

18吋晶圓廠對臺灣半導體製造之挑戰

獻給

5070精英網友

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美國普渡大學土木工程系名譽教授

3-20-2013

報告大綱

- 背景說明
- 18吋(450mm)晶圓廠發展概況
- 450mm Global Consortium (G450C)
18吋全球聯盟
- 台灣半導體產業面臨之問題
- 結論

How's heaven Steve?




Perfect, Bill. It's just
that it doesn't have
any wall or fence...

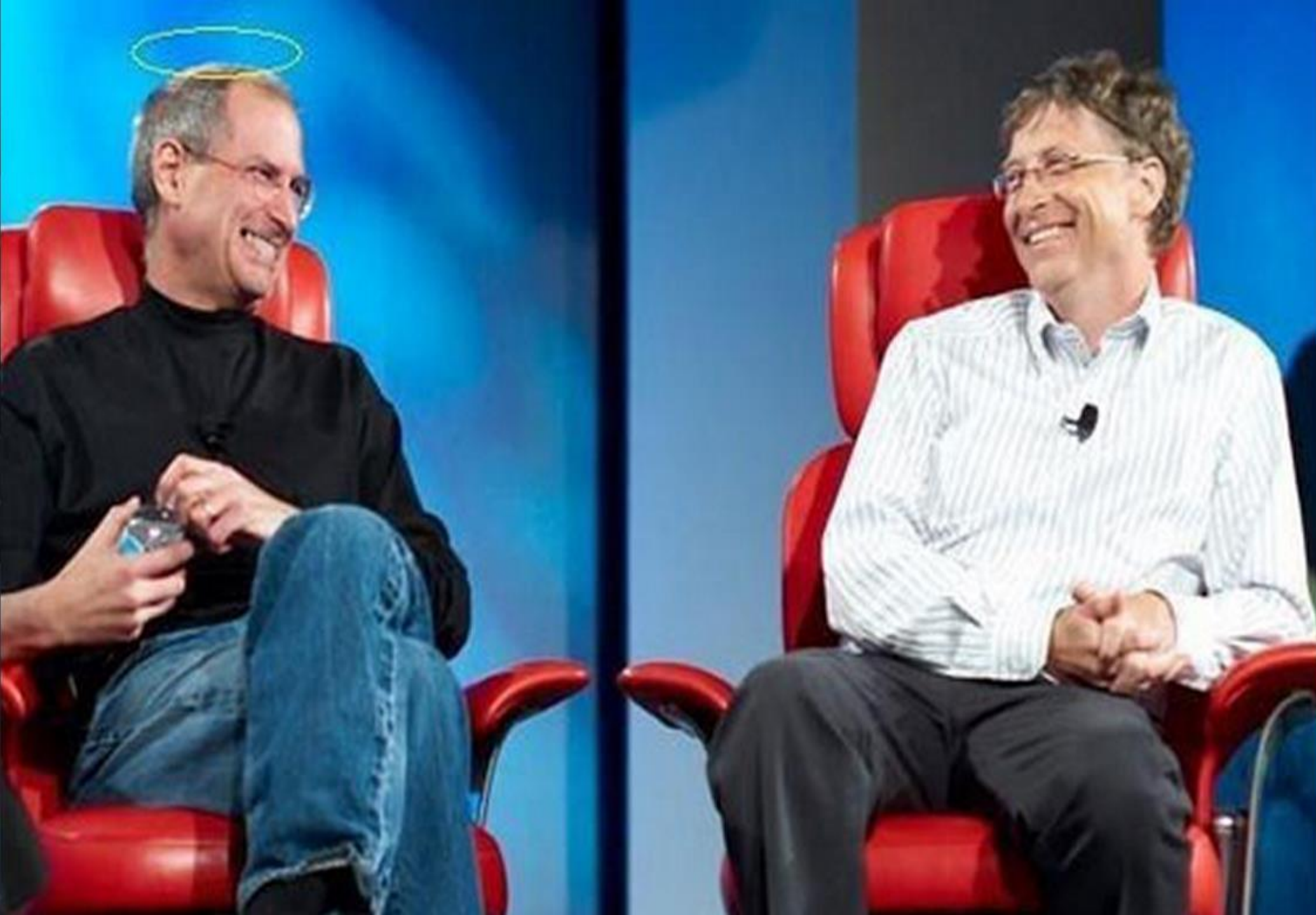




So?

A photograph of Steve Jobs and Bill Gates sitting in red chairs on a stage, facing each other. Steve Jobs is on the left, wearing a black turtleneck and blue jeans, with a yellow halo around his head. Bill Gates is on the right, wearing a striped shirt and dark pants, with his hands clasped. The background is a blue wall.

