

Commercial CAD: Challenges and Opportunities

Ted Vucurevich

CTO – Advanced Research and Development

Cadence Design Systems

Agenda

- Commercial CAD: Today's Problems
- Tomorrow's Opportunities
- Conclusions

Quiz #1

Commercial CAD is?

1. Too Expensive
2. Too Late to solve my “real” problems
3. Too Complicated
4. Too Important to ignore

Answer: It Depends on your viewpoint

Many Late-Era CMOS Silicon Challenges

Very low supply voltages

Increasing leakage power,
pervasive signal integrity
issues

Design cost 4X vs. 130nm
Mask costs 2X vs. 90nm

Scalability of EDA infrastructure,
low-power design techniques, analog
and digital together, handling analog IP

Very large chips (100MG+)

Feature size & spacing
approach lithography limits

Defect yields, process
variation impacts, design
rule complexity

Pipelined HW / SW
Co-Design mandatory

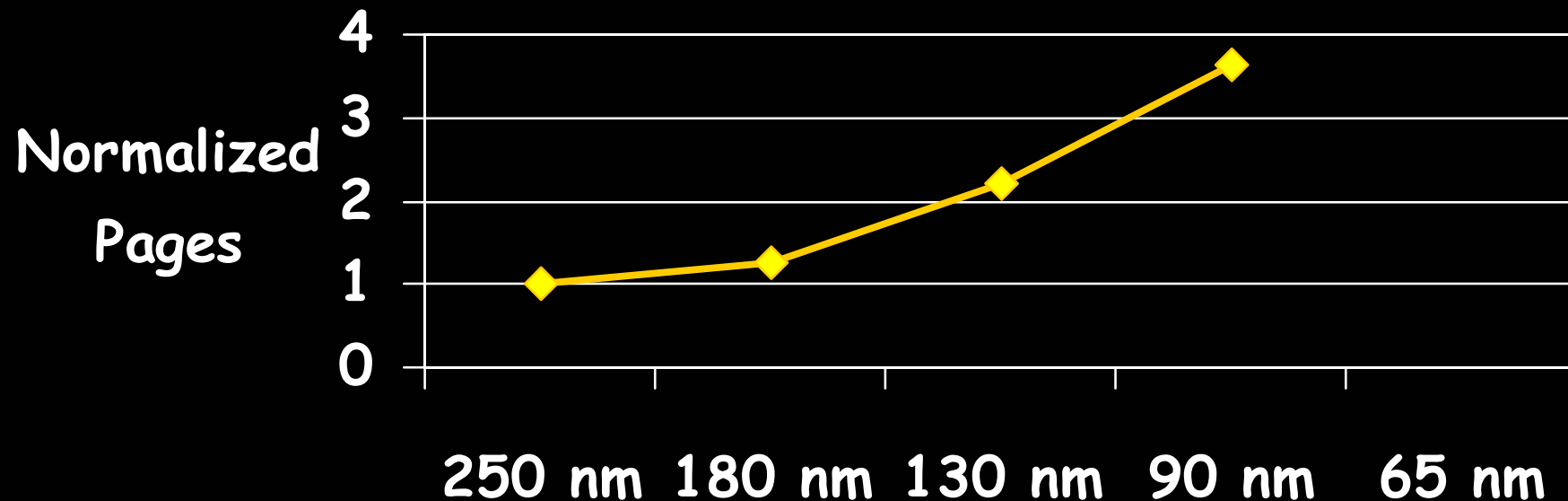
Guardbands and process variation
consume much of clock cycle, some
new design techniques needed

Very high-performance chips
(1GHz+)

cadence

What is Manufacturable?

Design Rule Complexity



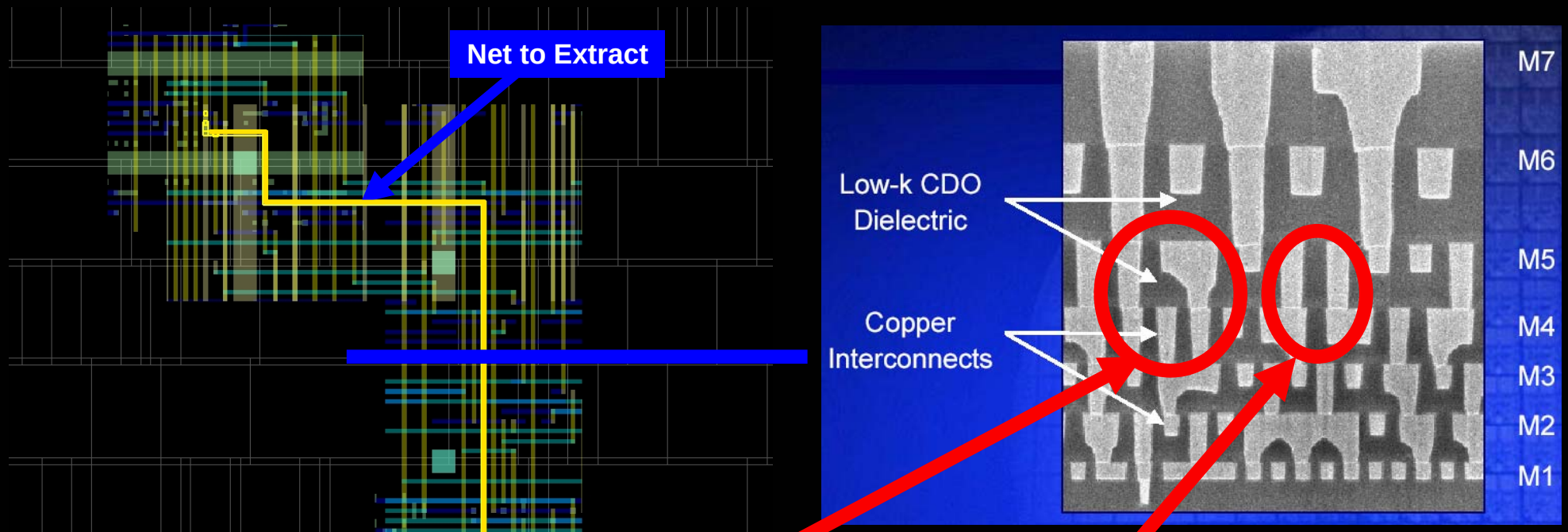
Node

Increasing lithographic complexity is driving increasingly complex design rules.

Source: Mark Mason (TI)

