

**SEVENTEENTH ANNUAL**

**BiTS**

**Burn-in & Test Strategies Workshop**

TM

**March 6 - 9, 2016**

**Hilton Phoenix / Mesa Hotel  
Mesa, Arizona**

**Archive - Distinguished**

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Distinguished  
Speaker

BiTS Workshop 2016 Schedule

## Tutorial Day

Sunday March 6 - 8:30 pm

### Recovery from the Downturn; Technologies That Will Drive Semiconductor Business for the Coming Years

**Risto Puhakka**

President

VLSIresearch

## Distinguished Speaker – Abstract



**Risto Puhakka**

The semiconductor markets have been going through downturn in recent quarters. At the time of this speech, the recovery is around the corner if not already underway. Is semiconductor industry ready to exploit new technologies to drive the next cycle? What will be China's role this time? What is required from test? We will have numerous opportunities, technologies and devices that will drive the business for years to come. The presentation will explore and define these opportunities.

## Distinguished Speaker – Biography



**Risto Puhakka**

**Risto Puhakka** is President of VLSIresearch, leading the company's commercial operations and market research activities. He is an expert in Semiconductor Capital Equipment markets as well as Semiconductor Manufacturing. Risto advises managers, boards, and investors about semiconductor market trends and strategic industry statistics. He is a regularly invited speaker at conferences about various topics in semiconductor manufacturing and equipment markets.

Risto is a graduate of Helsinki University of Technology (MSc) and UC Berkeley, Haas School of Business (MBA). When Risto is not working he cherishes time with his family, runs very long distances, and is occasionally spotted flying model airplanes.

# Recovery from the Downturn: *Drivers for the Coming Years*

**Risto Puhakka**  
**VLSIresearch**

2016 BiTS Workshop  
March 6 - 9, 2016





# Agenda



- Current Events
  - Downturn – is it over?
  - Mergers and Acquisitions
- Strategic Shifts
  - China
  - IoT and Next Big Thing
- Forecast

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## China's Leaders Put Economy on Bubble Watch 🔑

China's leaders made clear they are emphasizing growth over restructuring this year, but suggested they are trying to avoid inflating debt or asset bubbles as they send massive amounts of money coursing through the economy.



WSJ 3/6/16



# Top Semiconductor Suppliers

*Mixed results*

## LEADING SEMICONDUCTOR MANUFACTURERS

(sales by company, \$B)

		2014	2015	Growth
<b>INTEL</b>	MPU	55.9	55.4	-0.9%
<b>SAMSUNG</b>	Memory + Logic	37.7	42	11.3%
<b>TSMC</b>	Foundry	25.1	26.6	5.7%
<b>TI</b>	Analog	13	13	-0.2%
<b>INFINEON</b>	Power	5.9	6.9	15.9%

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# Weakness Continues

*Electronics is below long term growth trends*

	CAGR		Y-o-Y growth		CAGR
	'03 – '11	'12 – '15	2015	2016	'15 – '18
<b>Electronics</b>	6.6%	2.2%	-1.1%	2.0%	5.0%
<b>ICs</b>	8.6%	5.0%	-1.3%	3.4%	5.9%
<b>IC Eqpt</b>	8.1%	1.3%	-0.6%	-5.0%	5.7%

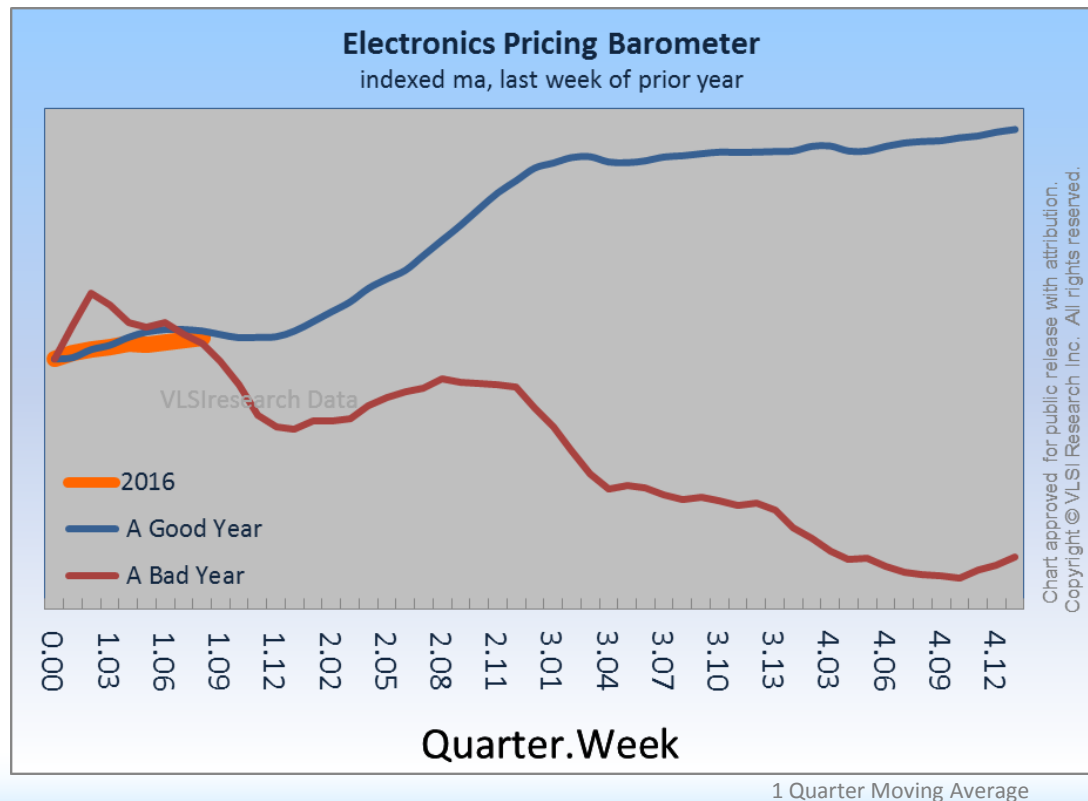
# Electronics Pricing: weekly trends for

