IEEE SW Test Workshop

Semiconductor Wafer Test Workshop

Wafer level testing
Challenges and opportunities
Scope: CPU + Chipsets

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Overview

- Moore's Law

Last 10yrs

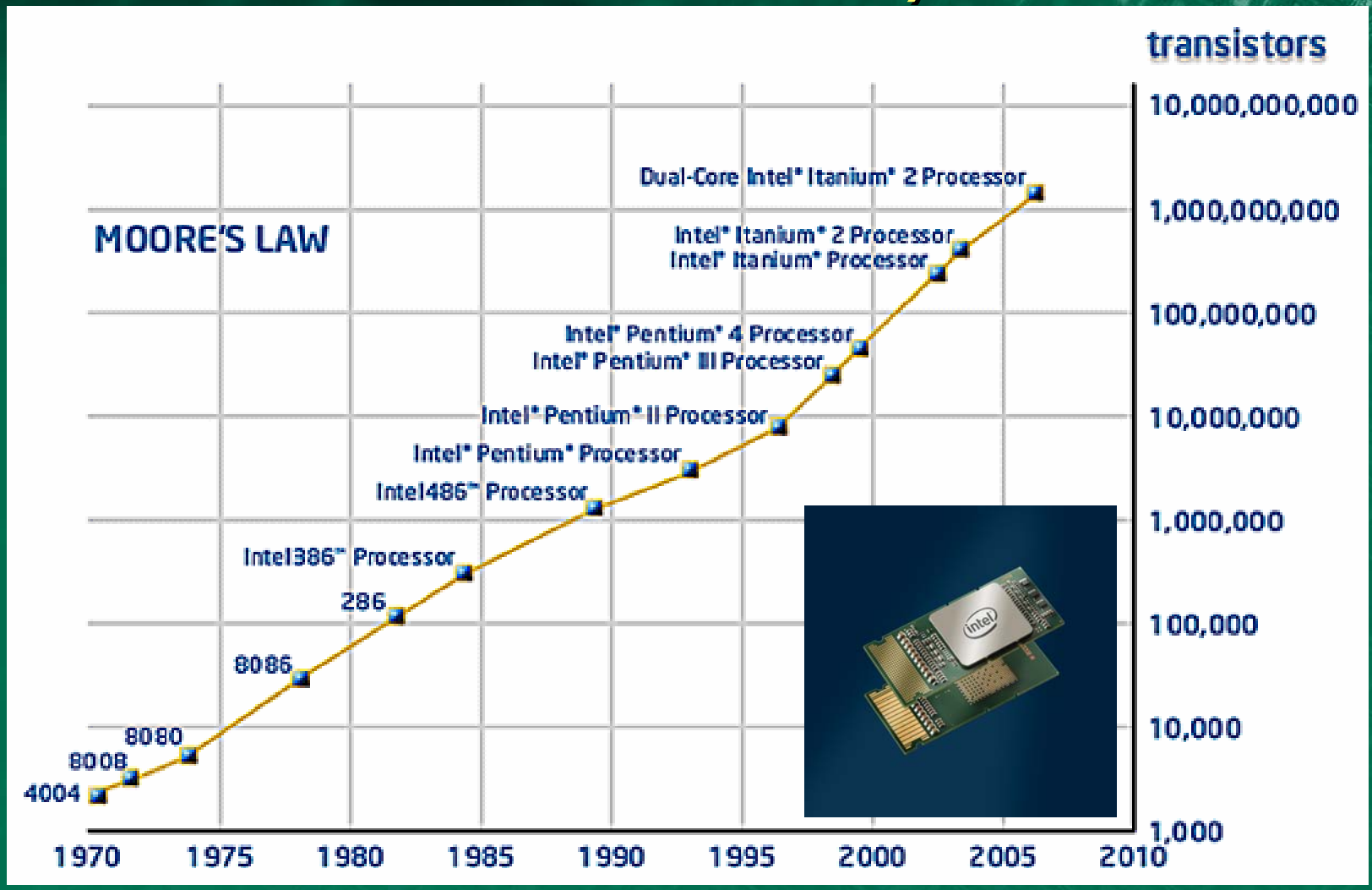
- Test cost prediction from 1990s
- Equipment development impact: CMT

Future Challenges

- Current cost projections
- Example of cost reduction through SIU
- Other vectors of test cost

- A word on collaboration
- Summary

Moore's Law: Our friend, our challenge



http://www.intel.com/technology/mooreslaw/index.htm

How to test 2X transistors/2yrs cost-effectively with high quality?

