CSE 333 – Operating Systems Introduction

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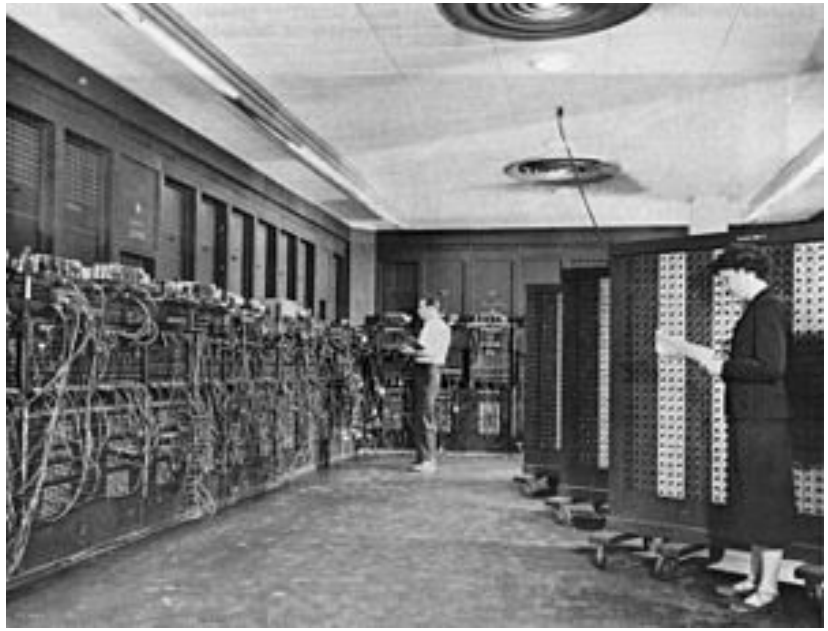
The First General Purpose Programmable Electronic Computer: ENIAC

- ENIAC: Electronic Numerical Integrator And Computer
- Designed to calculate artillery firing tables
- Estimated Cost: $6.000.000
- Contains
  - 17,468 vacuum tubes,
  - 7,200 crystal diodes,
  - 1,500 relays,
  - 70,000 resistors,
  - 10,000 capacitors, and
  - around 5 million hand-soldered joints.
- Comsumed 150 KW power.



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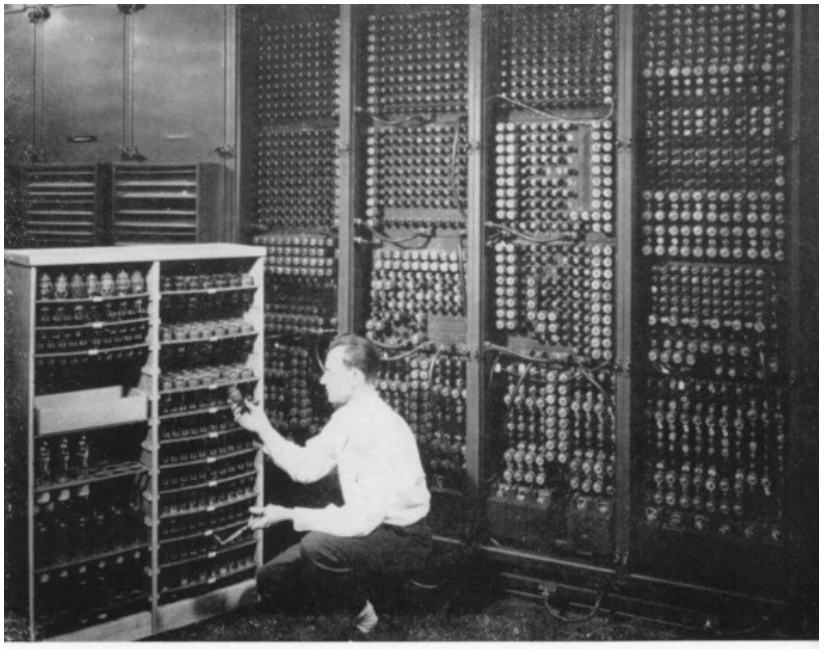
The First General Purpose Programmable Electronic Computer: ENIAC

- Occupied 167 m².
- Weight: more than 27 tons.

