Gordon Moore

Robert Dennard

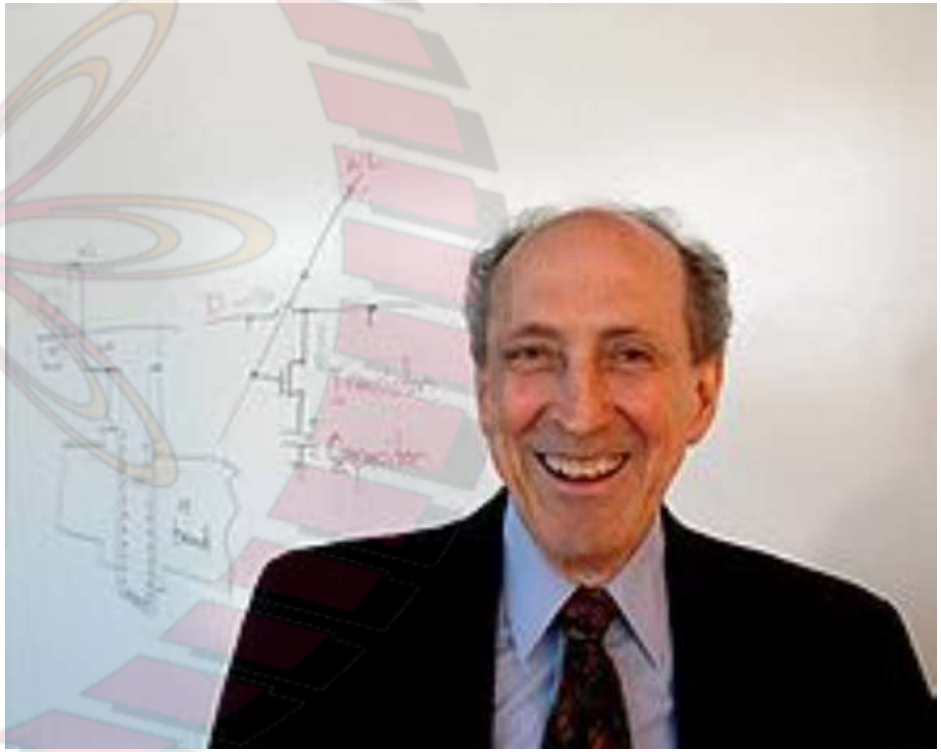
