Moore's Law: Definition

Moore's Law is the observation that the number of transistors on a microchip would double approximately every two years.

However, in recent years, Moore's Law has started to slow down and is no longer valid at the same rate it once was.

This slowdown can be attributed to a range of physical, electrical, and engineering limitations as transistor sizes

approach atomic scales. Following are the major concepts that limits this law to be true.

1. Temperature Increases as Power Increases:

As transistor density increases, the power consumed by the chip also increases. Power consumption in a transistor is a direct

result of its activity: as more transistors are packed onto a chip, more of them are working at the same time, thus requiring

more power. This increase in power consumption leads to an increase in heat generation.

2. Power Increases as Transistor Density Increases:

This concept goes hand in hand with the first one: as more transistors are packed into a smaller area, the total power

consumption of the chip increases. Each transistor requires power to switch between states (from 0 to 1 and vice versa), and as

the transistor count increases, so does the total power required for operation.

3. Voltage Scaling Reduces (Dynamic) Power Consumption:

Dynamic power consumption, the power used when a transistor is switching between states, is proportional to the square of

the supply voltage. In simpler terms, if you lower the voltage, you can reduce the power consumption. This is why voltage

scaling (reducing the operating voltage of transistors) has been a common technique to control power use and improve the

energy efficiency of chips.

4. Voltage Scaling Cannot Prevent Leakage Power Loss:

Even when voltage scaling is applied to reduce dynamic power consumption, a major issue persists: leakage power. Leakage

current is the current that flows even when a transistor is supposed to be off, and it increases exponentially as the transistor

size shrinks. This leakage power is a significant contributor to total power consumption in modern chips, and it cannot be

significantly reduced through voltage scaling.

5 Voltage Scaling is Limited Due to Noise or Threshold Voltage:

In modern transistors, the threshold voltage is the minimum voltage required to switch the transistor from an "off" state to an

"on" state. Lowering the supply voltage reduces the threshold voltage, but doing so makes the transistor more susceptible to

noise and increases the chances of errors in the circuit. Additionally, extremely low voltages may prevent transistors from fully

turning on or off, which is essential for correct functioning.