- Computational Power:
  - 5.000 addition/substraction (per accumulator),
  - 385 multiplication,
  - 40 division,
  - 3 square root operations per second.

- It had twenty ten-digit signed accumulators which used ten's complement representation.



The First General Purpose Programmable Electronic Computer: ENIAC

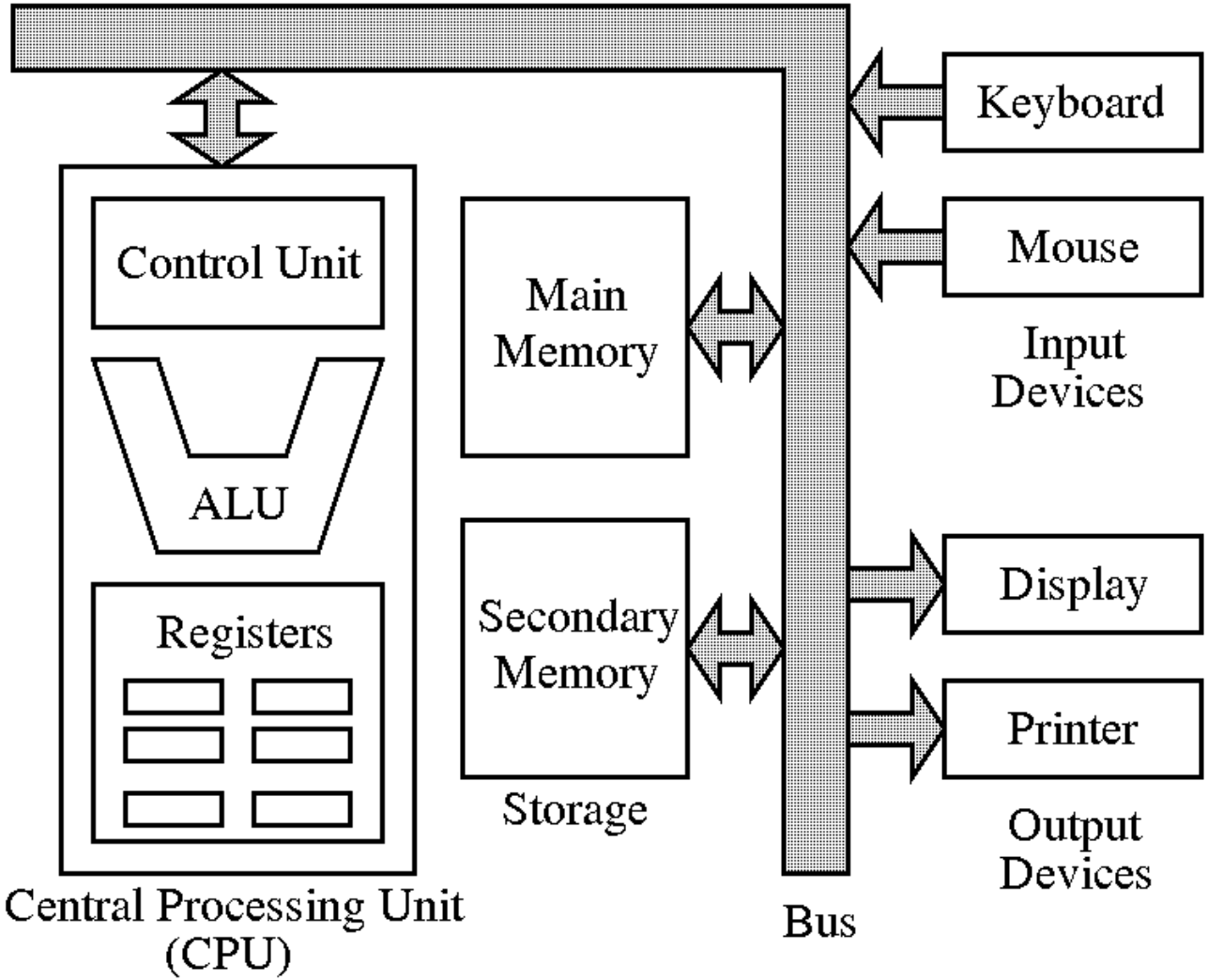
- It was being programmed by six ladies.
- The process of getting the program into ENIAC was by manipulating its switches and cables.
- The task of taking a problem and mapping it onto the machine was complex, and usually took weeks.