Modeling at 65nm and beyond

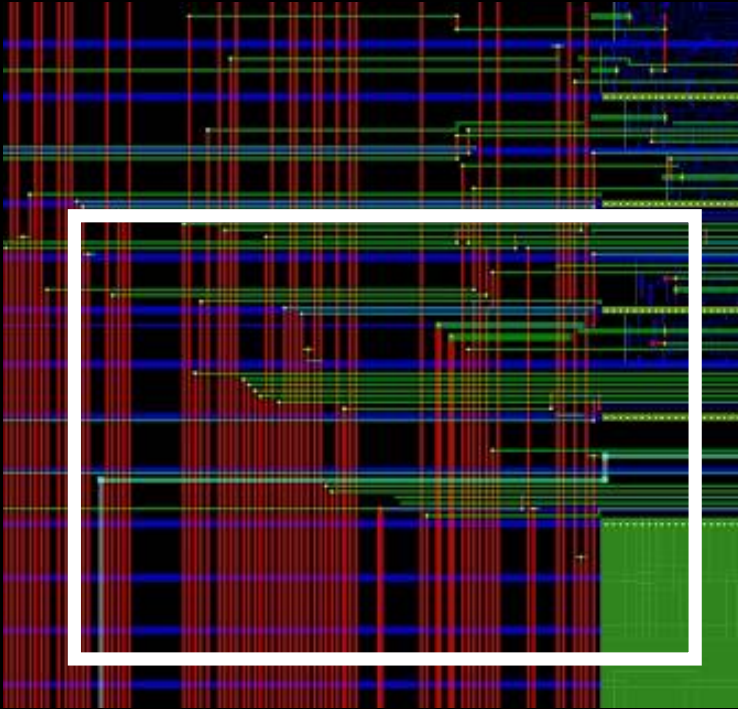
3d Pattern Based Modeling



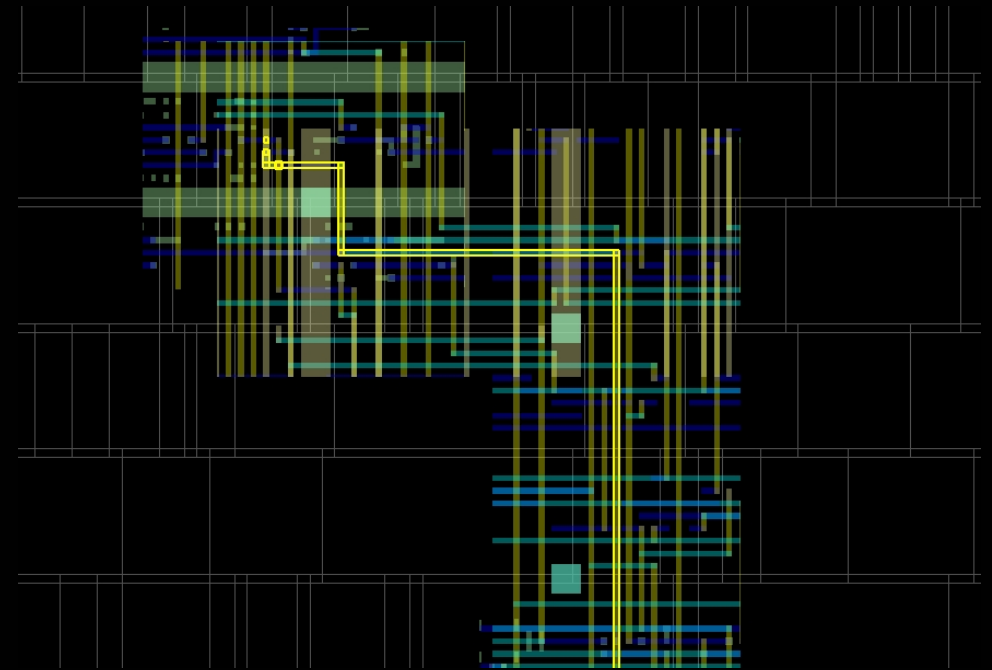
- Sidewall capacitance dominates
- Complex 3D structures

Source: David Overhauser

Physical Data Organization must evolve

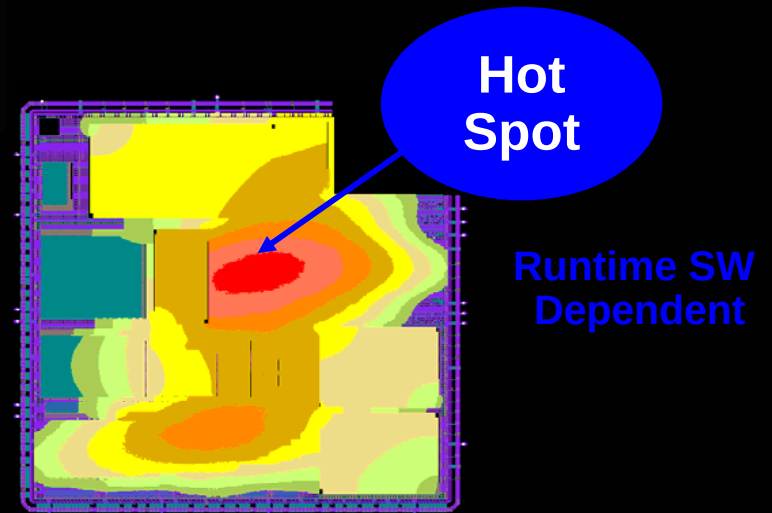
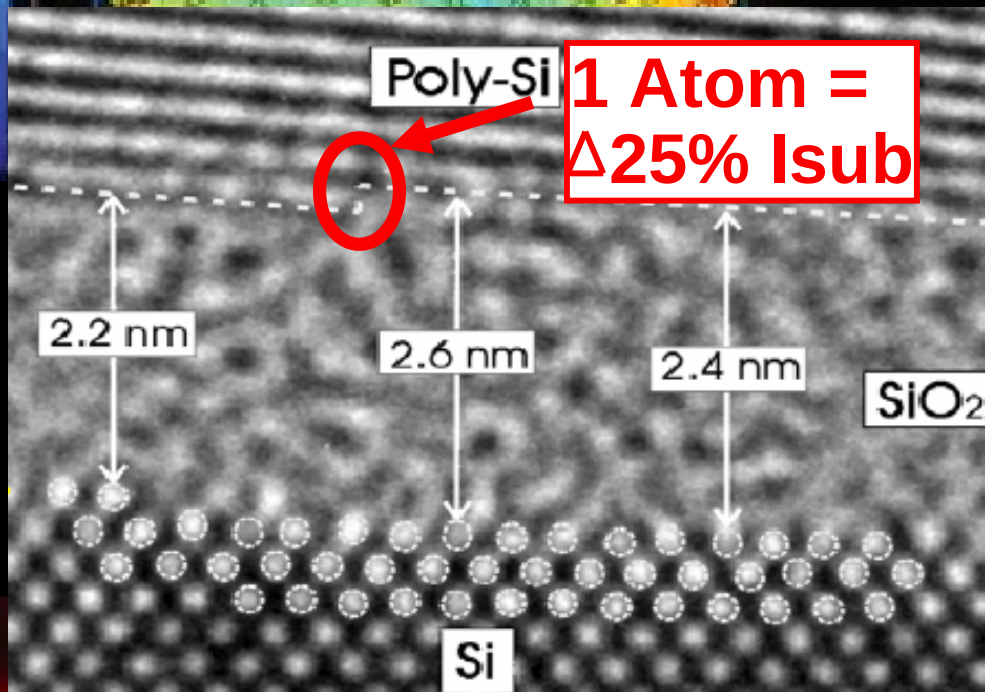
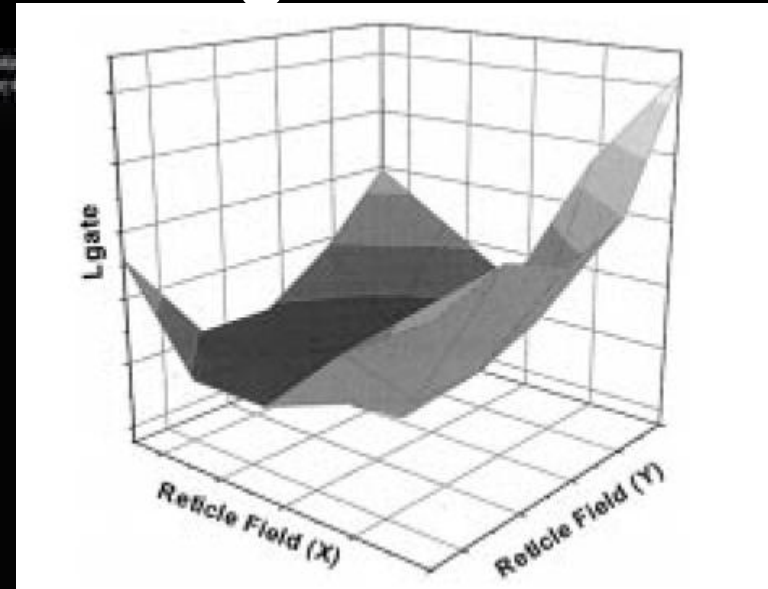
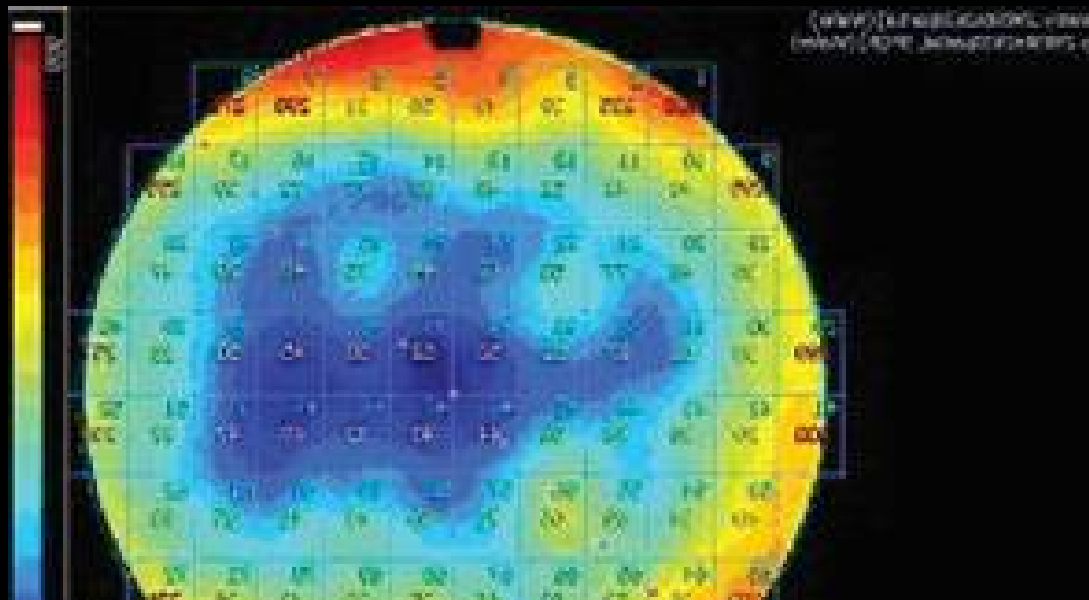


What's in the Box?

