# SoC evolution and the impact for designers and manufactures

Electronic Design Process Symposium
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Jim Hogan

**March 11, 2011**

**“never compromise the user experience” Job’s Law**

**or display, battery life and graphics/video**

Relentless push for higher quality user experience – at minimum system cost!

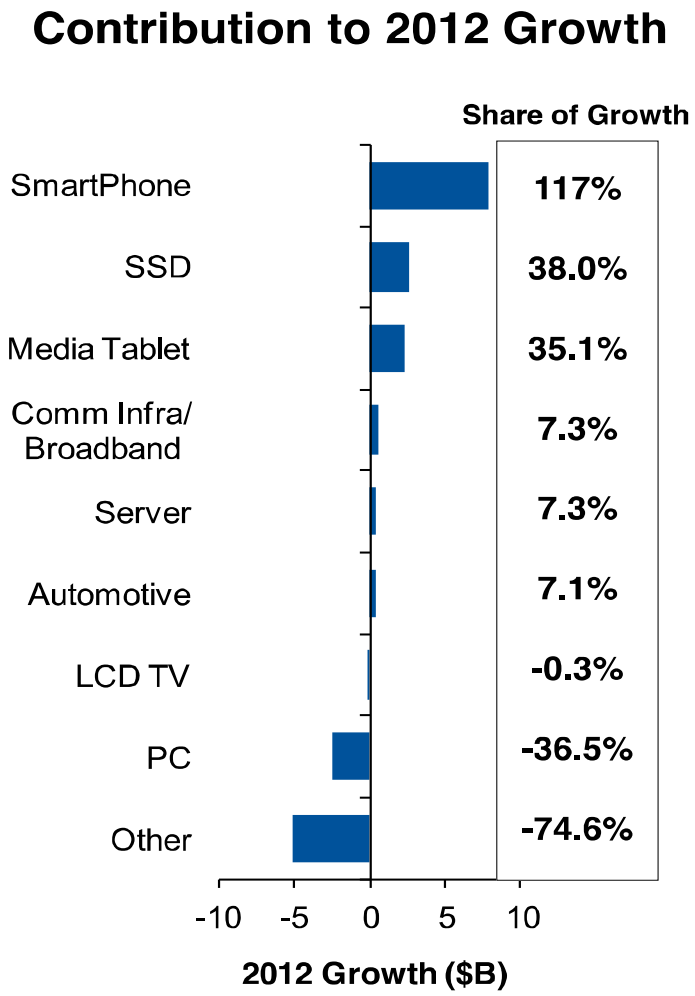
Feature convergence – Video, Voice, Data, Audio (in every consumer device!)

Critical demand for 1GHz and beyond

# System Landscape Chaos

| | The Big Four + Microsoft | | | | | OEM's | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Customer** | Devices | Commerce | Search | Social | Software | Devices/ Digital Media | Devices | Devices | Devices | Devices |
| **Smartphone Patent Position** | NORTEL | | MOTOROLA | | NORTEL MOSAID | NORTEL | | | MOSAID | NORTEL |
| **Cloud Content** | iTunes App Store | amazon.com | Google | | | Sony Entertainment Network, SONY PICTURES, SONY MUSIC | | | | email |
| **Operating System** | iOS | ANDROID | ANDROID | | Windows | SONY ANDROID | Windows Phone TIZEN ANDROID | ANDROID | Windows Phone, symbian OS | BlackBerry, QNX SOFTWARE SYSTEMS |
| **Phone** | iPhone | | Droid | | | Sony Ericsson Xperia ARC | Galaxy | U9000 | N8 | Blackberry Bold |
| **Tablet** | iPad | Kindle Fire | Xoom | | | Tablet S | Galaxy | Ideos S7 | | Playbook |
| **TV/Game** | iTV | | Google TV | | | | | | | |
| **SoC** | SAMSUNG | | NVIDIA TEGRA | | | | SAMSUNG NVIDIA TEGRA | | SAMSUNG | |