Recapping the Last 10yrs

Test Cost Trends: Circa 1997

Each generation:

- 2x transistors

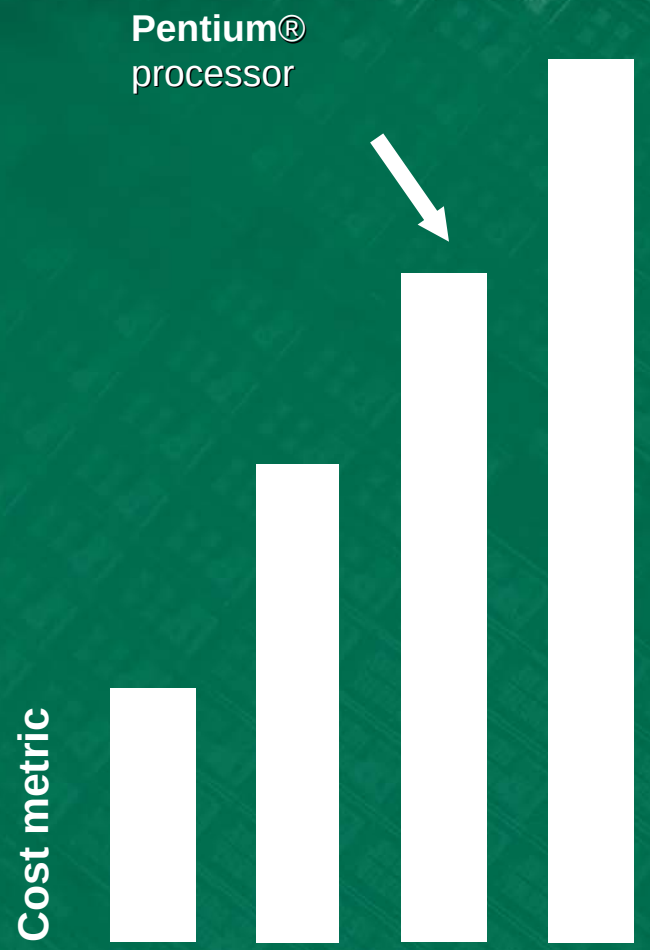
➔ test complexity increases

➔ longer test time

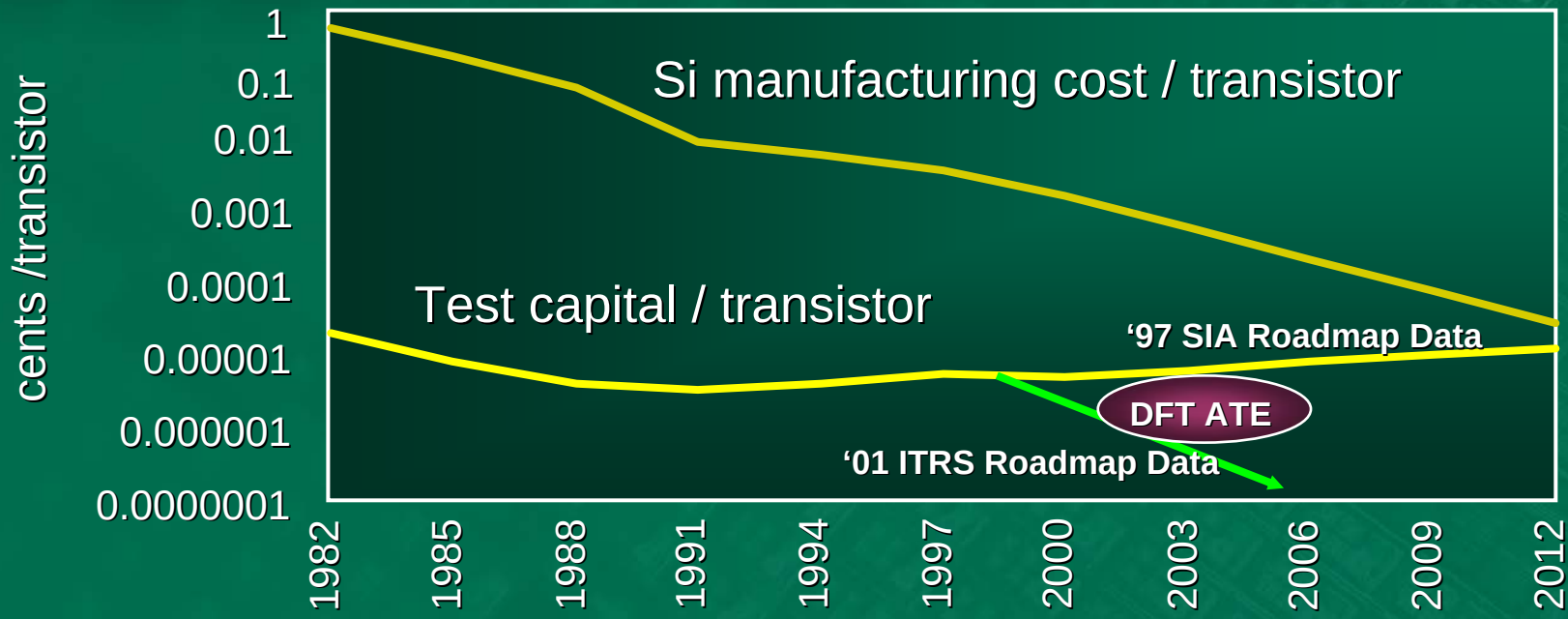
- 2x performance

➔ tester speed reqt increases