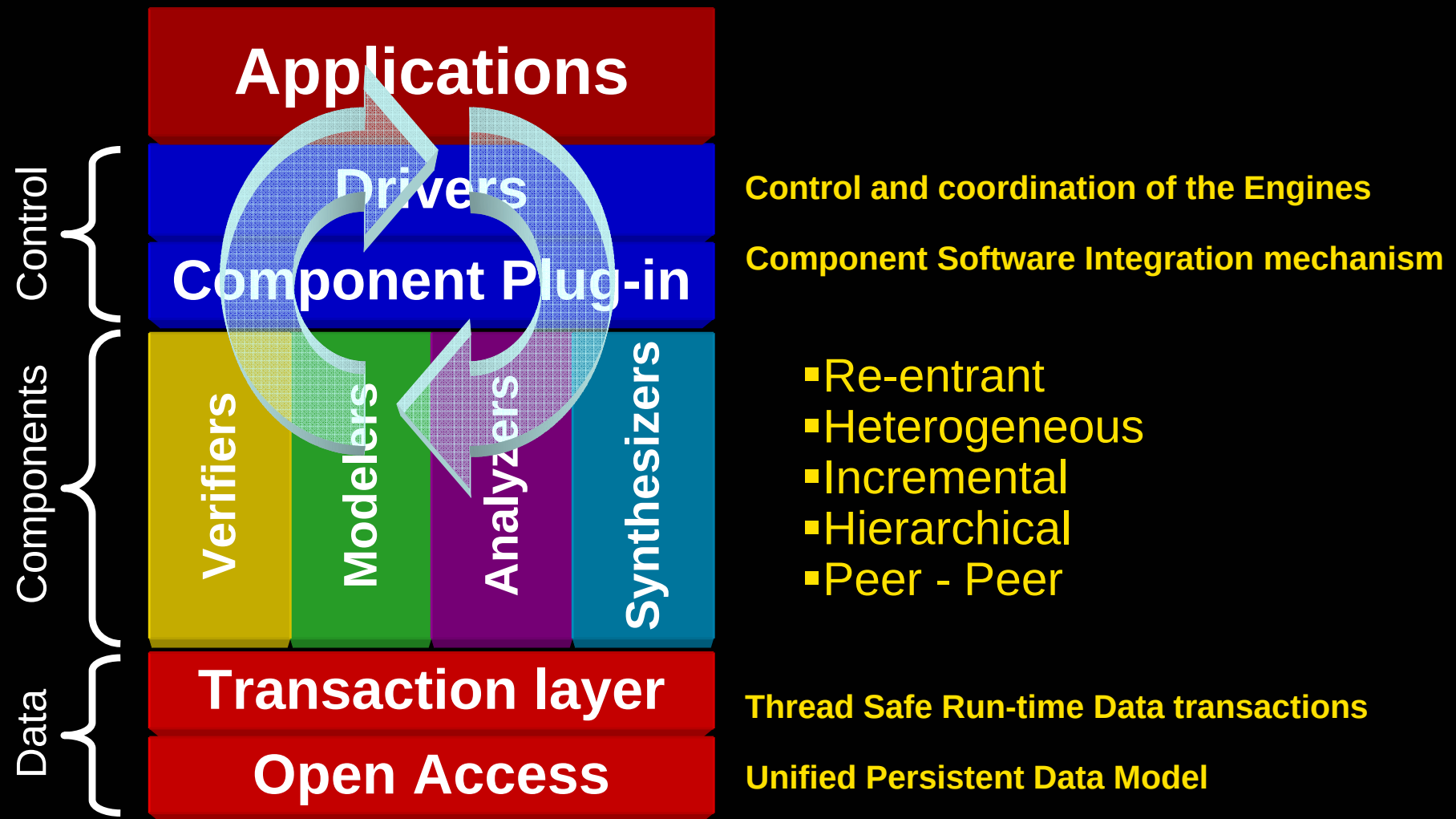


Who's my neighbor?

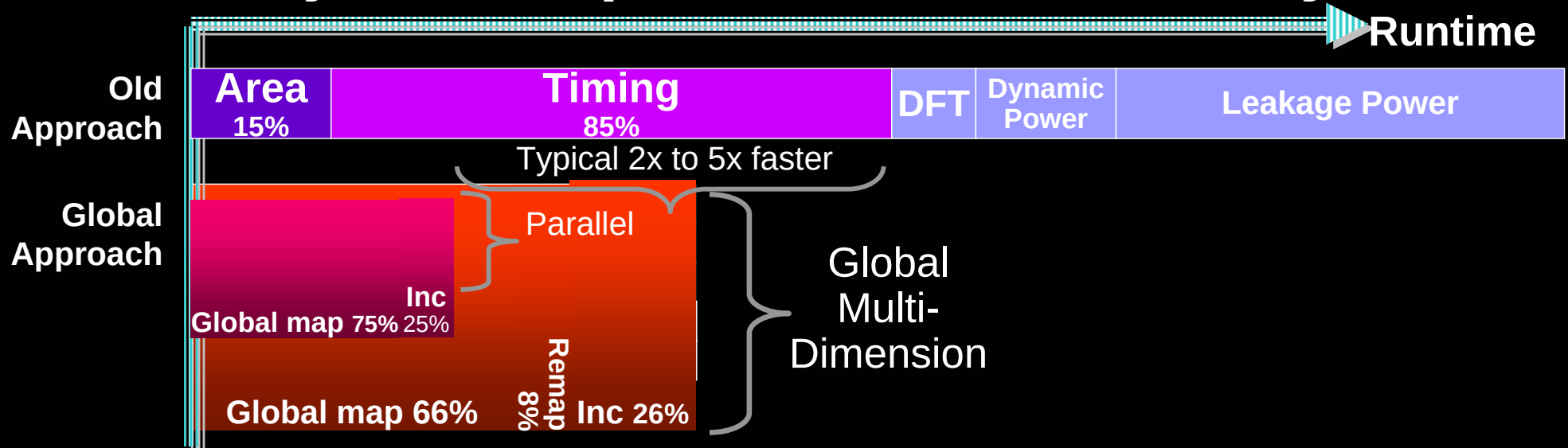
Variability is a First Class design concern



