THIRTEENTH ANNUAL BiTS 2012 Burn-in & Test Strategies Workshop

Keynote Address

ARCHIVE 2012

3-D SEMICONDUCTORS
MARKET OPPORTUNITIES

by

Jim Feldhan
President
Semico Research

ABSTRACT

Mr. Feldhan will provide a brief economic overview along with Semico's Semiconductor Forecast. As ICs become more complicated and push the technology roadmap, system performance and chip to chip interaction is becoming a limiting factor. The result, test and packaging is coming to the forefront. 2.5D and 3D package offer great advantages, yet there are still technical issue to overcome. Mr. Feldhan will present the Semico roadmap to 3D packaging, the end products that adopt 3D and how that adoption will evolve over time.

3-D Semiconductors Market Opportunities

Jim Feldham
Semico Research Corporation

2012 BiTS Workshop
March 4 - 7, 2012

Agenda

- Industry Overview
- Semiconductor Forecast
- 3D Roadmap
- Applications and Potential

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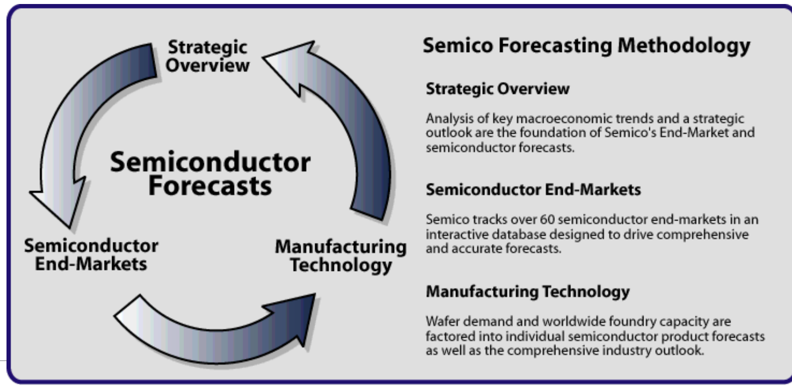
Semico Information



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Uncertainty Weighing on the Market

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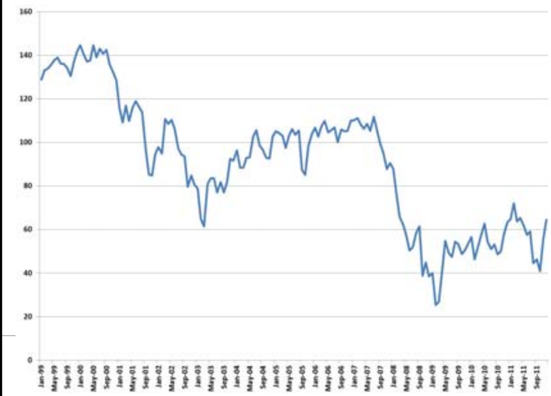
Economic Conditions In U.S. Improving

Consumer Confidence



- Unemployment down for 3 months to 8.5%
- Private sector employment up 200K in Dec. & up 1.6M for 2011
- Consumer Confidence up

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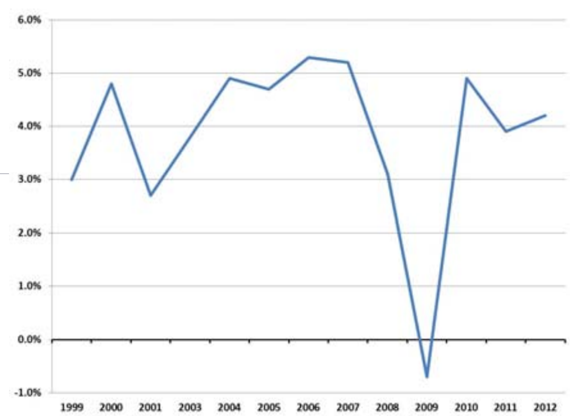
Macro Indicators Slight Improvement - 2012