**We don't need windows
and gates**



西江月

楊慎

滾滾長江東逝水。

浪花淘盡英雄。

是非成敗轉頭空。

青山依舊在。幾度夕陽紅

白髮漁樵江渚上。慣看秋月春風。

一壺濁酒喜相逢。

古今多少事。

都付笑談中

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台灣半導體產業的重要度

掌握亞洲ICT市場商機潛力

經建會綜計處 新聞稿 (100.1.20)

- 我國為全球ICT產品的設計與製造大國，為掌握亞太市場商機，應積極發展ICT應用與消費端產品之製造及服務業。
 - 台灣為全球ICT生產鏈的重要一環。2010年有多項ICT產品排名全球前3大(見表一)，其中晶圓代工、IC封裝、IC測試、Mask ROM 與 EPROM等高科技產品更居世界第一。

中華民國對外貿易發展協會

(Taiwan External Trade Development Council, TAITRA)

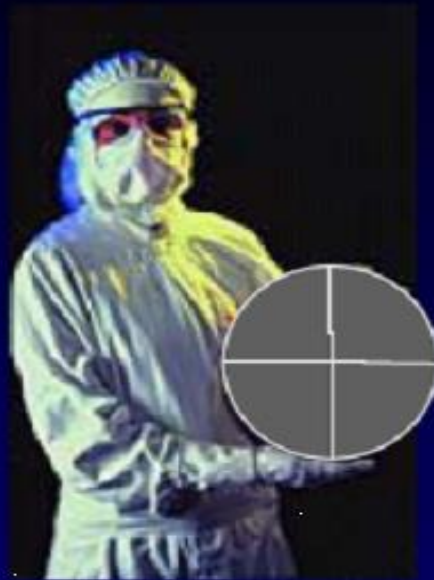
August 23, 2012

Taiwan's competitiveness in the industry is drawn from its well established production pipeline, highly experienced engineers and strong R&D capabilities. According to statistics from Taiwan's Institute for Information Industry (III), Taiwan is top in worldwide market share in over 12 product categories including cable CPE (96.2%), notebook PC (89.4%), and tablet devices (86.5%). Other product areas in which Taiwan has top ranking include WLAN NIC, motherboards, LCD monitors, IP phone, desktop PC, and smartphones. Moreover, the island serves as a major procurement center for global ICT companies and buyers.

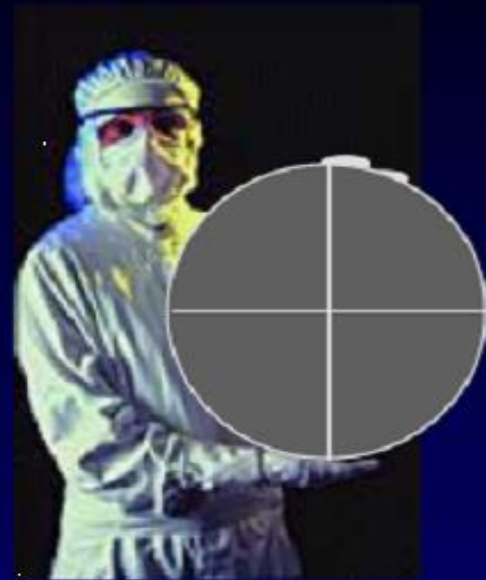
晶圓愈來愈大



200mm/1990



300mm/2001



450mm/ 2014

投資金額愈來愈高

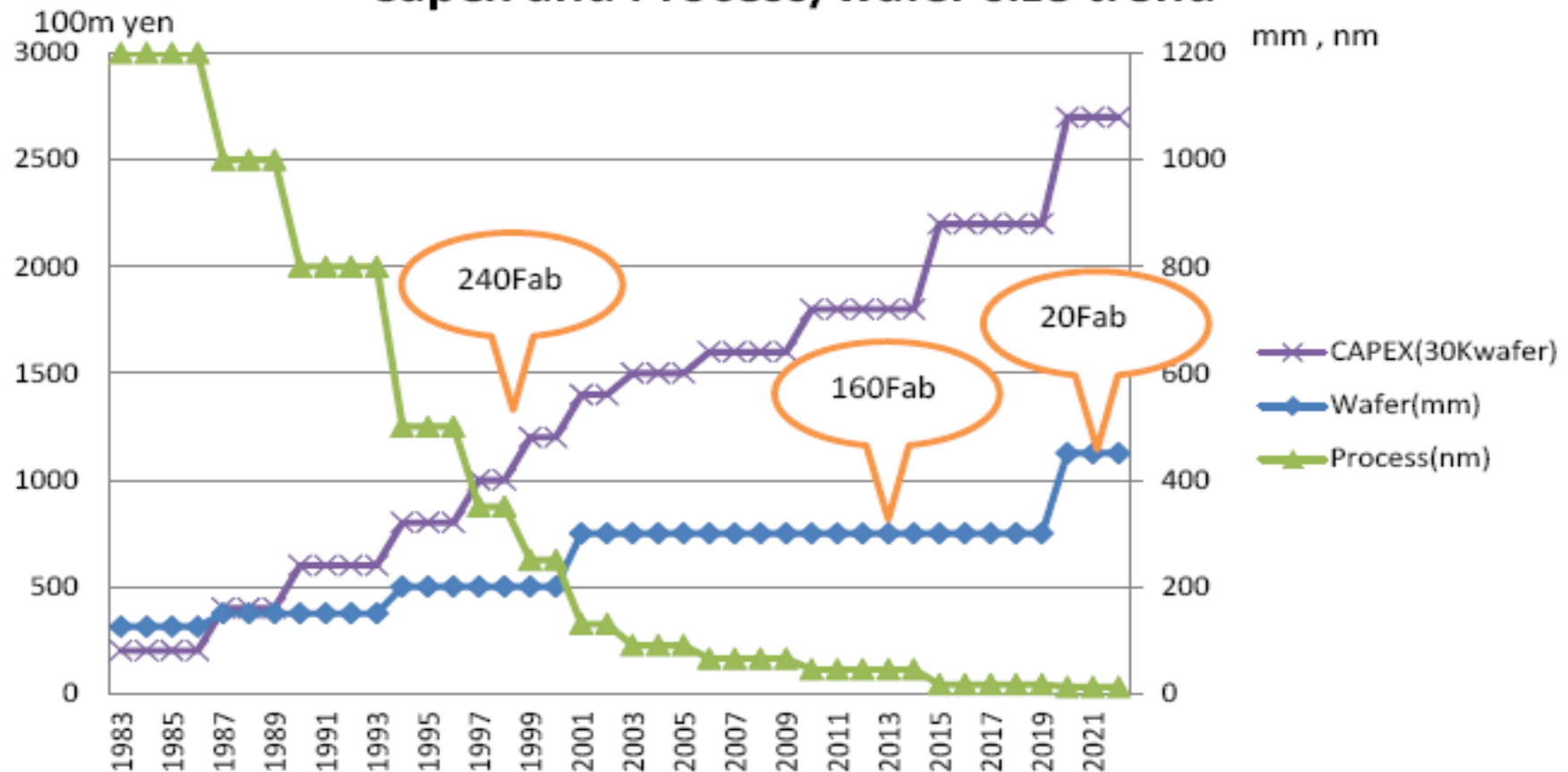
	技術進入障礙	資金進入障礙	廠商家數
150mm(6吋)	>0.5um	5億美金 (155億台幣)	113
200mm(8吋)	0.5um~0.13um	12億美金 (372億台幣)	76
300mm(12吋)	0.13um~22nm	33億美金 (1000億台幣)	27
450mm(18吋)	22nm導入	80~100億美金 (2800~3500億台幣)	<10