Next Gen Architecture will be needed



Multi-Objective Optimization Necessary



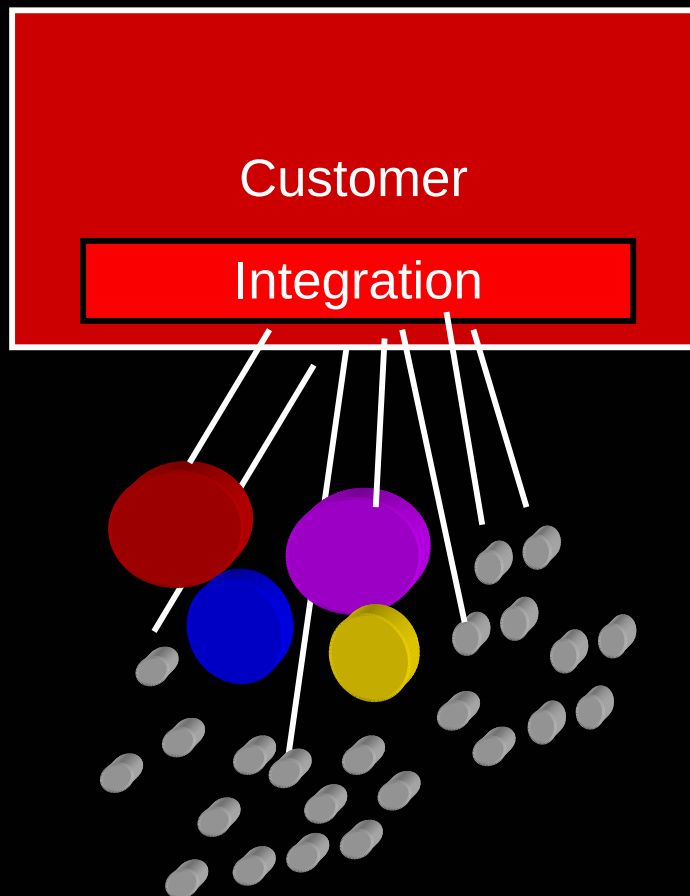
Consumer Device

- 500k gates + 10 RAMs
- 130nm process
- 5 clocks
 - Fastest=200MHz

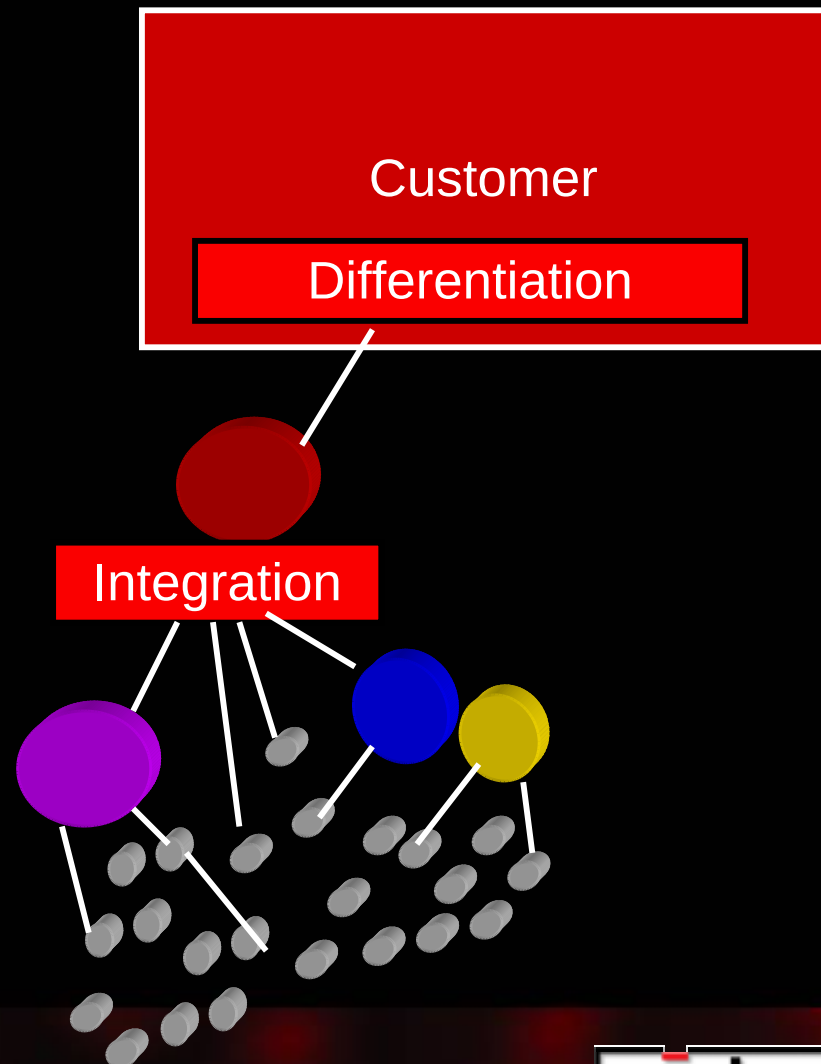


The CAD Eco-System is changing

Today



Tomorrow



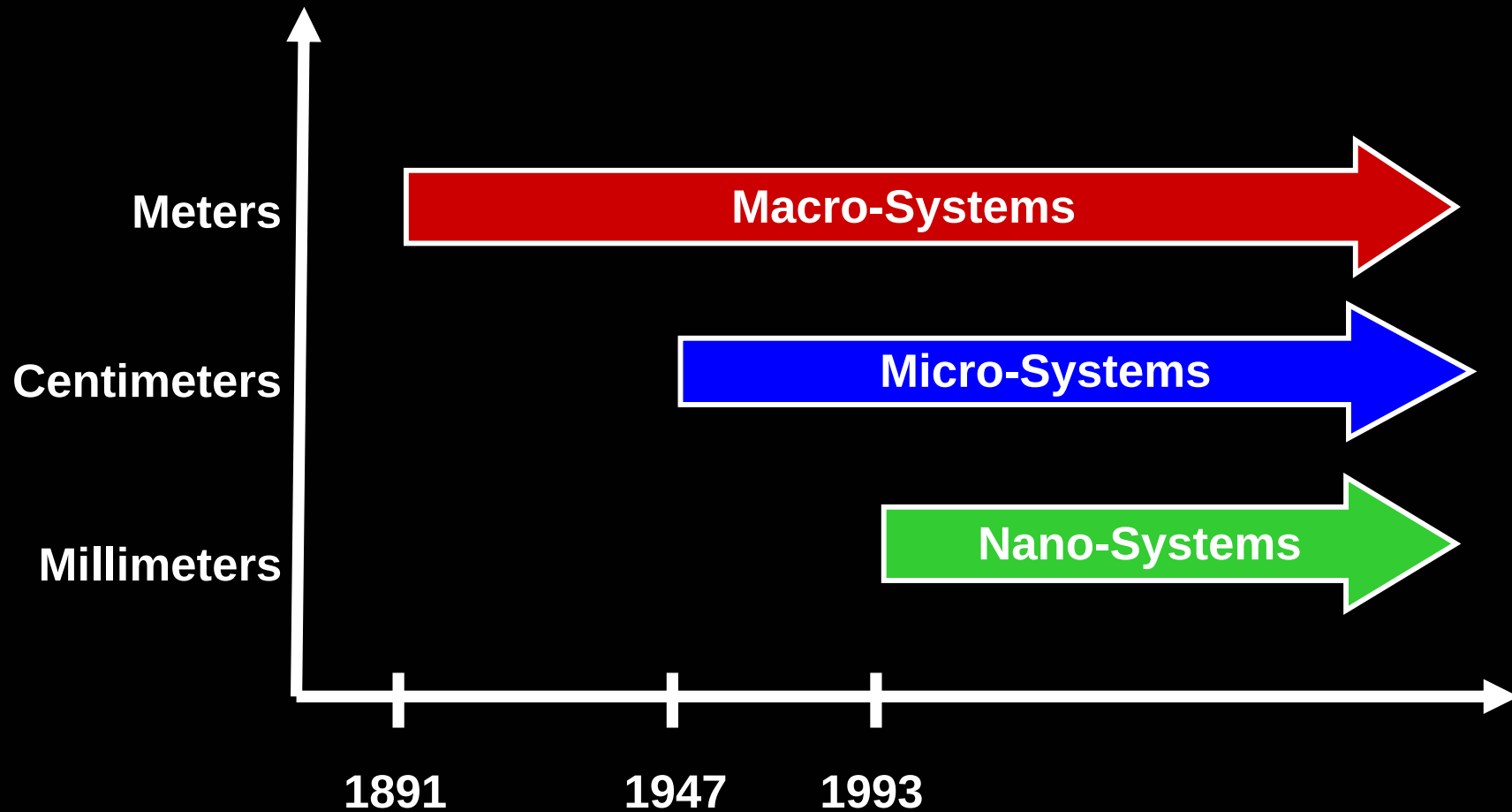
Answers to the most pressing questions about Commercial CAD today:

1. 3.5
2. The ones you would expect
3. Yes
4. No
5. Yes. Micro and Nano Systems
6. 42

