 €
Workstation	1 m	10^4 €
PC	3 10^{-1} m	10^3 €
Palmare	10^{-1} m	10^2 €
Embedded Computer	10^{-2} m	10 €
Wireless sen-sors	10^{-4} – 10^{-3} m	10^{-1} €

When was the computer born?

First attempts to build calculating machines in the 1600s

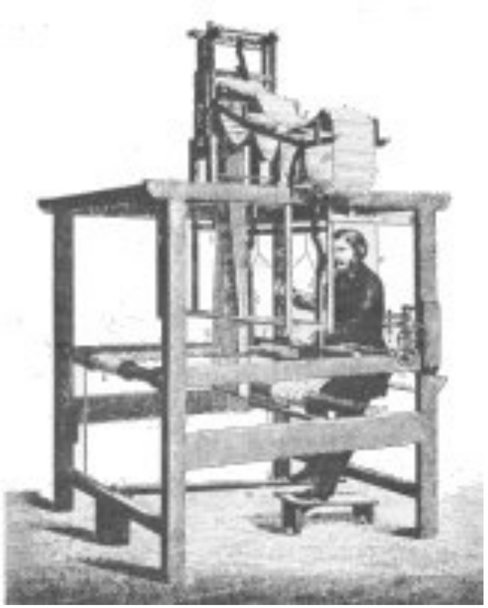


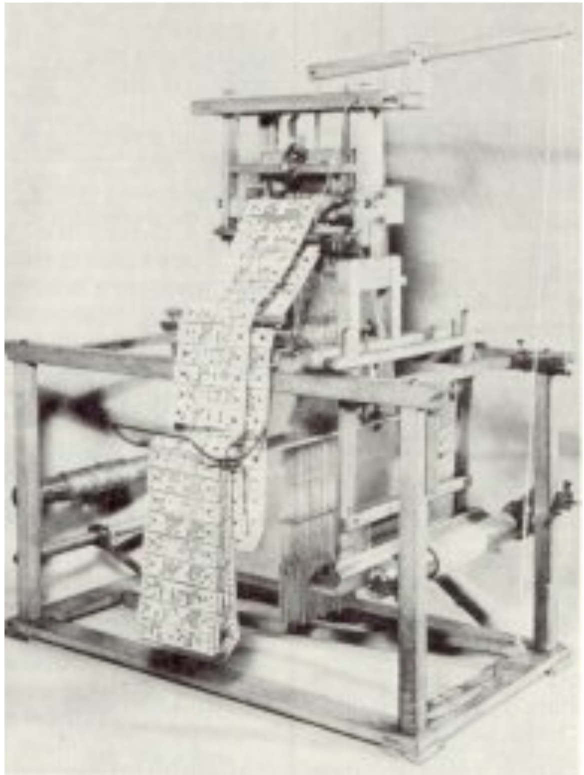
B. Pascal, 1642, la "Pascalina"

1674 Leibnitz, improves the *Pascalina*

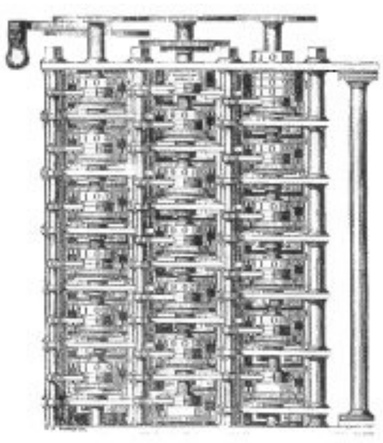
Jaquard (1800)

1801 the automatic loom (telaio)





Charles Babbage (1791-1871)



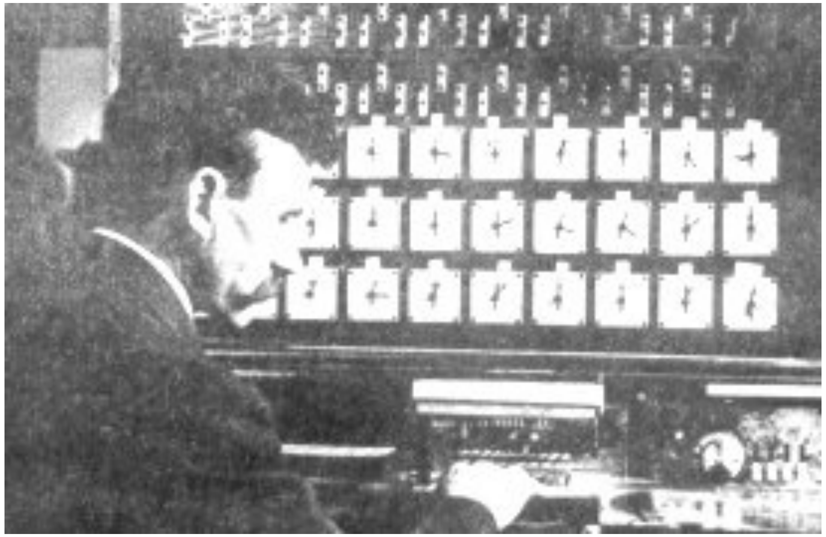
"*Analytical Engine*"

1) "input"
2) "output"
3) "store" (magazzino)
4) "mill" (macina - proc.)
5) " schede-istruzioni "

Ada Lovelace (1815-1852)

" Our analytical machines weave designs algebraic like Jacquard looms they weave their designs onto the cloth "

