Very Large Scale Integration II - VLSI II

Introduction to Digital World

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Syllabus (Tentative)

- Week 1 (Project 1: OpenLane Instalation and First Try)
  - Introduction to Digital World
  - Digital Design Methodology
- Week 2
  - Verilog Basics
- Week 3 (Project 2: Combinational Circuit RTL Design)
  - Verilog Basics
- Week 4
  - Functional Verification
- Week 5 (Project 3: Sequential Circuit RTL Design and Verification)
  - Synthesis
  - Place and Route
- Week 6
  - Layout
- Week 7 (Project 4: Sequential Circuit RTL to GDS and Verification)I
  - Instruction Set Architecture
  - RISCV Instruction Set Architecture

Syllabus (Tentative)

- Week 8
  - Memory Structures
  - Cache Hierarchies
- Week 9 (Project 5: Memory Design, Synthesis)
  - Hardware Arithmetic
- Week 10
  - RF & Datapath & Single Cycle Control
- Week 11 (Project 6: ALU Design)
  - Basic Pipelining
- Week 12
  - Hazard Handling
- Week 13 & 14 (Project 7: Pipeline Design)
  - Q&A
- Final Project: Implementation of hazard handling, writing an application and test

Text Books

- Morris Mano, Charles Kime, Tom Martin, Logic and Computer Design Fundamentals, Pearson Education Limited, 5th Edition, 2015.
- John L. Hennessy, David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann, 6th Edition, 2017.
- Frank Vahid, Digital Design with RTL Design, Verilog and VHDL, Wiley, 2nd Edition, 2010.
- Frank Vahid, Tony Givargis, Embedded System Design: A Unified Hardware/Software Introduction, John Wiley & Sons, 2002.

Grading

- Average of first 5 homeworks will be grade for midterm
- Average of last 3 will be grade for final
- Term grade=midterm*0,6+final*0,4

Outline

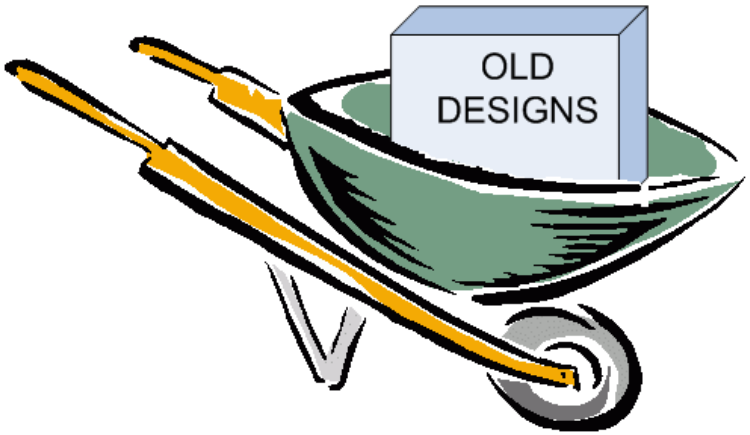
- Why Digital?
- Why NOT Digital?
- Considerations of Digital Technology
- Limitations of Digital Technology

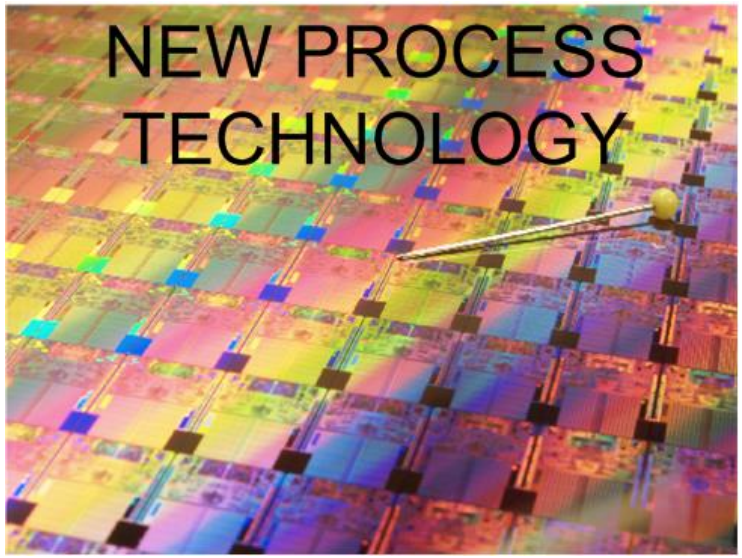
Why Digital?