➔ more expensive testers

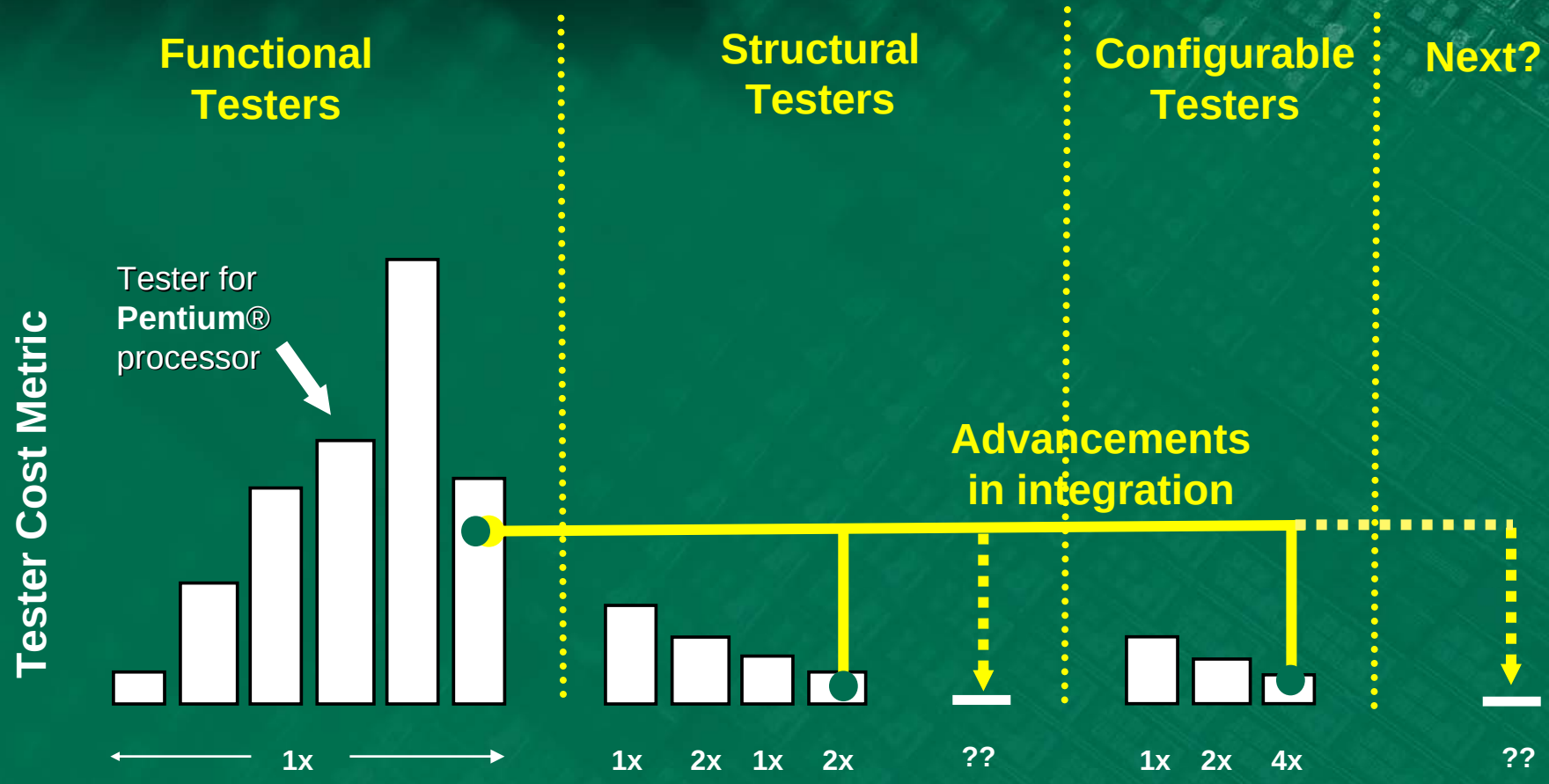


1997 SIA Roadmap – Alarming!



- 1997: Predicted per xtor test cost to exceed fabrication cost
- 2001: DFT & Structural Test reduce equipment cost & complexity
  - **Lower requirements on I/O data rate, #IO, etc**

