

# CPU Development in Park: Delays of a 4GHz Processor

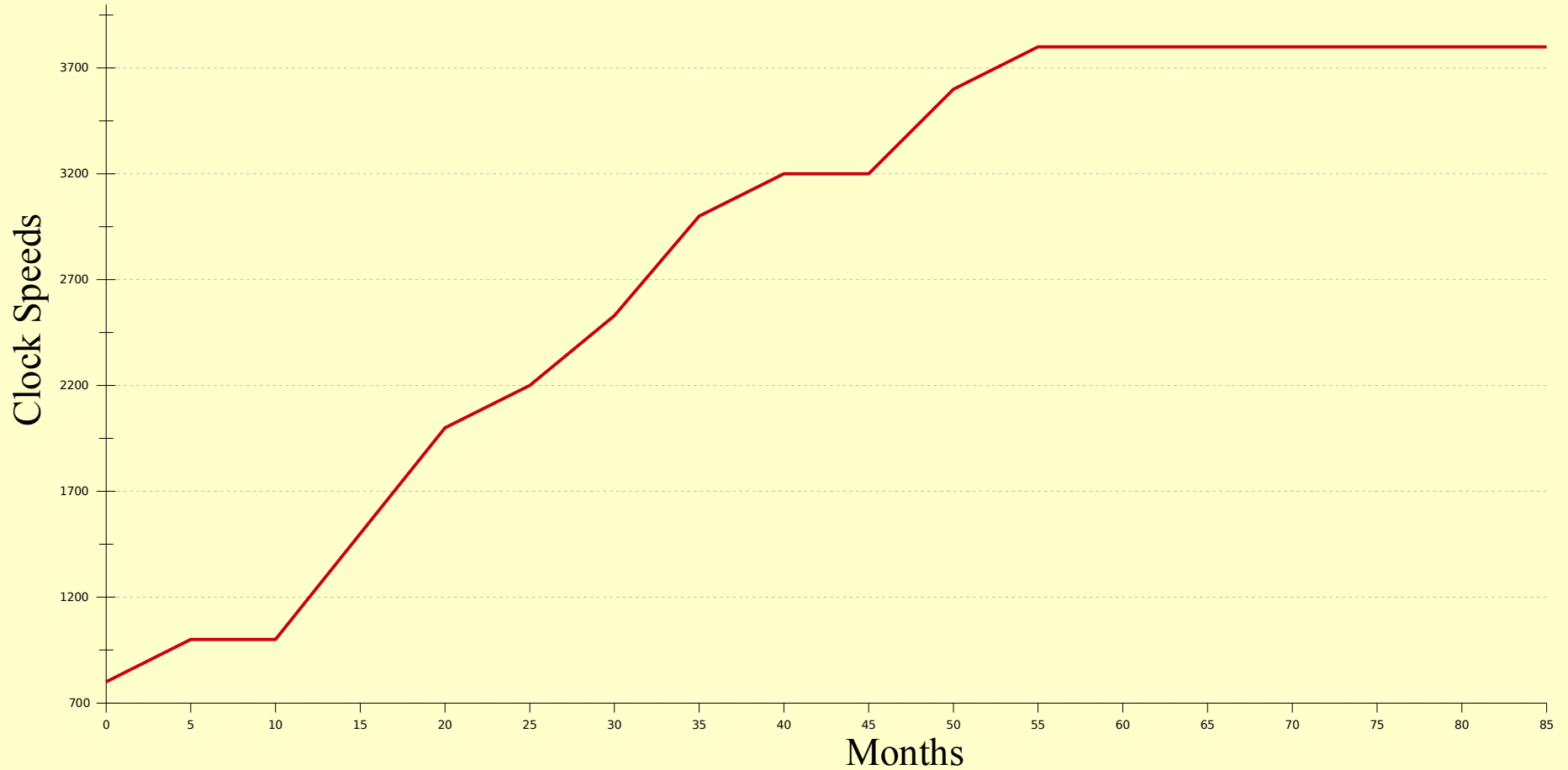
Derek Hildreth

# Question

- Shopping market
  - Consumers base buying decisions upon clock speed.
- Consistent increase
  - The clock speed had consistently increased until 2005 where it stopped at 3.8GHz.
- Two years and counting
  - Why hasn't there been a 4GHz+ processor released to the public?