PC notebooks Tablets Smartphones Cell phones Digital Cameras Appliances TVs

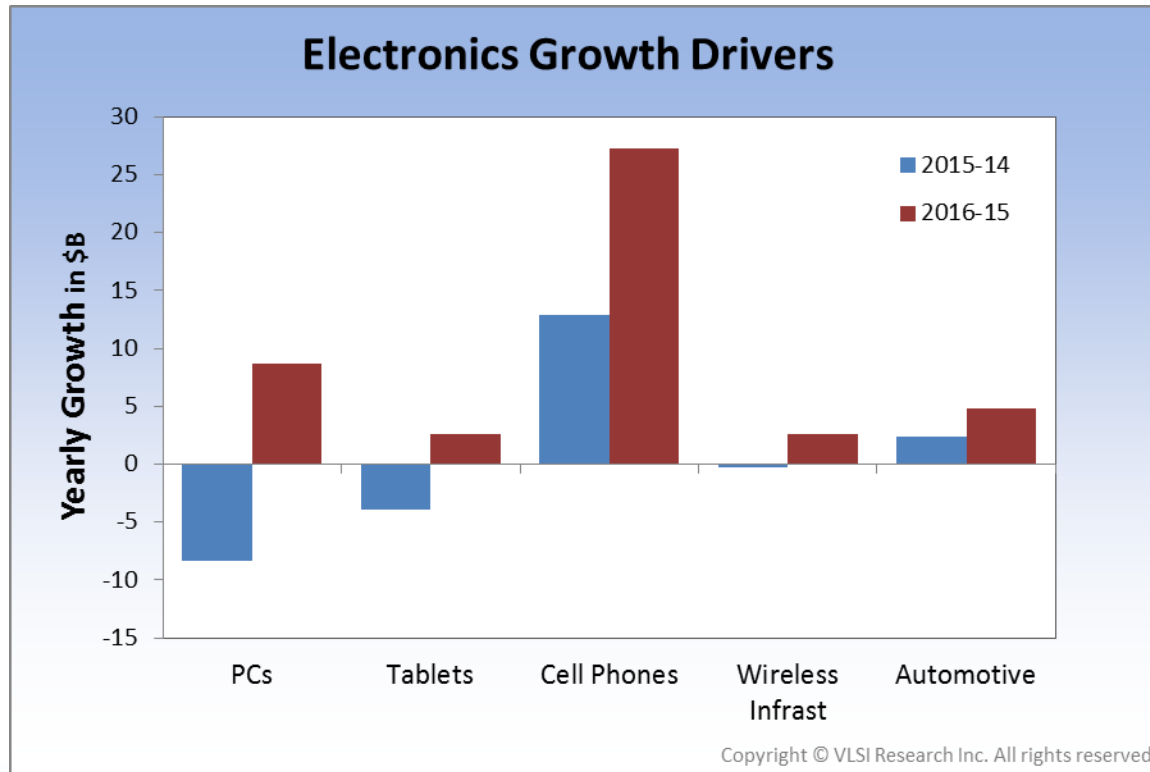
- Price Trend:

## Firming

- Mobile & Tablets behind trend



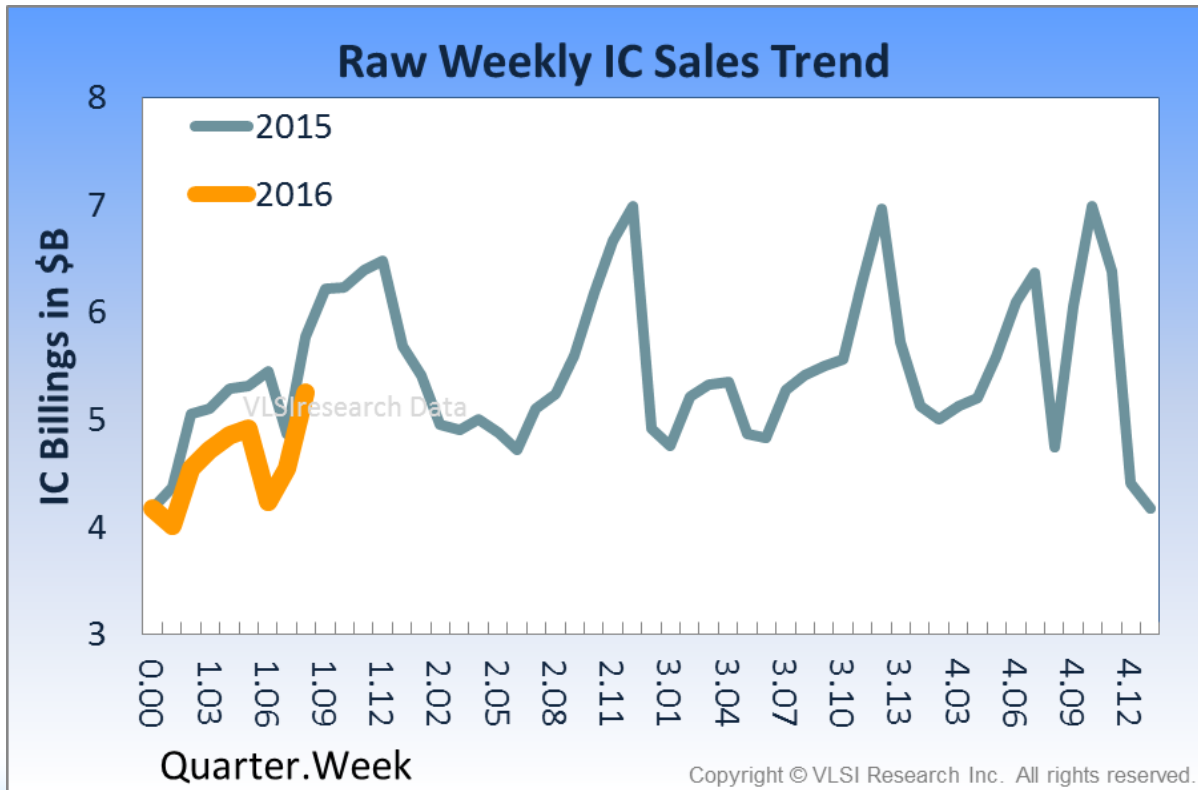
# Electronics Markets by Application



- Smart Phones are still the biggest driver
- Automotive is significant
  - But beware
- Real IoT and Wearables still too small to have an impact
- Wearables still an IoP limited market

# Raw IC Sales

Raw: data has not been 'cooked' with a moving average or some other statistical manipulation



IC Sales soared but with poor Y/Y comps

- W/W Rocketed + 16%
- W/Q Soared + 11%
- Y/Y Dropped - 9%



## IC Weather Report

Warms to Chilly

- Memory: Clear, Warmer
- Foundry: Cold, Warmer
- IDM: Cold, Warmer
- SoC: Cold, Warmer
- IoT: Chilly, Warmer

Raw: data has not been 'cooked' with a moving average or some other statistical manipulation

# MERGERS AND ACQUISITIONS



# A bit of history: Scale driven industries experience a Cambrian explosion and a Cretaceous mass extinction

## Fabbed Chip Makers

- Start-up era: 1960's-70's
- Consolidation era: 80's-90's

## Semiconductor Equipment

- Start-up era: 70's-80's
- Consolidation era: 90's-00's

## Fabless Chip Companies

- Start-up era: 90's-00's
- Consolidation era: 10's-20's

## It's a ~20 year cycle

- At ~40 years of age, most entrepreneurs hit their stride
- By ~60 years most are ready to move on