Von Neumann Architecture (Stored Program Computer)

- Proposed by Hungarian scientist John von Neumann'ın in 1945.

- A stored-program computer includes by design an instruction set and can store in memory a set of instructions (a program) and a set of data.

Von Neumann Architecture

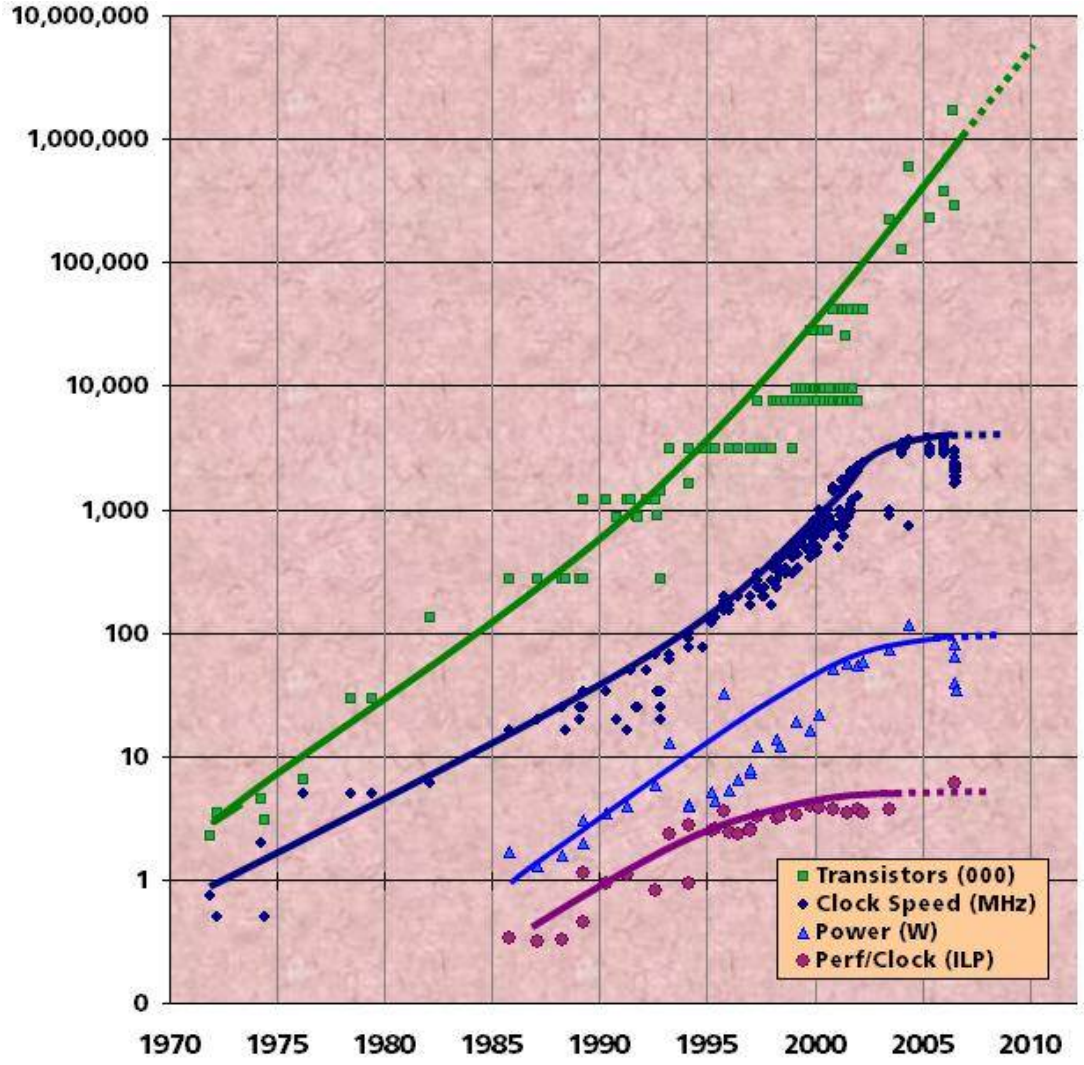


Integrated Circuits and the Moore's Law