# Consistent Increase

*Clock Speeds Over Time*



# What Happened?

- Marketing
  - Decisions made by manufactures to increase profits.
- Electric Migration
  - Movement of atoms within the CPU.\*
- Electrical Current Jumps
  - Flowing electricity skips important instructions.\*\*
- Alternative designs
  - Such as Quantum Computing

\*(Electromigration, 2003)

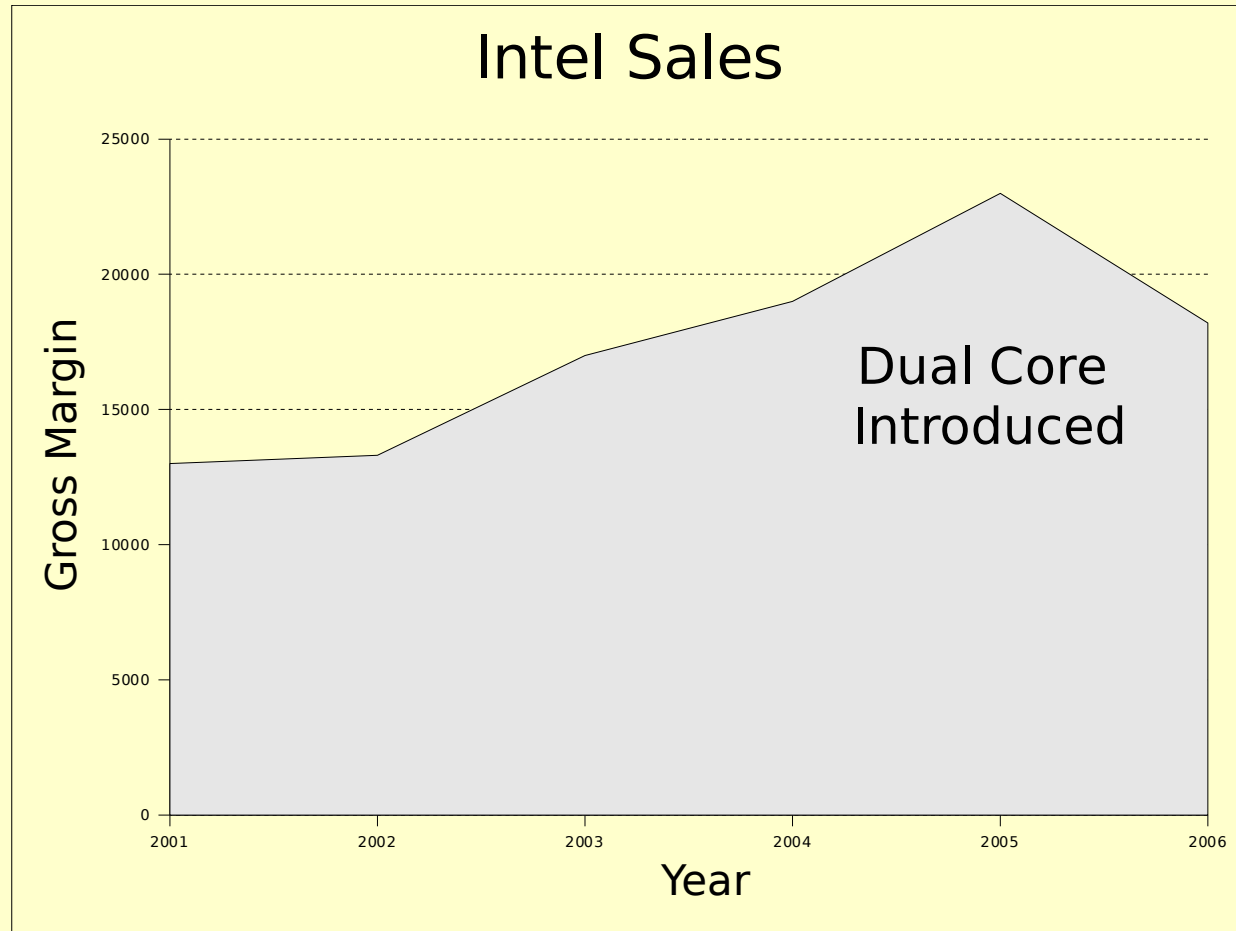
\*\* (Subthreshold, 2007)

# Marketing

- Intel introduced dual core CPUs.
  - Lower clock speed, but faster.\*
  - More efficient than single core CPUs.

| <b>Processor</b> | <b>Clock Speed</b> | <b>Score</b> |
|------------------|--------------------|--------------|
| Core 2 Duo E6400 | 2.1GHz             | 1892         |
| Pentium 4 570    | 3.8GHz             | 1162         |

# Marketing Continued



- These cheaper, faster CPUs sell better!\*
- Why manufacture single cores anymore?