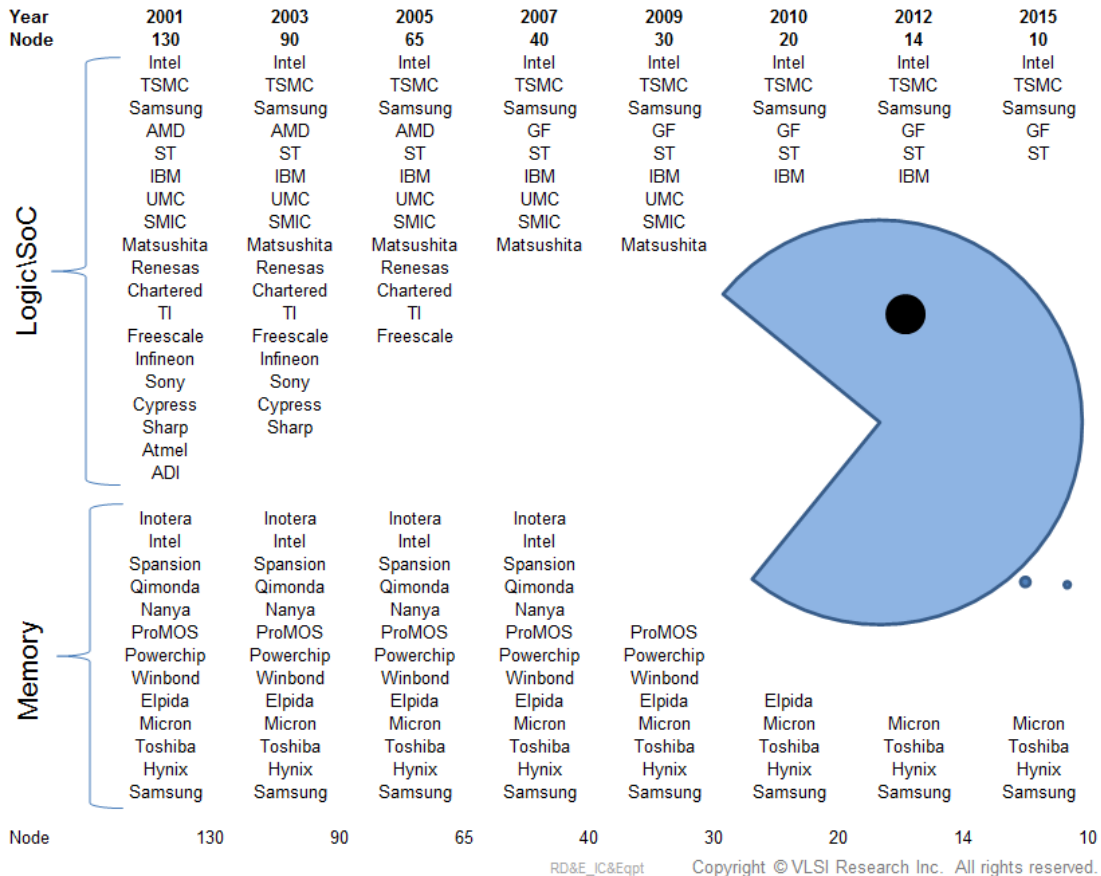
Examples:

Henry Ford started Ford at 45  
Bob Noyce started Intel at 41  
Gordon Moore started Intel at 39  
David Lam started Lam at 37  
Irwin Jacobs started Qualcomm at 52  
Henry Samueli started Broadcom at 37  
Jen-Hsun Huang started Nvidia at 30 (52 now)

# Fabbed Pac Man

Companies Developing Leading Edge Processes with their own Fabs

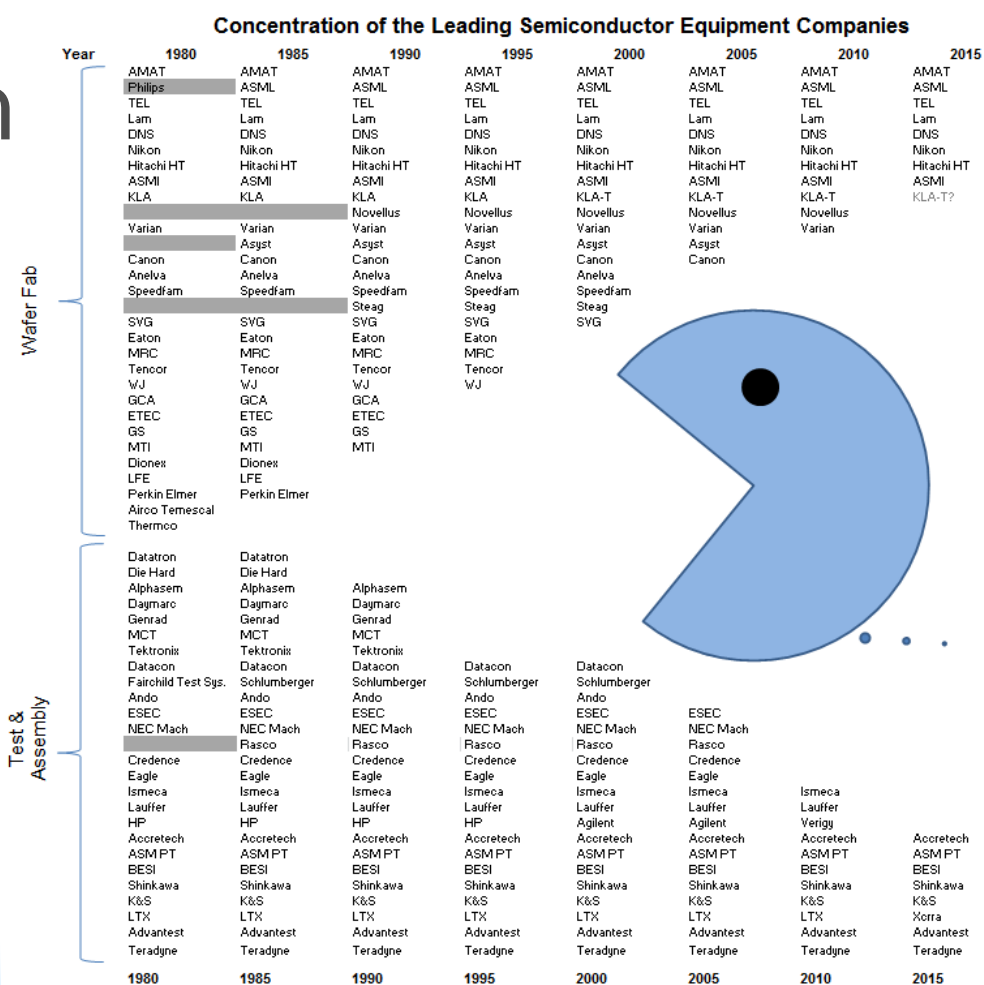
- Only 9 left
  - 5 left in Logic SoC
  - 4 left in Memory
- Down from >100
  - In the early 80's
- Structural Drivers
  - Scale
  - Fab & R&D costs
  - Financial Crisis
  - Technology failures



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# Equipment Pac Man

- Only 17 left
  - 9 left in WFE
  - 8 left in Test & Assy
- Down from >500
- Structural Drivers
  - Lack of Global Scale
  - Technology Failure
  - Financial Crisis
  - PICOS



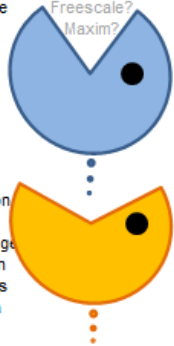
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# Fabless Pac Man