資料來源：經濟部 (2008/Q4)

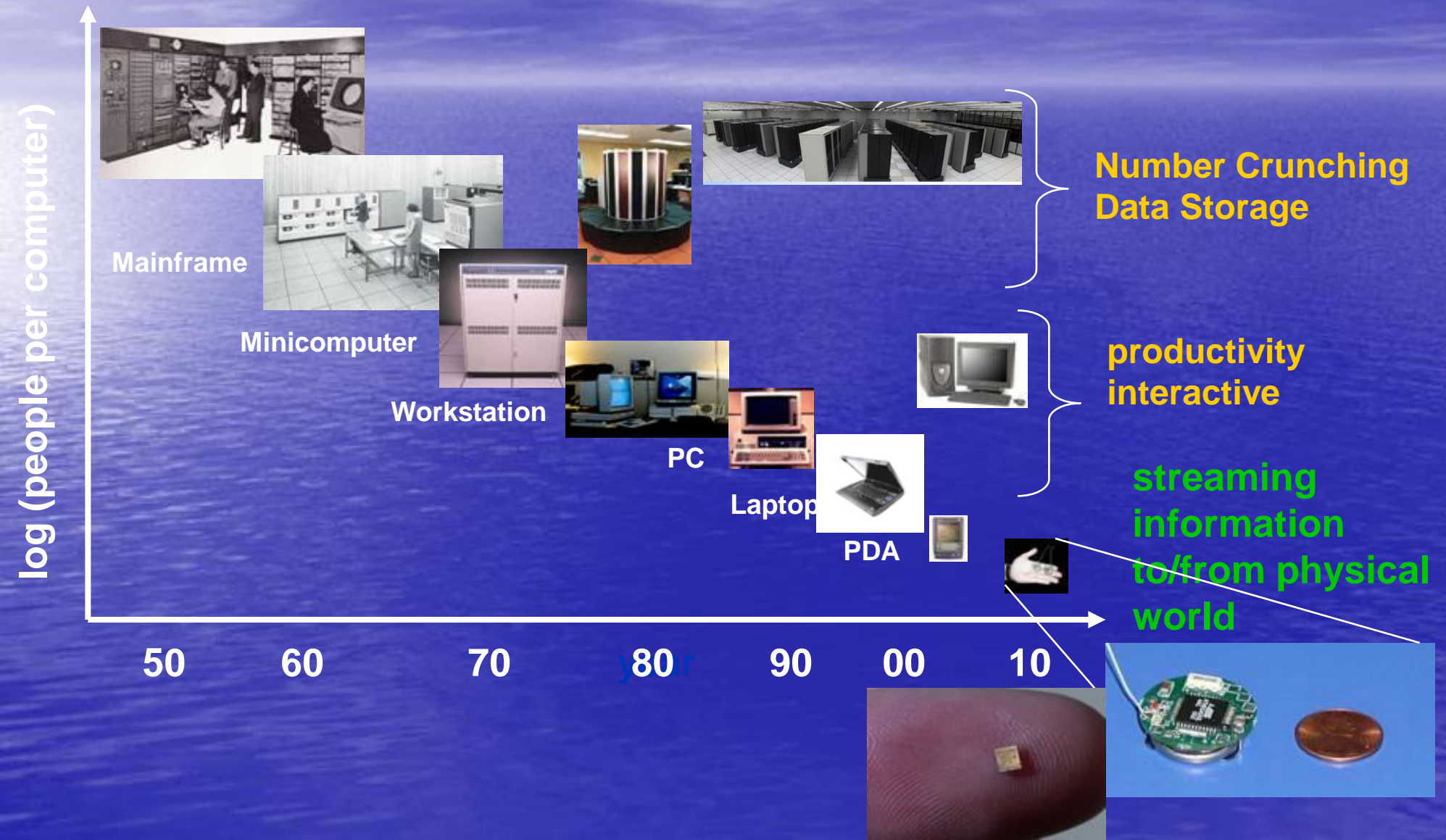
附註：1元美金=31元台幣計

450mm capex