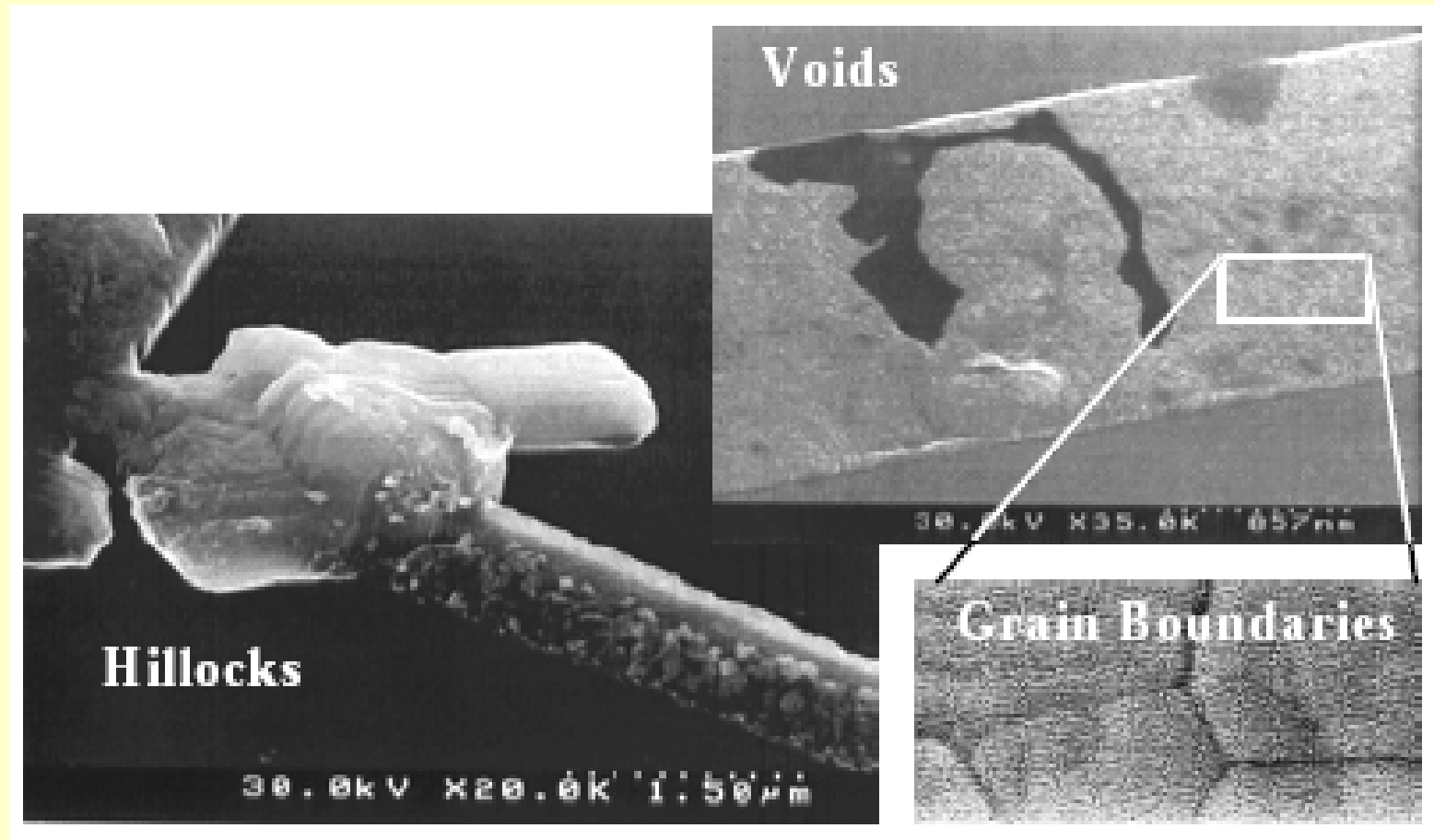
# Electric Migration

- Clock speed boosts
  - The faster, the hotter
    - More voltage makes for a faster processor, but more voltage means higher temperatures.
  - Heat leads to electric migration
    - A phenomenon known as electromigration.\*
      - “Electromigration occurs as a result of metal atoms being moved via the momentum of electrons.”\*\*