- Lots left
  - 19 majors left
  - 4 folding into merger
- Down from 100's
- Structural Drivers
  - Cost of Design
  - Lack of IP Scale
  - Shift back to Horizontals

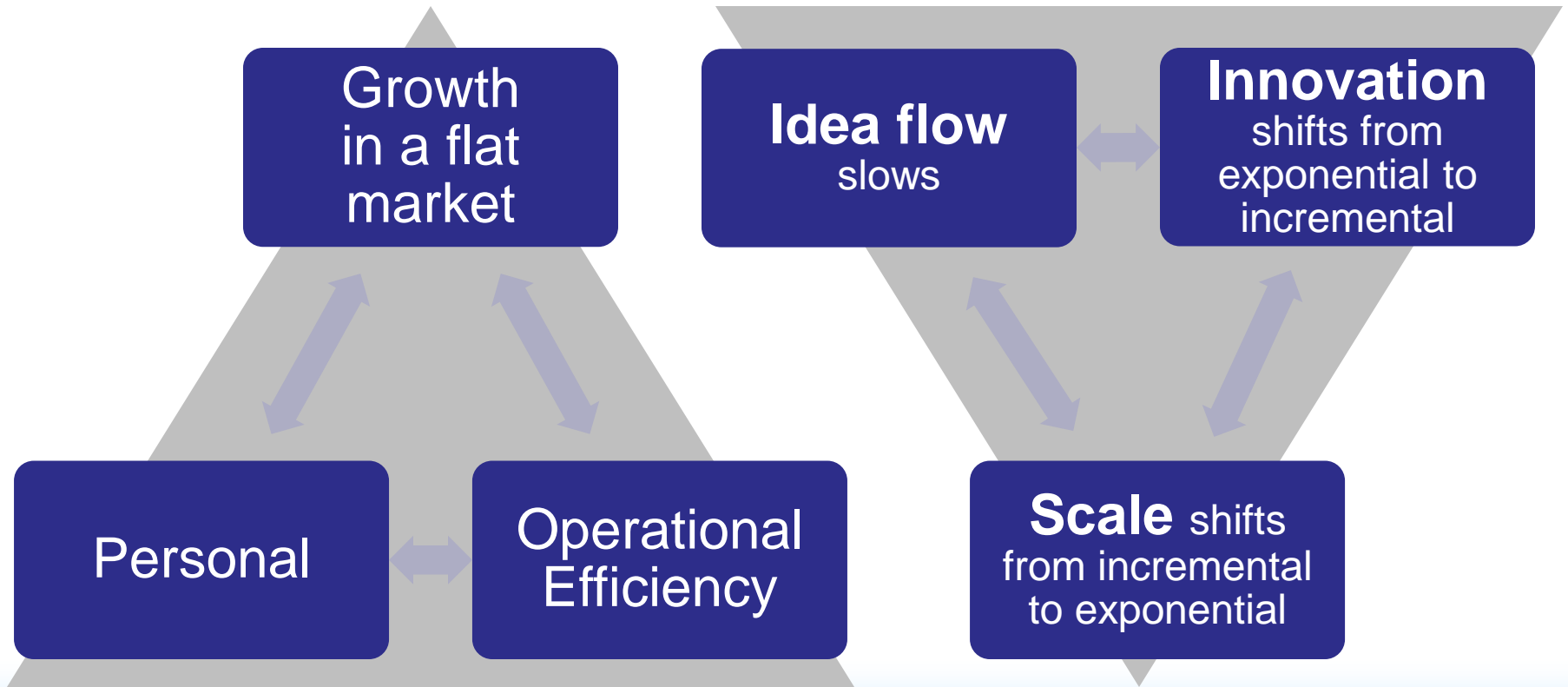
Concentration of the Leading Fabless Semiconductor Companies

Year Node	2001 130	2003 90	2005 65	2007 40	2009 30	2010 20	2012 14	2015 10
	Qualcomm	Qualcomm	Qualcomm	Qualcomm	Qualcomm	Qualcomm	Qualcomm	Qualcomm
	TI	TI	TI	TI	Apple	Apple	Apple	Apple
	Sandisk	Sandisk	Sandisk	Sandisk	TI	TI	TI	TI
	Renesas	Renesas	Renesas	Renesas	Sandisk	Sandisk	Sandisk	Sandisk
	MediaTek	MediaTek	MediaTek	MediaTek	Renesas	Renesas	Renesas	Renesas
	Infineon	Infineon	Infineon	Infineon	MediaTek	MediaTek	MediaTek	MediaTek
	Avago	Avago	Avago	Avago	Infineon	Infineon	Infineon	Infineon
	NXP	NXP	NXP	NXP	Avago	Avago	Avago	Avago
	AMD	AMD	AMD	AMD	NXP	NXP	NXP	NXP
	Nvidia	Nvidia	Nvidia	Nvidia	AMD	AMD	AMD	AMD
	Marvell	Marvell	Marvell	Marvell	Nvidia	Nvidia	Nvidia	Nvidia
	HiSilicon	HiSilicon	HiSilicon	HiSilicon	Marvell	Marvell	Marvell	Marvell
	Silicon Labs	Silicon Labs	Silicon Labs	Silicon Labs	HiSilicon	HiSilicon	HiSilicon	HiSilicon
	Triquint	Triquint	Triquint	Triquint	Silicon Labs	Silicon Labs	Silicon Labs	Silicon Labs
	Altera	Altera	Altera	Altera	Triquint	Triquint	Triquint	Qorvo
	Broadcom	Broadcom	Broadcom	Broadcom	Altera	Altera	Altera	Altera?
	Freescale	Freescale	Freescale	Freescale	Broadcom	Broadcom	Broadcom	Broadcom?
	Maxim	Maxim	Maxim	Maxim	Freescale	Freescale	Freescale	Freescale?
	Axxia	Axxia	Axxia	Axxia	Maxim	Maxim	Maxim	Maxim?
	CSR	CSR	CSR	CSR	Maxim	Axxia	Axxia	Axxia
	Hittite	Hittite	Hittite	Hittite	CSR	CSR	CSR	CSR
	IRT	IRT	IRT	IRT	Hittite	Hittite	Hittite	Hittite
	ISSI	ISSI	ISSI	ISSI	IRT	IRT	IRT	IRT
	LSI	LSI	LSI	LSI	ISSI	ISSI	ISSI	ISSI
	MStar	MStar	MStar	MStar	LSI	LSI	LSI	LSI
	Omnivision	Omnivision	Omnivision	Omnivision	MStar	MStar	MStar	MStar
	RFMD	RFMD	RFMD	RFMD	Omnivision	Omnivision	Omnivision	Omnivision
	Silicon Image	Silicon Image	Silicon Image	Silicon Image	RFMD	RFMD	RFMD	RFMD
	Spansion	Spansion	Spansion	Spansion	Silicon Image	Silicon Image	Silicon Image	Silicon Image
	Synaptics	Synaptics	Synaptics	Synaptics	Spansion	Spansion	Spansion	Spansion
	Volterra	Volterra	Volterra	Volterra	Synaptics	Synaptics	Synaptics	Synaptics
	Sun Microsystems	Sun Microsystems	Sun Microsystems	Sun Microsystems	Volterra	Volterra	Volterra	Volterra
	PA Semi	PA Semi	PA Semi	PA Semi	Sun Microsystems	Sun Microsystems	Sun Microsystems	Sun Microsystems
Node	130	90	65	40	30	20	14	10