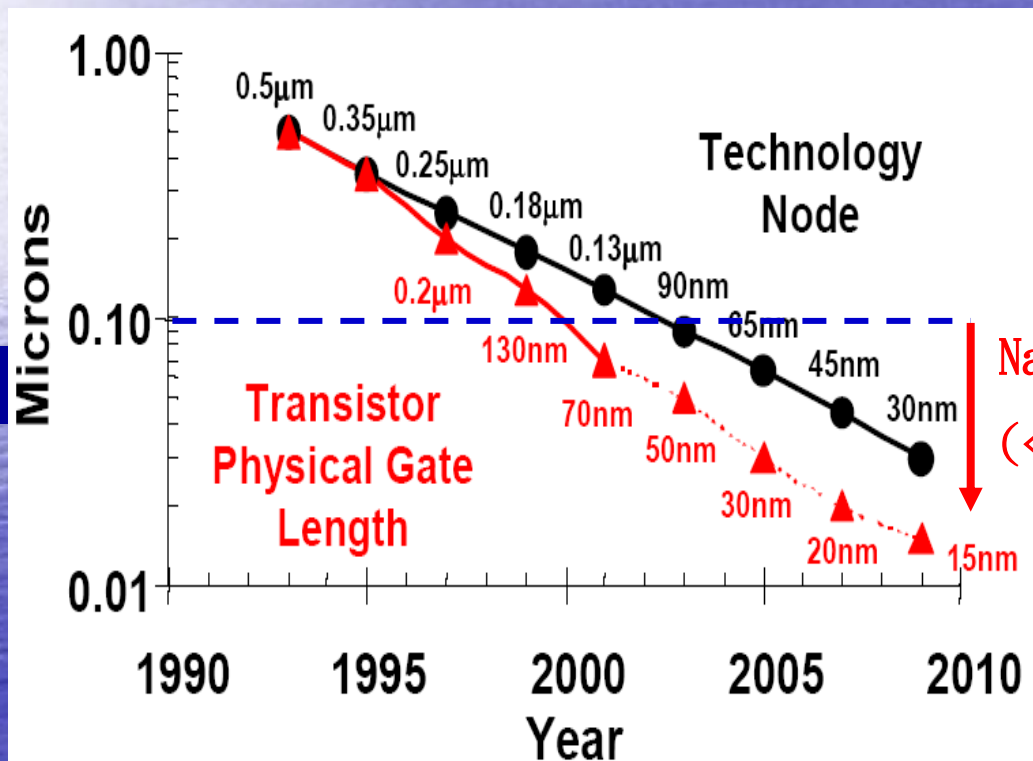
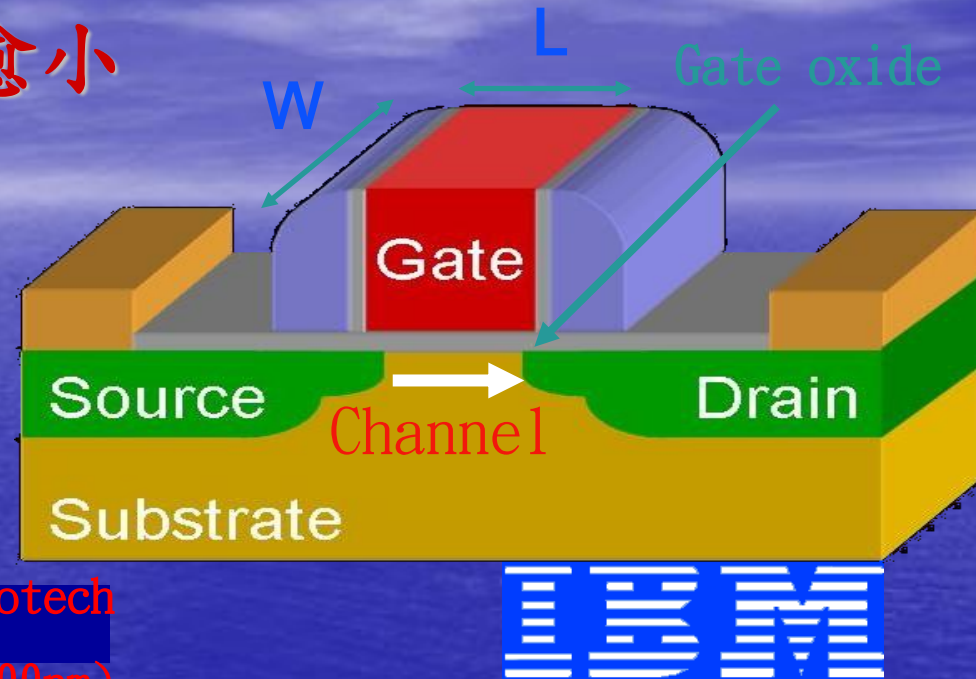
Capex and Process/wafer size trend