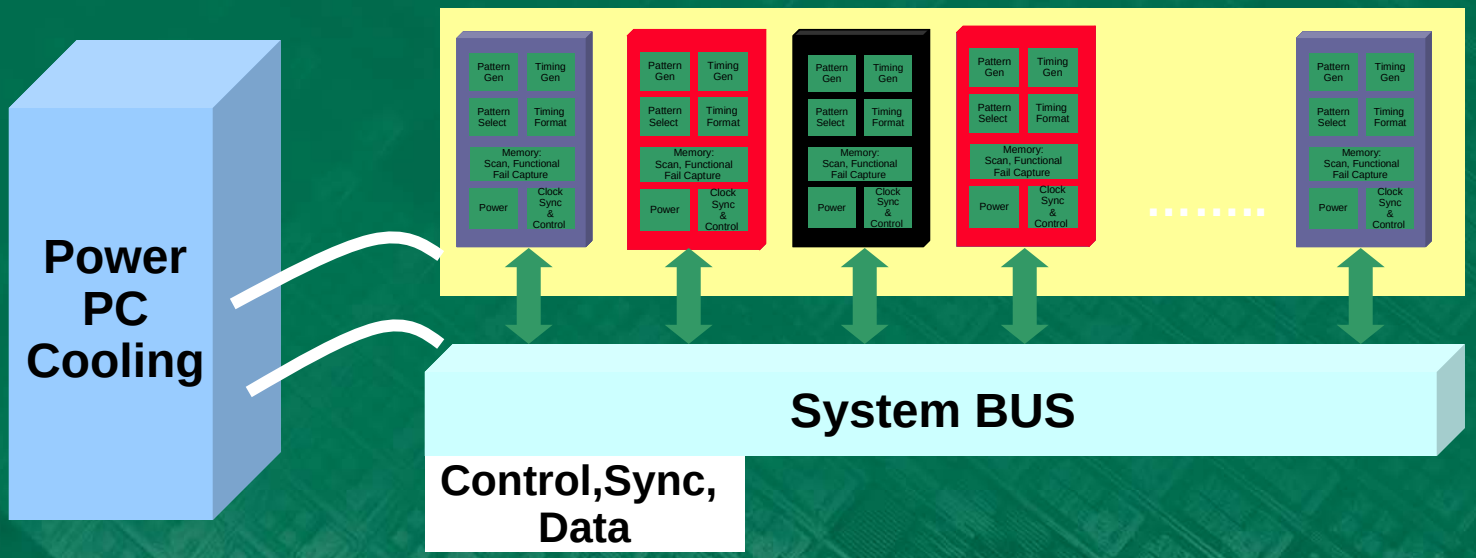
1. Developing New Tester Architectures



- Per site wafer tester is 1/10 of 1995 tester
- Distribute tests. Maximize on cheapest tester
- Introduce methods to confine requirements within tester capability
- Develop equipment for increased performance at lower cost

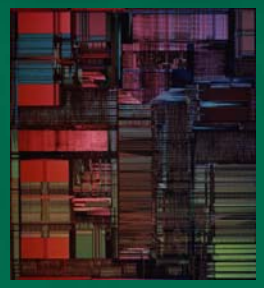
Configurable Modular Tester (CMT) and Open Architecture

- Common tester shell with replaceable boards
  - True parallel test without any penalty
- Scalable system from commodity through high end
  - Adaptable to changing production demands (i.e. CPU, chipsets, communication products, …)
  - Upgradeable as new test technology is developed