- Boost in the computational power: Invention of
  - the first silicon based transistor in 1954,
  - the first integrated circuit in 1958.

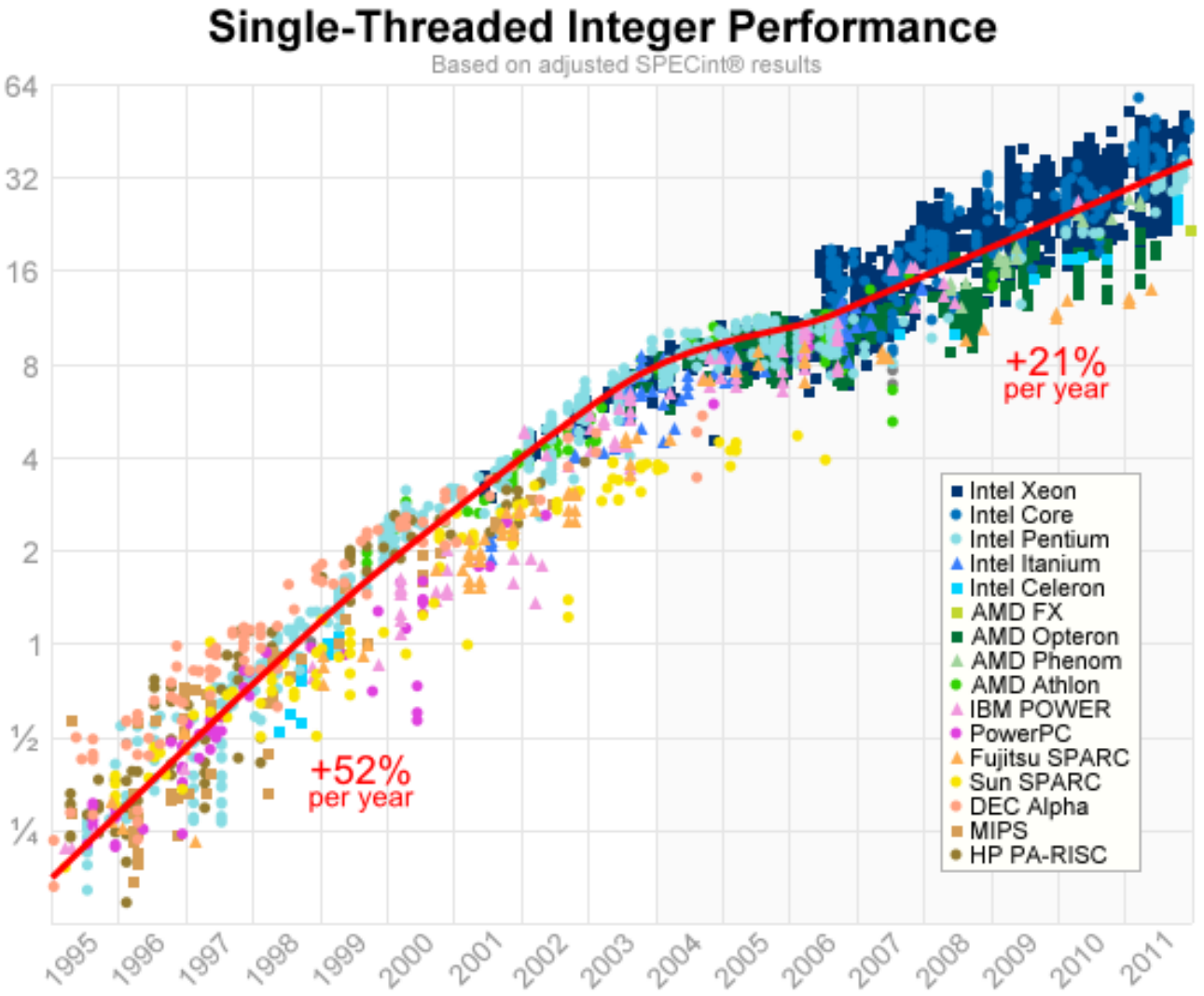
- In the 1965 paper of the co-founder of the Intel Corp, Gordon E. Moore:
  - "The number of transistors (the circuit elements) that can be placed on integrated circuits economically will be doubled in every two years".