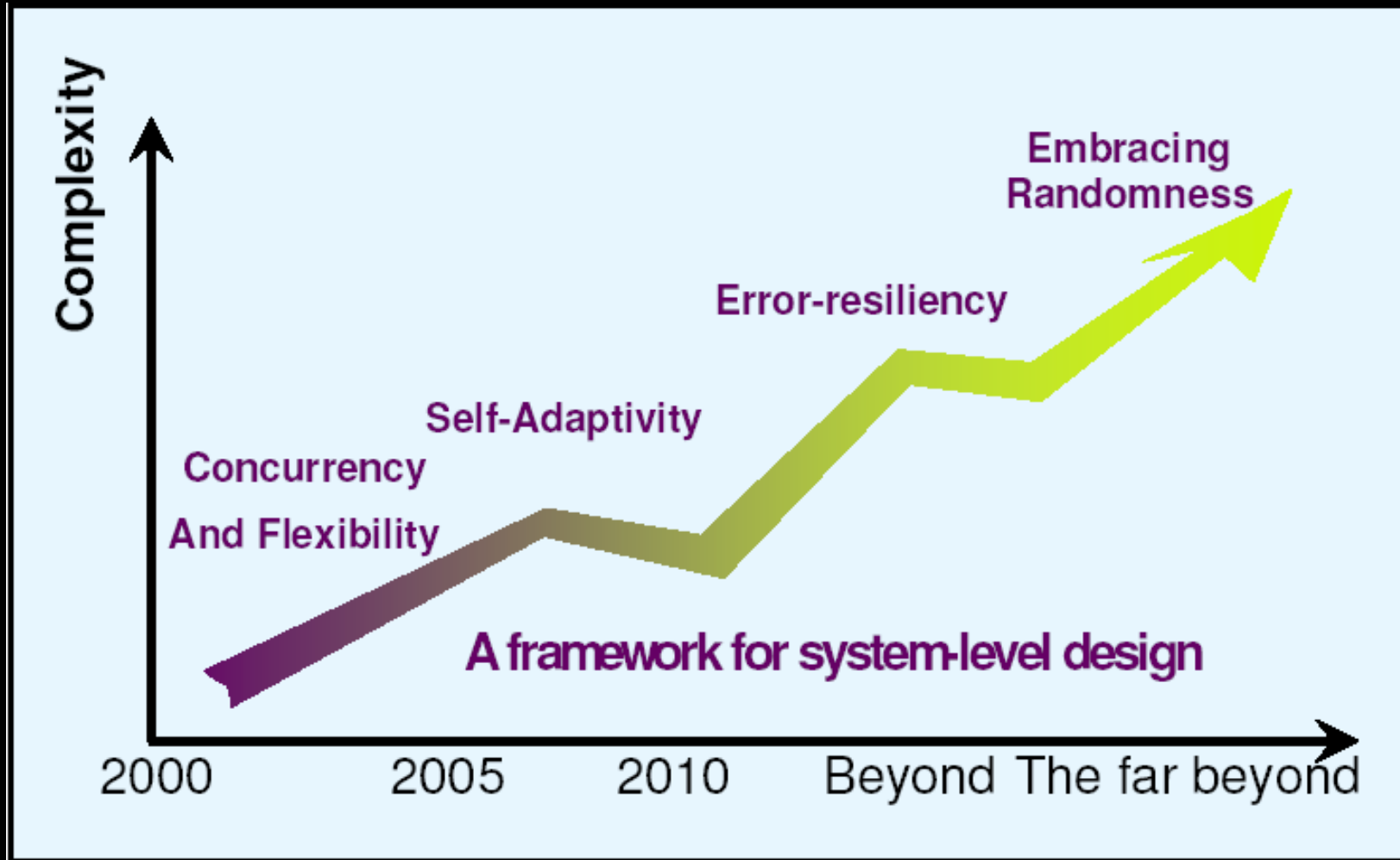
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It's the System Stupid

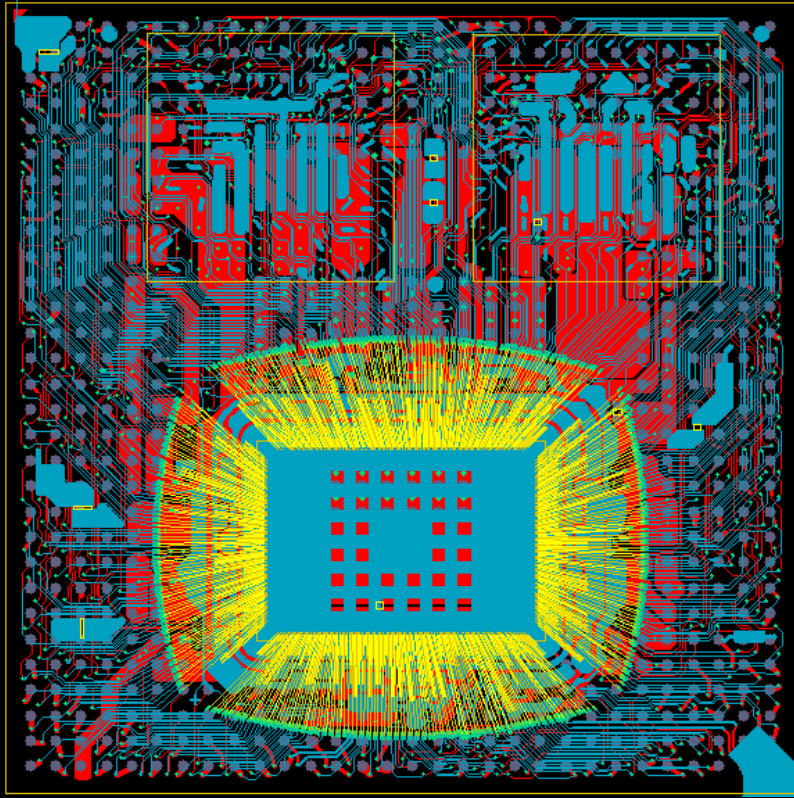


Electronic System and Architectural Design

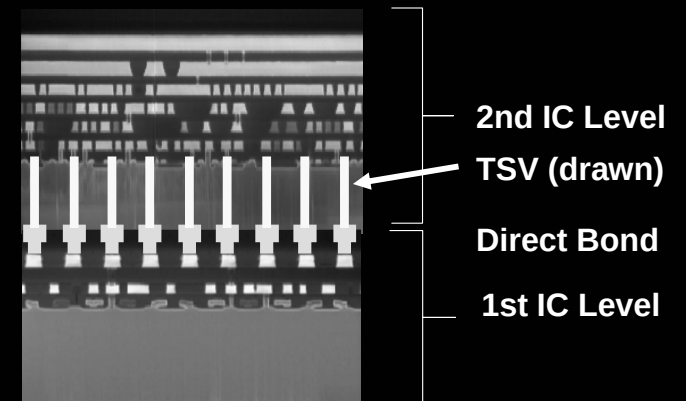
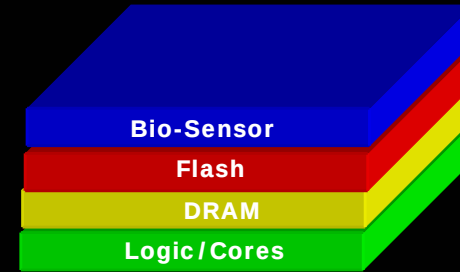


Source: Jan Rabaey UCB

Micro-Chips to Micro-Systems



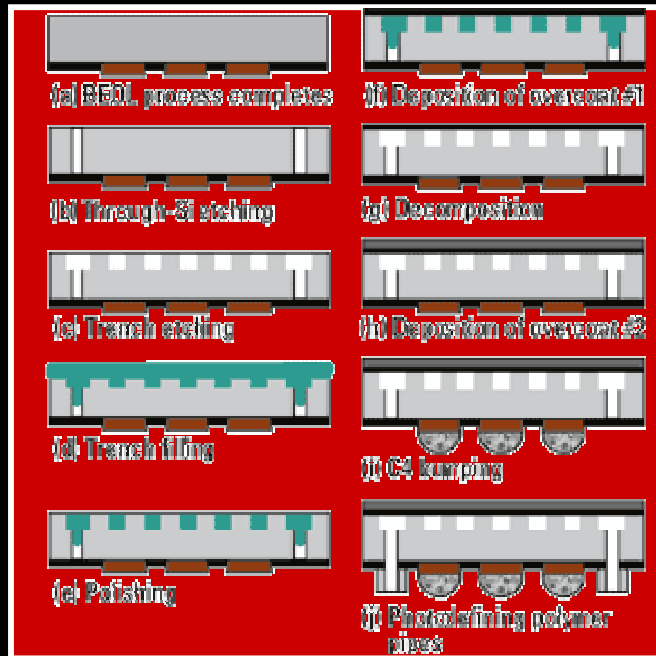
System-in-Package (SiP)