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# The M&A Driver Time Triangles



# Where do we go from here ...

- M&A has just started for the fabless world
  - Merchant Fabless versus Captive Fabless
  - Distinction between IDM and Foundry will blur
- Technology earthquakes will rock today's structures



# HOW WILL CHINA CHANGE SEMICONDUCTOR BUSINESS?

# The National IC Industry Development Policy

1. Investment Fund: China's Government Funds for National IC Industry Support
  - Facilitate IC industry consolidation
  - Enhance the competitiveness of the leading IC enterprises
2. Amount of Money: 120 billion RMB(\$19.5B) between 2014-2017
3. Purpose:
  - National level support and funding
  - Support target IC enterprises
4. Allocation of funds:
  - Wafer manufacturing (40%)
  - Chip design (30%)
  - Chip packaging and testing (30%)

# Local Government Support in China

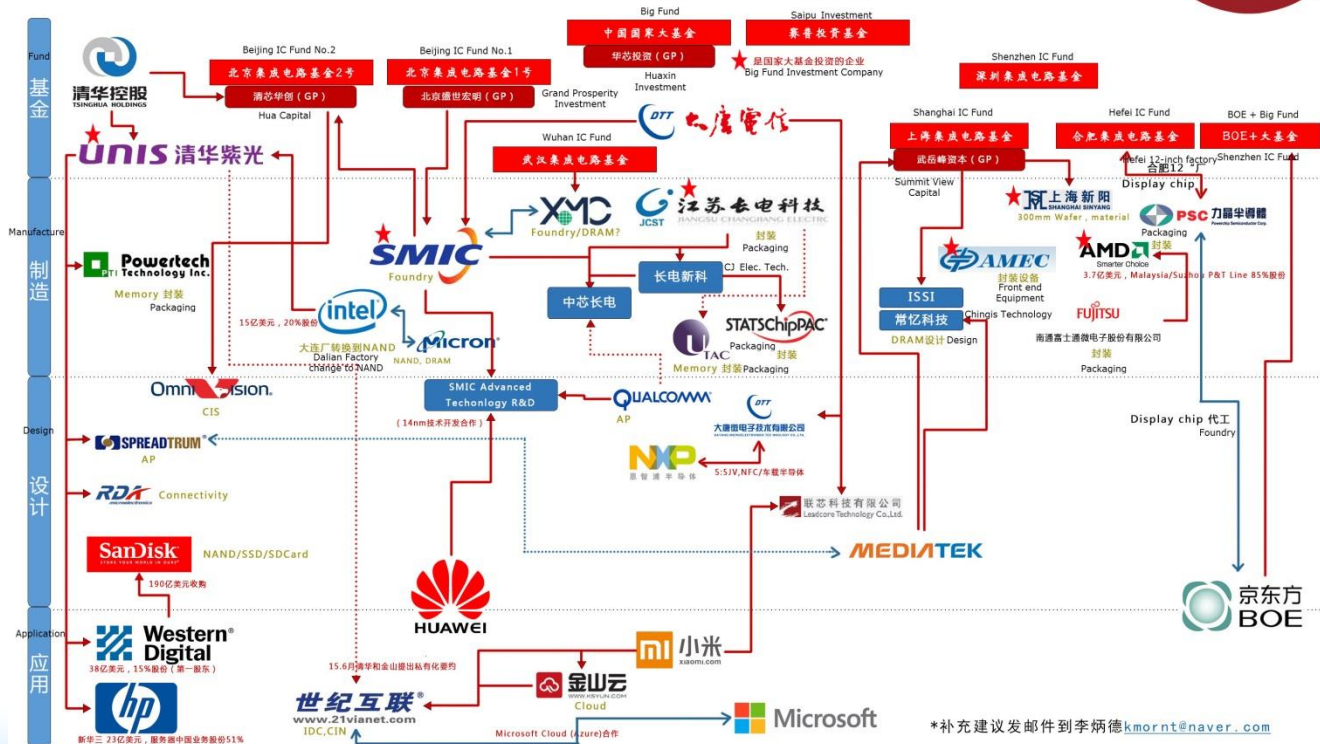
1. Investment fund: local government and private equity investments in China
2. Amount of Money: 600 billion RMB(\$97.4B)
3. Purpose:
  - Promote resource integration and M&A
  - Invest in key enterprises, project and innovation entities or platforms
4. Sources of fund:
  - Beijing IC industry Equity Investment Fund (\$4.9B)
  - Wuhan, Shanghai, Shenzhen are following Beijing Fund Model to support local IC industry

# Made in China 2025

1. The "Made in China 2025" was published by China's State Council in May 2015.
2. The plan proposed a "three step" strategy
  - Leading manufacturing power by the year 2049
3. The "Made in China 2025" clearly outlines target to raise its self-sufficiency rate for ICs to 40% in 2020, and 70% in 2025
4. Open up its market and attract foreign investors to invest in key areas
  1. new information technology
  2. bio-medicine
5. Foreign companies and institutions should be encouraged to set up R&D centres in China.

# 2015年中国大陆半导体行业投资图

IC咖啡，知晓天下“芯”鲜事



\*补充建议发邮件到李炳德 [kmornt@naver.com](mailto:kmornt@naver.com)