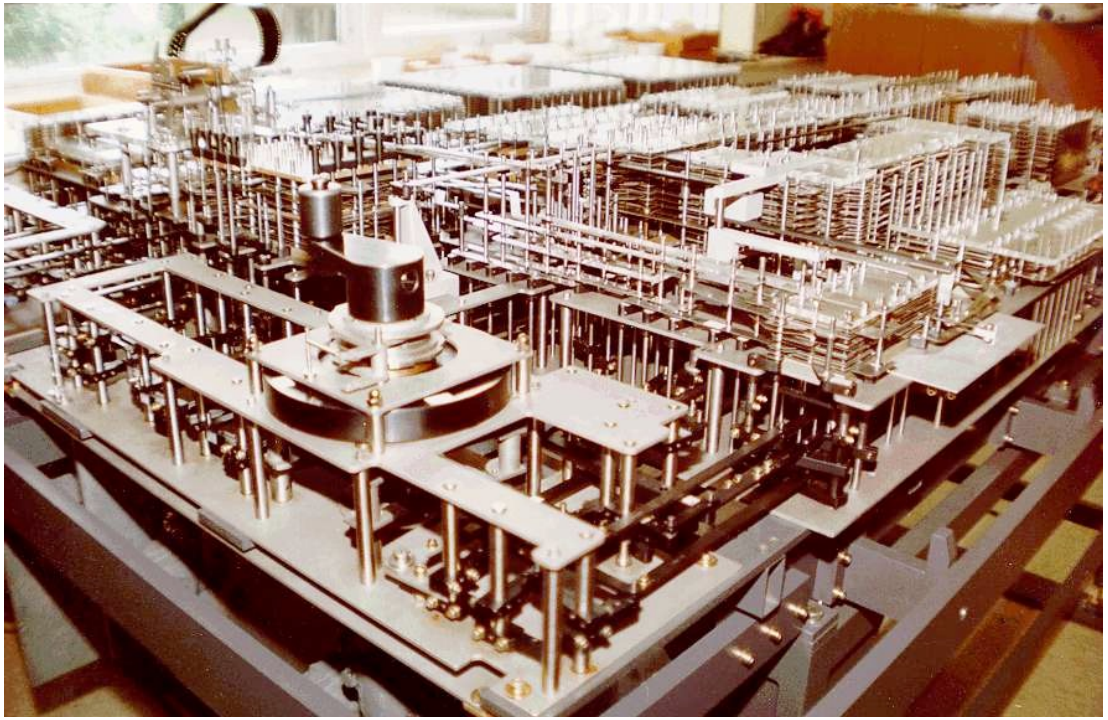
Hollerith (1890)



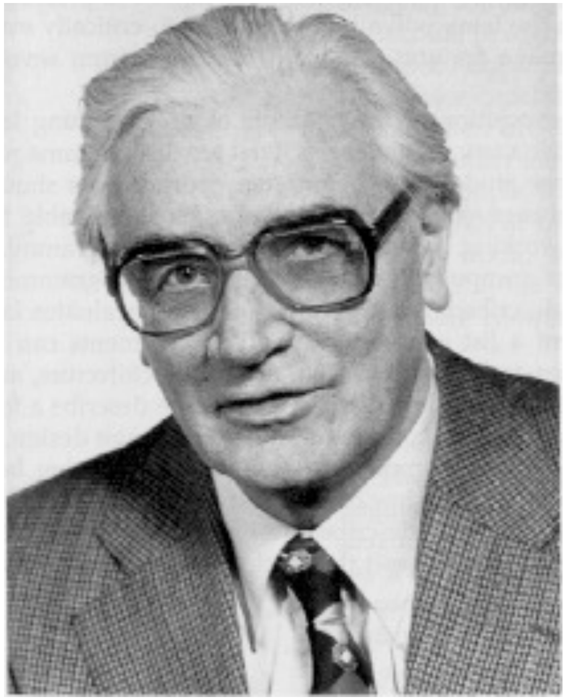
”*Censimento negli Stati Uniti*"

ENIAC 1946 17.000 valvole elettroniche,
i suoi 10.000 condensatori, 70.000 resistori