World GDP



- World GDP drops to 3.9% growth in 2011 as economies cool in second half 2011
- Improving in 2012 to 4.2% growth
- Main drivers in 2012 include
  - Emerging markets
  - Improved U.S. & Europe economies
  - Sustained growth in China and India

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World Outlook

GDP Growth

	2010	2011	2012
China	10.3%	9.5%	8.9%
India	7.4%	7.8%	7.2%
Korea	6.1%	4.3%	4.6%
Brazil	7.5%	3.2%	4.3%
U.S.	2.8%	1.6%	2.5%
EU	2.3%	1.5%	1.7%
Japan	3.9%	-0.5%	1.7%

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Semiconductor End Markets

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PC's Weak 2H 2011 Extends into Q1 2012

- HDD supply affecting PC production
- Desktop inventories for OEMs getting tight
- Corporate demand remains stronger than consumer, but it too is weakening
- Motherboard inventories are lean
- Regional view
  - Motherboard shipments to China for New Year were ~30% below plan
  - Emerging-market demand remains strongest
  - Western Europe continues to remain weak
  - U.S. stable

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HDD Update

- HDD prices up ~10% for PC OEM, ~30-40% for white box builders
- Lead times for server HDD are up to 2 months from 1 month
- HDD shortages to peak in January. May take until mid to end Q2 to solve
- HDD return to full production Q3

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Handsets: Smart Phones Driving the Market

- Smart Phones still strong
  - 15% in 2011
  - 16% CAGR 2011-2015 reaching 1.35 billion in 2015
- Qualcomm pushing new features and functions
- 2012 will be a good year for smart phones again: 14% for 2012

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Consumer Electronics

- **PCB shipments weak in Q4 2011, but above seasonal levels for Q1 2012:**
  - Set-top boxes
  - DVD players
  - Digital video
  - Cameras
  - HDTVs
  - MP3 Players
  - eReaders
- **Apple iPad & Kindle Fire very strong**

amazon.com

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Another Wave of Growth Coming

RESHAPING INDUSTRIES

Source: Qualcomm

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Expanding Mobile Broadband

NON-HANDSET MOBILE BROADBAND DEVICE SHIPMENTS EXPECTED TO GROW AT ~40% CAGR FROM 2010–2015

Source: Qualcomm

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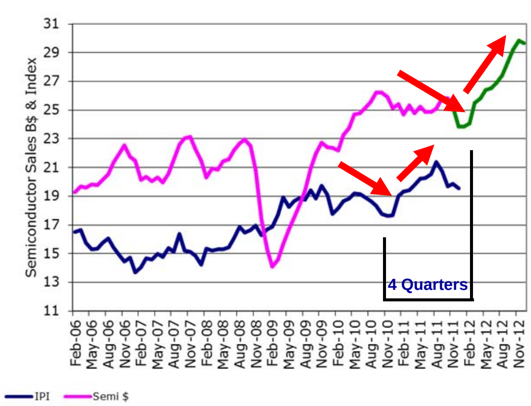
Semiconductor Forecast

