

Physical Limitations for Moore's Law

Short Explanation written by Maral Tokanova

1. Size of a transistor

Slowing down the Tick-tock clock is a physical necessity, because we are approaching the limit where the transistor size is only a few atoms (the size of a silicon atom is 0.2 nanometers).

2. Chip overheating

Increasing transistor density leads to increased power consumption. Small transistors use less power, but density scaling is faster. High power leads to high temperature. Overheating of the chip occurs due to current leakage through the dielectric layer, which also has to be reduced when the transistor itself is reduced.

3. Data rate

Another physical limitation is the data rate, which cannot exceed the speed of light. It takes several clock cycles for data to get from one end of the CPU to the other end. As the chips get larger with more and more transistors, the speed begins to be limited by the data transfer itself on the chip.

4. Dennard Scaling

Voltage can't go too low, proportionally to a size of transistors. It must stay above threshold voltage, otherwise noise problems occur.

5. Weak market competition

Technological limitations are not the only thing that slows down the evolution of processors. Another factor is the weakening of market competition. Intel's biggest competitor, AMD, is now focusing more on what it calls APUS (Accelerated Processing Units), which are smaller processors with integrated graphics for mini-PCs, tablets and other ultra-mobile devices. Intel now has an overwhelming market share of processors for high-end PCs and servers. The fierce competition between Intel and AMD, which pushed the development of x86 processors forward for several decades, has almost disappeared.