Moore's Law and CPU Frequency Trend

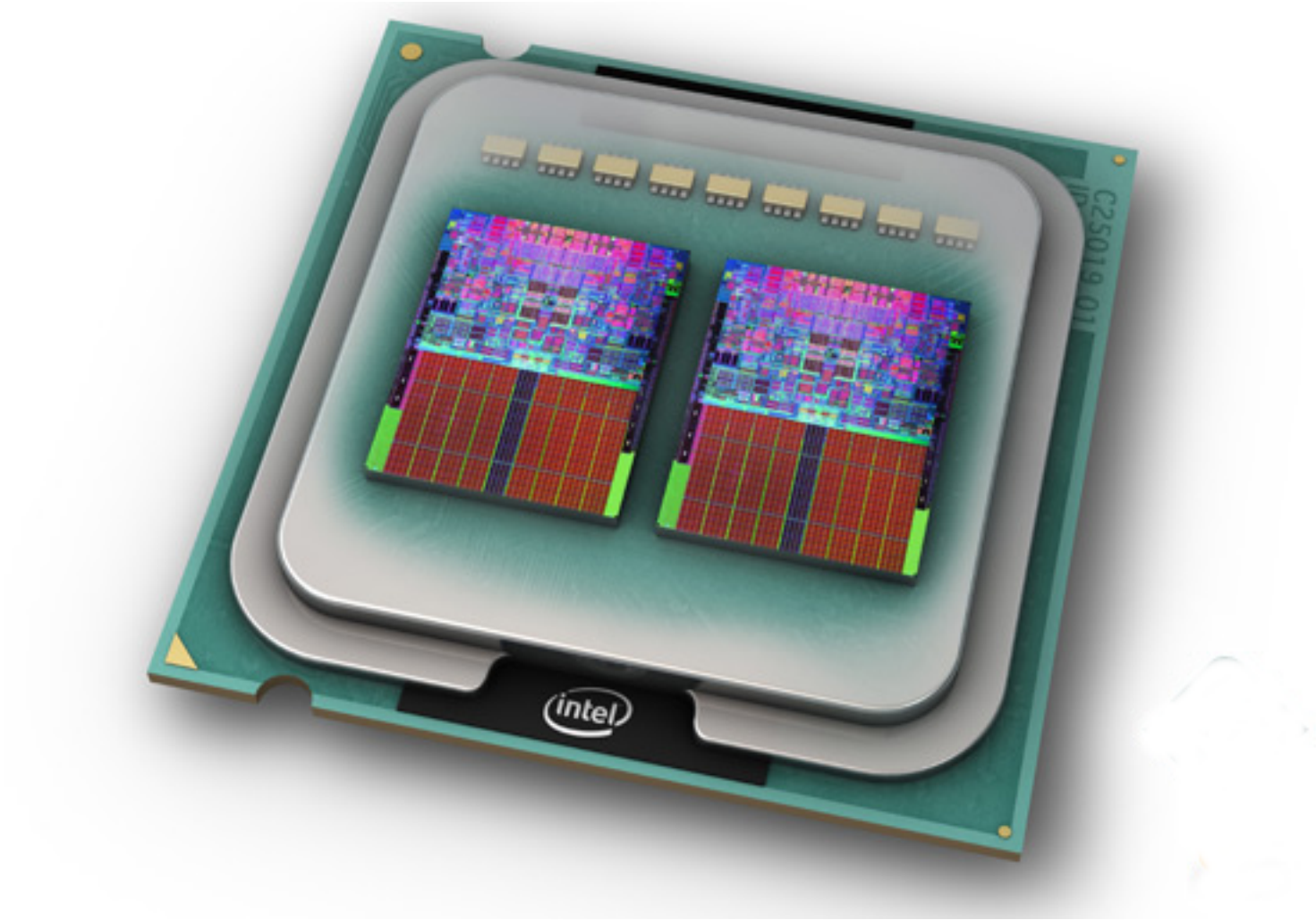


Semiconductor Fabrication Technology
•10 µm — 1971
•3 µm — 1975
•1.5 µm — 1982
•1 µm — 1985
•800 nm — 1989
•600 nm — 1994
•350 nm — 1995
•250 nm — 1997
•180 nm — 1999
•130 nm — 2002
•90 nm — 2004
•65 nm — 2006
•45 nm — 2008
•32 nm — 2010
•**22 nm** — 2012
•14 nm — est. 2015
•10 nm — est. 2017
•7 nm — est. 2020
•5 nm — est. 2022