愈來愈小



閘寬(Gate Length) 愈來愈小



內含32億顆電晶體的繪圖晶片，
使用TSMC 40奈米製程製作。



本晶片由NVIDIA公司提供。

廠房設施之興建是愈來愈快



2002 08 08

投資金額

1,000~3,000 仟億

興建時間

9~11月完成

產業面臨問題

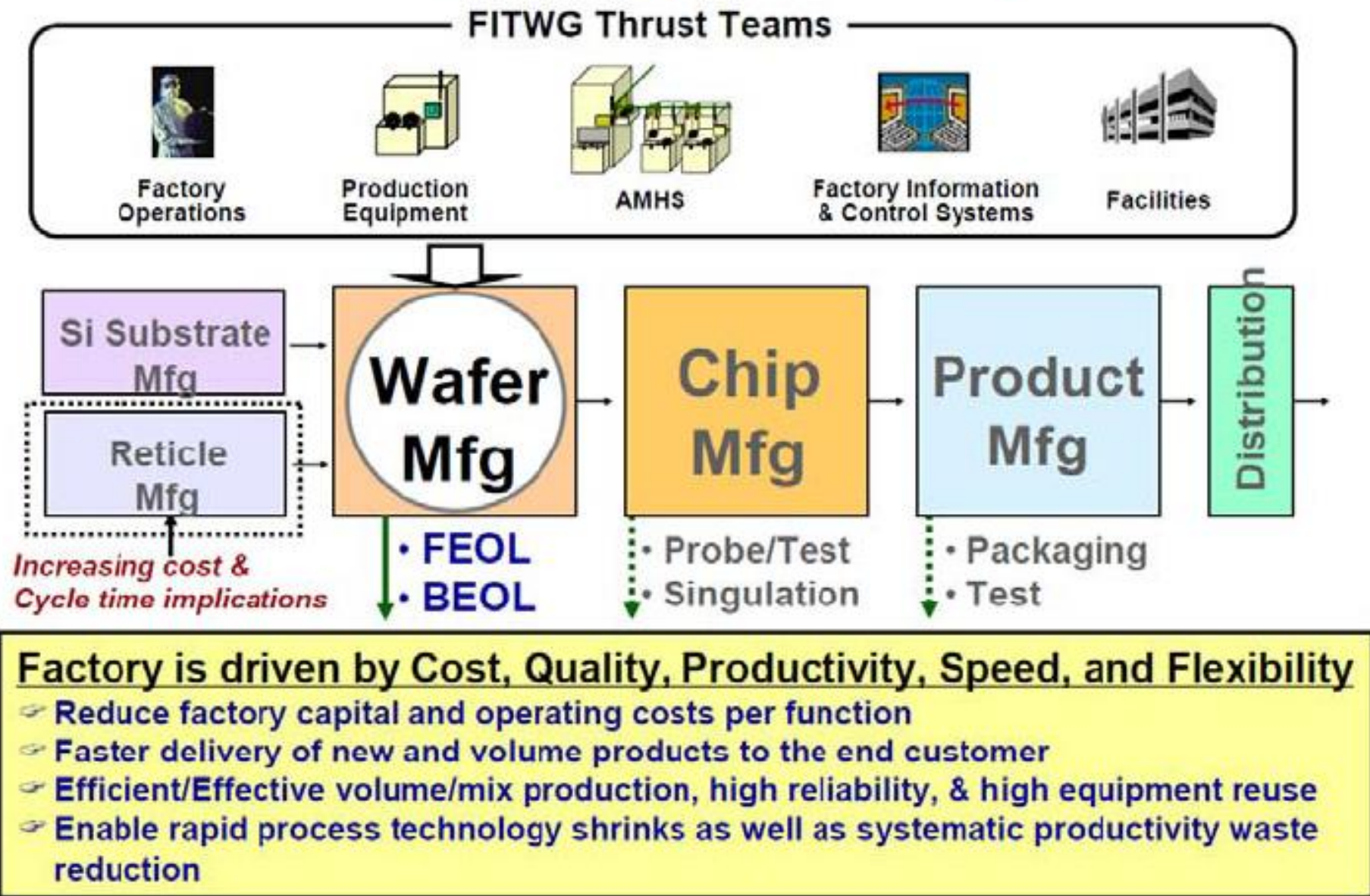
- ✓ 投資愈來愈多
- ✓ 能耗愈來愈大
- ✓ 製程愈來愈敏感
- ✓ 複雜度愈來愈高
- ✓ 建廠時程愈來愈短

Year of Prod								2017
DRAM 1/2 P								20.0
MPU Physic								14.0
Wafer Diamo								450
								(18)
Factory cons								
groundbreaking to first tool	10	9	9	9	9	-	-	
move-in (months)								

報告大綱

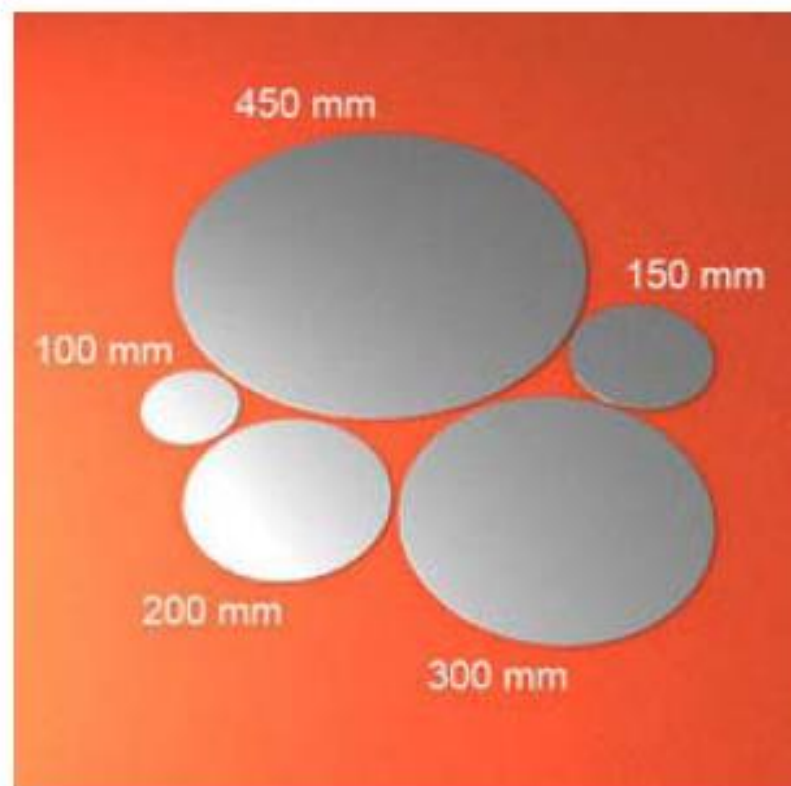
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Factory Integration Scope*



