What's Next After CMOS

Mark Horowitz, Stanford

- Can I go home now?

The End of Silicon is Near
(again, or is it still)

- There is talk about the coming demise of silicon
  - 0.1μ barrier (or is it 0.07μ, or 0.03μ)
- This has two effects:
  - Talk about the next new technology
    - Quantum devices
    - Quantum computing
    - Molecular computing
    - Wet-ware
  - Talk about what post-silicon life will be like

Executive Summary

- The end of silicon is not a new topic
  - Heard most of this stuff before
    - The names of the new technology is what changes
- Scaling will eventually end
  - Nothing can stay on an exponential group curve forever
- Nothing will 'take over' silicon role
  - Silicon has really defined
    - The way we think about computing
    - The way we think about system design
    - The way we think about logic

Main Problem - Money

- You need it to develop technology
  - Lots of it for an advanced complex technology
- In the long term need to make money to get funding
  - Research efforts start with small amounts of money
  - Need to start making money to increase funding
- Silicon is making lots of money
  - It will compete against you with its best stuff
  - 1B gates, running at GHz in a low risk technology

The Deck is Stacked

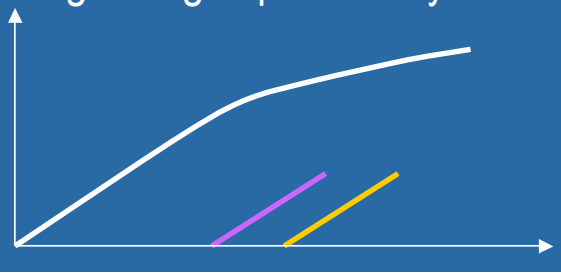
- Our design processes is optimized for silicon
  - Working on making it better for over 30 years
- Silicon has set:
  - Notions of logic (binary signals)
  - Digital design styles
  - Computing (distinct memory and logic)
  - Relative size and speed of memory logic
- No new technology will fit this mold well
  - Changing the world is hard
  - If you build it, generally they don't come
    - Unless they absolutely have to

End of Scaling

- Silicon will not disappear
  - It will still be a huge business
    - Growth rate is slower
    - Very slow scaling
- Silicon will become like concrete and steel
  - Basis of a huge industry
  - Critical to nearly everything
  - But fairly stable and predictable
- Will remain the dominate substrate for computing
  - But it eventually will be less exciting

Don't Give Up

- Need insertion strategy
  - Need to find some reason to exist in a silicon world
  - Start the exponential to bring in the funding you need
  - Once you have base can expand
    - Start educating the world on the new-world order
- In this future silicon is stable and very large
  - New niche technologies will be growing exponentially
  - Small compared to silicon
  - Not mainstream computing
  - But much more exciting



Don’t Be Stupid

- There is more to the world than computing
  - Don’t be a computing is everything weenie
  - Silicon’s strength is also its weakness
- Silicon weakness
  - People don’t want a computer in their door lock
    - It is just the cheapest way to build the door lock
    - Use computing since it is cheaper than using metal tumblers
  - While information processing might be fundamental
    - It might not be the way we think about it today