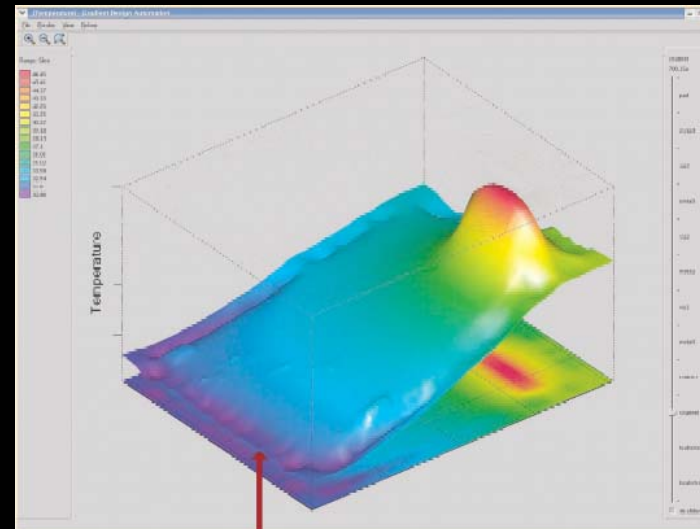
Ziptronix

3D Systems

MicroFluidics: Answers for Power?

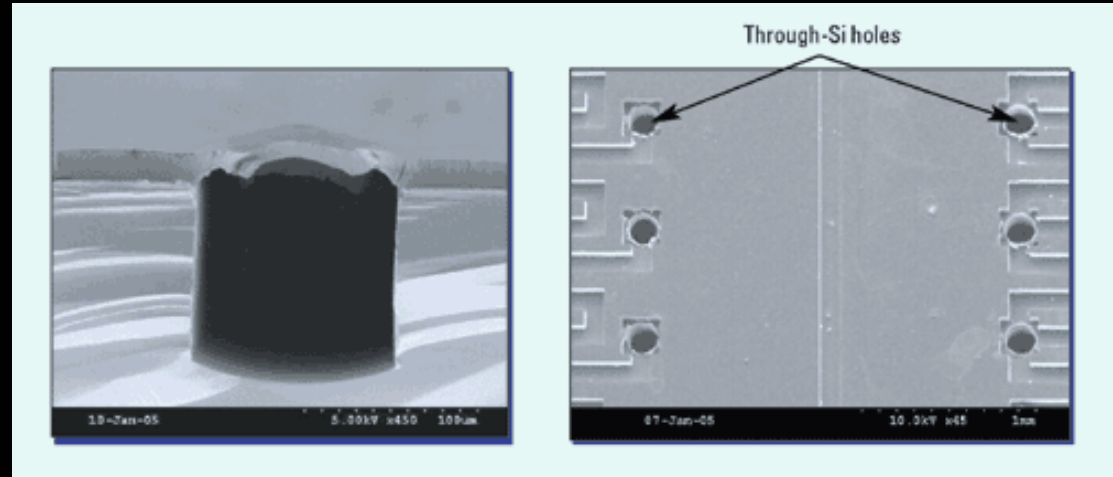


The researchers concluded it should be possible to remove a heat flux of 100 W/cm² with a pressure drop of <2 atmospheres.



“Firebolt™”
Chip level
Thermal Analysis

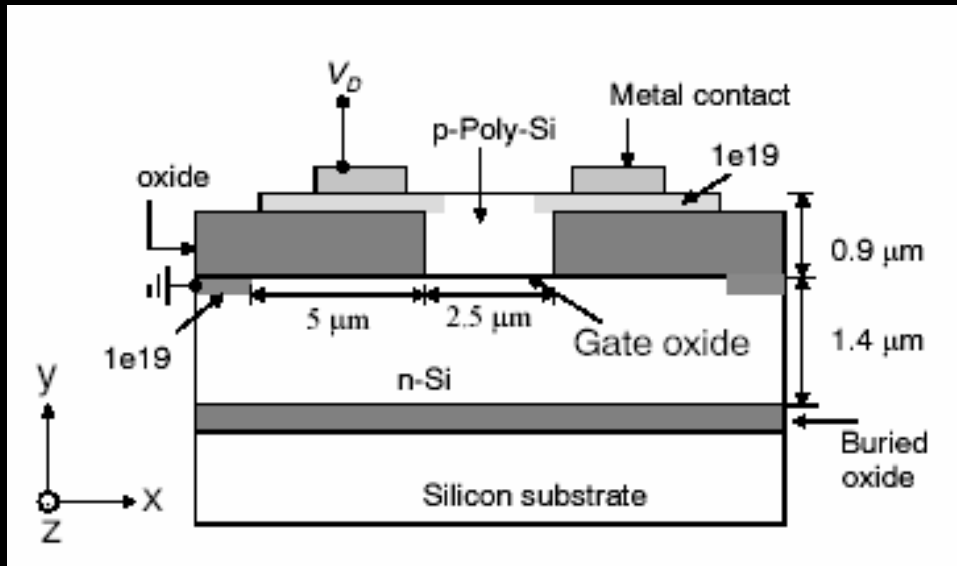
GRADIENT



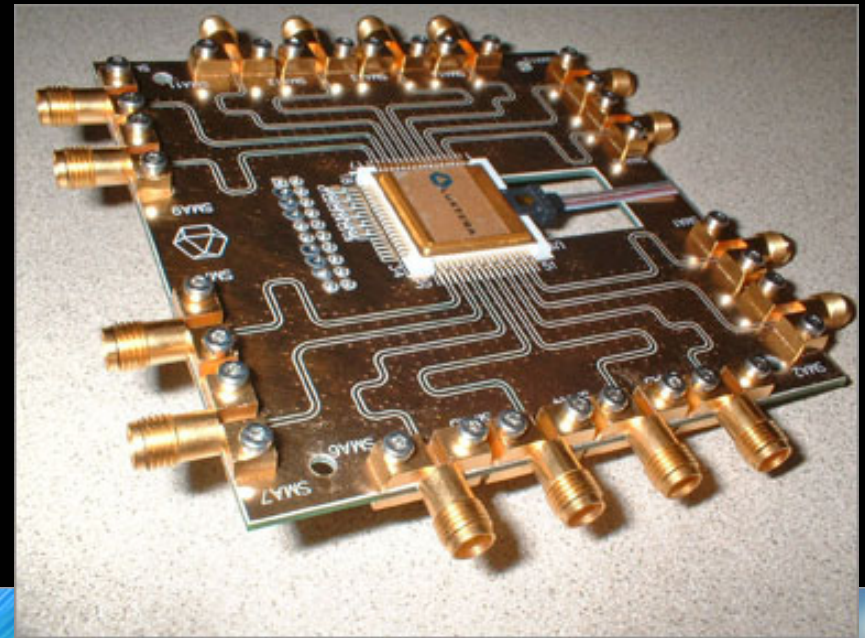
Microfluidic Channels

(Source: Georgia Institute of Technology)