\*(Electromigration, 2003)

\*\* (Polkowski, 2007, para. 2)

# Electromigration Continued

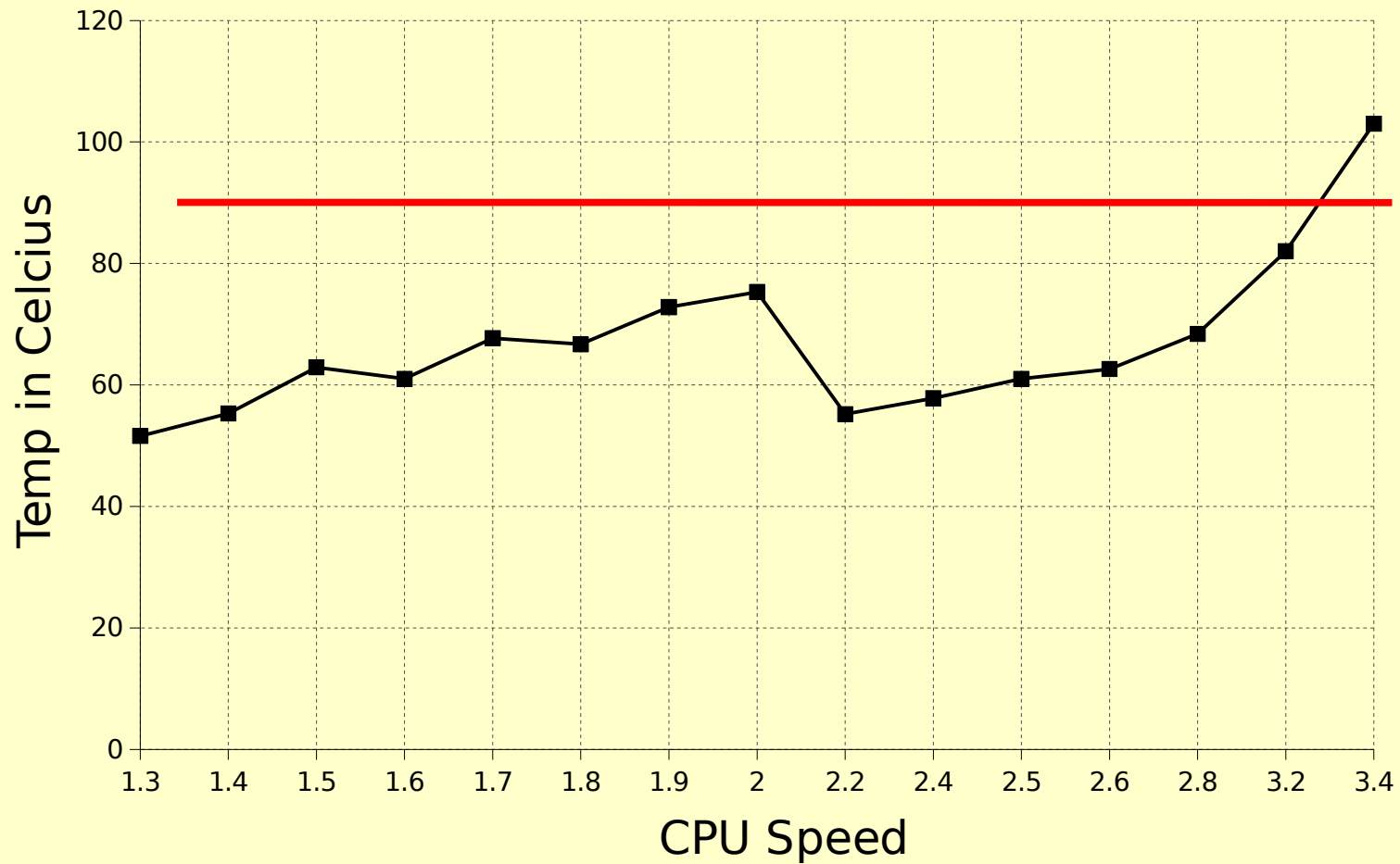


- The effect of electromigration will ultimately lead to CPU failure.\*



# Electromigration Continued

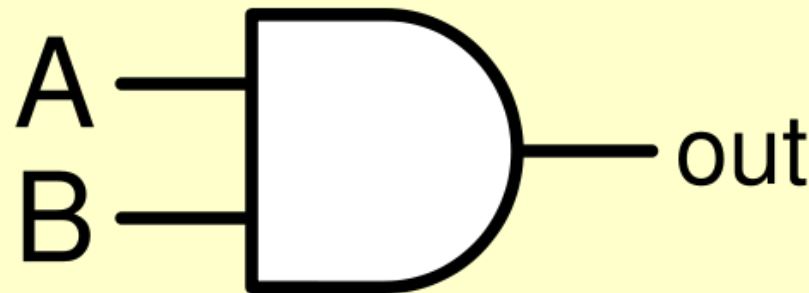
## Speed vs Temp



# Intro to Electrical Current Jumps

- Integrated Circuits

- A tiny electronic circuit that is located on a block of material that can carry an electric current.