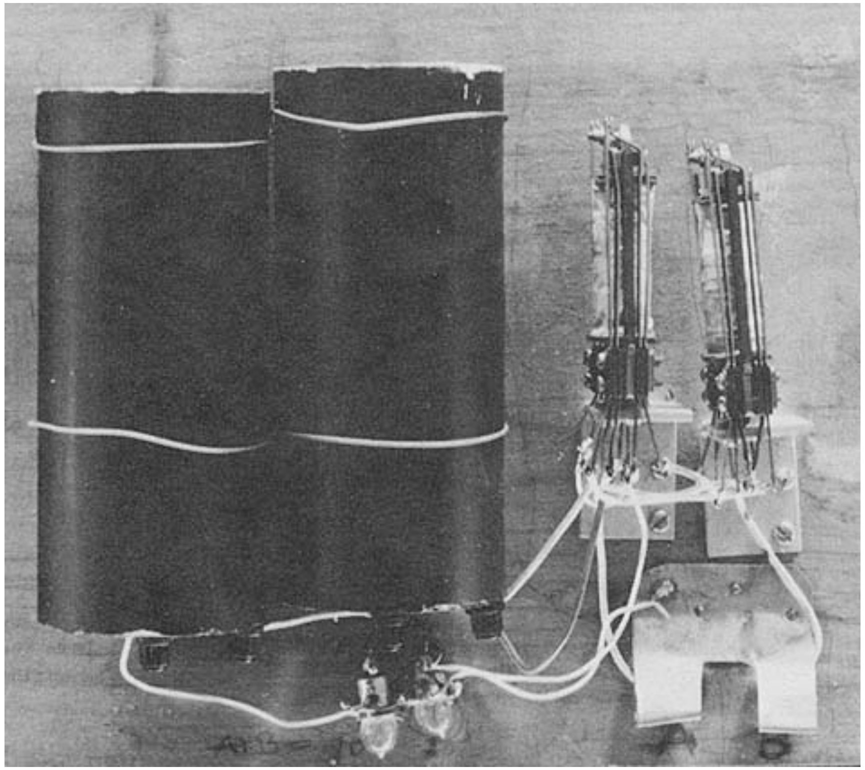
(1930-1940) *Konrad Zuse*



Perforated belt machine

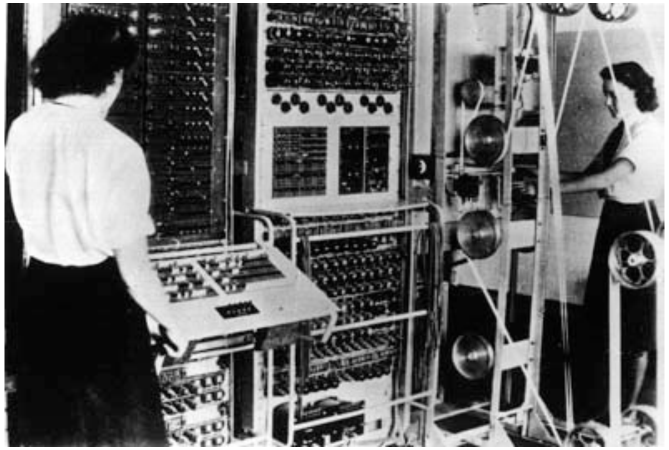


George R. Stibitz (1940)

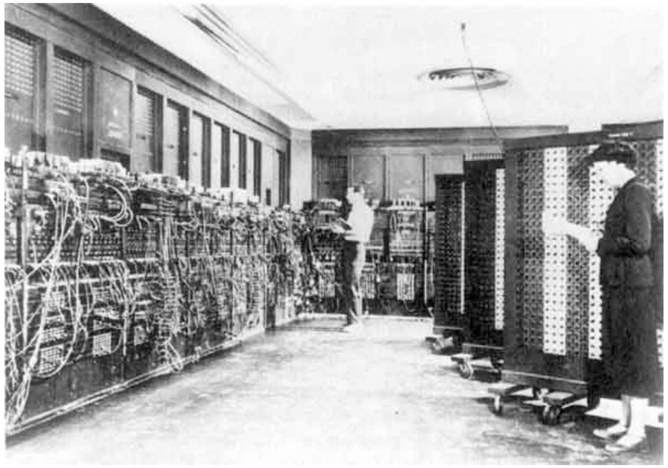


Computer con relè e lampadine

Alan Turing (1940-1954)

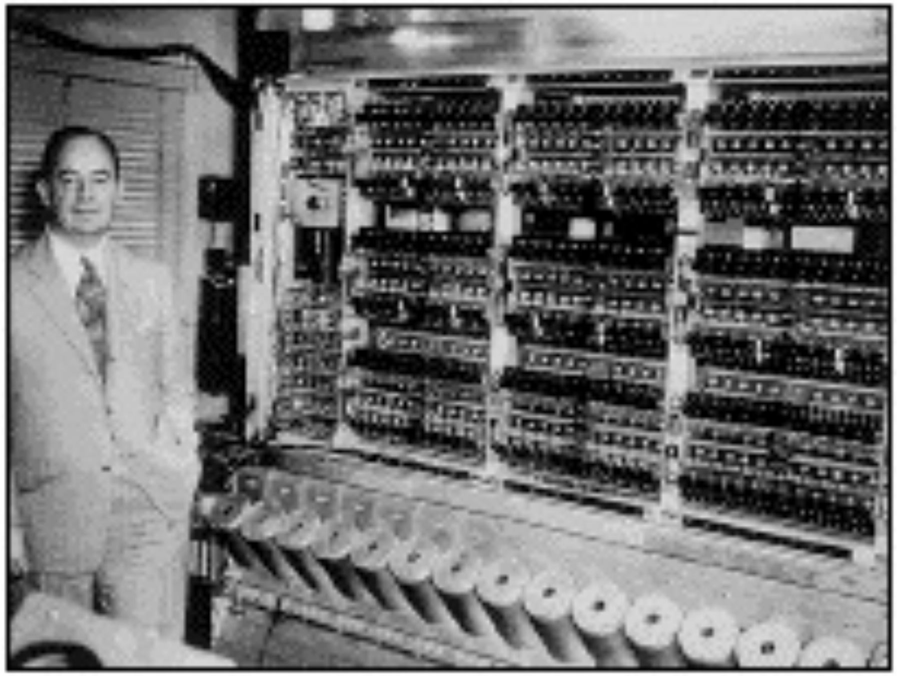


Colossus 1944



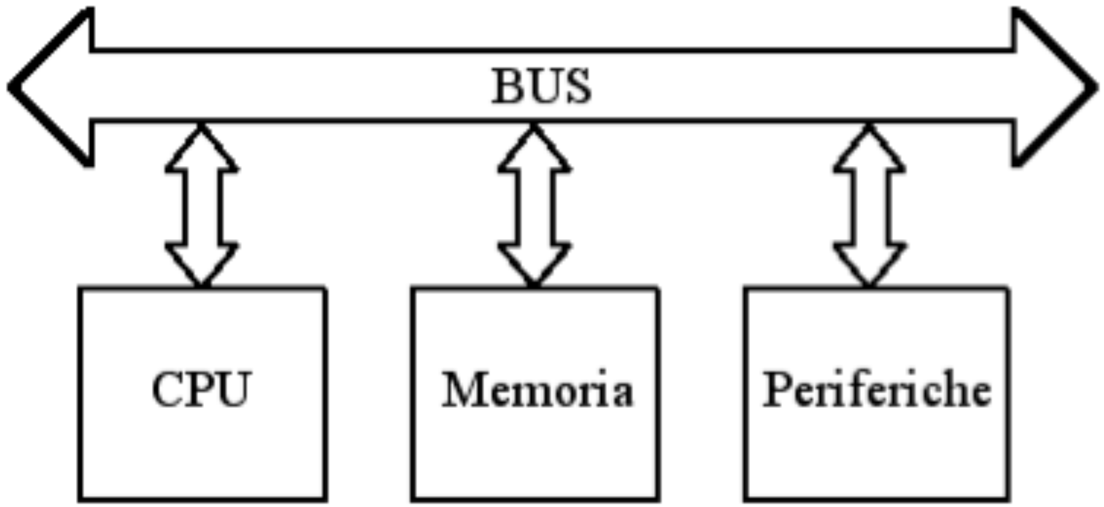
ENIAC

John Von Newman (1903-1957)