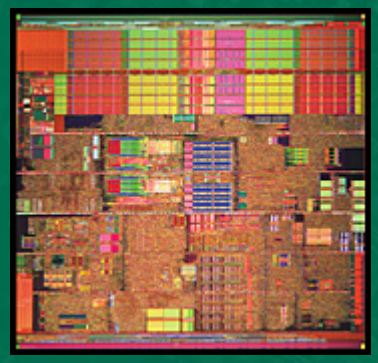
Intel Test Cost Trends Today

Intel® Pentium® Processor on 350nm Technology



1995 - 133MHz
3.3M transistors

Intel® Pentium 4® Processor on 90nm Technology



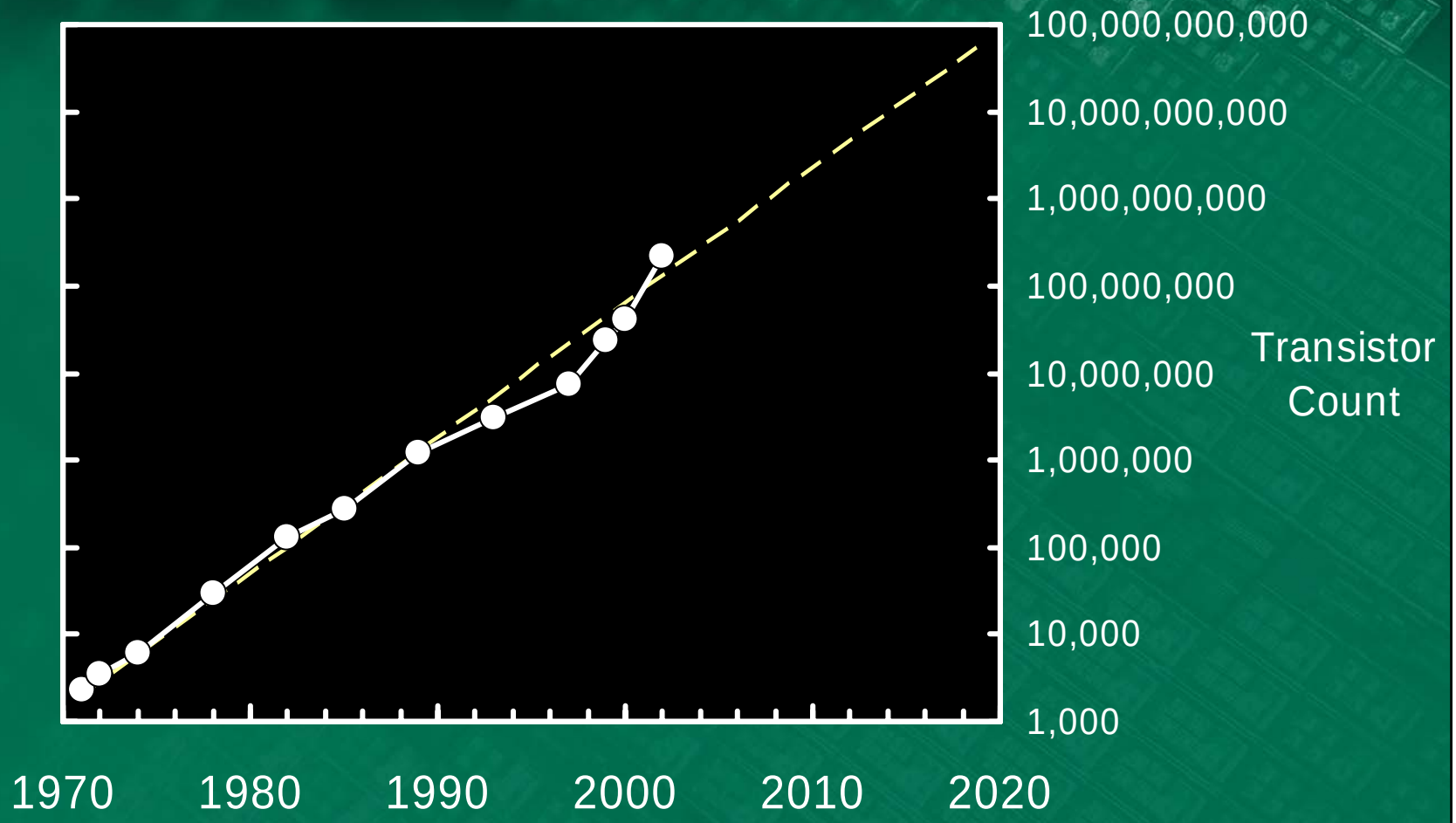
2004 - 3.8GHz
125M transistors

- 65nm CPU's have >~80x as many transistors as Pentium® processor but cost less to test

Cost increase projections from 1997 were effectively curbed with cooperative collaboration on Test equipment arch (and DFT)

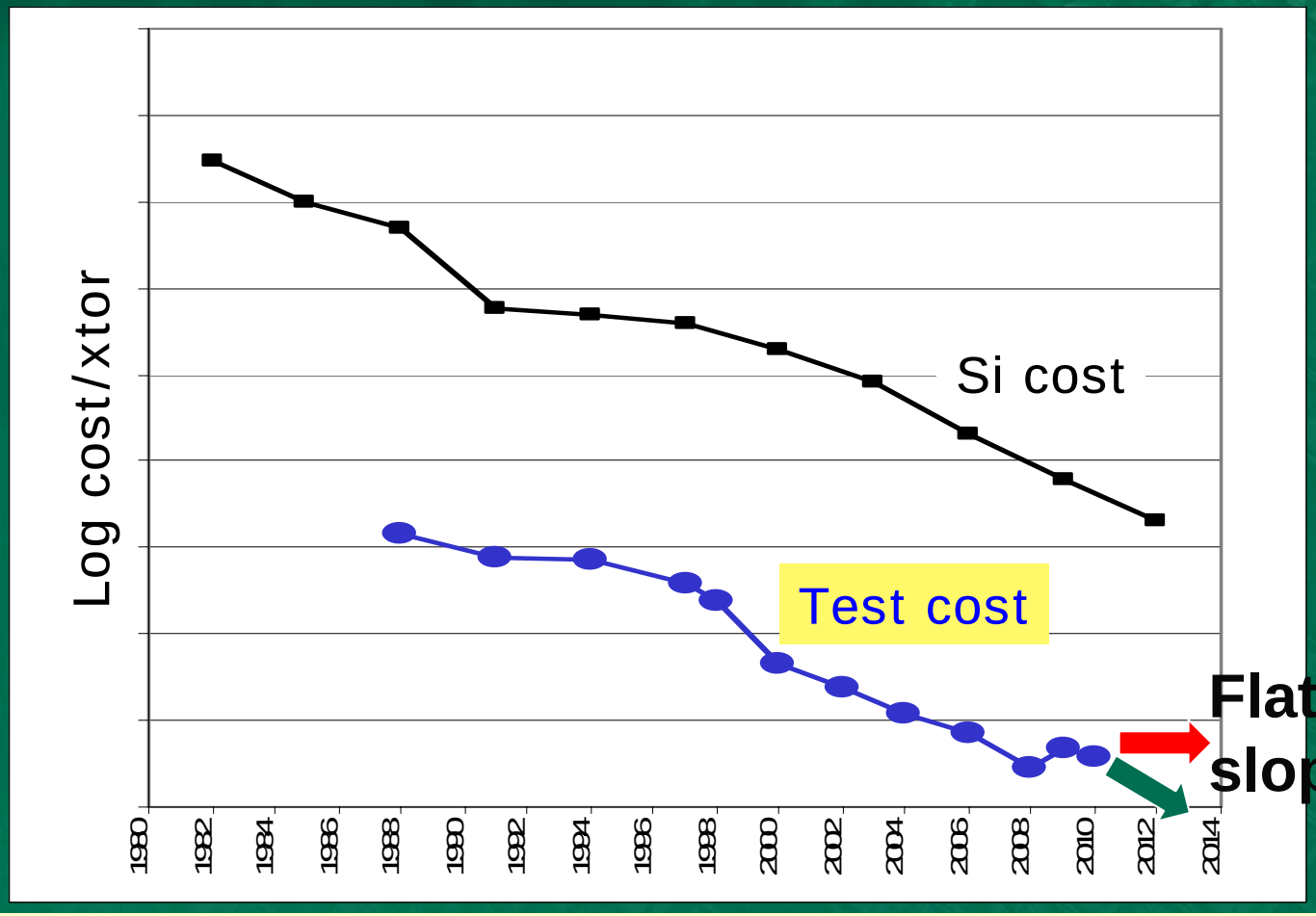
But, going forward ….