# Key Semi Segments




Source: Gartner Dec 2011, Semico Nov 2011, IDC April 2011

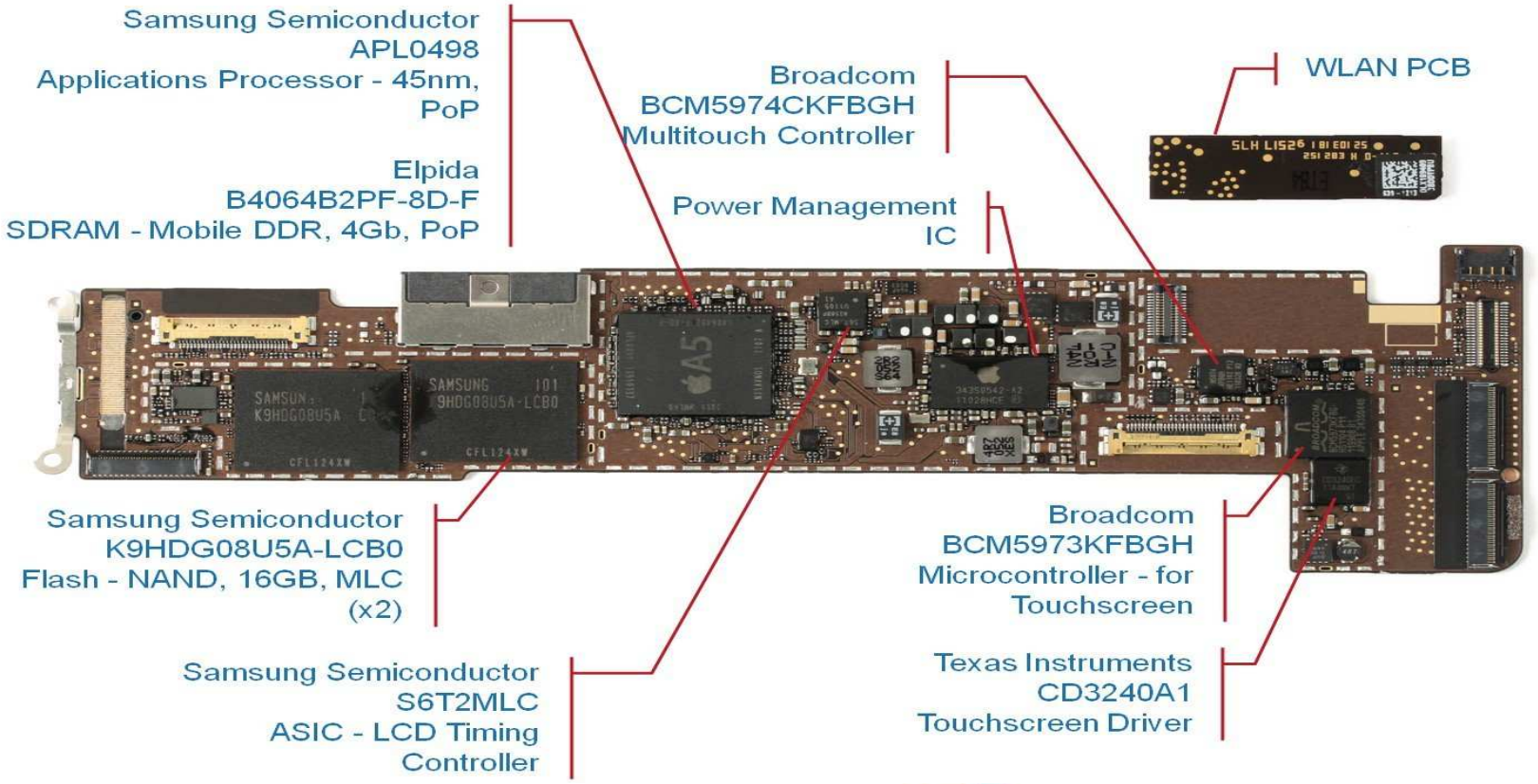
CUPERTINO, California—January 24, 2012

"The Company posted record quarterly revenue of **$46.33 billion** and record quarterly net profit of $13.06 billion, or $13.87 per diluted share. These results compare to revenue of **$26.74 billion** and net quarterly profit of $6 billion, or $6.43 per diluted share, in the year-ago quarter. **Gross margin was 44.7 percent compared to 38.5 percent in the year-ago** quarter. **International sales accounted for 58 percent of the quarter's revenue**.