*: ITRS Factory Integration 2011 Edition (www.itrs.net)

450mm Wafer



Wafer Size	Thickness	Weight	10mm Die/Wafer
100mm	525 um	10 g	56
200mm	725 um	53 g	269
300mm	775 um	125 g	640
450mm	925 um	342 g	1,490

450mm Overview





450mm Fab Outline

■ Sustainable Operation

- Safety, Energy Saving, and Sustainable Environment

■ Innovative Process

- New Ideation, New Methods, New Techniques

■ GigaFab

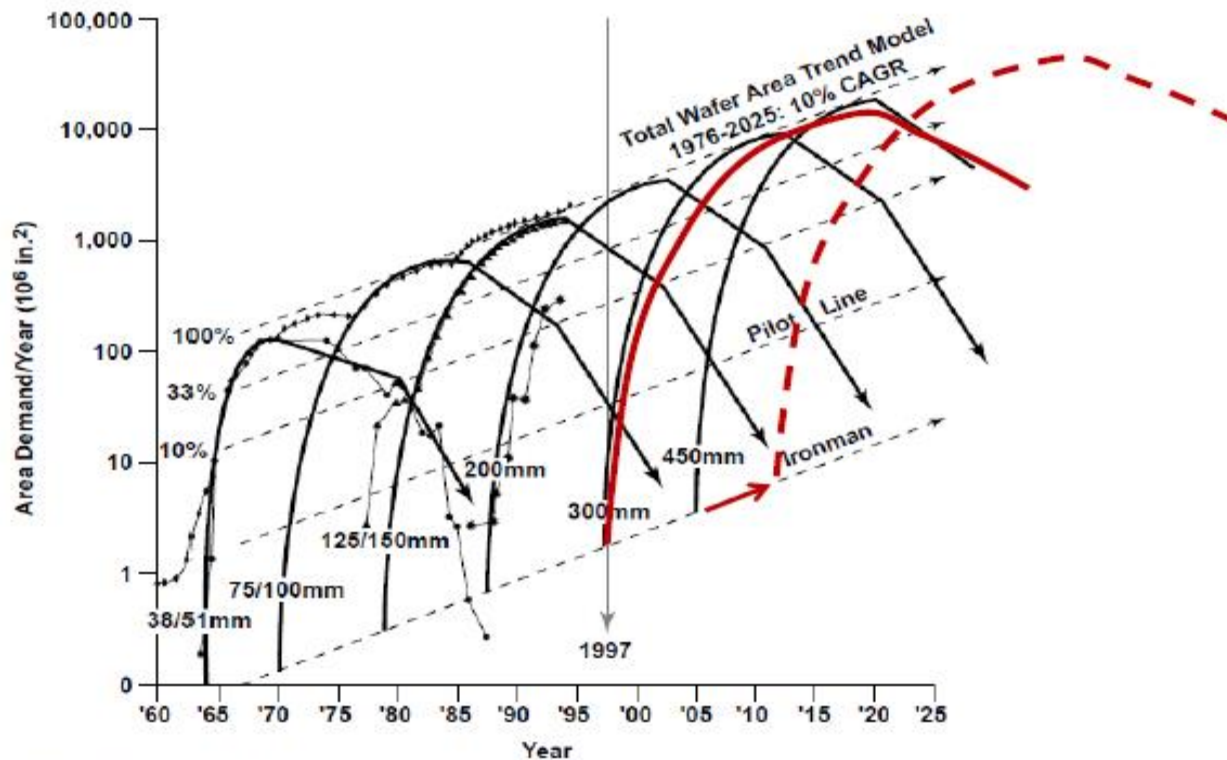
- Engineering Productivity, Manufacturing Cost