- Ease of Design
  - Low Idea-to-Product Time

Why Digital?

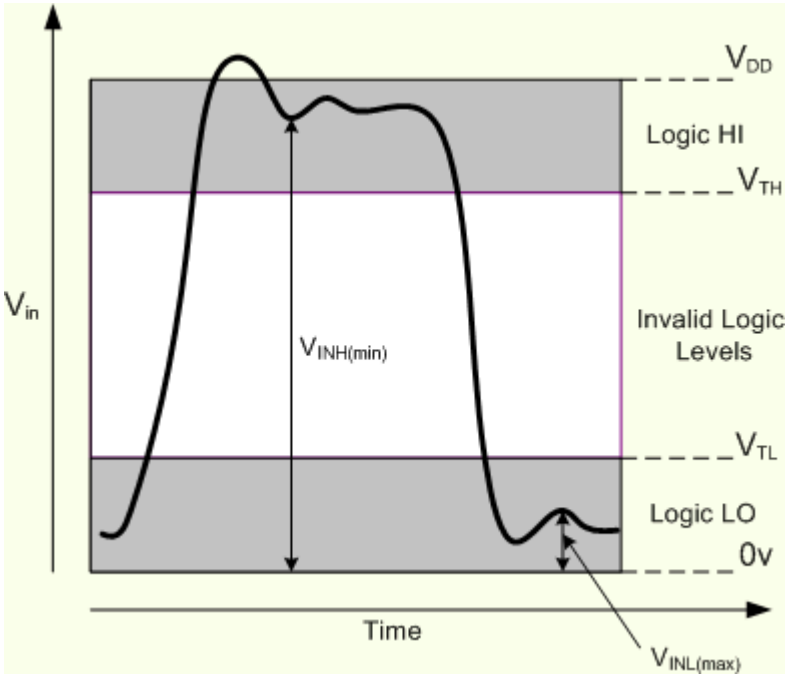
- Ease of Design
  - Portability





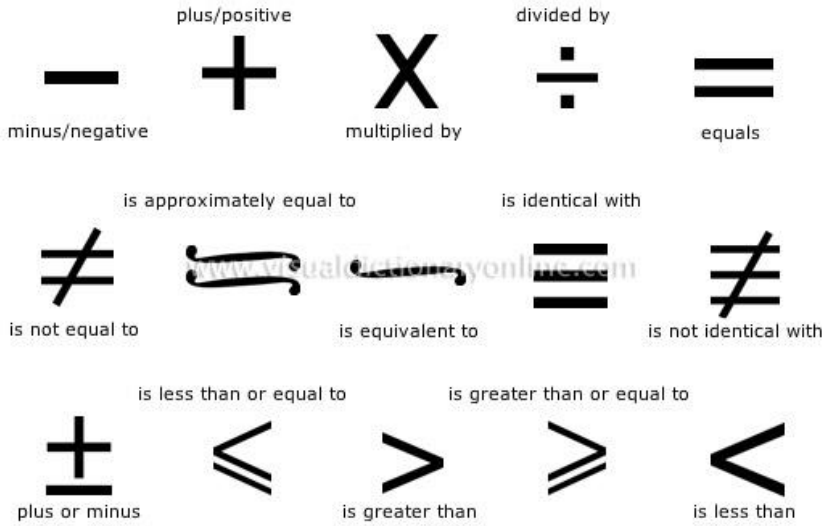
Why Digital?

- Ideal World
  - Immunity to Noise



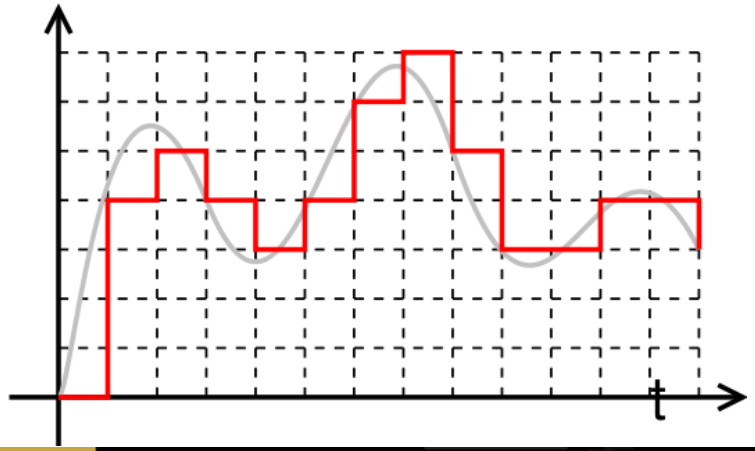
Why Digital?