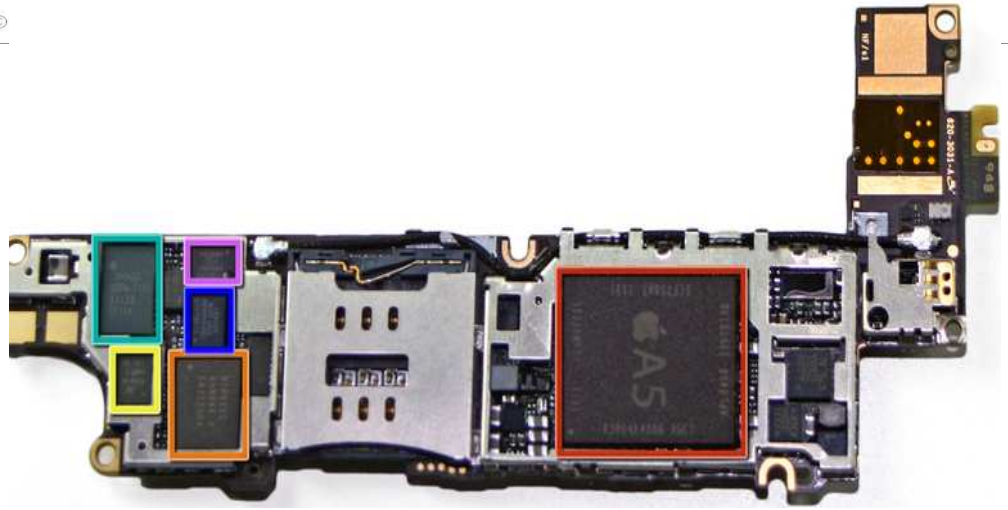
The Company sold **37.04 million iPhones** in the quarter, representing **128 percent unit growth** over the year-ago quarter. Apple sold **15.43 million iPads** during the quarter, a **111 percent unit increase** over the year-ago quarter. The Company sold **5.2 million Macs during the quarter, a 26 percent unit increase** over the year-ago quarter.

Apple sold 15.4 million iPods, a 21 percent unit decline from the year-ago quarter.

| 28-Mar-12 | | | | |
|---|---|---|---|---|
| | Apple | Exxon | Intel | ARM |
| Market Cap (B) | **575.9** | 404.7 | 136.9 | 13.03 |
| Enterprise Value (B) | **542.8** | 412.6 | 133.4 | 12.58 |
| Revenue (B) | 127.8 | **433.5** | 54 | 0.785 |
| Cash (B) | **30.16** | 12.66 | 14.84 | 0.554 |





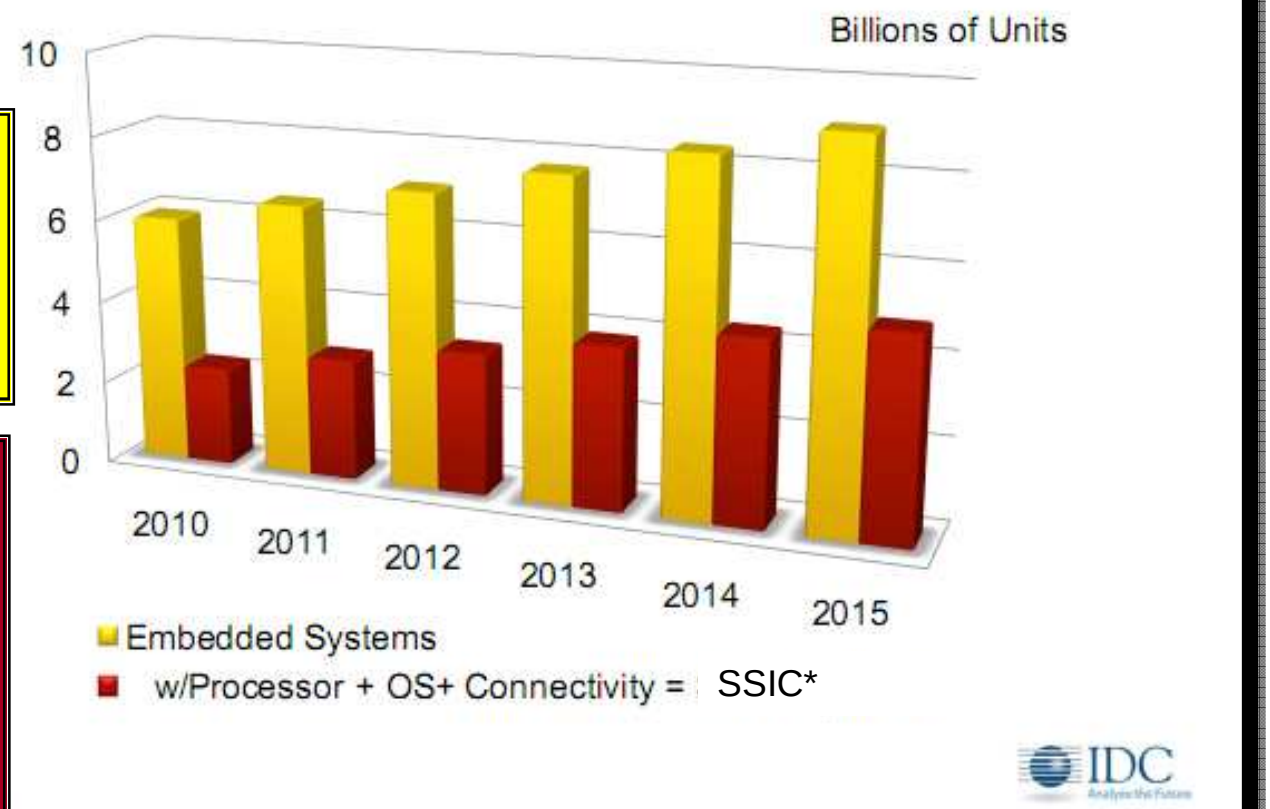
What is different?