■ Nanotechnology

- 16nm node and below



IC Industry Irreversible Track

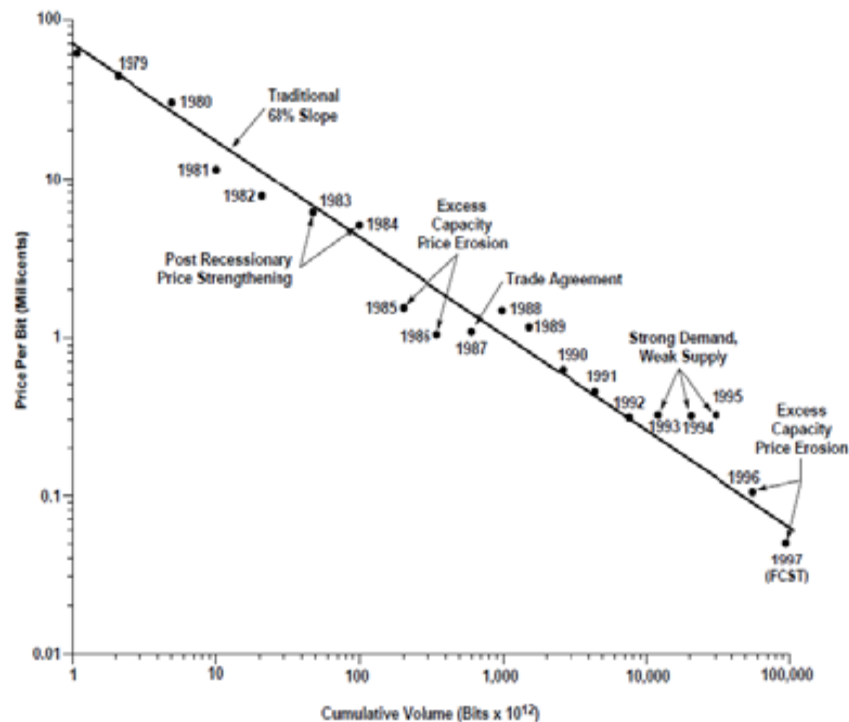
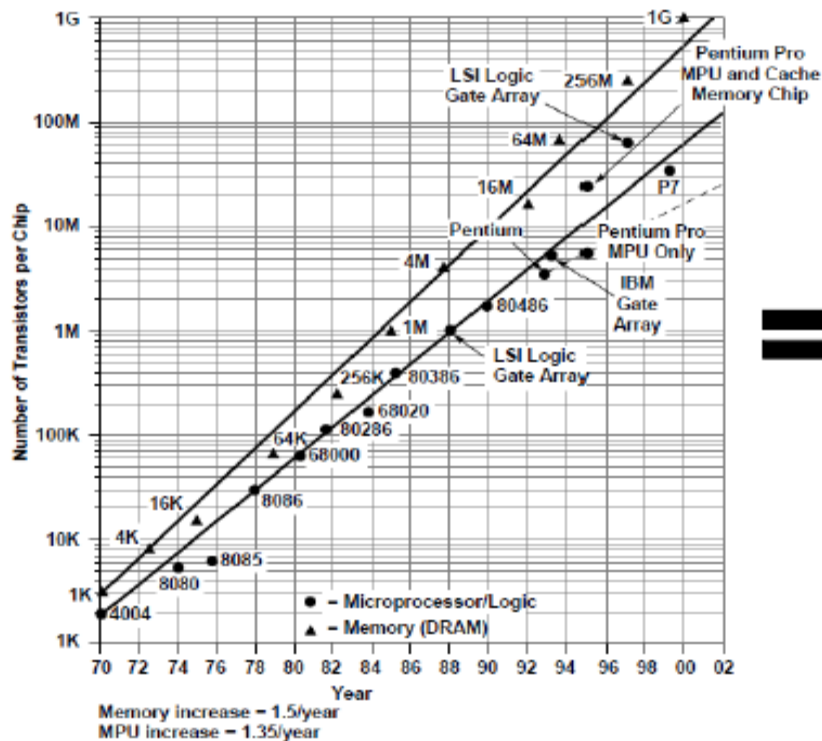


