Define Moore's Law

- Moore's Law is an **observation** made by Gordon Moore in 1965.
- It states that the **number of transistors** on an integrated circuit **doubles approximately every two years**.
- This leads to exponential growth in computing power and reduction in cost per transistor.

Why Moore's Law Has Now Stopped Being True

Moore's Law has stopped holding true in recent years due to **physical limitations** in transistor and chip scaling.

Physical Limitations Preventing Continuation

1. **Power Consumption**
    - Transistors consume power when switching.
    - Increasing transistor density increases overall power consumption.
    - Results in the **power wall**—unsustainable energy requirements.

2. **Temperature**
    - More power leads to higher heat generation.
      Traditional cooling (e.g., air or fan-based) cannot dissipate excess heat.
    - Chips risk overheating or melting.
3. **Voltage Scaling Limitations**
    - Power is proportional to the square of voltage:
      $\mathbf{P = \alpha \times C \times F \times V^2}$
    - Lowering voltage reduces power, but:
        - Voltage must stay above a **minimum threshold** for transistors to switch.
        - Very low voltages increase **susceptibility to noise**, reducing reliability.
4. **Dennard Scaling Breakdown**
    - Assumes that reducing transistor size allows proportional voltage and current reduction.
    - No longer valid because:
        - Voltage cannot be scaled indefinitely.
        - Fails to account for **leakage power**.
        - Cannot maintain constant power density at smaller scales.
5. **Power Leakage**
    - As transistors shrink, **insulating layers become thinner**.
    - Leads to **leakage current**, even when transistors are idle.
    - Increases baseline power consumption and decreases efficiency.