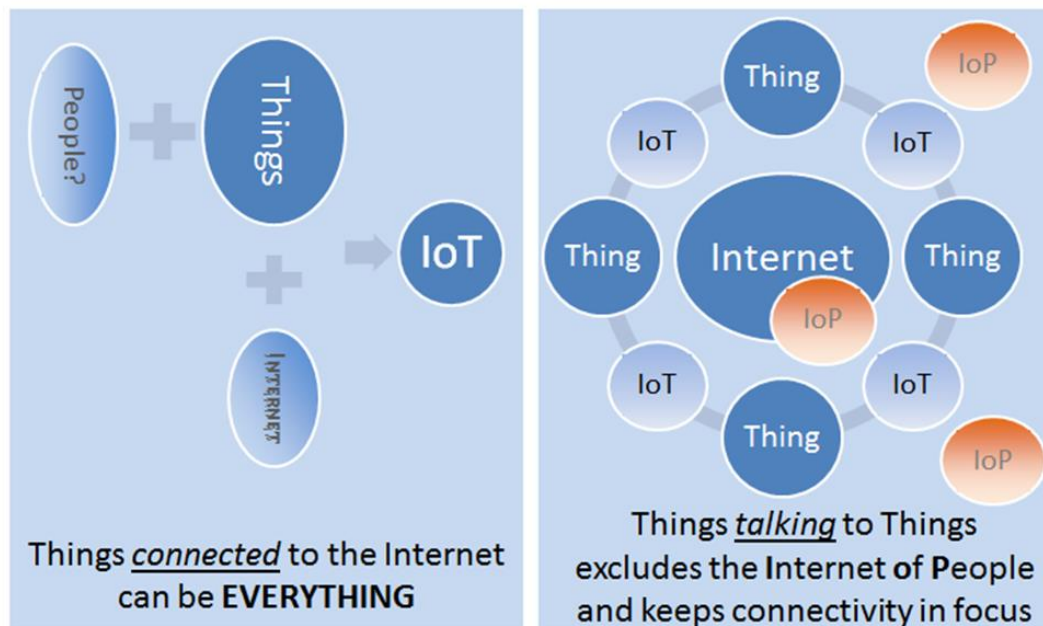
Source: IC Cafe

# NEXT BIG THING; WHAT WILL DRIVE OUR INDUSTRY NEXT DECADE



# IoT market potential clouded by definitional differences

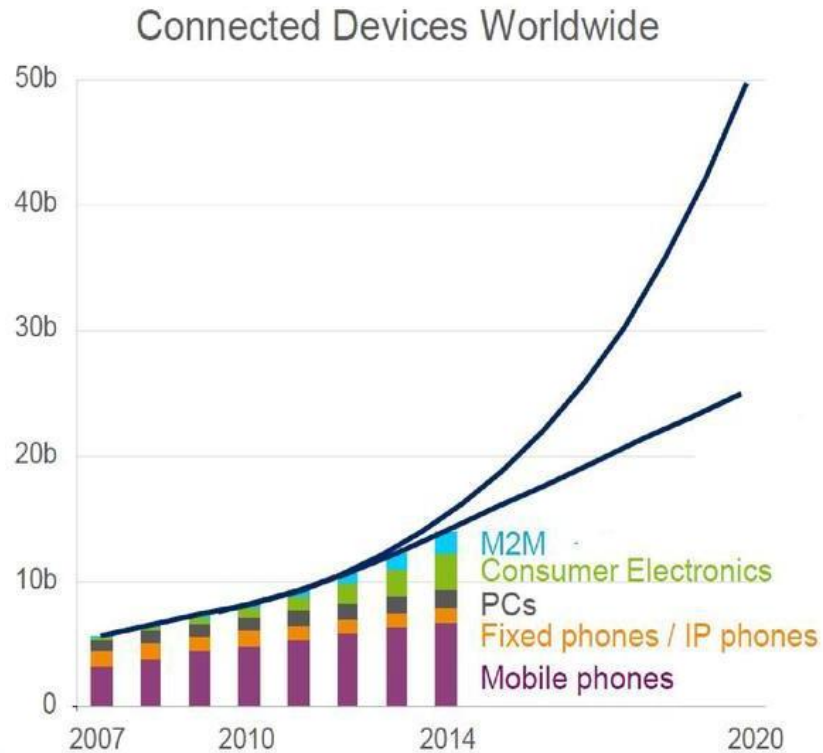
## IoT's Definition Confusion



- Several Studies
  - Can't define it
  - But it's big
- IoT versus IoP
- Wearables prominence in IoT marketing
  - Ro-IoT not exciting

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# Volume of Devices Will Explode

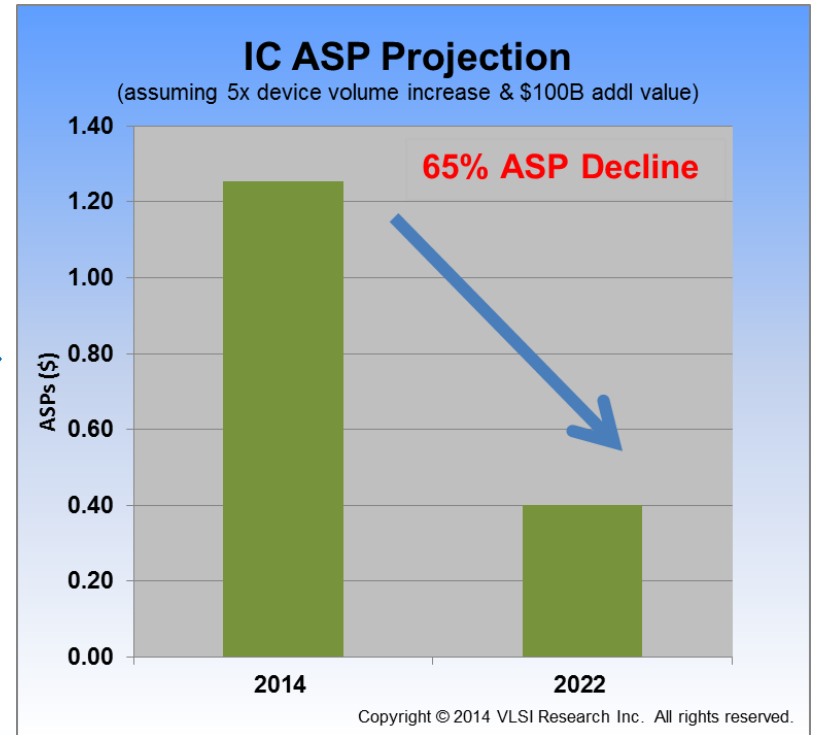
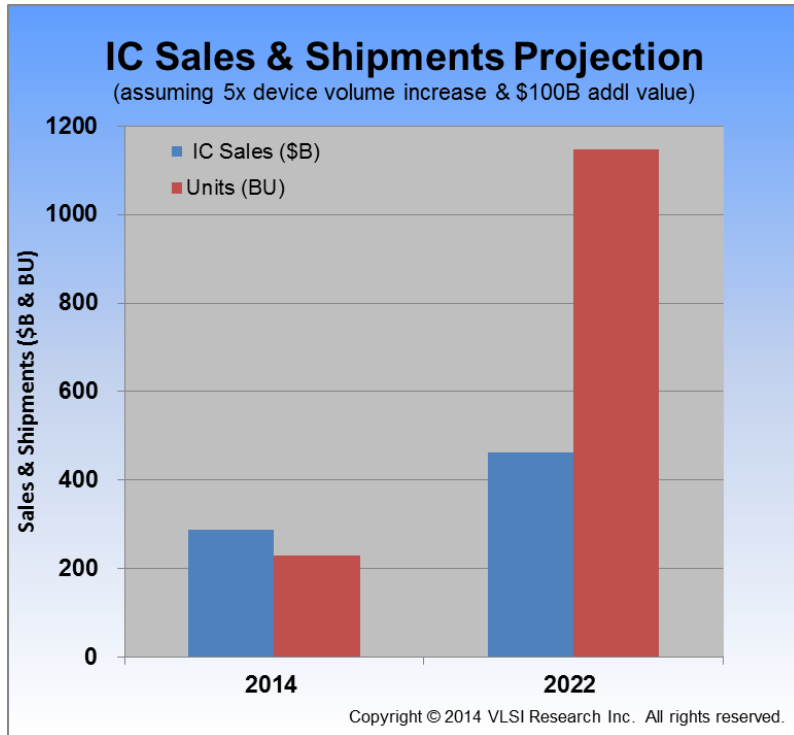