Photonics: Next-Gen Micro-Optical Systems



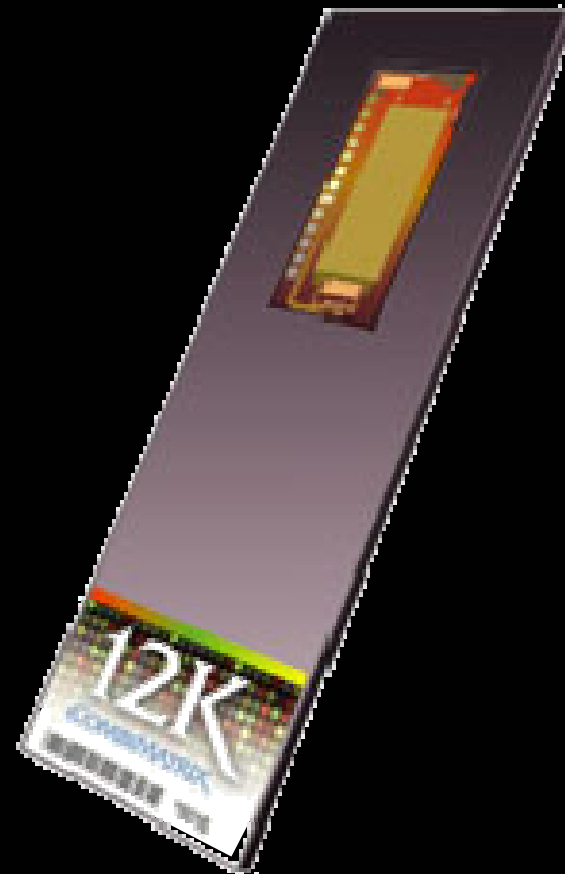
SOI MOS WaveGuide



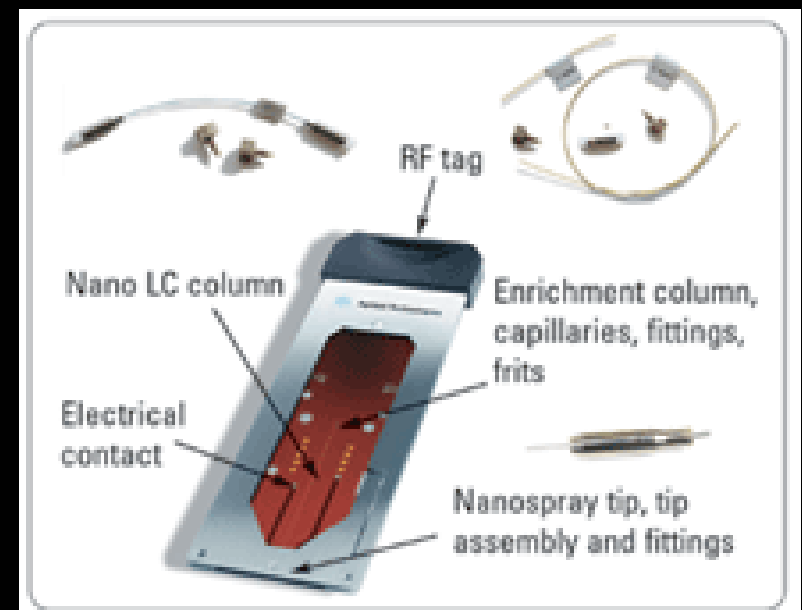
Luxtera 10Gbit CMOS Photonics Platform

CMOS PHOTONICS™

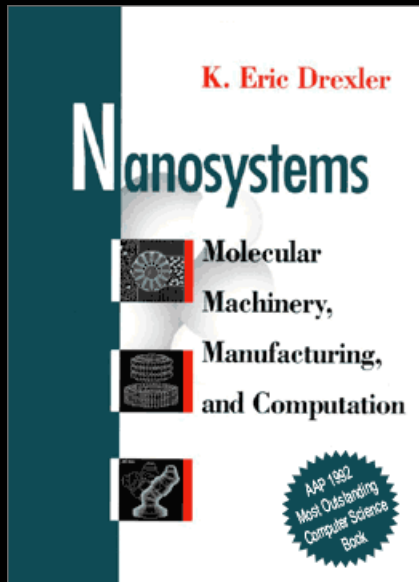
Lab-on-a-chip: Next-Gen Micro-Bio Systems



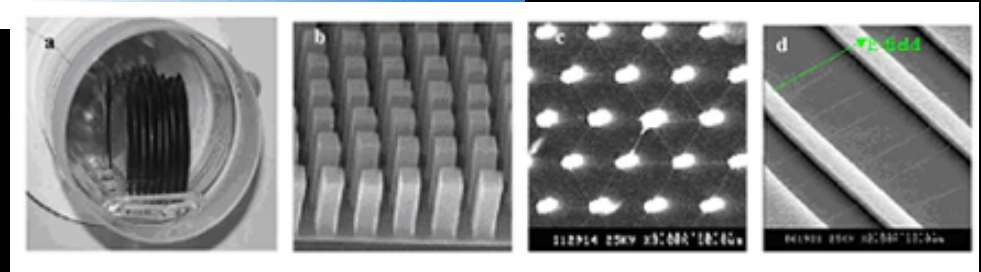
Next-Gen Molecular Analysis



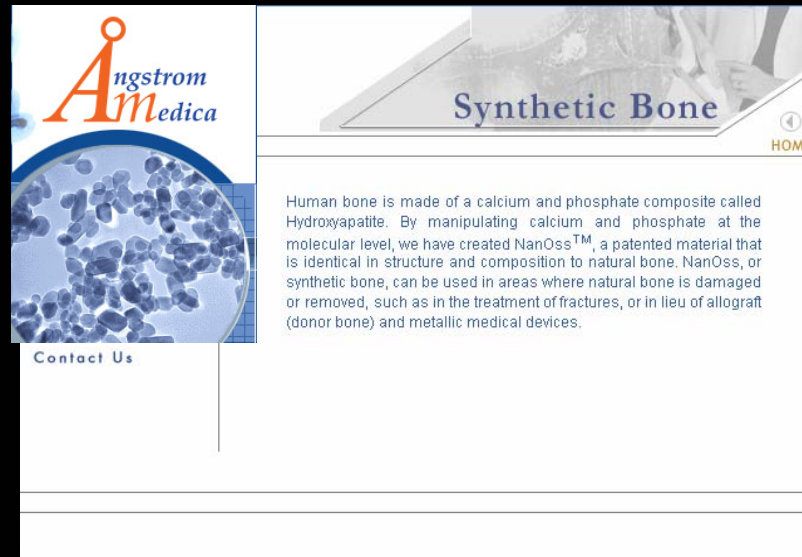
Nano-Systems: The Next Frontier



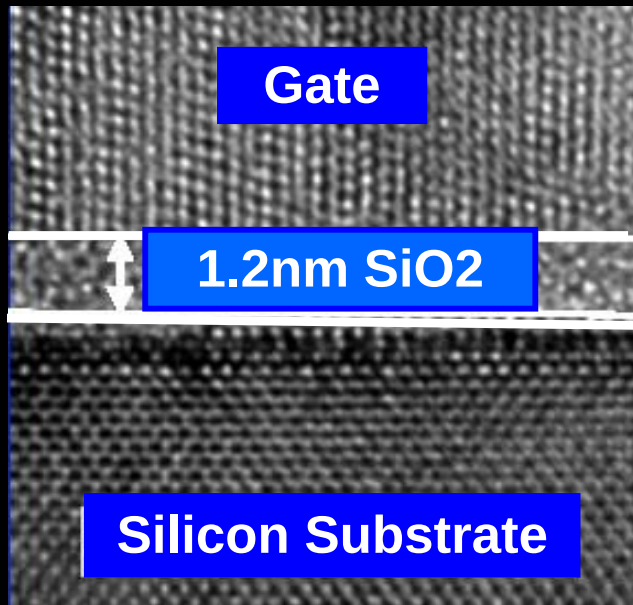
Artificial Blood: Robert A. Freitas Jr.



