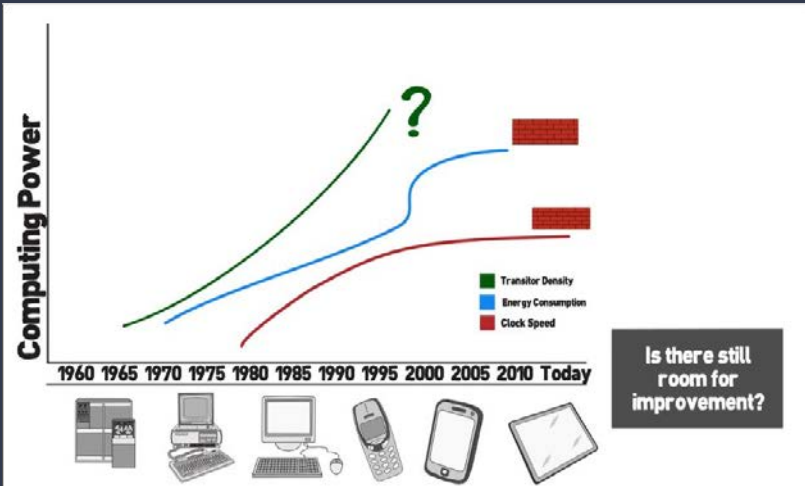# Limits on Fundamental Limits of Computation

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Presented by Stephen Sher
October 11, 2017

Summary
tl;dr

Computing power is contingent on transistor density, energy consumption, and clock speed.
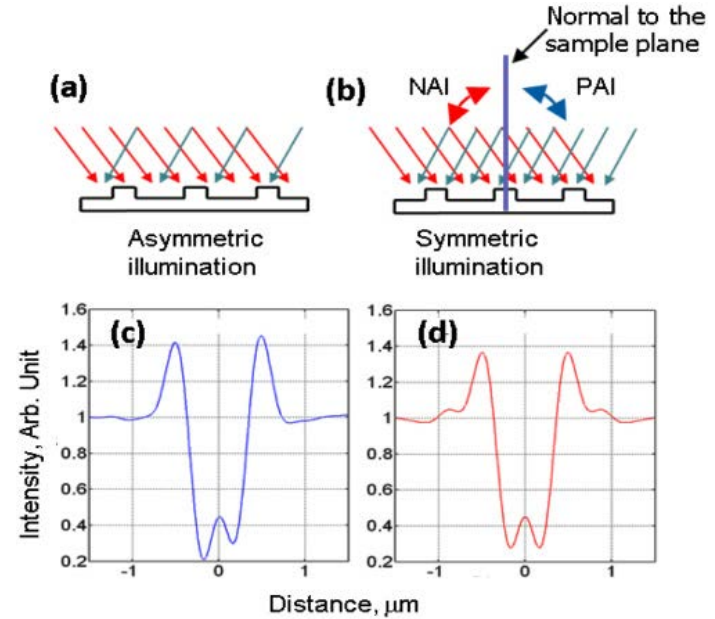
Future growth of computing power is limited by:

- Materials and manufacturing

- Engineering design

- Power and energy

- Time and Space

- Information and computational complexity

Problem

Abbe diffraction limits precision lasers

Asymmetric illumination allows greater precision
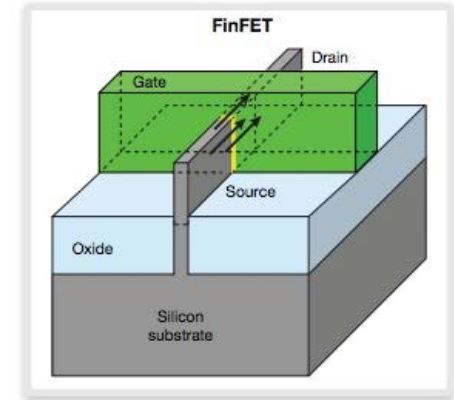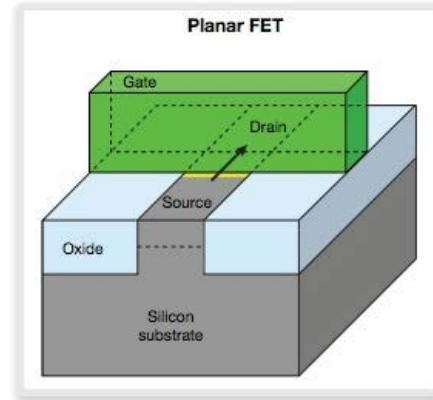

Solution

Problem

Transistors need to be precise on the atomic level

New transistor design (wider dielectric layers) and new technology (FinFET, tunnelling transistors) help reach greater precision and scaling.

Solution

Problem

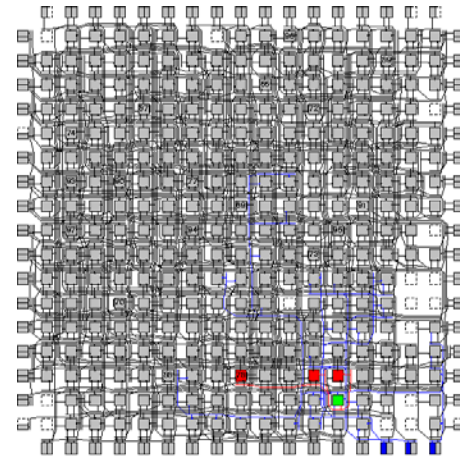Abbe diffraction limits precision lasers

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Design automation allows engineers to focus on optimization, rather than architecture.

Routing succeeded with a channel width factor of 6.

Solution

Problem

Zero-energy computation is impossible

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Applied superconductivity (not scalable) and quantum architecture (not applicable) are alternatives

Solution

Problem

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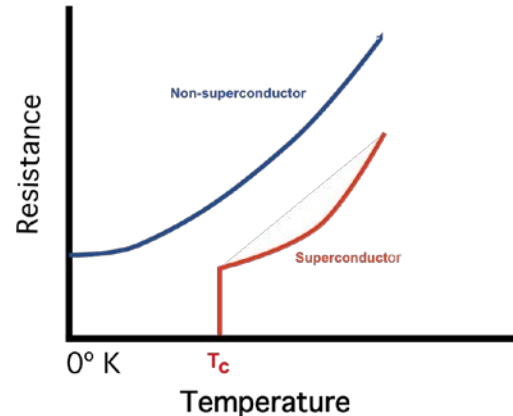Hardware optimization is difficult to solve

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Three dimensional circuits (difficult to manufacture) and quantum circuits (niche usage) allow greater energy efficiency

Solution

Problem

Abbe diffraction limits precision lasers

Transistors need to be precise on the atomic level

Hardware optimization is difficult to solve

Zero-energy computation is impossible

Parallelization does not scale infinitely

P =/= NP conjecture limits fast solutions for important problem

Asymmetric illumination allows greater precision

New transistor design (wider dielectric layers) and new technology (FinFET, tunnelling transistors) help reach greater precision and scaling.

Design automation allows engineers to focus on optimization, rather than architecture.

Applied superconductivity (not scalable) and quantum architecture (not applicable) are alternatives

Three dimensional circuits (difficult to manufacture) and quantum circuits (niche usage) allow greater energy efficiency

Approximation algorithms are fast and yield reasonably accurate results

Solution

Conclusion

Limits are going to…limit the progress of computation power.

Understanding these limits is the first step towards circumventing it.

Discussion

Are there non hardware / software limitations?

To what extent do we benefit from more computing power?

To what extent do we need to consider computation limits in our research?

We're not electrical engineers nor computer science theorists. They'll make progress. Why should we care?