CPU Performance

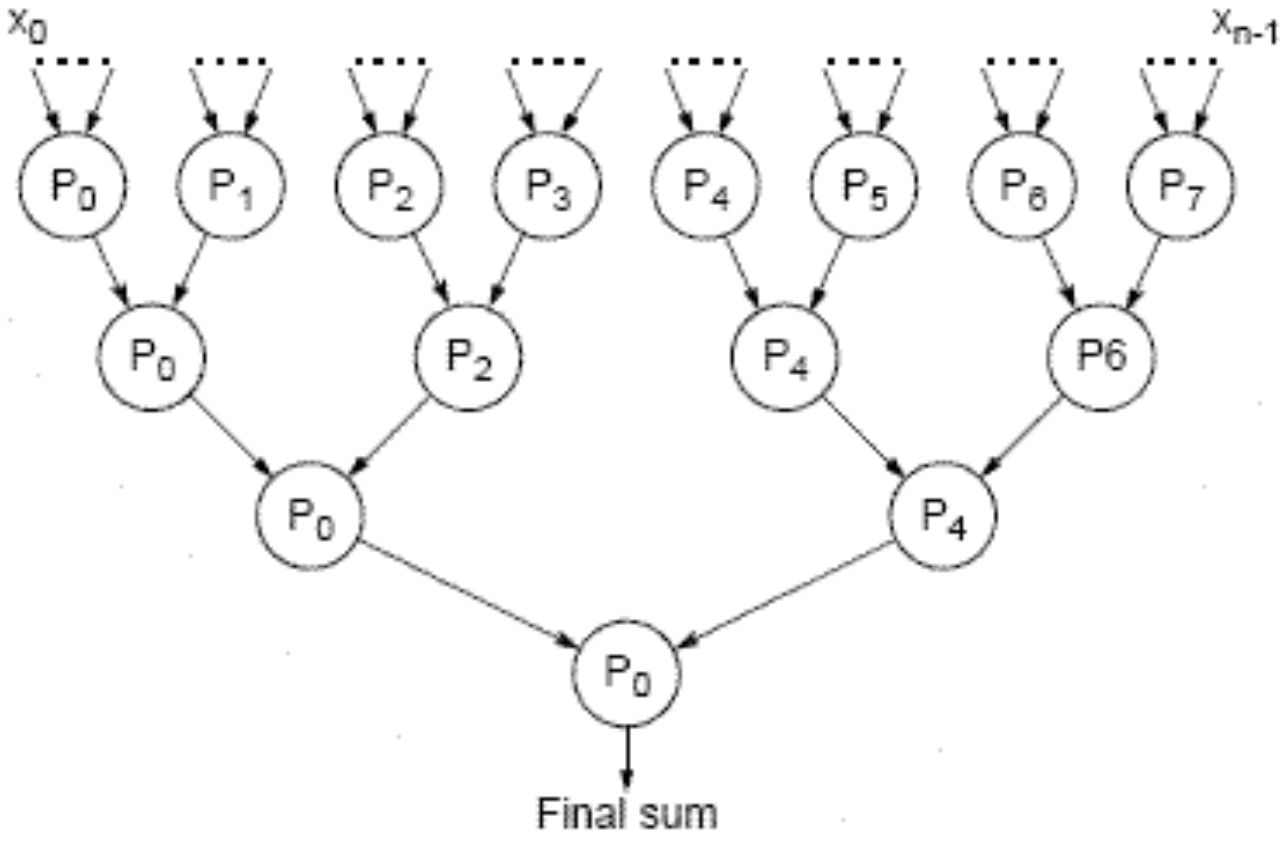


New Trend: Multi-Core CPUs



Parallel Programming

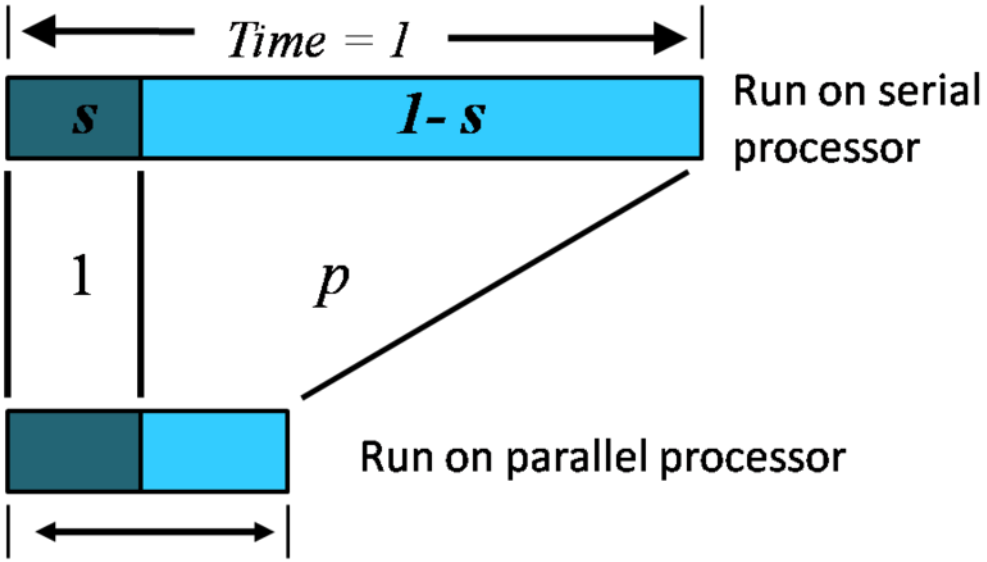
- We need parallel programming in order to use Multi-Core CPU's efficiently..



Are Multi-Core CPUs Permanent Solution?

- In general, a computational task has one or more non-parallelizable (sequential) parts.

- Amdahl's Law:
  - "The speedup of a program using multiple processors in parallel computing is limited by the time needed for the sequential fraction of the program."



$$Time = s + (1-s) / p$$

What is next?