- They are made up of components that help regulate the flow of electricity.
- They are arranged and combined to carry out instructions in a specific manner.\*



# Intro to Electrical Current Jumps

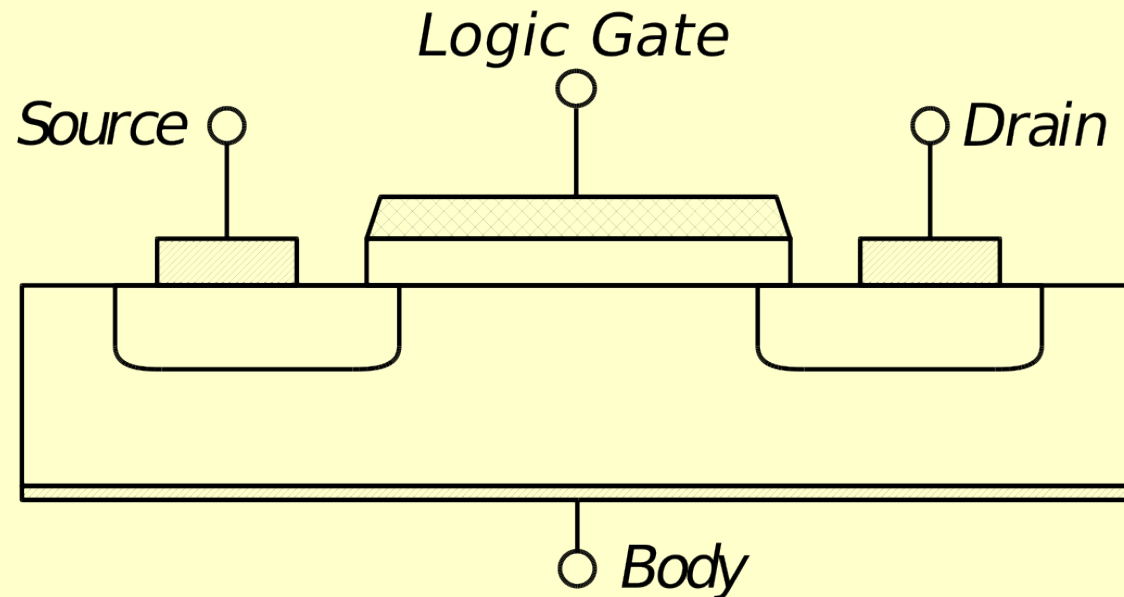
- Nanotechnology
  - “The science and technology of building electronic circuits and devices from single atoms and molecules.”\*
  - Measured in nanometers (nm)
    - Integrated circuits of recent processors are 45nm
      - Human hair: 80,000nm\*\*
- And with shrinking integrated circuits...