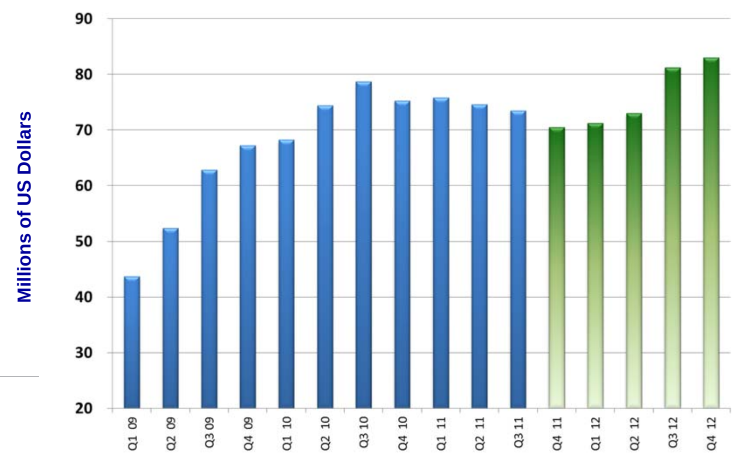
Semico IPI



Source: Semico Research Corp. IPI Report

***IPI = Inflection Point Indicator**

Quarterly Semiconductor Revenue Forecast



2011 Flat

2012 Up 10%

Source: Semico Research Corp. IPI Report

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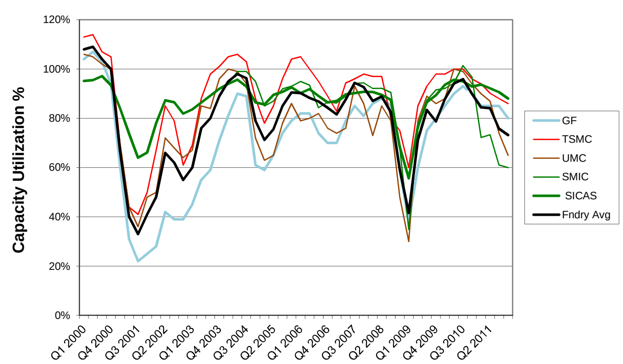
Foundry Capacity Utilization



- Foundry capacity utilization dropped
  - 74% by year end 2011
  - 91% in 2012

Source: Sicas, Company Information, Semico

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TSMC and GF Lower 2012 Capex

In Millions of $US

	2008	2009	2010	2011e	2011r	2011	2012e
GF	$576	$690	$2,750	$5,400	NA	$5,400	$3,000
SMIC	$700	$190	$775	$900	$800	$800	$800
TSMC	$1,886	$2,671	$5,900	$7,800	$7,400	$7,290	$6,000
UMC	$349	$551	$1,800	$1,800	NA	$1,800	$1,800
	$3,511	$4,102	$11,225	$15,900		$15,290	$11,600

Source: Company Information & Semico Research Jan 2012

2012 Forecast Assumptions

- End products continue to have richer semiconductor content
  - More memory, radios, MEMS, applications and baseband processors
- Consumer is bargain shopping
  - HDTVs, set-top boxes, cameras, games etc.
  - Unit sales growing
- Aggregate IC ASPs stabilizing
- 2012 Capex will be flat compared to 2011
- Supply chain has pulled back, in Q1 2012 supply chain will realize inventories are too low
- Market will overreact to this slowdown
- Pent up demand due to flooding in Thailand

3D Roadmap

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3D Technology is Sexy But Still Going Through Puberty

- We expect technology to be adopted faster than it is
- But there are gating issues
  - Eco system
  - EDA
  - Assembly and test processes
  - Product life and reliability testing
- Implementation is happening in stages

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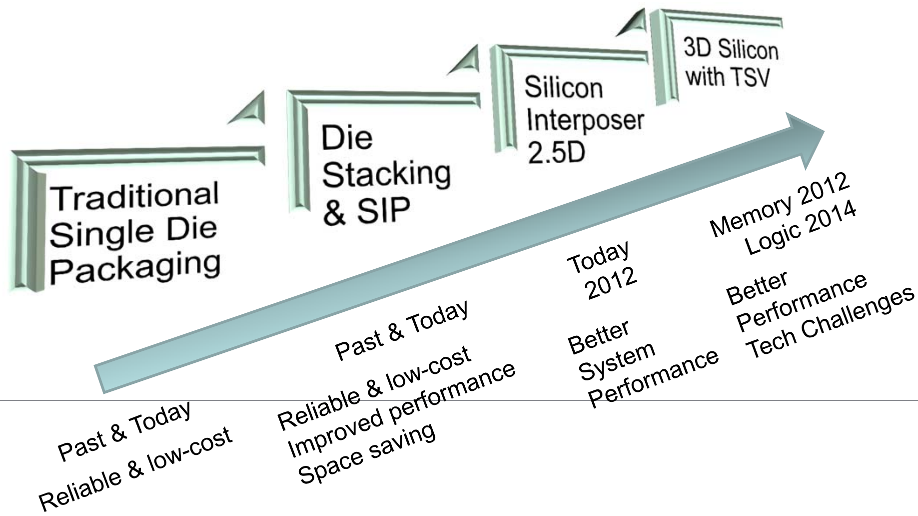
"3D Will Be Introduced In 2 Years"…
Hearing that for 5+ years