Moore's Law is Alive and Well



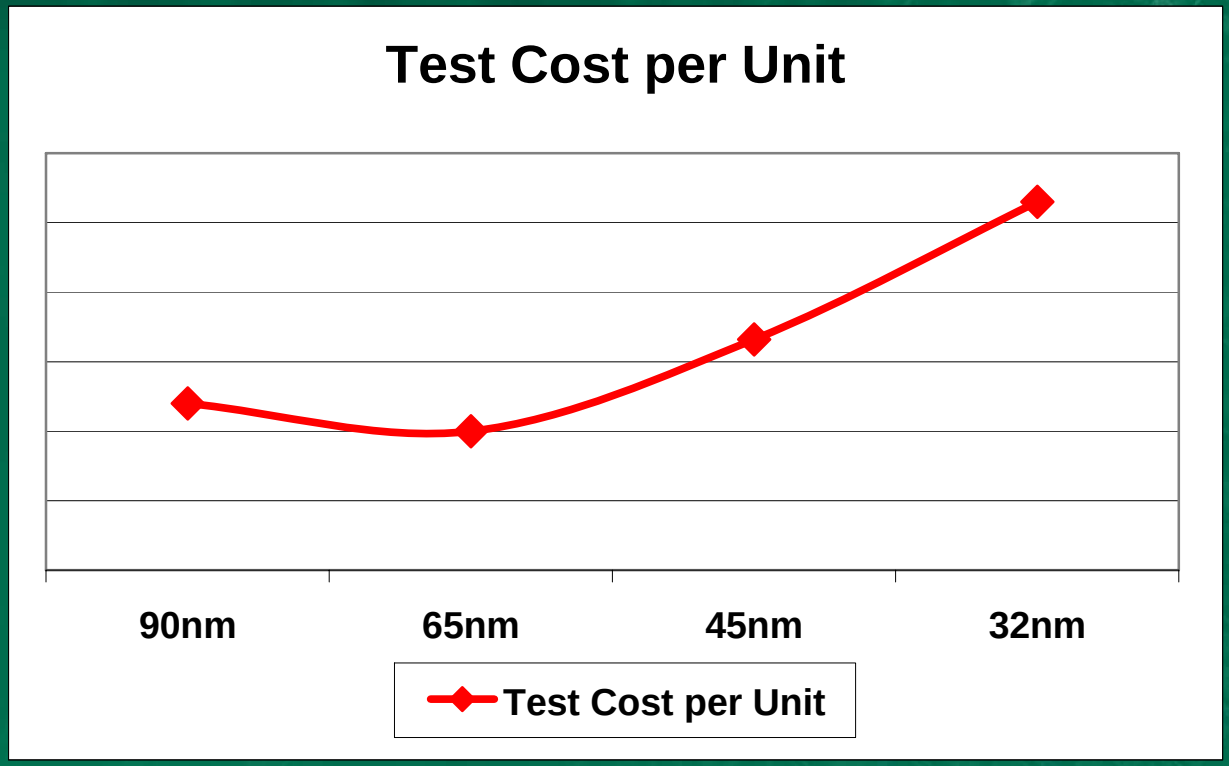
Finding the path to 100 Billion transistor devices
Need to reduce test cost/xtor by ~100X in 10-15yrs

Disturbing trends re-emerging …



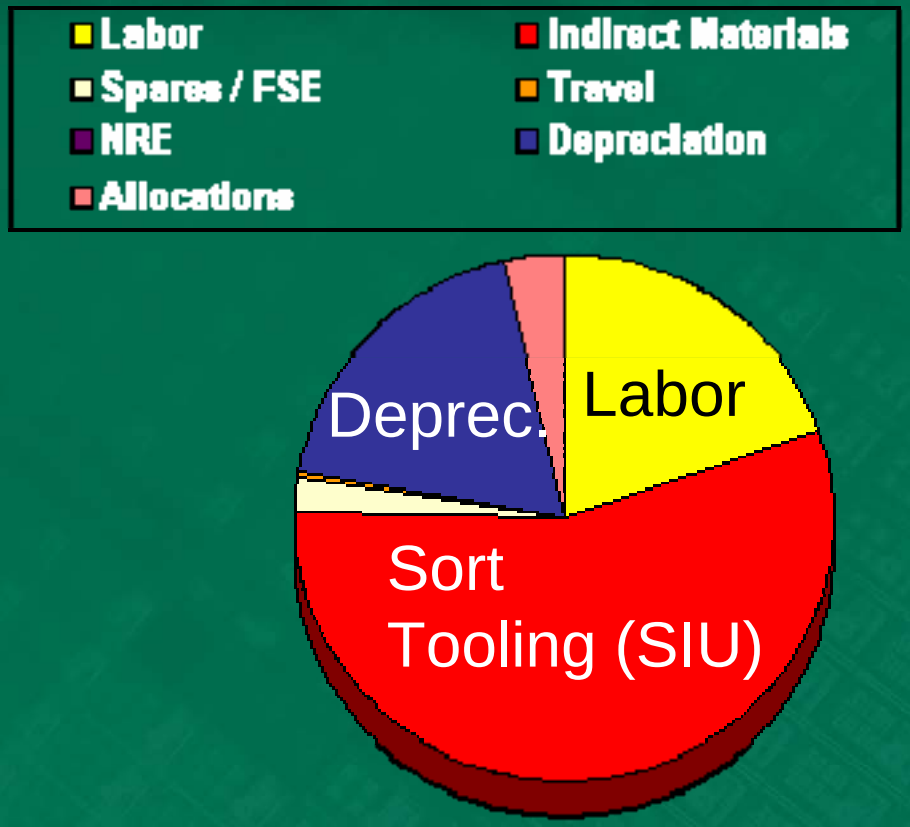
Need actionable plan to cut cost by 10x in ~5yrs