- Ideal World
  - Only mathematical and logical operations
    - Zero error for some operations
    - Customizable precision



Why Digital?

- Ideal World
  - Easy Signal Processing

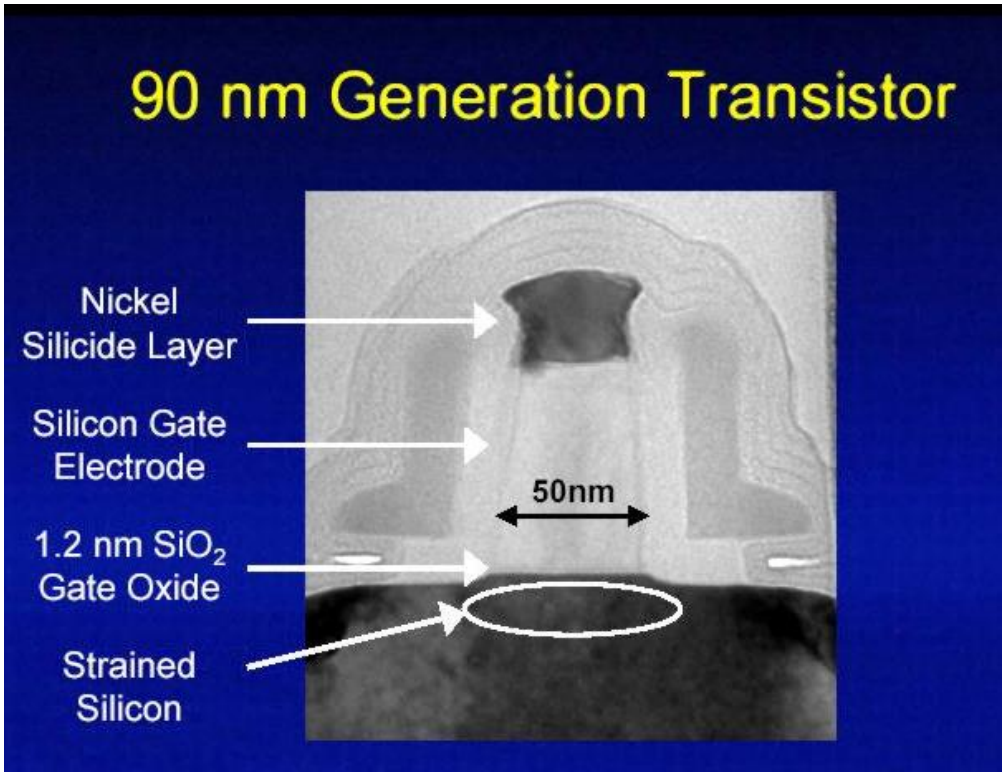


Why Digital?

- Programmability
  - Can be programmable on the fly
  - Can change the behavior completely

Why Digital?