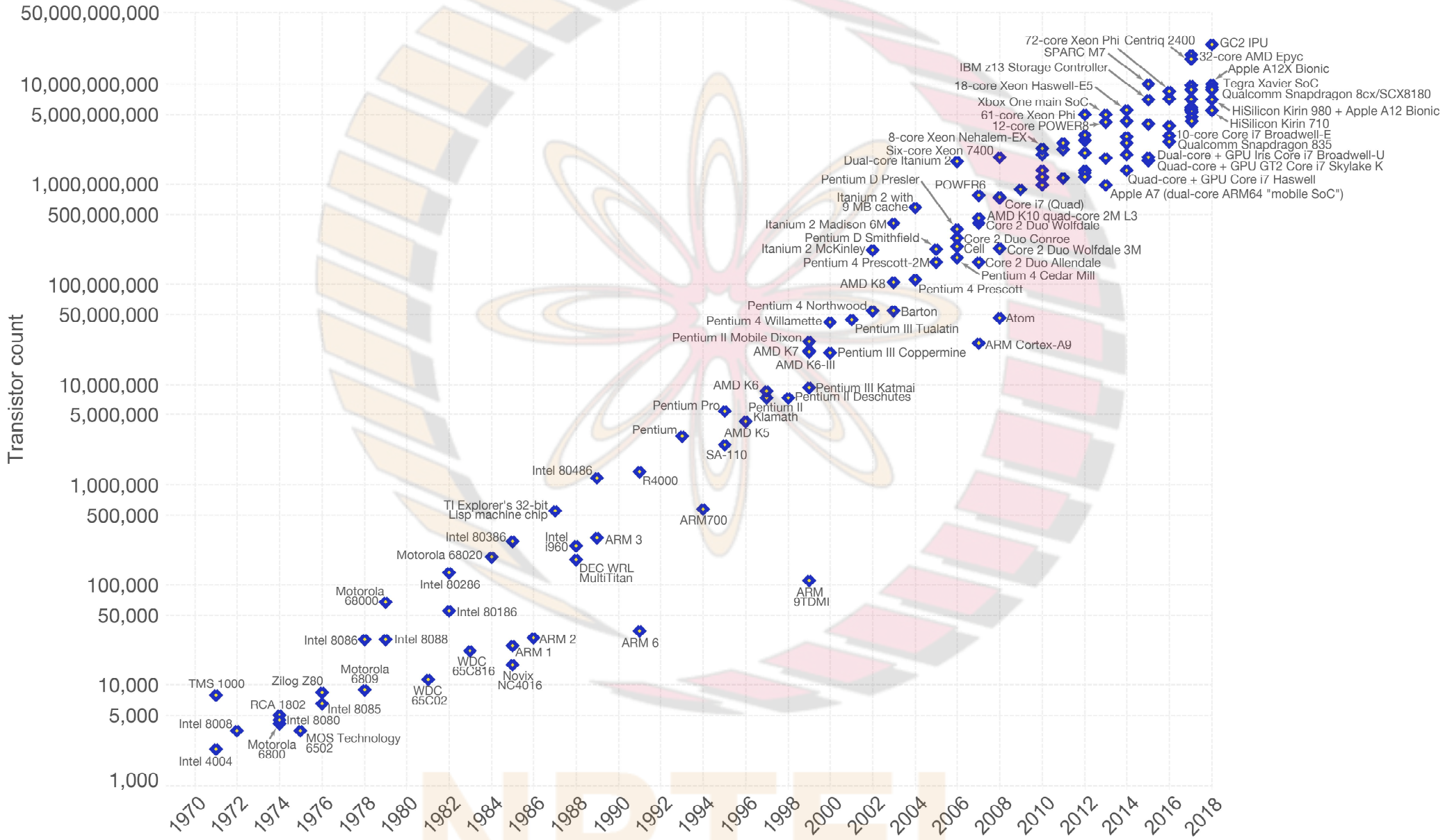