Something needs to change ….



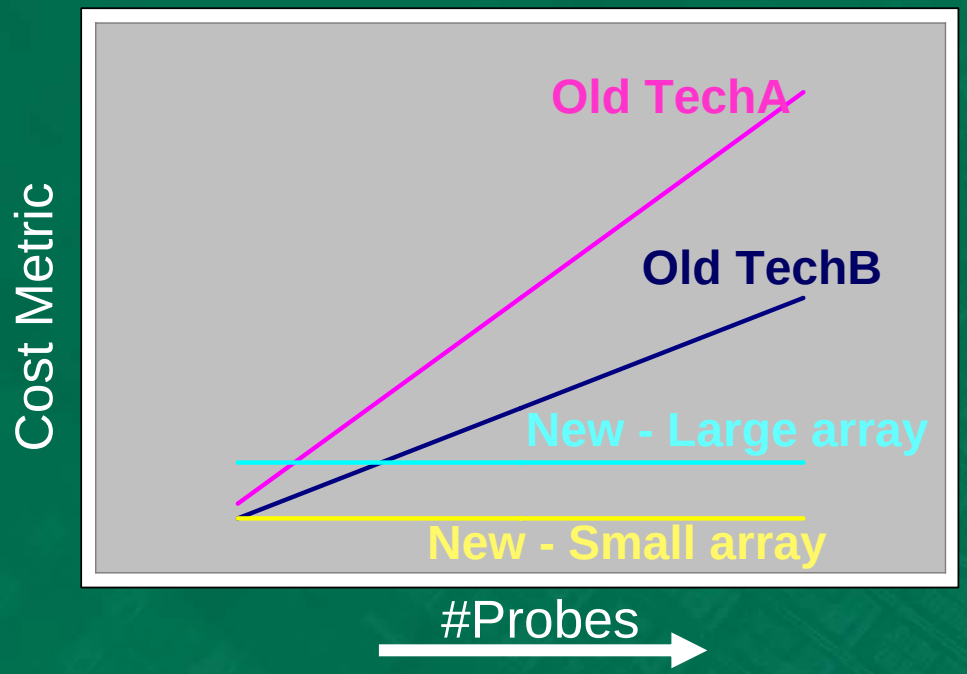
Need actionable plan to cut cost by 10x in ~5yrs

