

Moore's Law

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Moore's Law is the observation made in 1965 by Gordon Moore, co-founder of Intel, that the number of transistors per square inch on integrated circuits had doubled every year since the integrated circuit was invented. Moore predicted that this trend would continue for the foreseeable future. In subsequent years, the pace slowed down a bit, but data density has doubled approximately every 18 months, and this is the current definition of Moore's Law, which Moore himself has blessed. [1]

Moore's law is an observation and projection of a historical trend and not a physical or natural law. Although the rate held steady from 1975 until around 2012, the rate was faster during the first decade. In general, it is not logically sound to extrapolate from the historical growth rate into the indefinite future.

Moore's law is stopped being true in today's world because of several reasons which are as follow:

- Space constraint: Though the size of transistors is getting small ever year but a certain threshold can't be crossed because of several power, temperature and voltage reasons. in the production of these tiny transistors Lithography exposure stage is crucial stage and the size of system that is going to be printed is governed by Rayleigh equation

$$CD = \frac{k_1 \lambda}{NA}$$

where CD (Critical Dimension) is the smallest feature size the system can print, λ is the wavelength of the light used, NA is the numerical aperture of the system's lens and k_1 is known as the resolution factor and accounts for all other process variables. Improving resolution (thus keeping Moore's Law alive) then comes down to using shorter wavelengths of light, increasing the numerical aperture and / or reducing k_1 . [2]

- Power/Temperature Wall: Increasing the quantity of transistors increases the total power consumption on the dice where all transistors are installed. In the process of transitioning from one state to another a significant amount of heat is dissipated which is observed in form of heat. So unless there is new research in field of material science, there is strong possibility of melting of the dice where transistors installed because of currently available materials. [3][4]
- Voltage Scaling: One way to reduce the dynamic power is to reduce the voltage supplied to transistors. When a certain voltage is applied to transitory there is some standard error associated with it. It means that the total power supplied to transistor is $V \pm \Delta v$ where Δv is error is uncertainty associated with the system. When we reduce the voltage we have to ensure that we consider this uncertainty of the system otherwise transistor won't be triggered. Also Voltage scaling can't prevent loss due to leakage in transistors. [3]

References:

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