Carbon Nano-tube Manufacturing

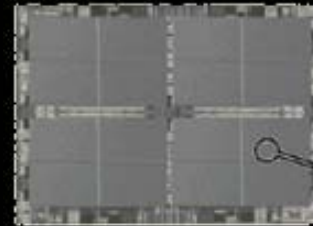


Evolving CMOS: One material at a time



65nm Gate Oxide

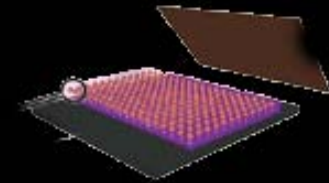
1mb Molecular DRAM



~1nm



Molecular
Storage
Element

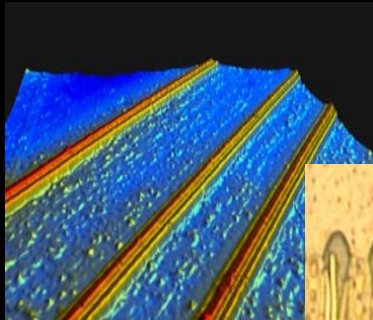


ZettaRam
Memory
Cell

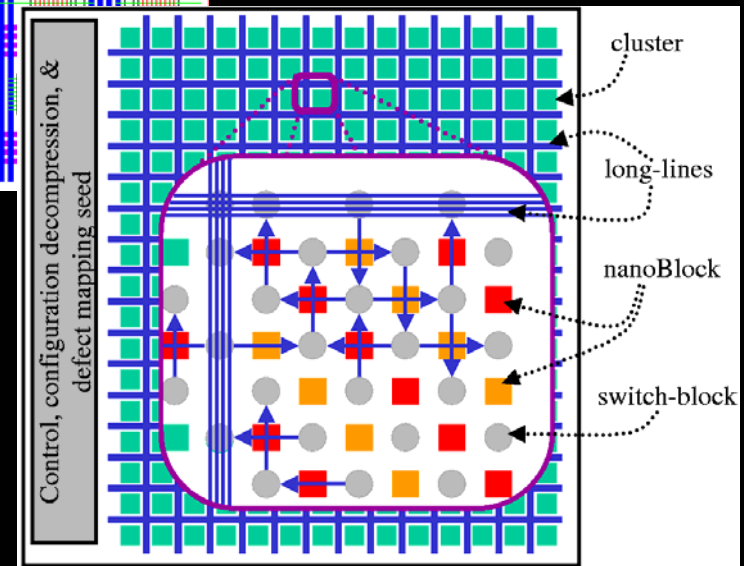
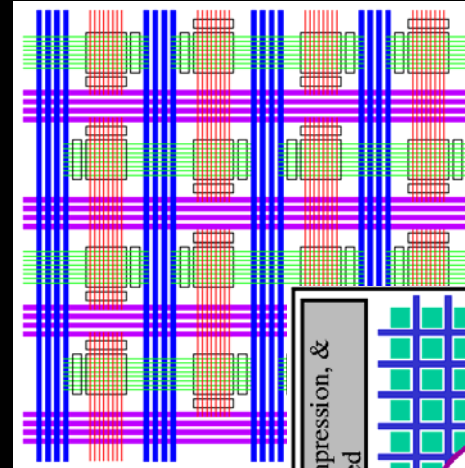
Molecular Material

Nano Computing

Wires:
NanoTubes

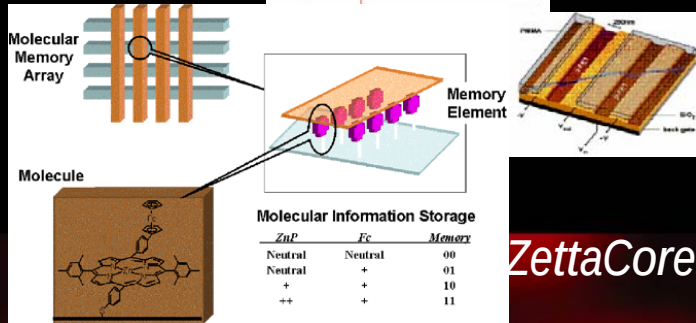
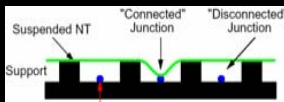


Gates:
NanoFabrics



+

Devices:
Memory, Gates



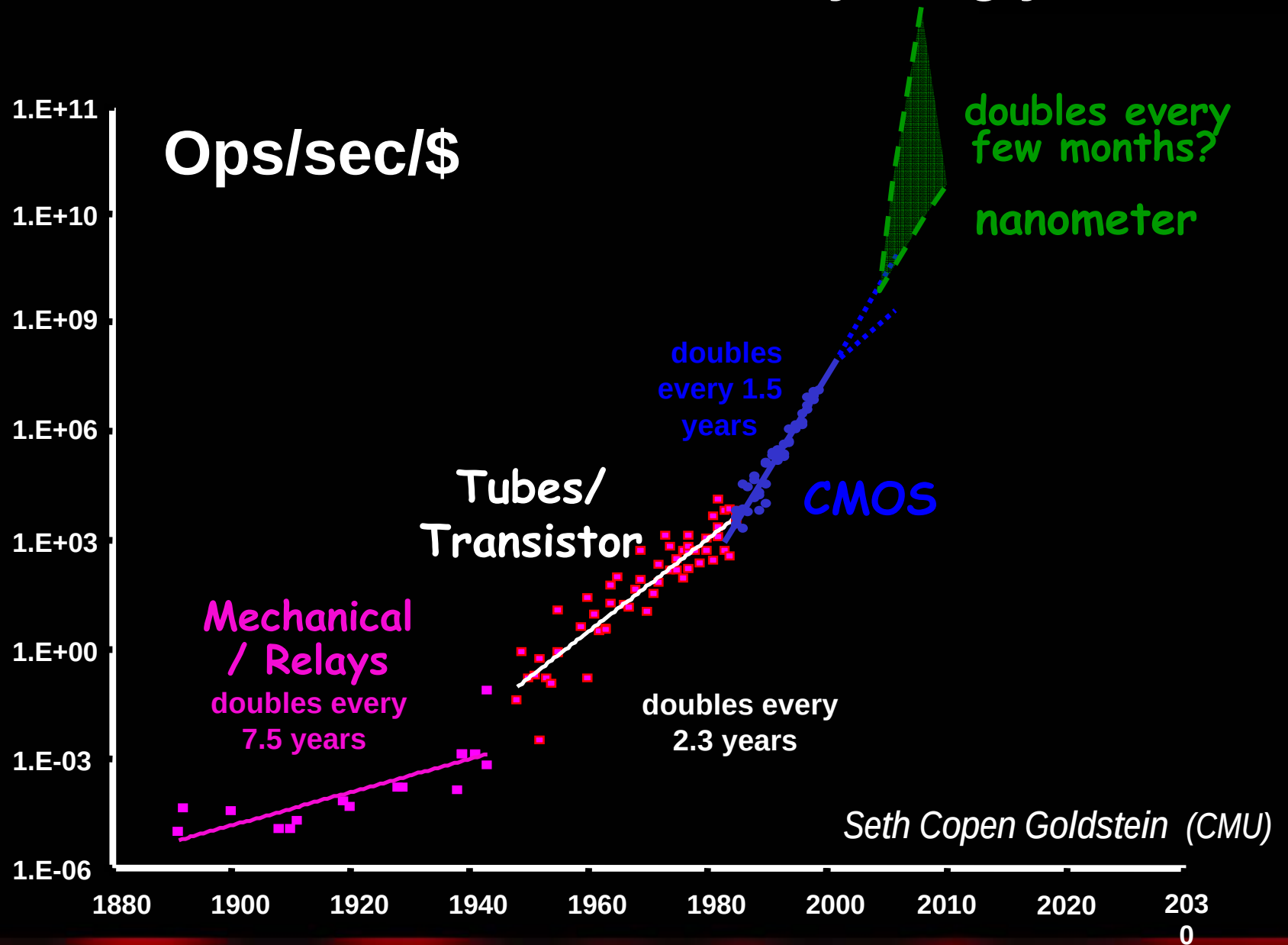
GigaGate Capacity!

ZettaCore Memory

After: Butts, DeHon, and Goldstein (ICCAD 2002)

cadence

Moore's Law: You haven't seen anything yet!



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- Conclusions

Conclusions: More Answers than Questions

- No
- Tremendous Opportunities in Micro and Nano Systems
- Modeling, Analysis, Optimization
- EE's, CS's, Bio, Chemical, Medical, Mechanical, Optical, Physics, Mathematics
- Yes

Conclusion: The Whole Story

- Is Commercial EDA Dead?
 - **No**
- Why not?
 - **Tremendous Opportunities in Micro and Nano Systems**
- In what fundamental areas?
 - **Modeling, Analysis, Optimization**
- What will the micro and nano-system design teams look like?
 - **EE's, CS's, Bio, Chemical, Medical, Mechanical, Optical, Physics, Mathematics**
- Are you glad you are still in CAD?
 - **Yes!!!**