\*(nanotechnology, 2003)

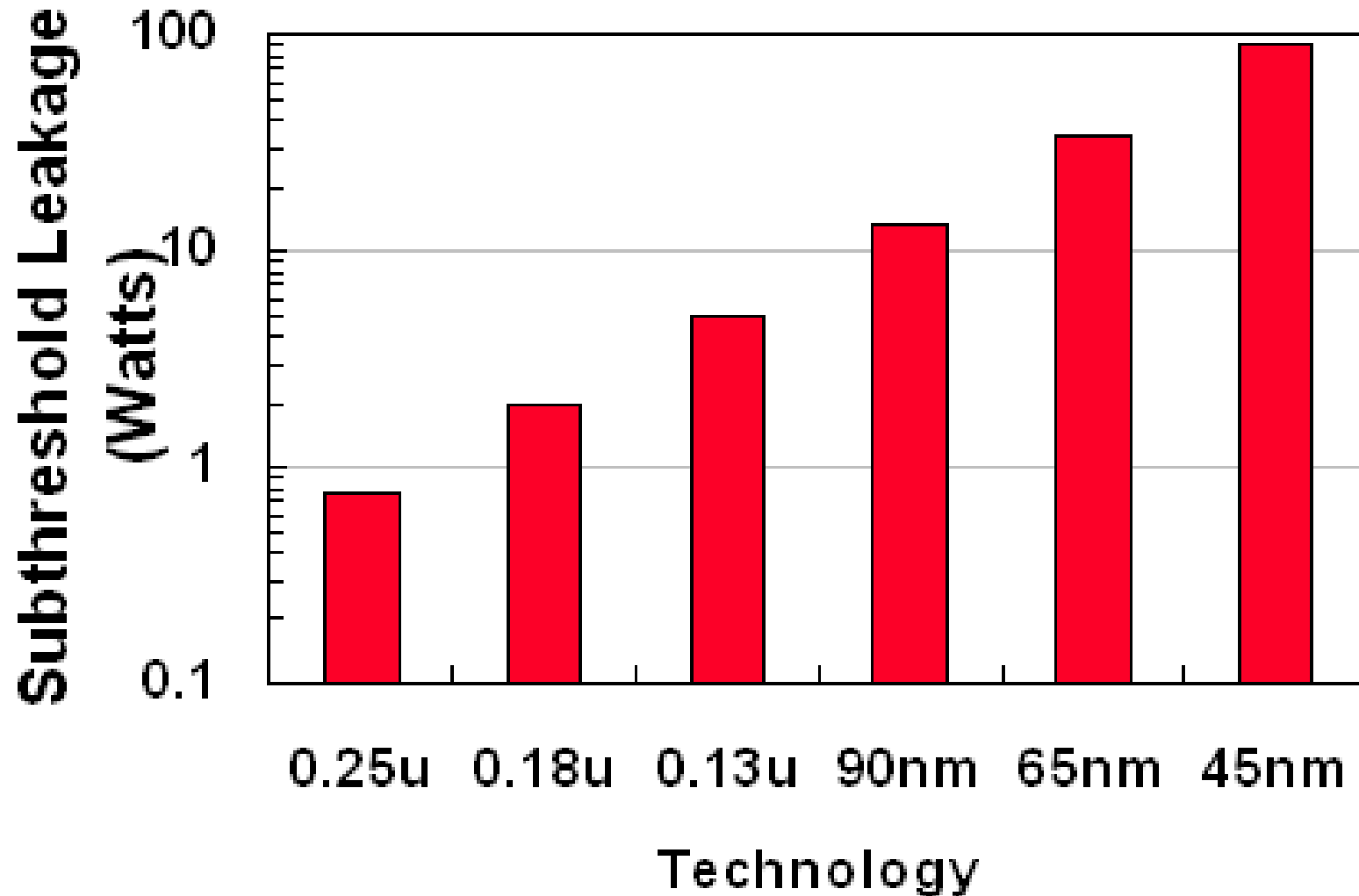
\*\* (National, n.d.)

# Electric Current Jumps

- Also known as Subthreshold Leakage.
  - When electricity jumps directly from an inlet of an integrated circuit to the outlet, skipping the important instructions.
  - These cause CPU inefficiencies.



# Electric Current Jumps Cont.



# Alternative Design

- Quantum Computing
  - Take a single atom...
    - ...and manipulated it to produce signals that are understood by a computer.
    - Manipulation by laws of quantum physics.\*
  - Still in very early stages of development.
- Multiple Core Processors
  - Dual Core, Quad Core, 80 Cores...
    - All doing their share of the work, making it faster.

# Conclusion

- The absence of a 4GHz CPU
  - Explained by:
    - Marketing Strategies
    - Electronic Migration
    - Electrical Current Jumps
  - Alternative designs:
    - Dual core CPUs
    - Quantum computing

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