Source: Erickson, NXP

- Two fold increase in connected devices in today's applications
- Five fold increase, if M2M\* driven expansion materializes

\*Machine-to-machine

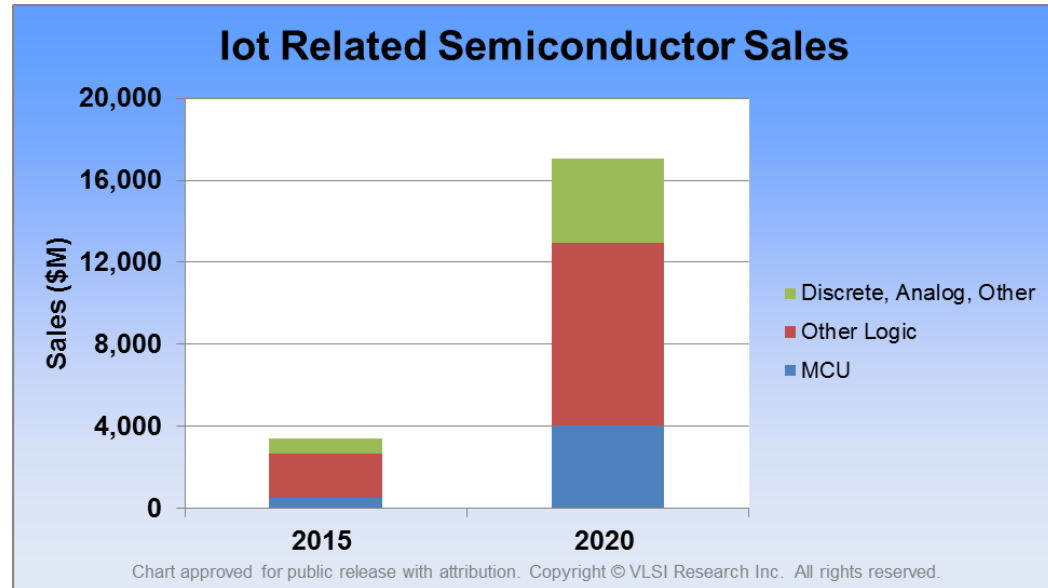
# IC ASPs Have to Be Significantly Lower



# VLSI's View:

## IoT Is Like Touch Screen for Smart Phones

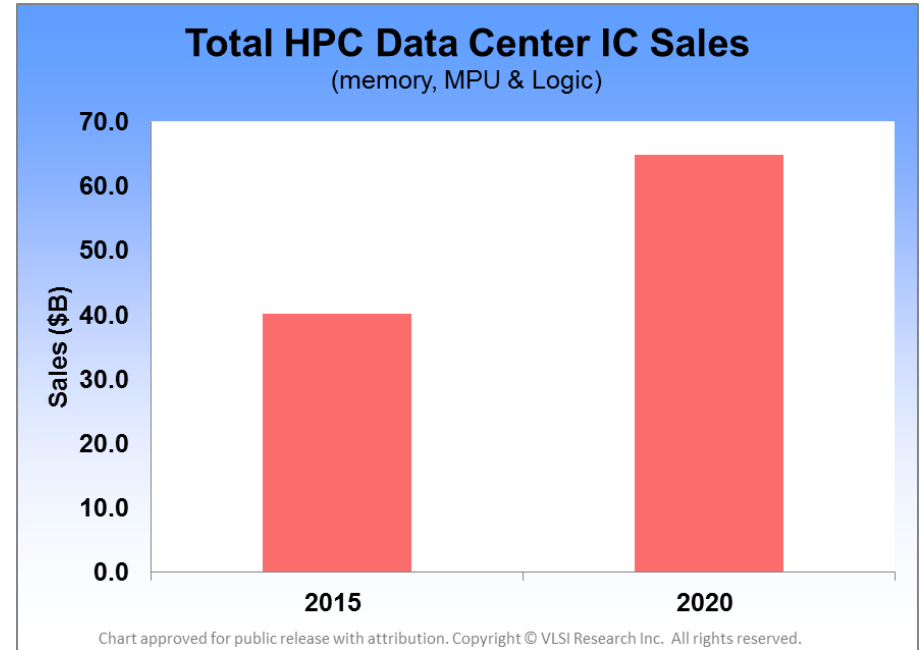
- YES, High Growth ~38% CAGR
  - But < \$20B in five years
  - Almost all of the growth in these segments
- Low cost, low profit
- High volumes
- Lack of differentiation at the semiconductor level



# What if We Consider This:

*IoT is a low cost automated data generator*

- All IoT Devices are generating data and sometimes lots of it
  - Either personal behavior information
  - Machine information
  - Data collection is automated
- The semiconductor value is captured at the data center level
  - Data storage and delivery
  - Memory
  - High Performance Computing



# EQUIPMENT FORECAST

# VLSI's forecast summary

From January

- ICs: **Downgraded**
- Equipment: Unchanged
- Electronics: **Downgraded**

Forecast as of March 2016:	2015	2016
<b>Semi Equipment (\$B):</b>	<b>\$ 49.3</b>	<b>\$ 46.8</b>
Sequential Change	-0.6%	-5.0%
<b>Capacity Utilization:</b>	87.4%	86.4%
<b>ICs (\$B):</b>	<b>\$ 284.2</b>	<b>\$293.9</b>
Sequential Change	-1.3%	3.4%
<b>IC Units (BU):</b>	240.8	253.2
Sequential Change	5.5%	5.1%
<b>Electronics (\$B) :</b>	<b>\$ 1,981</b>	<b>\$2,021</b>
Sequential Change	-1.1%	2.0%

# Equipment Trend for 2015 and 2016

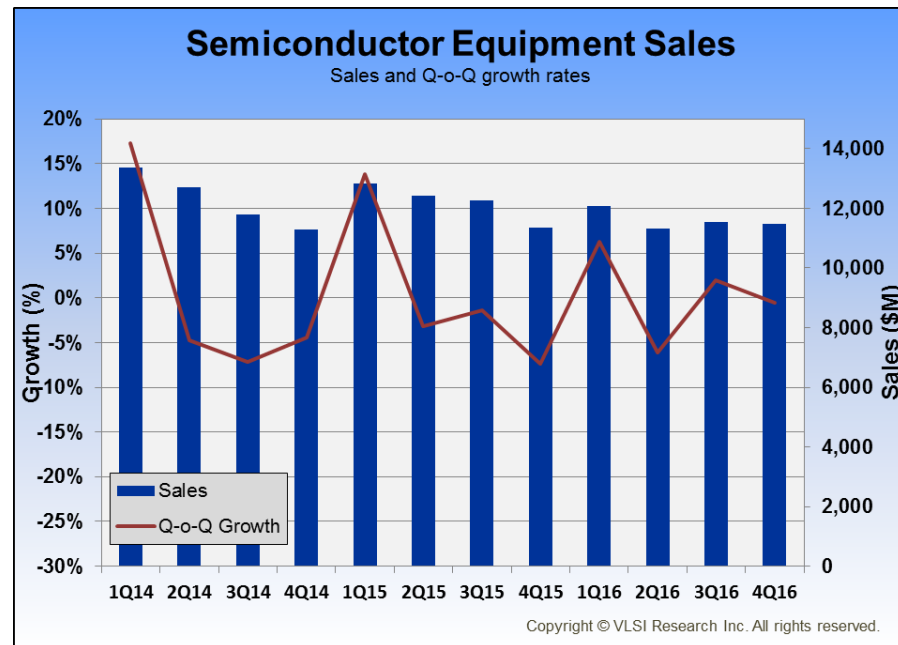
2016 outlook is improving

## Semiconductor Equipment Sales

(worldwide sales, \$M, Calendar Year)