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Is 2.5D a Stepping Stone to 3D

No

- Potentially cheaper
- Likely adequate for many applications
- Large pitch interposers for
  - MEMS
  - RF
  - Other applications
- High performance systems

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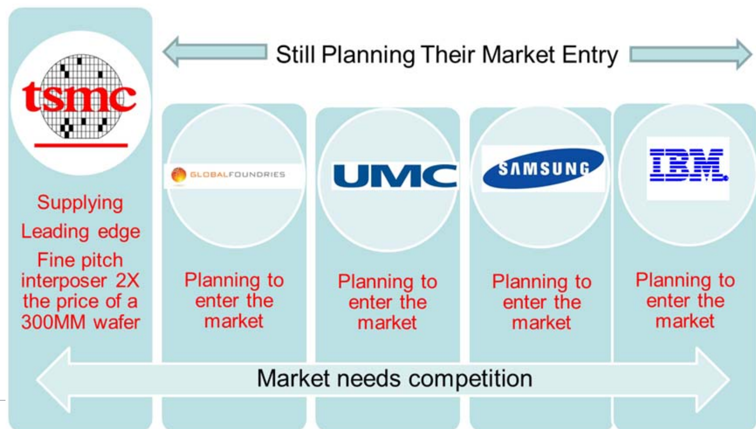
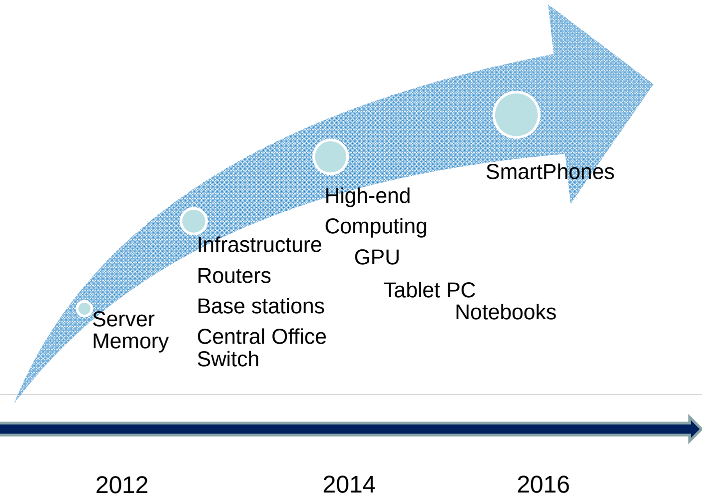
Silicon Interposer Has Its First Born



Interposer & 3D Applications Through 2014

- Wired communications
  - Routers
  - Sever Farms
  - CO switches
- Storage area networks
- Military
- Video processing
- Workstations
- Servers
- Gaming
- Notebooks
- Desktops
- Tablets

Interposer & 3D TSV
IC Application Roadmap



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Traditional Migration
Drive To Better Performance

Semiconductor Migration

Moores Law → 300mm to 450mm → 22nm > 16nm > 14nm & smaller

- Wafer Fabs expensive $7 – $10 Billion
- New process nodes every 2 years
- Short life for leading edge
- PCB limiting system performance

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A New Way to Achieve Performance

200mm 300mm → Mixed technology → 3D Packaging

- 3D packaging up to 10X system performance
- Will extend process node and wafer size life
- Be a catalyst for new applications
- Allow for smaller form factor
- Need to improve price points