- Technology (scaling) driven

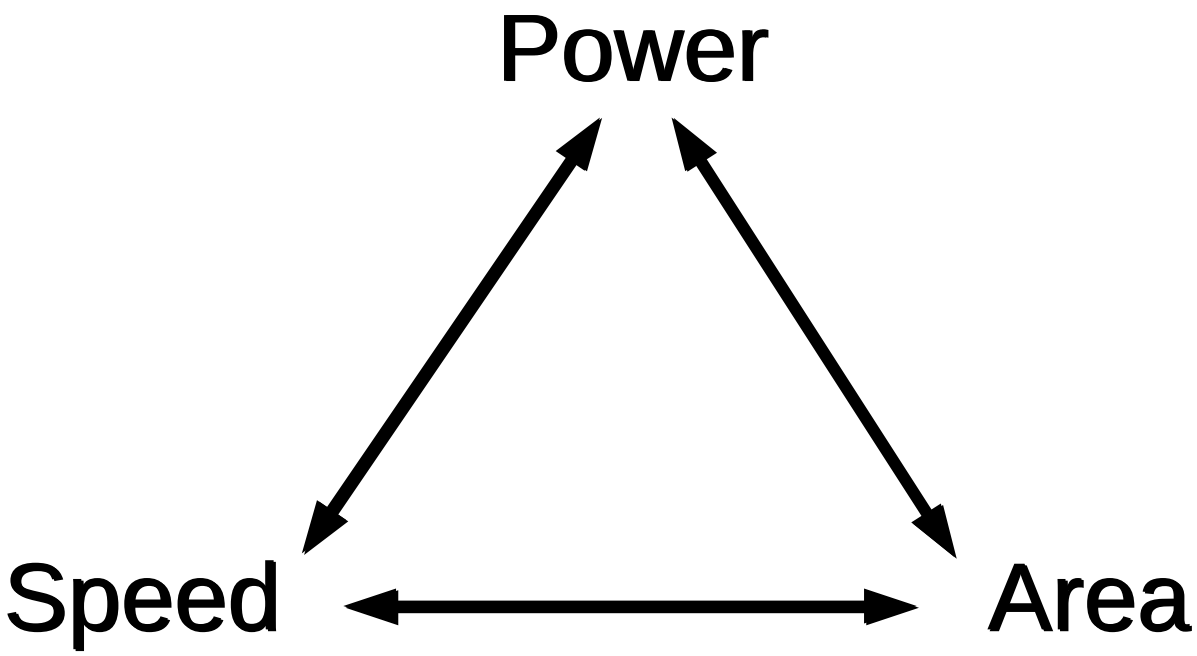


Why NOT Digital?

- Sound
- Electromagnetic Waves
  - Light etc.
- All other sensory data
  - Pressure
  - Temperature
  - Humidity etc.
- Short, The World is **ANALOG**