	2014	2015	2016
<b>Wafer Process Equipment</b>	<b>32247.0</b>	<b>32153.5</b>	<b>30072.9</b>
<i>y-o-y growth</i>	14%	0%	-6%
<b>Test &amp; Related Equipment</b>	<b>3875.7</b>	<b>3690.2</b>	<b>3653.2</b>
<i>y-o-y growth</i>	24%	-5%	-1%
<b>Assembly Equipment</b>	<b>3932.5</b>	<b>3399.6</b>	<b>3266.7</b>
<i>y-o-y growth</i>	28%	-14%	-4%
<b>Total Systems</b>	<b>40055.1</b>	<b>39243.3</b>	<b>36992.8</b>
<i>y-o-y growth</i>	16%	-2%	-6%
<b>Service</b>	<b>9096.6</b>	<b>9646.1</b>	<b>9442.1</b>
<i>y-o-y growth</i>	13%	6%	-2%
<b>Total Semiconductor Equipment</b>	<b>49151.7</b>	<b>48889.4</b>	<b>46434.8</b>
<i>y-o-y growth</i>	15%	-1%	-5%

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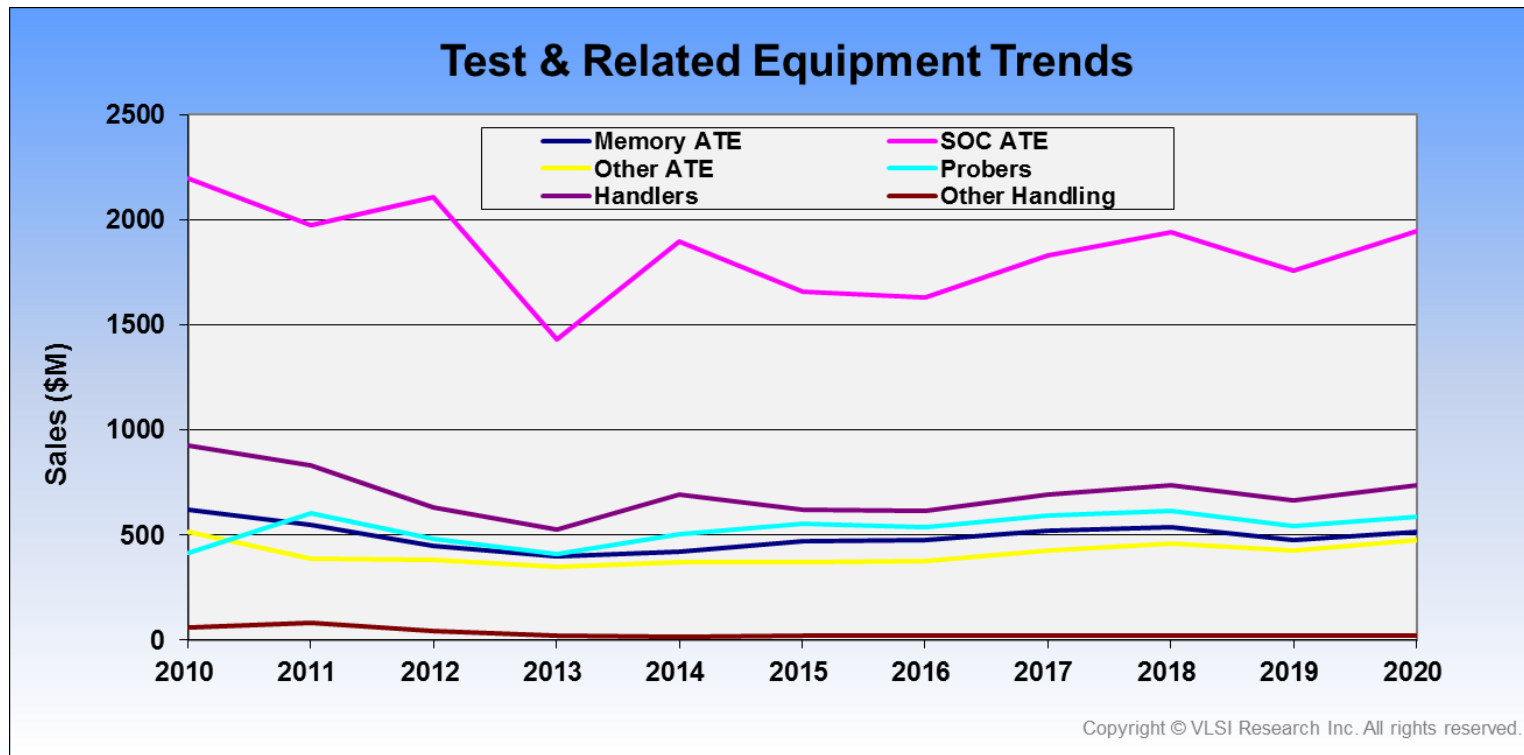




# Trends in Test

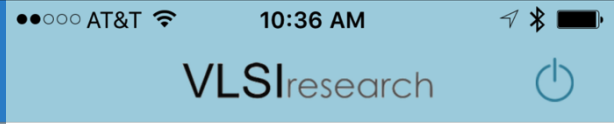
- High-end test continues to expand
  - Both memory and SOC
- Other segments mixed with over capacity
  - SOC test at \$1.9B in 2018
  - Leading mobile device and systems suppliers continue to need high-end SOC test
    - They need high-end testers to cover mobile device functionality
  - Analog, MCU, and power are drivers
    - Strongly driven by Automotive test requirements
    - IoT devices will require new test capabilities
- SOC tester demand is expected to improve from previous years' trends
  - Productivity gains from parallel testing are expected to diminish, leading to increased tester demand
- Memory test continues to be challenging
  - Only high-end capacity is needed
  - Low COO requirements drive sales
- Handler and prober demand continues to be challenging
  - OSAT share gains drive productivity but new capacity is also needed
  - Multi-site testing drives higher ASPs

# SOC Leads Test Spending



# Summary

1. Semiconductor industry has been in recession and the recovery may still take awhile
2. M&A in Semiconductors will continue
3. China will be a significant factor in semiconductor industry in coming decade
  - Its success is highly dependent on IP
4. IoT will drive semiconductor business
  - But it will not be specific for IoT devices
  - Data Center business is likely to thrive
5. Equipment sales will decline ~5% in 2016



# Thank You



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