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New Memory Timelines

	2011	2012	2013	2014
DRAM	2xnm now	1xnm wall?		
NAND	1x-2xnm now	5nm wall?		
PCM	Limited production			Volume prod.????
3D DRAM		Pilot Production	Volume; HMC pilot	HMC prod.
3D NAND			Pilot	Production

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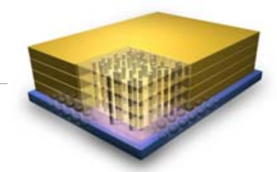
3D DRAM

Reasons to go 3D:

- The wall is coming
- 3D structure could lower power consumption in DRAMs in datacenters
- Increased bandwidth for mobile applications



- Modules
  - Samsung
  - Micron
- Wide I/O
  - Samsung
  - Elpida
  - Hynix/Sematech/CNSE Albany
- DRAM + Logic
  - Micron/IBM/Samsung
    - Hybrid Memory Cube (HMC)
  - Elpida/Powertech/UMC
  - Tezzaron
- MonolithIC 3D
- Intel/ITRI

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3D Market Applications

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Data Center Issues

- Data Center traffic exploding
  - 2010 1.4 zettabytes → 2015 4.7 zettabytes
- Data throughput is critical
- Limited floor space
- Energy cost
  - Cooling: one of the biggest expenses
  - Chip power consumption

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3D Offers Viable Solution

- 3D offers
  - Wider data buses memory and logic
  - Faster system performance
  - Higher system density
  - Lower power consumption
  - Lower latency
  - Fast ROI from a Data Center perspective

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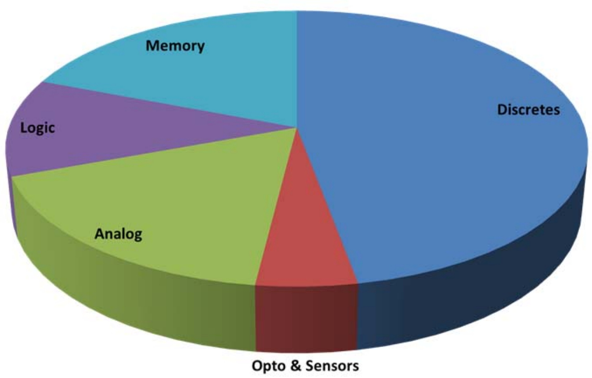
2015 Server BOM (Units)



3D Opportunities

1st Memory

2nd Sensors – MEMs

3rd Logic

4th Beyond 2015
Memory and Logic

Source: Semico Research Corp. MAP Model

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Server TAM

- 2015 – 16.5 million mid-range and high end servers
- 18.3 billion silicon die
- With 3D, servers can achieve more compact size, higher performance and consume less electricity
- Reliability must be proven
- Chip cost not as critical as ROI

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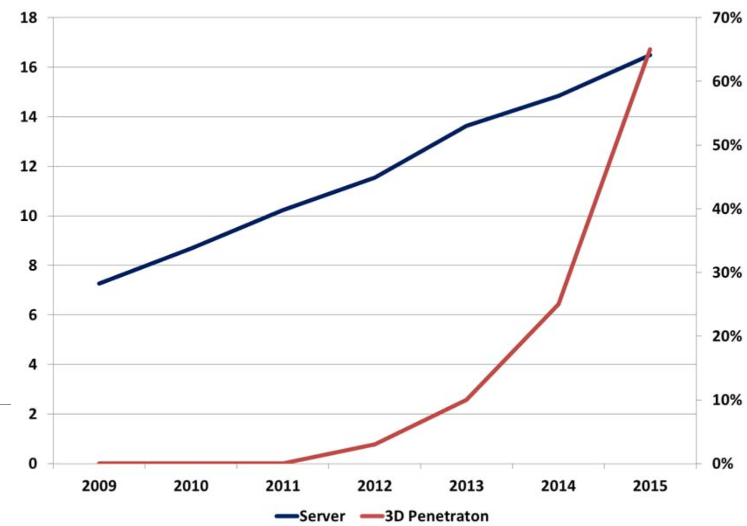
Server Market 3D Penetration