Tooling >50% Sort cost



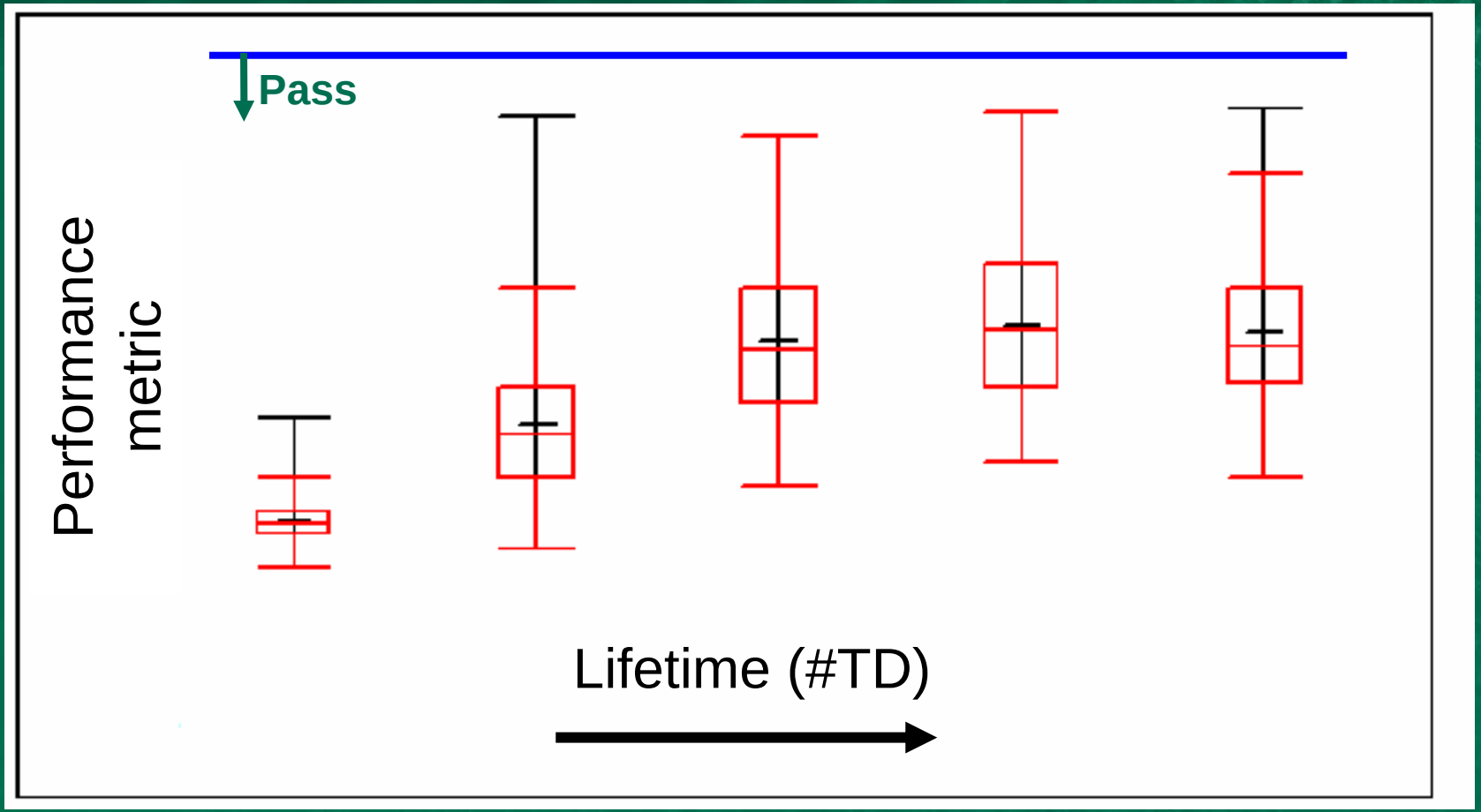
SIU costs need to be 1/10th current costs in ~5yrs

Technologies with flatter cost structure desired, and they exist



- Expectation: Lower and relatively flat cost. But, …
- …. Not an order of magnitude reduction. **Yet.**

Proof of concept of performance



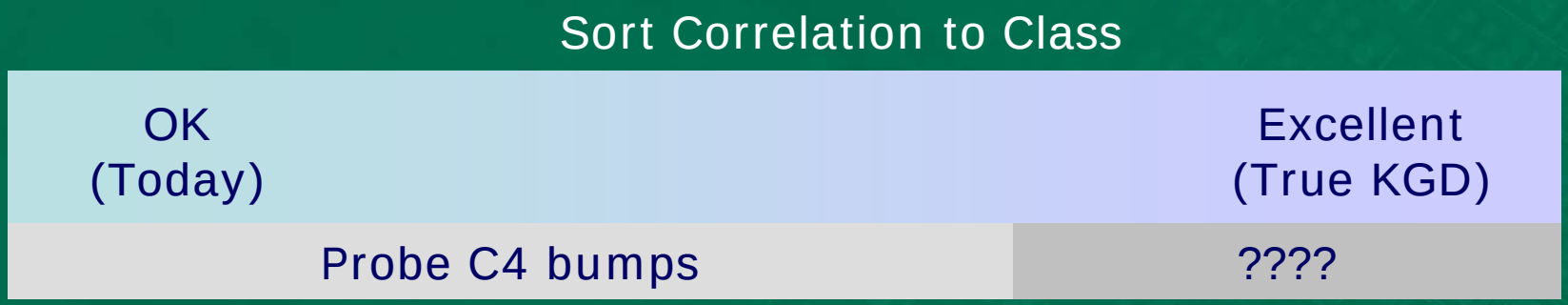
- Further development required ….

Parallelism: More economical with flatter cost structure

	Run rate over 1X
2X	>1.x
3X	>2.x
4X	>>2.x

- Parallelism is worth pursuing
- Pick optimal level of parallelism
  - Benefits have not scaled previously because of disproportionate increase in SIU cost

Known Good Die



- Environmental differences a challenge:
  - Thermal, electrical (packaging, xIU), content
- Some can be addressed by improved SIU electrical capabilities

Other cost levers

- Capital $
  - Content
    - Do no more testing than required
    - Distribute content proactively across sockets.
  - Reuse or redefine level of integration in equip
- HC $
  - Automation
  - Simpler process flow within Wafer Test
  - Robust technology
- Reducing need for capital and HC does not reduce tooling$

…. And don’t forget

- Lead time
- Line item agility

FOR Faster response to:

- Rapidly changing customer demand
- Increased WIP velocity in fab

Needs for next 10-15yrs

- Cost
- Lead time
- Agility

Supplier and customer collaboration a must to win

- Agree on what to design + fabricate
  - Comprehend use condition and manufacturing requirements
- Make it
- Make it work in required use condition
- Improve

Summary: Call to Action

- Reduce SIU cost to 1/10th in ~5yrs
- Collaboration key to achieving breakthrough results

Q & A