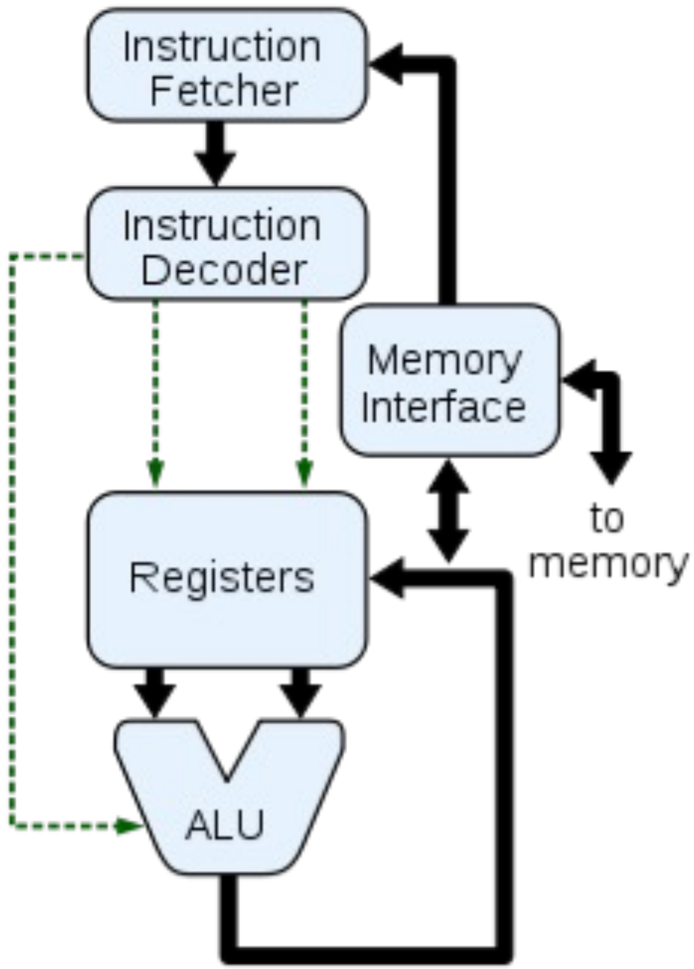
If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is.

Von Newman (1944)

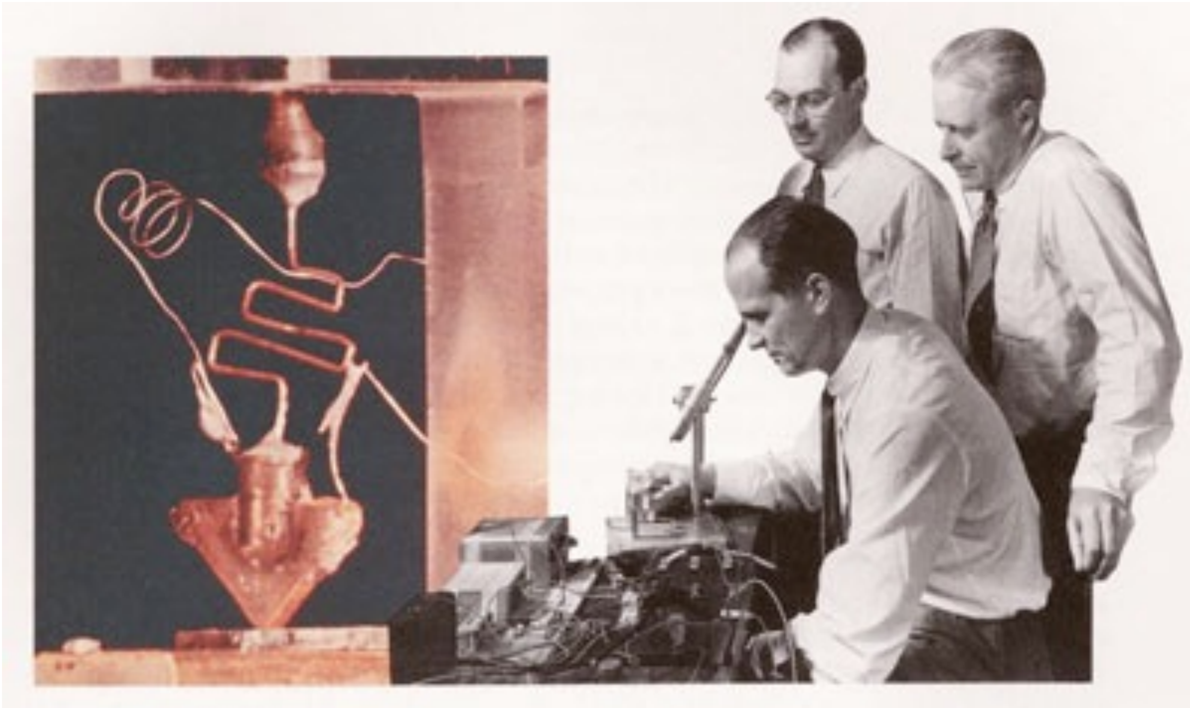


CPU

- Control Unit
- Arithmetic Logic Unit (ALU)
- Registers



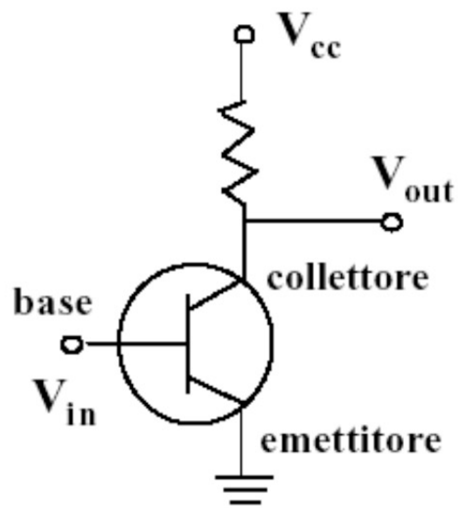
The first transistor (1947)