Intended use, the hardware and software are the same.

# Embedded Processor Market

Network cloud infrastructure
Printers, disk drives
Comm infrastructure (last mile)
Auto Drive Train, Safety

SSIC
- Smartphone
- E reader
- Tablet
- MP3
- Cell Phone
- PDA
- Automotive
  - Telematics
  - GPS, ABS, AV
- Home CE
- Wireless Home Appliances



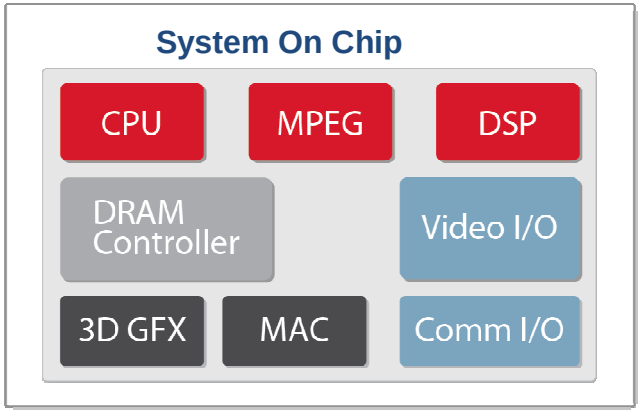

2015 Mobile SSIC's = 75% of market, 3B units in 2015

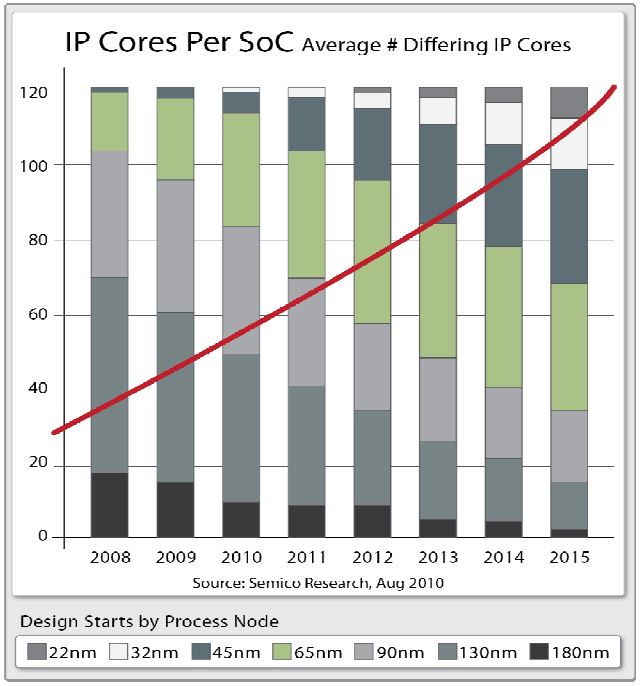
*Sonics terminology
Source: IDC April 2011, Semico, Dec 2011

# Challenge: SoC Architecture Trends

Distributed Heterogeneous Architectures

- Massive feature integration
  - Driven largely by Moore's Law (supply) and convergence (demand)
- Distributed architectures
  - Higher scalability (and independence)
  - Sharing memory
- Multiple processors
  - (Multicore) CPU
  - DSP
  - Special purpose (MPEG, GFX, …)
  - Always on controller
- Distributed DMA
  - Removes centralized DMA bottleneck
- Increasing software complexity
  - Re-use with multiple platform SoCs
  - Broader end use market coverage per SoC with software programmability