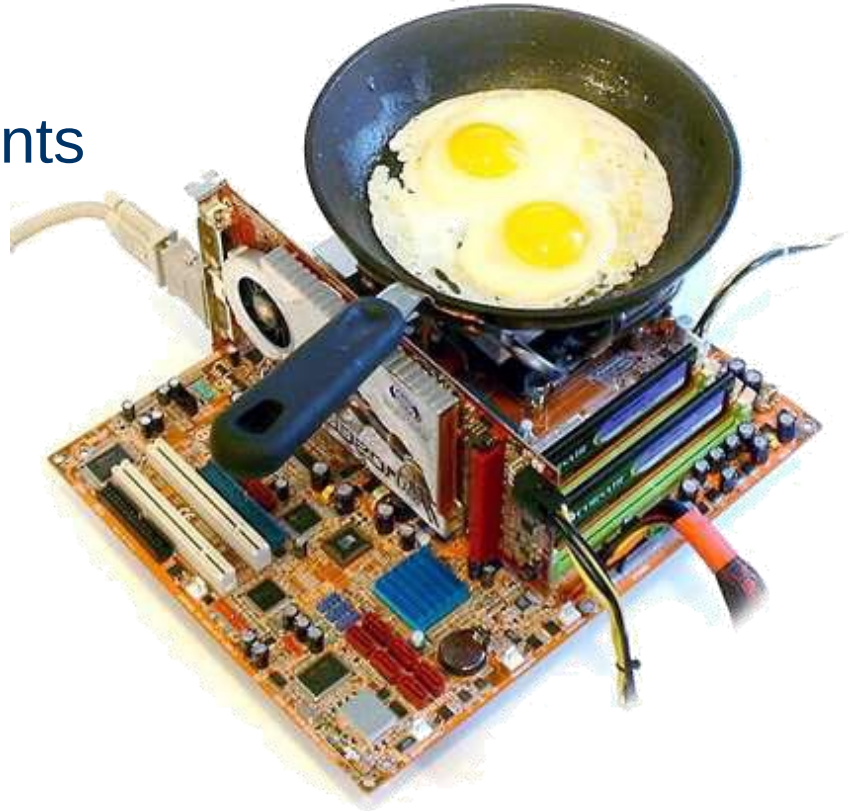
Considerations of Digital Technology

Trade-off Triangle



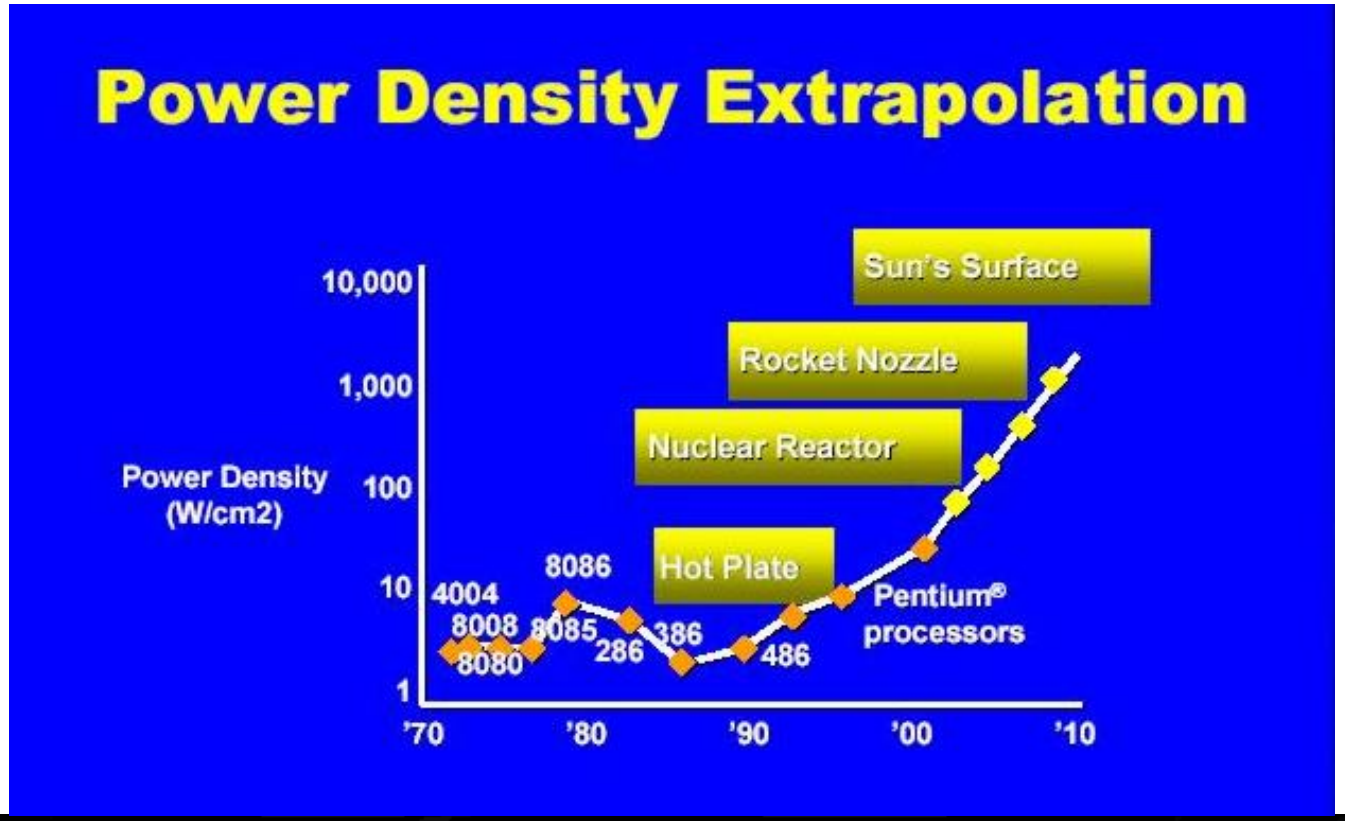
Limitations of Digital Technology

- Total Power = Dynamic Power + Static Power
- Dynamic Power → $C.f.V_{DD}^2$
- Static Power → Leakage Currents