1944 (Bardeen, Brattley e Shotky)

Basic functioning of a transistor

Se $V_{in} > 0.5V$ allora $V_{out} = 0$ V
Se $V_{in} < 0.5V$ allora $V_{out} = 5$ V

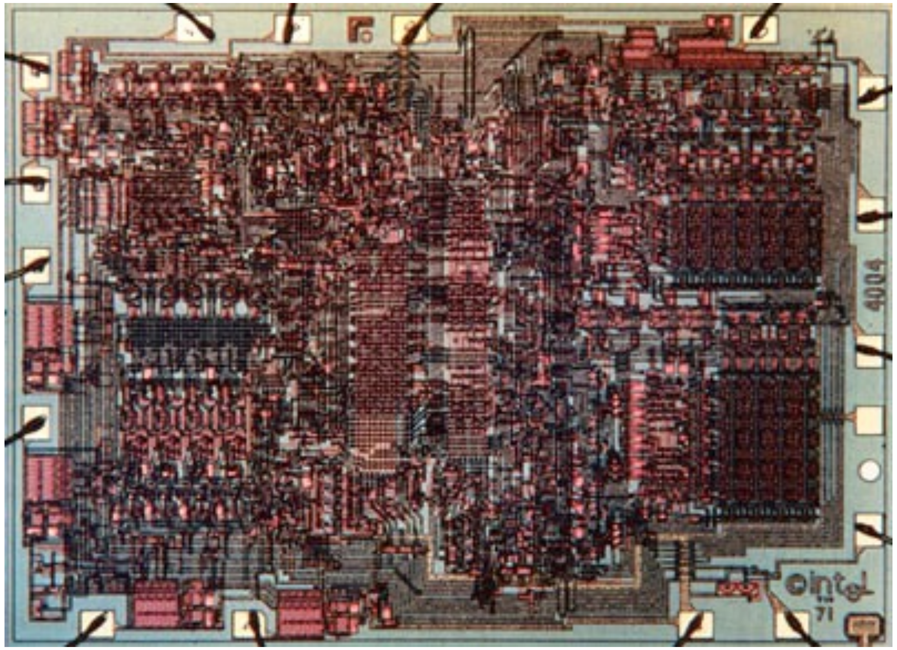


The first electronic computer IBM (1952)

IBM 701

Microprocessor (1971....)

Intel 4004, 8 bit, Federico Faggin



Il Personal Computer (1976....)

1976: Apple Computer Co. Comes Into Existence

Desires and physical limits

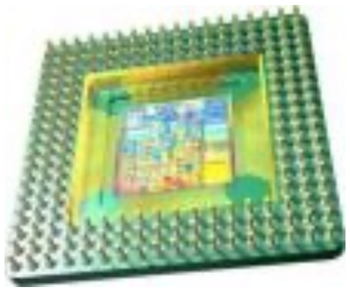
Microprocessors:

Physical limits to miniaturization ?

Physical limits to computing speed ?

Physical limits to energy dissipation ?

Microprocessors



Microprocessors

1971

Tre ingegneri elettronici della Intel, tra cui l'italiano Federico Faggin, inventano il microprocessore, un pezzetino di silicio capace di contenere centinaia (migliaia, milioni) di transistor.

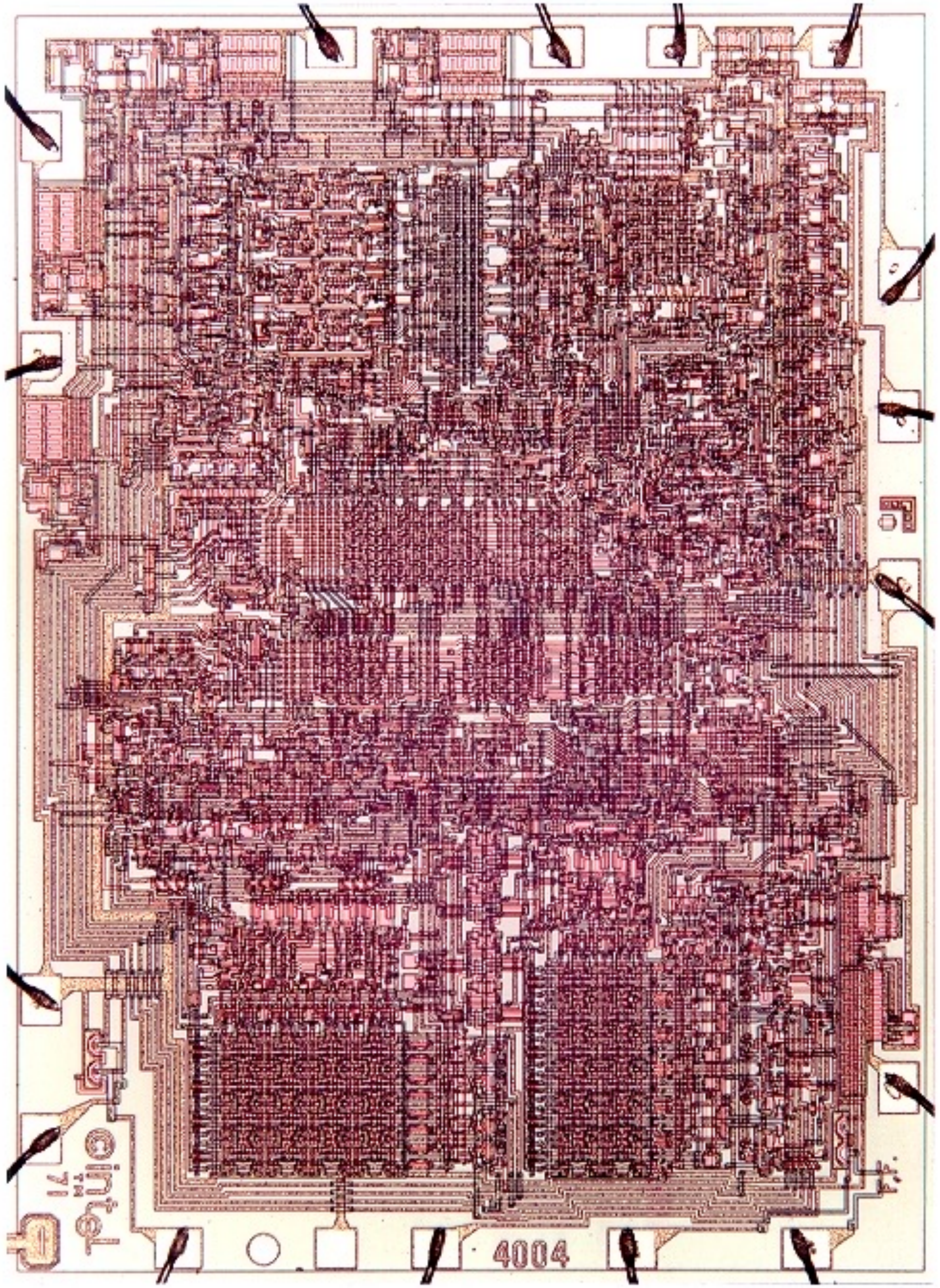
Alla produzione della Intel si affianca quella della Texas Instruments negli USA e presto di altre aziende in Giappone.