# Semiconductor Roadmaps Blur As Smartphone, Tablet Features Collide

| Devices | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|
| Application processor | 45nm (Dual core) | 45nm (Dual/Quad core) | 28nm (Quad core) | 28nm (Quad core) | 22nm (Quad Core) |
| Baseband processor | | | | | |
| WiFi | 65nm | 40nm (Dual core) | | | |
| BT/FM | | | | | |
| GPS | | | | | |
| NFC controller | | 65nm | 40nm | | |
| RF/Transceiver | 40nm | 40nm | 28nm | 28nm | |
| Audio/Video Codec | 180nm | 130nm | 130nm | 90nm | 65nm |
| Power management IC | | | | | |
| Noise cancellation IC | | 180nm | | | |
| Touchscreen controller | 130nm | 90nm | 90nm | | |
| Gesture recognition | | | 90nm | 65nm | |
| DRAM | 22nm | 19nm | 15nm | 13nm | 10nm |
| NAND flash | 22nm | 19nm | 15nm | 13nm | 10nm |
| e-compass/e-gyroscope | 250nm | 180nm | 180nm | 180nm | 180nm |
| **Total Devices** | 8 | 10 | 9 | 7 | 5 |

Discrete Packaged Semiconductor Price

System-in-Package

20

Gartner

**Tablets, Ultrabooks, Smart Phone Ap Proc SoC's remain as separate die**

**Wi-Fi / LTE advantages to remain as separate SoC's**

**Opportunities, addressing market specific performance, power, cost**

**SIP creates other opportunities: Wide I/O, MIPI LLI (C2C Next Gen)**

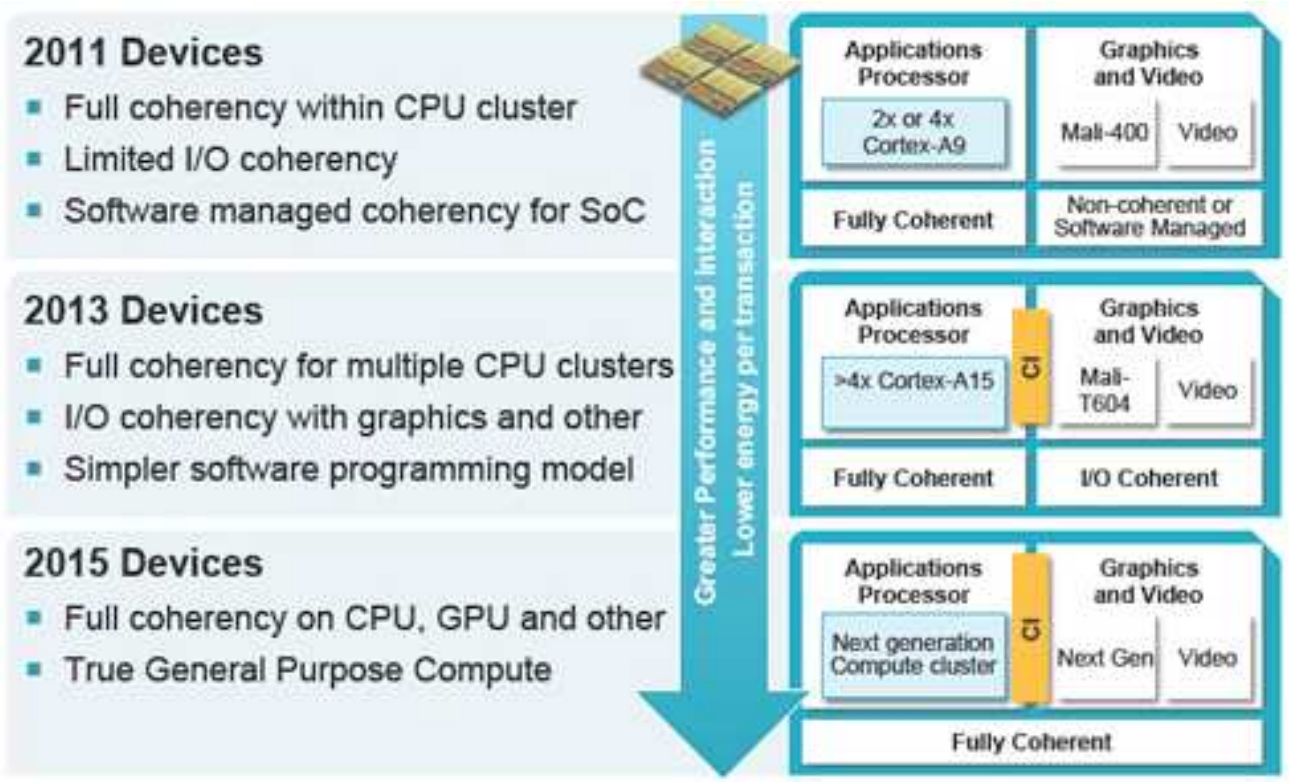
# ARM Roadmap
# we have seen this before – looks like Intel