Image: ©Wikipedia

Moore's Law – The number of transistors on integrated circuit chips (1971-2018)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are linked to Moore's law.



Data source: Wikipedia (https://en.wikipedia.org/wiki/Transistor_count)
The data visualization is available at OurWorldinData.org. There you find more visualizations and research on this topic.

Image: ©Wikipedia

MOSFET

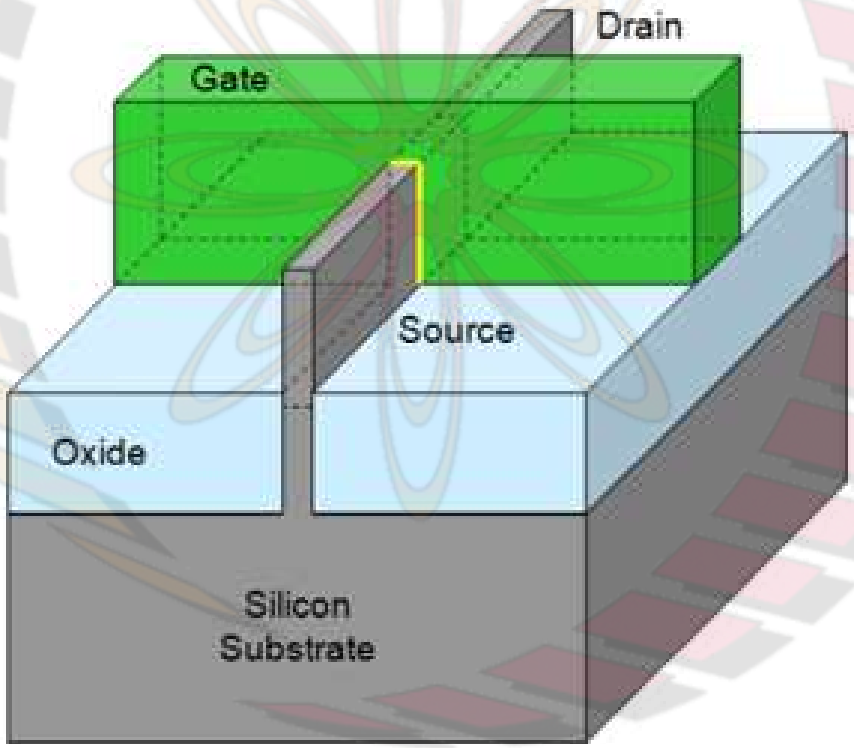


Image: ©Wikipedia

MOSFET scaling

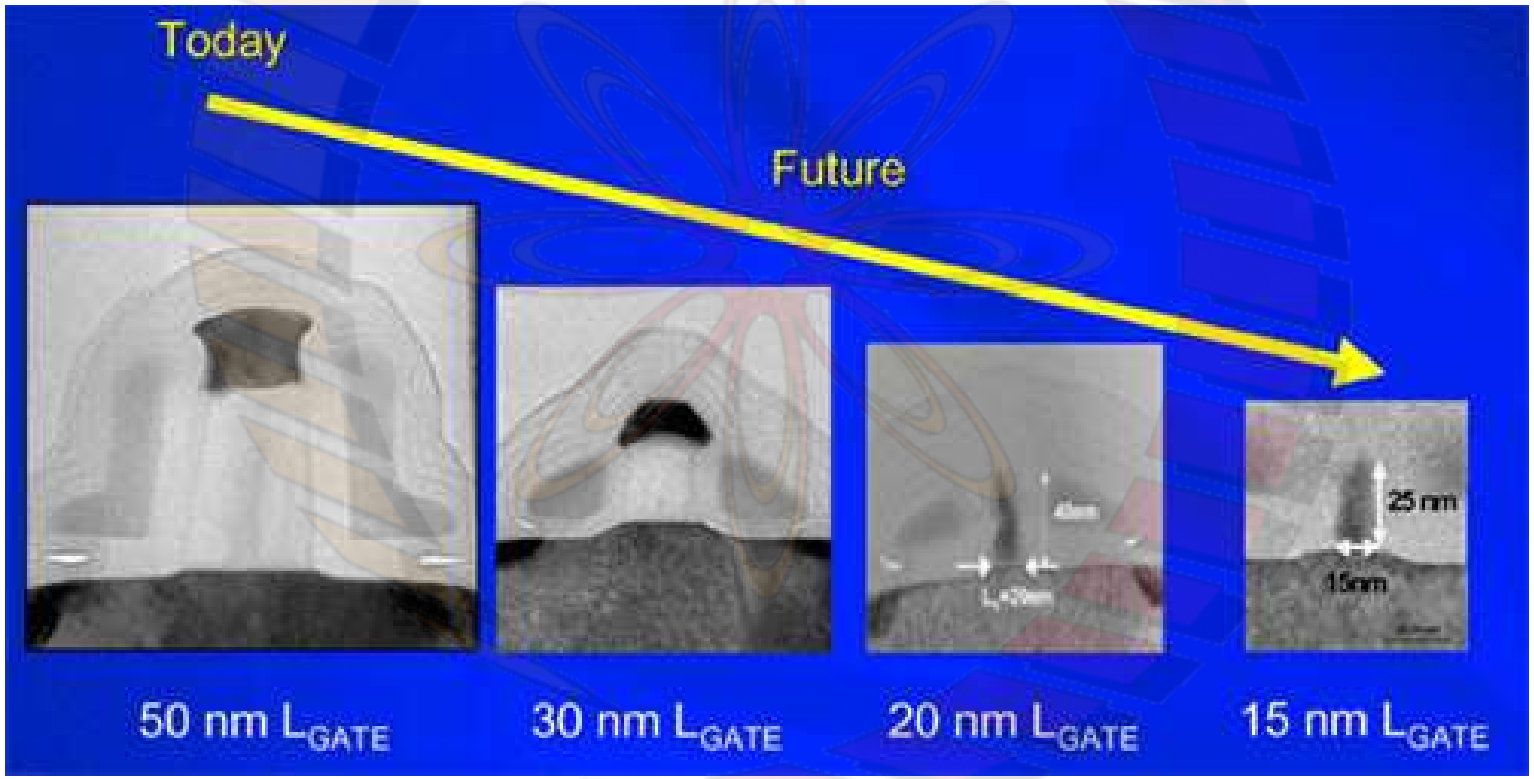
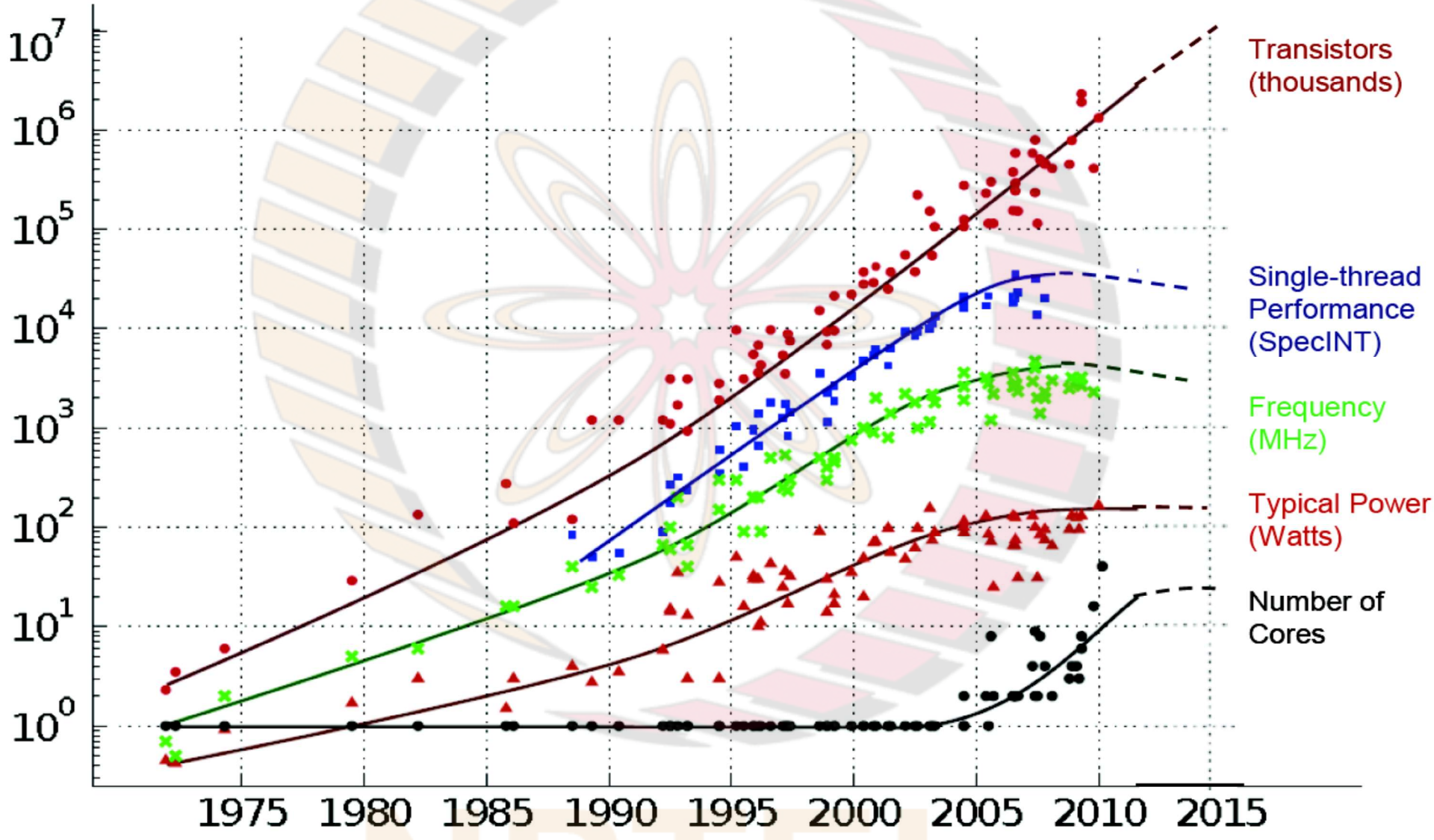