Ref: http://www.intel.com/education/mpworks/intro.htm

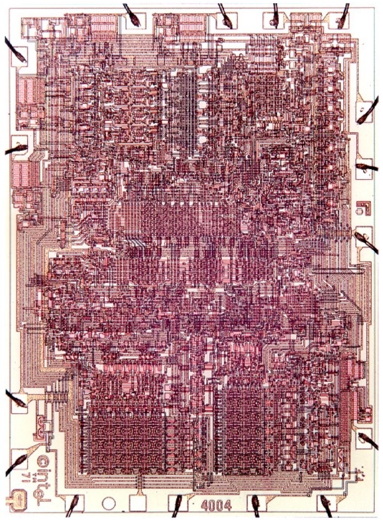
Intel 4004

1971

2,250 transistor Clk freq. 108 kHz



Microprocessore



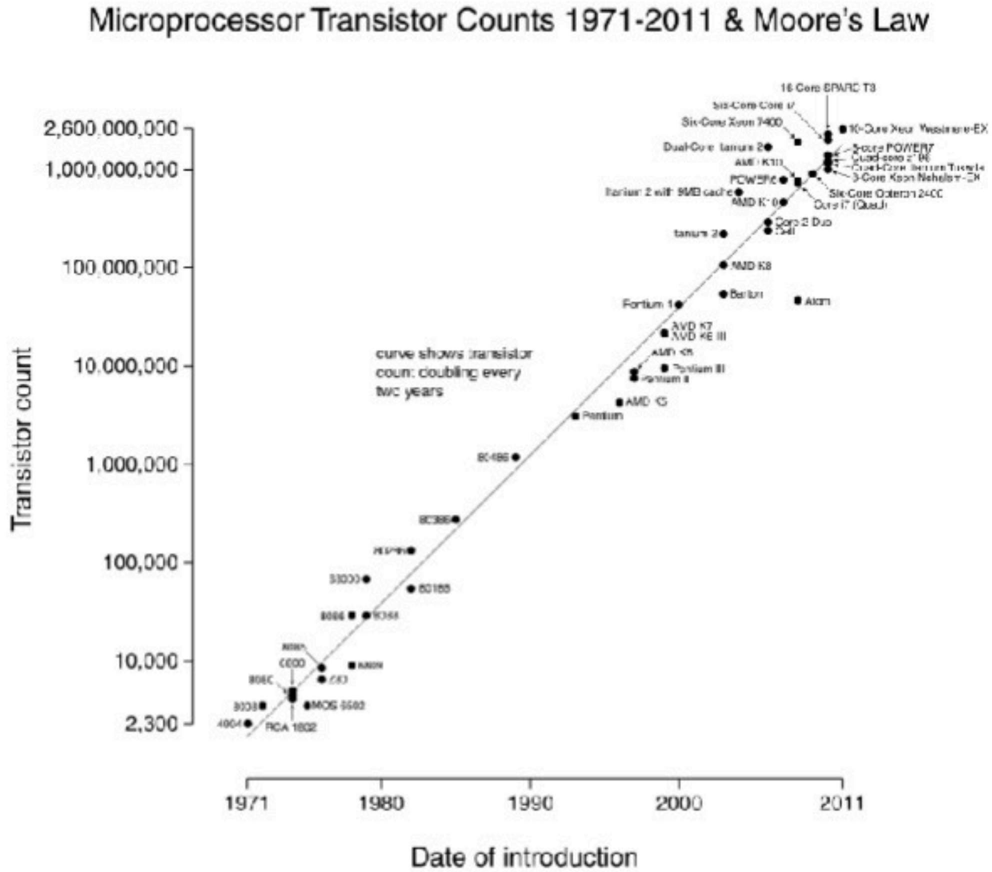
2000 - Pentium IV
42.000.000 transistors
Clk freq. 1,5 GHz