(Millions of Units and % Penetration)



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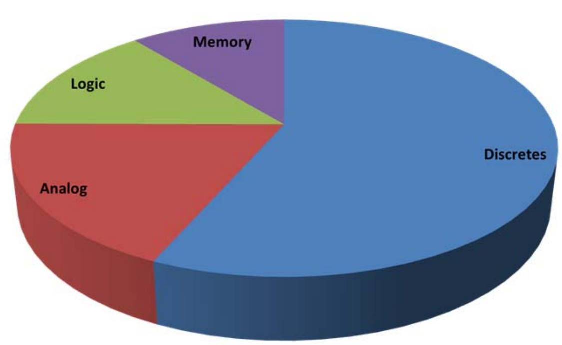
2015 Macro Base Station BOM



Opportunities

1st Memory

2nd Logic

3rd Memory, Logic & Analog

Source: Semico Research Corp. MAP Model

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2015 Macro Base Station TAM

- 2015 -- 700,000 macro base stations
- 654 million silicon die
- With 3D, base stations can faster and smaller with better performance vs. traditional base stations
- Chip cost not as critical as reliability & performance

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Other Comm Infrastructure Potential for 3D

Telecom and Datacom Network Equipment

- Broadband equipment, CPE, and subscribers
- 3G Mobile, LTE, and WiMAX infrastructure
- VoIP and IMS equipment
- 10G/40G/100G networking ports
- Data center and storage network equipment
- Security
- Enterprise and service provider routers
- Enterprise and carrier ethernet switches

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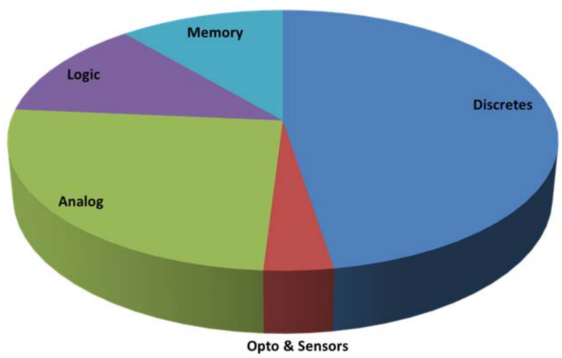
2015 Tablet BOM
(Units)



3D Opportunities

1st Sensors – MEMs

2nd Memory

3rd Logic

4th Beyond 2015
Memory and Logic

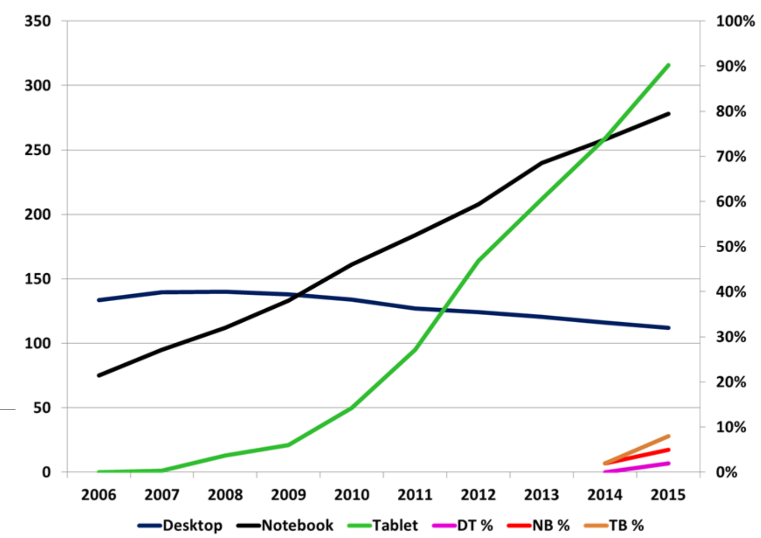
Source: Semico Research Corp. MAP Model

Tablet TAM

- 2015 -- 316 million tablets
- 54.9 billion silicon die
- With 3D, tablets can get 10X the performance
- Cost must come down
- Semiconductor BOM cost must be $100-$125

