"every aspect of information and information technology is growing at an exponential pace"

- Ray Kurzweil

Obviously, "every aspect" is a vast exaggeration, as Kurzweil himself makes clear when he explains that processor clock speed is no longer exponential, even though computations-per-dollar is still exponential.

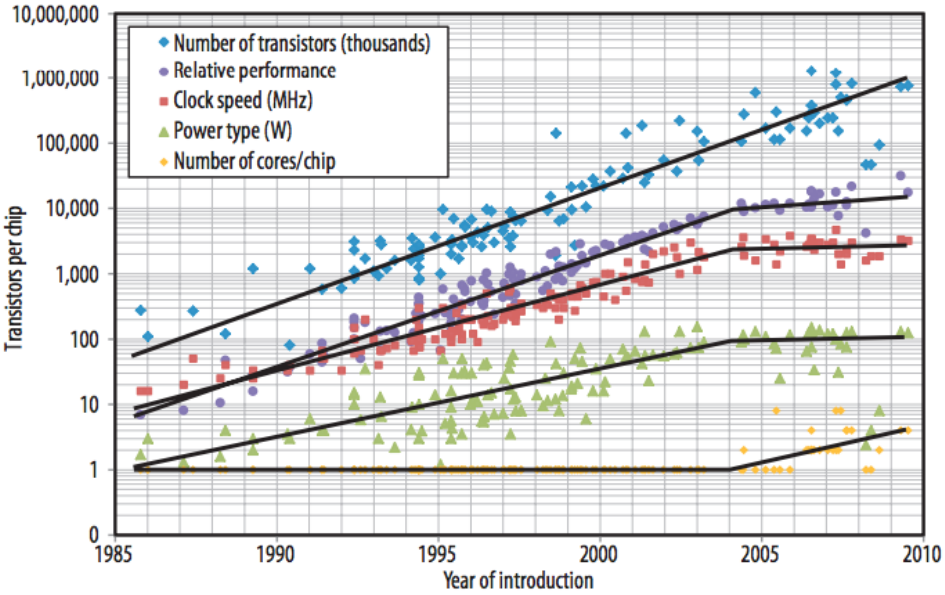

Figure 1. Transistors, frequency, power, performance, and processor cores over time. The original Moore's law projection of increasing transistors per chip remains unabated even as performance has stalled.

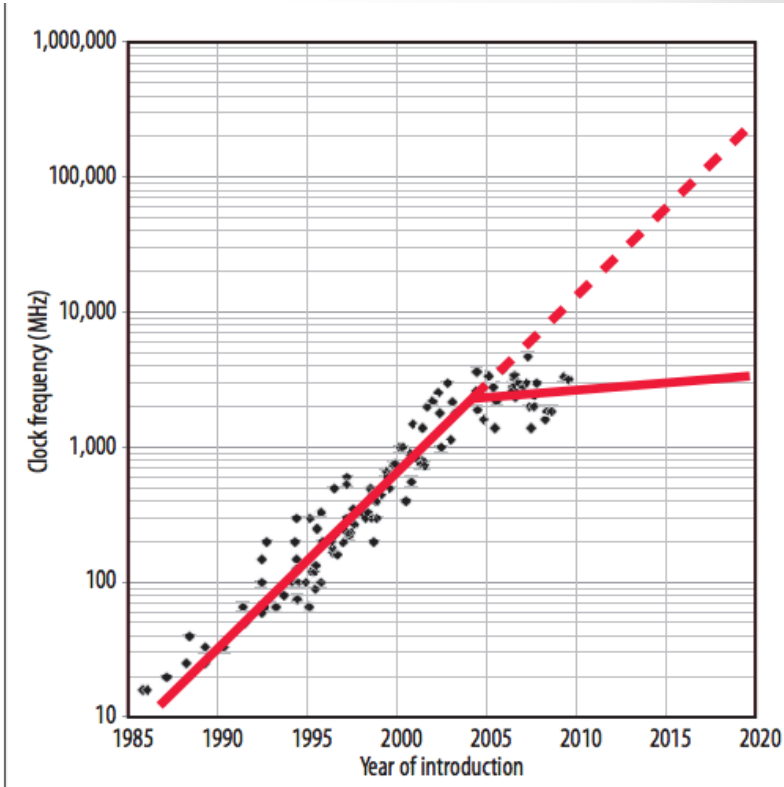

Figure 2. Historical growth in single-processor performance and a forecast of processor performance to 2020, based on the ITRS roadmap. A dashed line represents expectations if single-processor performance had continued its historical trend.

Fast exponential or superexponential (today)

- Computations per $
- Transistors per chip
- DNA megabases per $
- Cells per DRAM chip
- Lots more

- SAT solver algorithms
- Computer Go algorithms
- Facial recognition algorithms*
- Image recognition algorithms*
- Lots more

Not fast exponential (today)

- Processor clock speed (since 2004)
- Disk space per dollar (since 2011)
- DRAM
- MRI resolution?*
- Lots more

- Google search results quality*
- Wikipedia edits
- Patents per person per year
- Lots more

- Perhaps the single most important trend driving automation is the exponential trend in computations per dollar.
- Dennard scaling broke in 2004, but computations per dollar was maintained by leaping to multicore.
- “Dark silicon” is the fraction of a chip that needs to be powered off at all times due to power constraints.
- Given current trends, more than 50% of each chip will need to be “dark” within 10 years.
- Thus, the exponential trend in computations per dollar will break down unless we can make a radical architecture shift — more radical than single-core to multicore — within 5-10 years.
- My point is just that this key exponential trend is fragile, not guaranteed.