Microprocessore

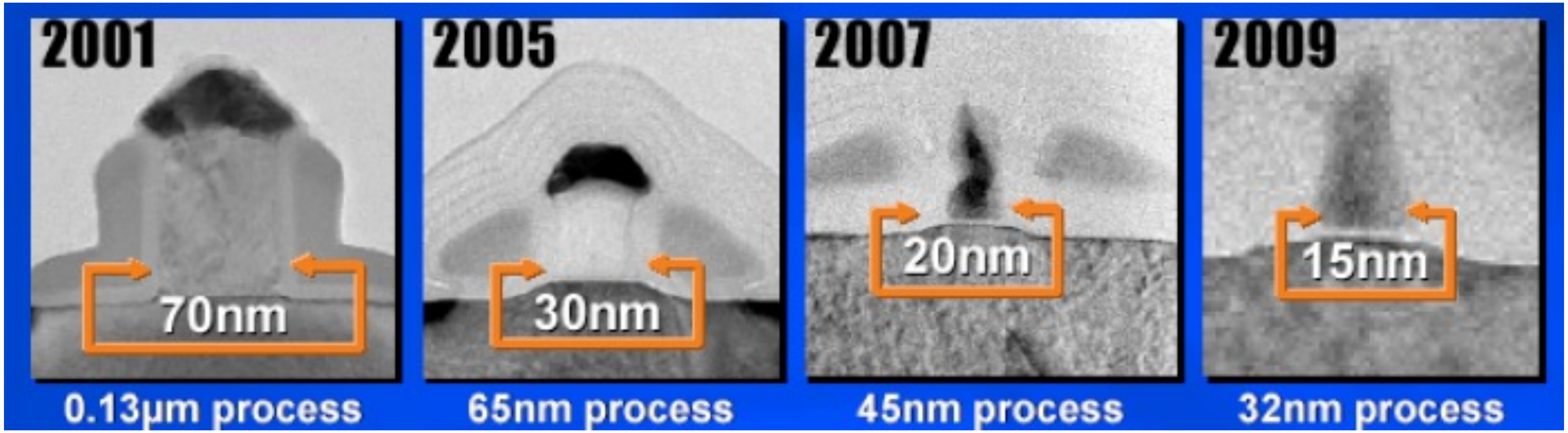
Processor	Transistor count	Date of introduction	Manufacturer	Process	Area
SPARC M7	>10,000,000,000	2014	Oracle	20 nm	
Intel 4004	2,300	1971	Intel	10 µm	12 mm²
Intel 8008	3,500	1972	Intel	10 µm	14 mm²
MOS Technology 6502	3,510[1]	1975	MOS Technology	8 µm	21 mm²
Motorola 6800	4,100	1974	Motorola	6 µm	16 mm²
Intel 8080	4,500	1974	Intel	6 µm	20 mm²
RCA 1802	5,000	1974	RCA	5 µm	27 mm²
...					
8-core Xeon Nehalem-EX	2,300,000,000[19]	2010	Intel	45 nm	684 mm²
10-core Xeon Westmere-EX	2,600,000,000	2011	Intel	32 nm	512 mm²
Six-core zEC12	2,750,000,000	2012	IBM	32 nm	597 mm²
Apple A8X (tri-core ARM64 "mobile SoC")	3,000,000,000	2014	Apple	20 nm	
8-core Itanium Poulson	3,100,000,000	2012	Intel	32 nm	544 mm²
12-core POWER8	4,200,000,000	2013	IBM	22 nm	650 mm²
15-core Xeon Ivy Bridge-EX	4,310,000,000[20]	2014	Intel	22 nm	541 mm²
62-core Xeon Phi	5,000,000,000	2012	Intel	22 nm	
Xbox One main SoC	5,000,000,000	2013	Microsoft/AMD	28 nm	363 mm²

Moore’s law - 1965

Moore's law is the observation that, over the history of computing hardware, the number of transistors in a dense integrated circuit doubles approximately every two years



Transistors dal vero



Da "Alcune riflessioni sulla legge di Moore", Roberto Saracco, Future Center, TILAB

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Physical limits of silicon transistors and circuits