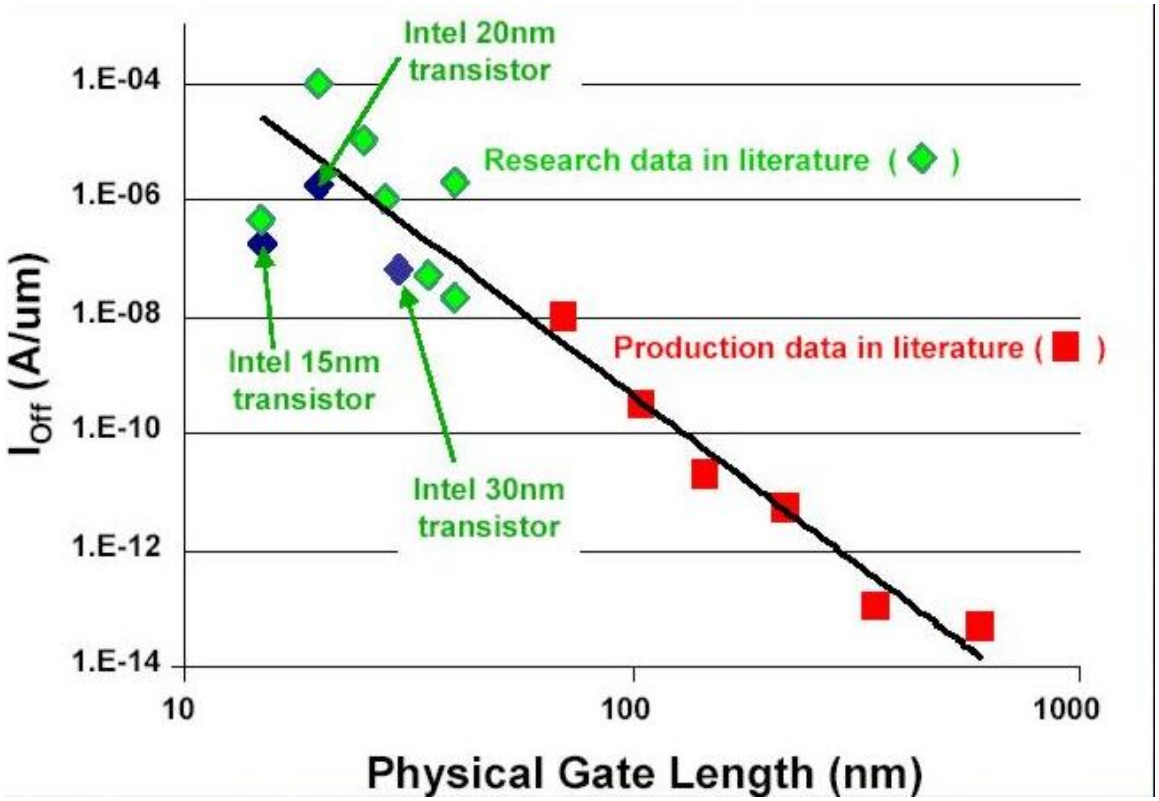
Limitations of Digital Technology

- Power Density = Power Consumption per Unit Area



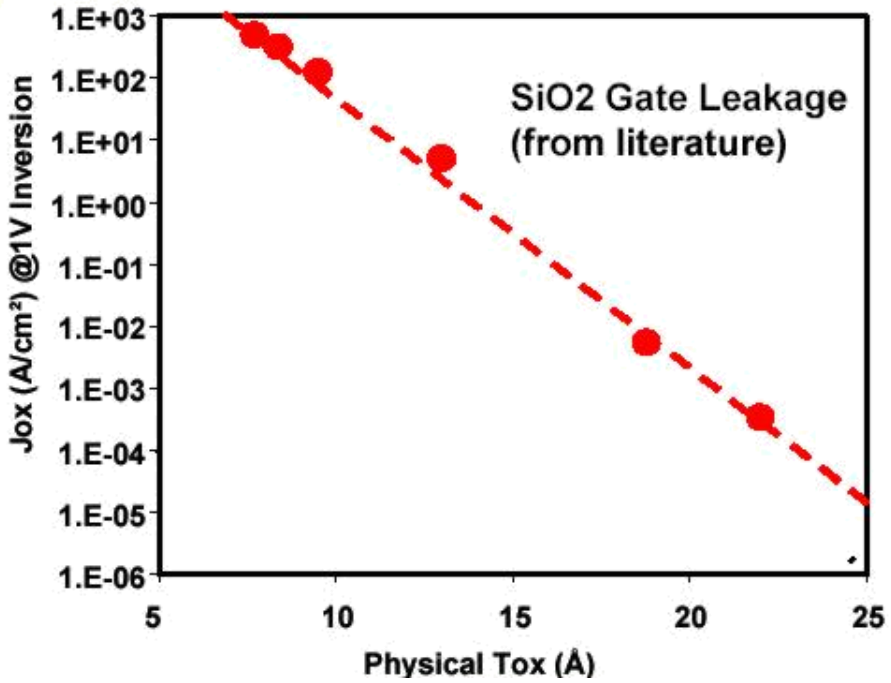
Limitations of Digital Technology

- Subthreshold Leakage Currents



Limitations of Digital Technology

- Gate Leakage
  - Thinner gates → faster transistors but more leakage



References

- http://download.intel.com/pressroom/kits/45nm/pin.jpg
- http://www.clipartheaven.com/show/clipart/tools_&_hardware/wheelbarrow-gif.html
- http://www.topnews.in/health/files/Aircraft-noise.jpg
- http://www.ami.ac.uk/courses/ami4822_dsi/u02/index.asp
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- http://upload.wikimedia.org/wikipedia/en/2/24/Lenna.png
- http://ixbtlabs.com/articles2/intel-65nm/
- http://www.tomshardware.com/reviews/cheap-thrills,1335.html