Computer Market 3D Penetration

(Millions of Units and % Penetration)



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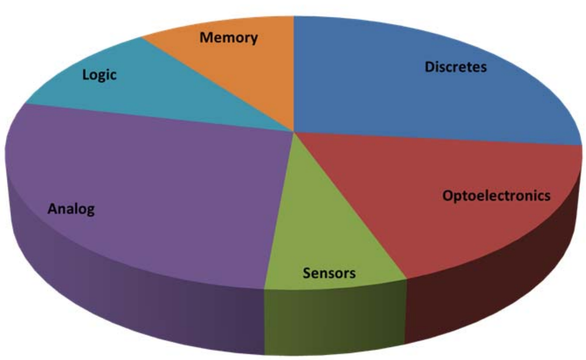
2015 Smart Phone BOM



3D Opportunities

1st Sensors – MEMs

2nd Memory

3rd Logic

4th Beyond 2015
Memory and Logic

Source: Semico Research Corp. MAP Model

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Smart Phone TAM

- 2015 -- 1.3 billion smart phone handsets
- 108 billion silicon die
- With 3D, smart phone can achieve 10X the performance vs. traditional PCB/IC assembly
- Cost must come down
- Semiconductor BOM cost must be $80-$100

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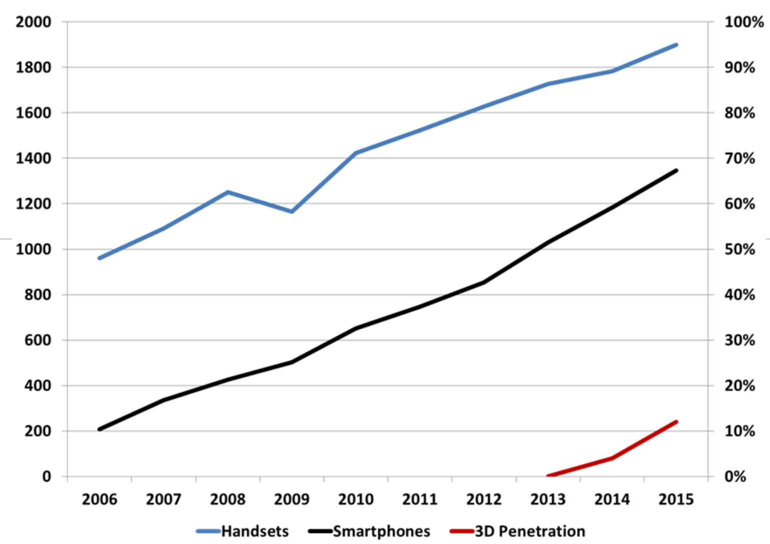
Handset Market 3D Penetration

(Millions of Units and % Penetration)



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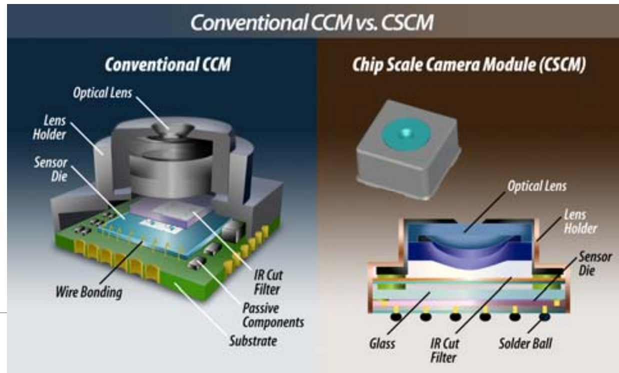
Consumer Market 3D Penetration

Toshiba's Chip Scale Camera Module for Cell Phones



Source: Toshiba

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Summary

- Applications need performance
- Adoption is starting
- Eco system needs development & maturity
- Implementation will occur in stages
- Cost reduction is the Holy Grail

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Questions for Semico

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