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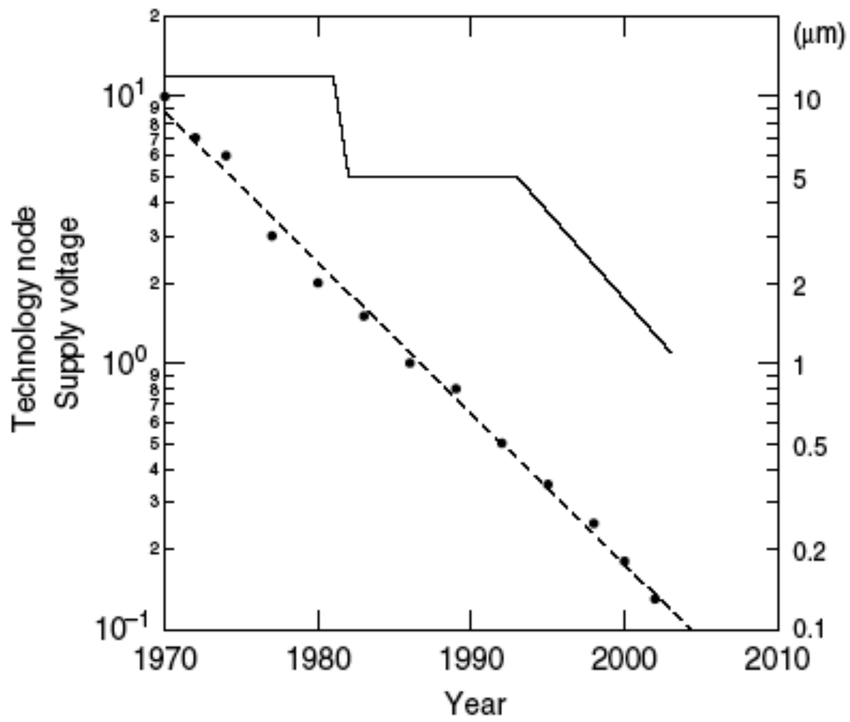
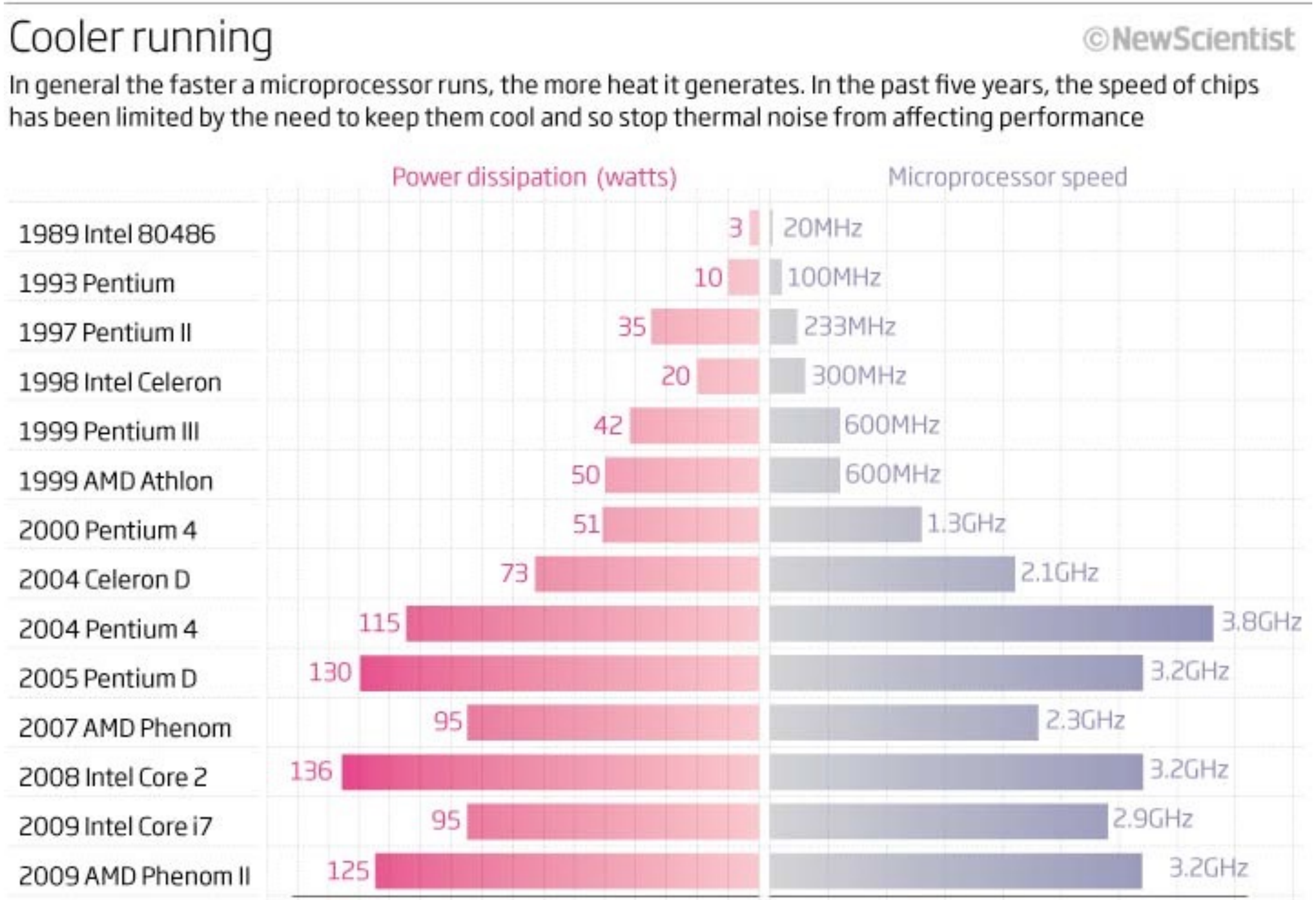


Heat generation problem



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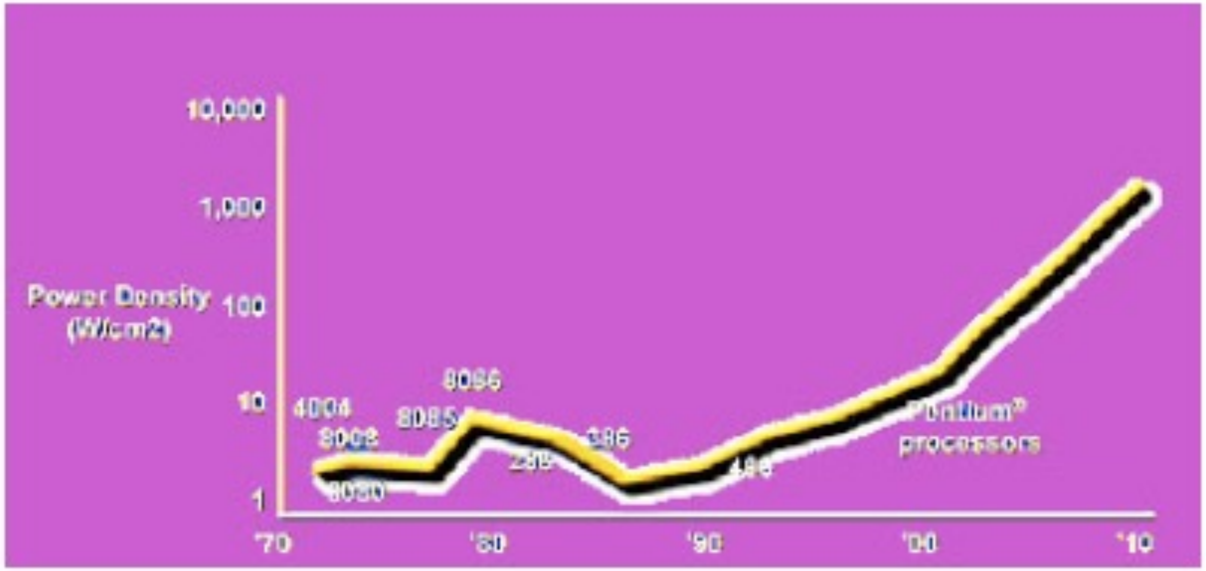

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