Image: ©Intel Corp.

Dennard Scaling of MOSFET's (1974)

Parameter	Factor
Dimension	1/k
Voltage	1/k
Current	1/k
Capacitance	1/k
Delay time	1/k
Power dissipation/ circuit	$1/k^2$

35 YEARS OF MICROPROCESSOR TREND DATA



Original data collected and plotted by M. Horowitz, F. Labonte, O. Shacham, K. Olukotun, L. Hammond and C. Batten
Dotted line extrapolations by C. Moore

Parallel computing

- High performance computing involves parallel programming
- You cannot run away from parallel programming in the future :).
- Problem is people do not think in parallel.
- Automatic parallelization has been a disaster so far.
- There are other limits / roadblocks to parallelism. Messages need to be communicated.
- Amdahl's Law

Amdahl's law

Amdahl's law states that if *P* is the proportion of a program that can be made parallel (i.e., benefit from parallelization), and (1 – *P*) is the proportion that cannot be parallelized (remains serial), then the maximum speedup that can be achieved by using *N* processors is given as

$$S(N) = \frac{1}{(1-P) + \frac{P}{N}}$$

Image: ©Wikipedia

Amdahl's law

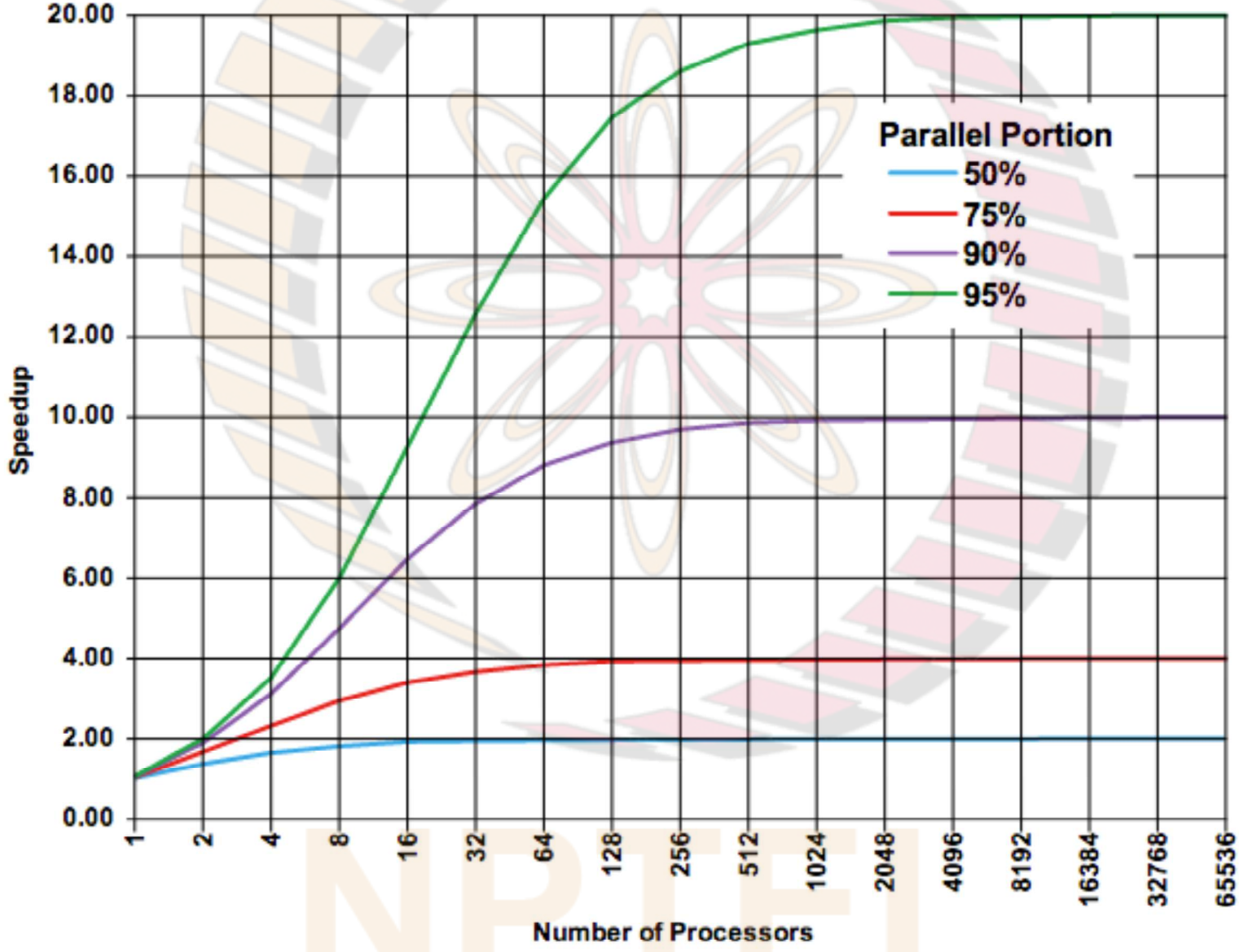


Image: ©Wikipedia