Module 1: Why Use Concurrency?
Topic 1.3: Power Wall

Power/Temperature Problem

- Transistors consume power when they switch
- Increasing transistor density leads to increased power consumption
  – Small transistors use less power, but density scaling is faster
- High power leads to high temperature
- Air cooling (fans) can only remove so much heat

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Dynamic Power

- **$P = \alpha * CFV^2$**

- α is percent of time switching
- C is capacitance (related to size)
- F is the clock frequency
- V is voltage swing (from low to high)

- Voltage is important
- 0 to 5V uses much more power than 0 to 1.3 V

Dennard Scaling

- **Voltage should scale** with transistor size
- Keeps power consumption, and temperature, low
- Problem: Voltage can’t go too low
  - Must stay above **threshold voltage**
  - **Noise** problems occur
- Problem: Doesn’t consider **leakage power**
- Dennard scaling must stop

Multi-Core Systems

- **$P = \alpha * CFV^2$**
- Cannot increase frequency
- Can still add processor cores, without increasing frequency
  - Trend is apparent today
- **Parallel execution is needed to exploit multi-core systems**
- Code made to execute on multiple cores
- Different programs on different cores