| | 2009 | 2011 | 2013 | 2015 |
|---|---|---|---|---|
| Processor | Cortex A8 | Cortex A9 | Cortex A15/A7<br>big.LITTLE | Atlas/Apollo 64-bit<br>big.LITTLE |
| Freq, Process | 1GHz, 65G<br>800 MHz 65 LP | 1.5 GHz, 40G<br>800 MHz 40LP | 2.5 GHz, 28 HPM<br>1.5 GHz, 28 LP | > 2.5GHz, 22”G”<br>1.5 GHz, 22”LP” |

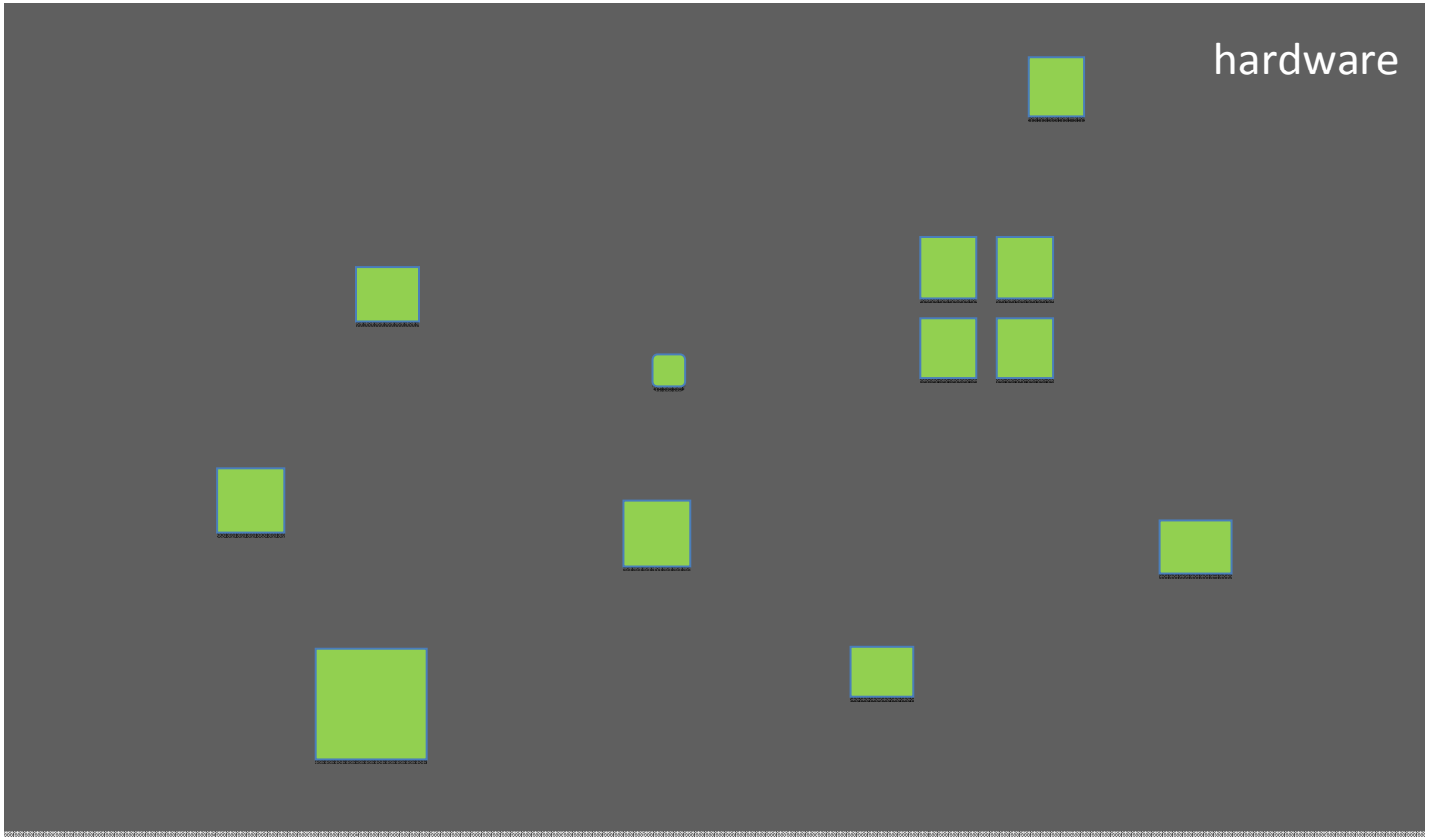
Cortex
A9
A5

Cortex
A15/A7
Big.LITTLE

Cortex
64-bit
Big.LITTLE

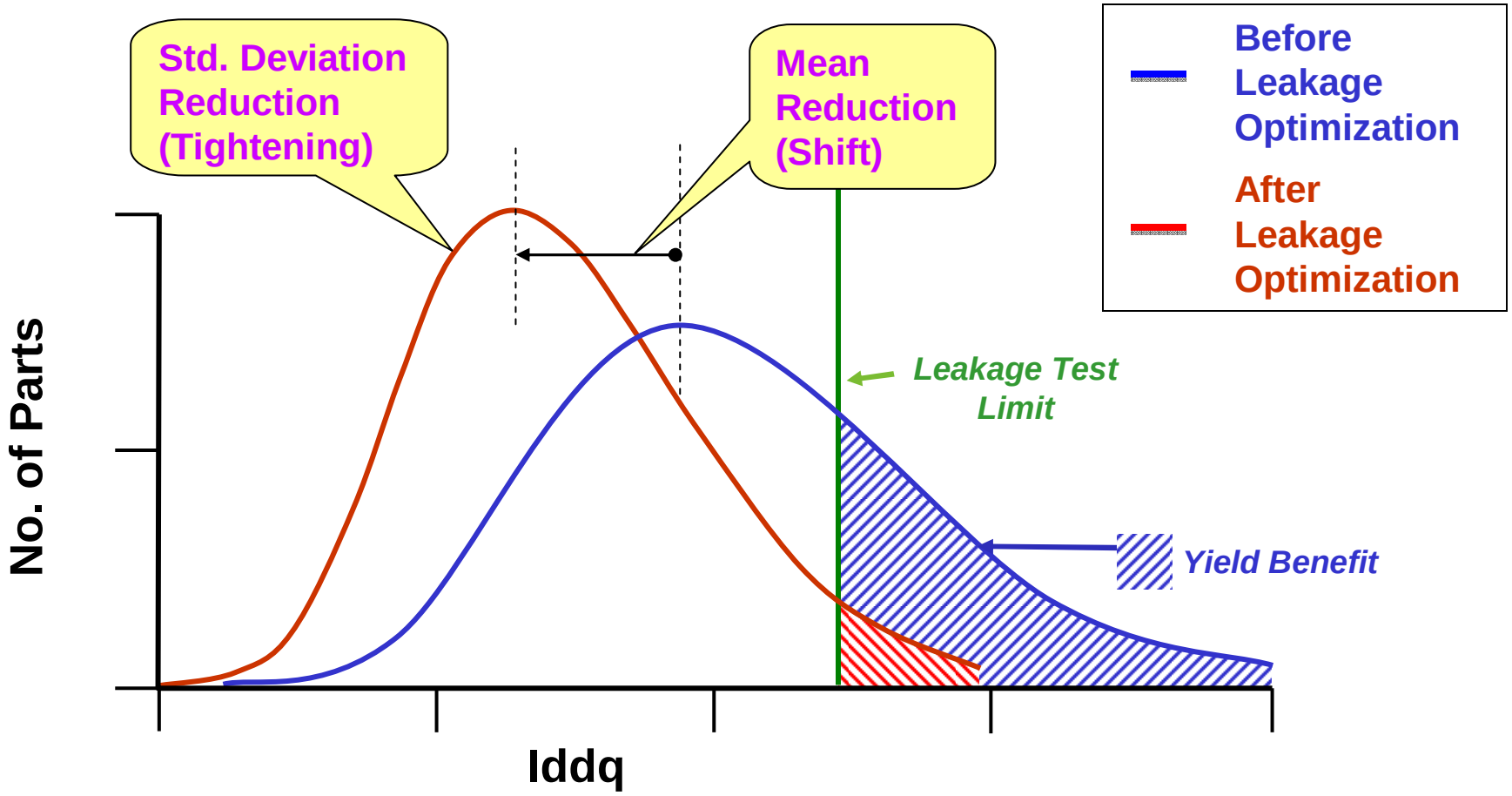


# (mostly) dark silicon




Courtesy from aggios

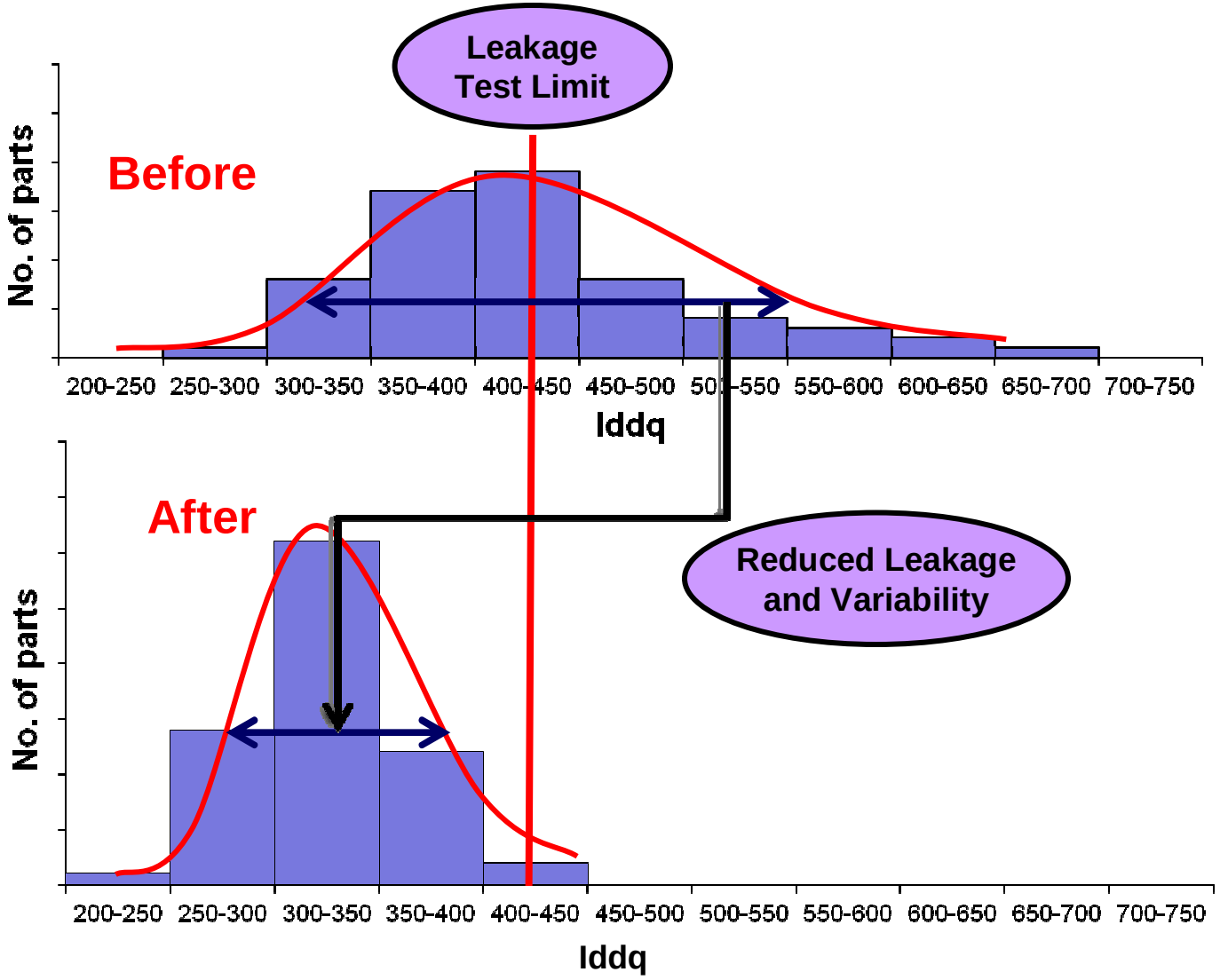
# Improved Leakage Yield With Multiple Gate Length Libraries




- **Yield improvement based on distribution shift and tightening**

***Source: Tela Innovations, Inc.***

# Leakage Yield Improvement Silicon Data




***Source: Tela Innovations, Inc.***

# 2012 SoC New Trends

- Power has emerged as the highest priority vs. PPA
- There is will be continuing pressure to collapse the value chain and System companies will attempt to retain more value
  - Specifically Fabless and IDMs are under attack, system companies have to follow Apple's lead
- SoC turnkey business models will emerge
  - Taking the old ASIC business and design flow to the next level of abstraction
  - New business model opportunities (NRE plus royalties)
- The space between Virtual and RTL will become increasingly interesting, e.g. turnkey businesses, SoC integration tools, integration fabrics…
- Increasing utilization of programmable fabrics for SoC. Witness Xilinx and Altera products that are only now starting to ship to system companies
- Board design and especially cell phones is becoming impossible at the current frequencies