Source: VLSI Research, SEMATECH, I300I

22624



IC Industry Irreversible Track

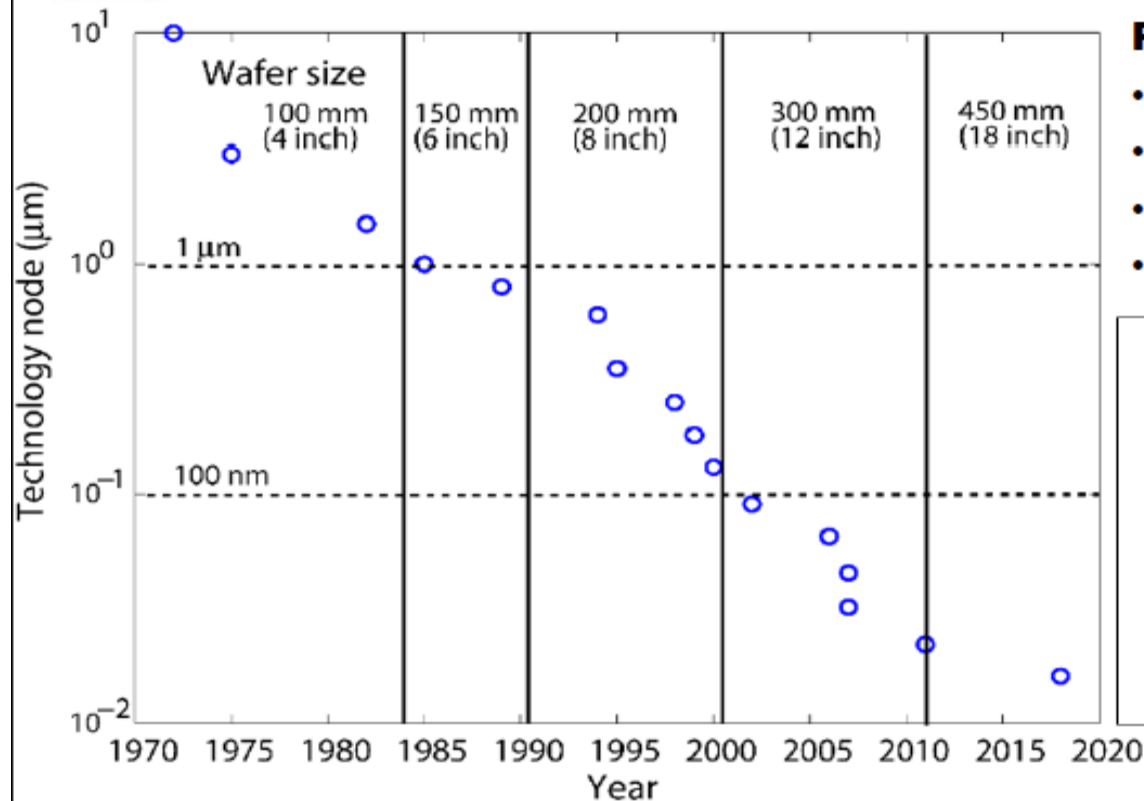


Source: ICE

743748



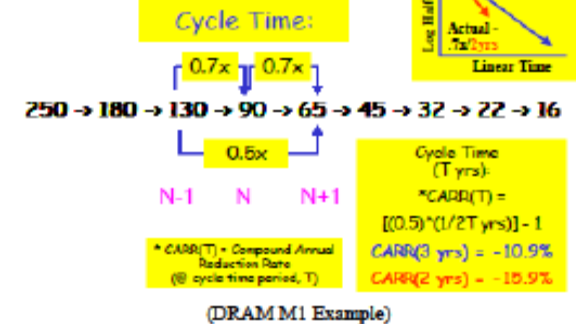
Technology Node and Wafer Size



Productivity Improvement:

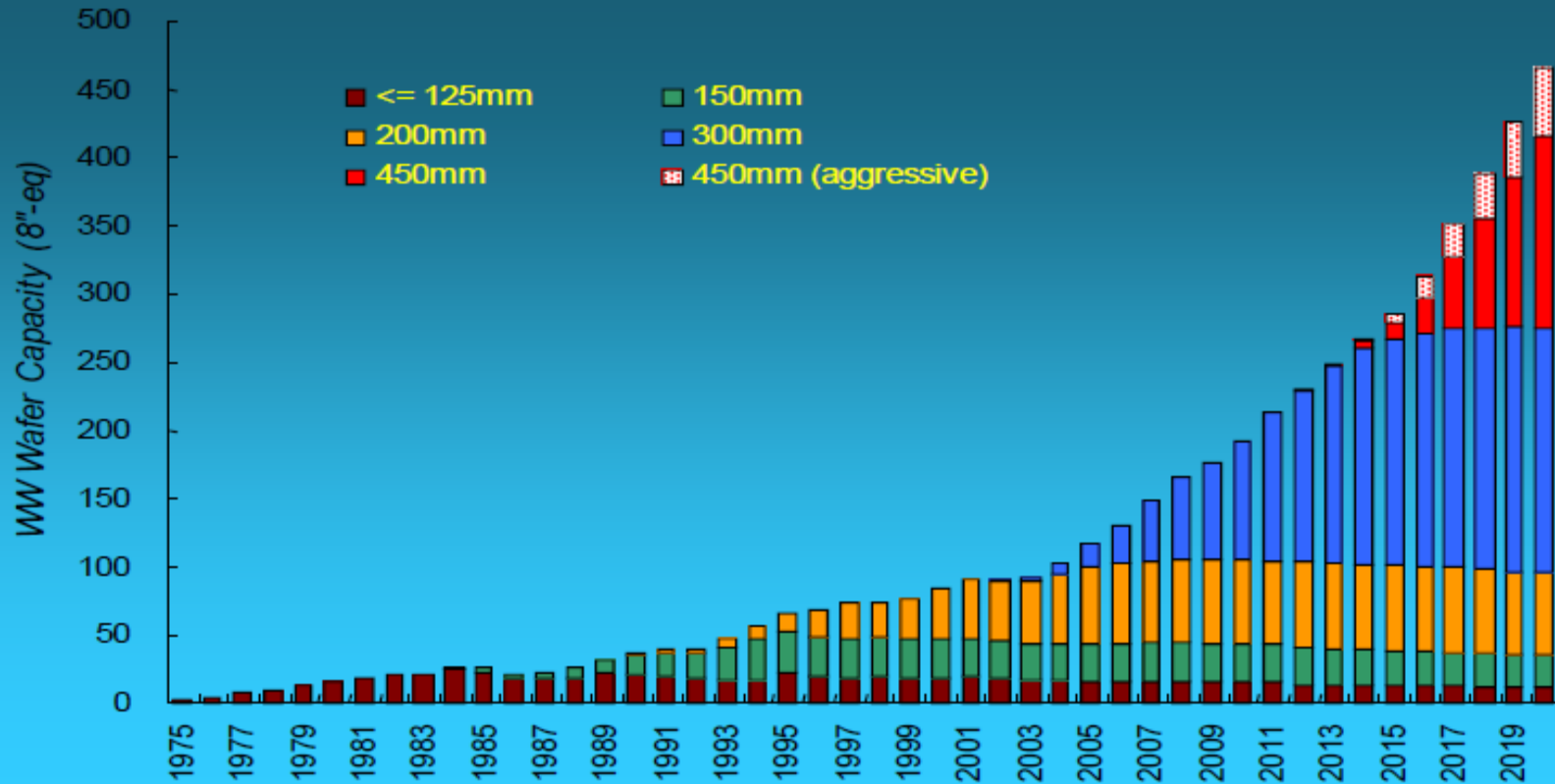
- **Wafer size transitions,**
- **Shrinking device geometries,**
- Equipment productivity, and
- Incremental yield.

Scaling Calculator +





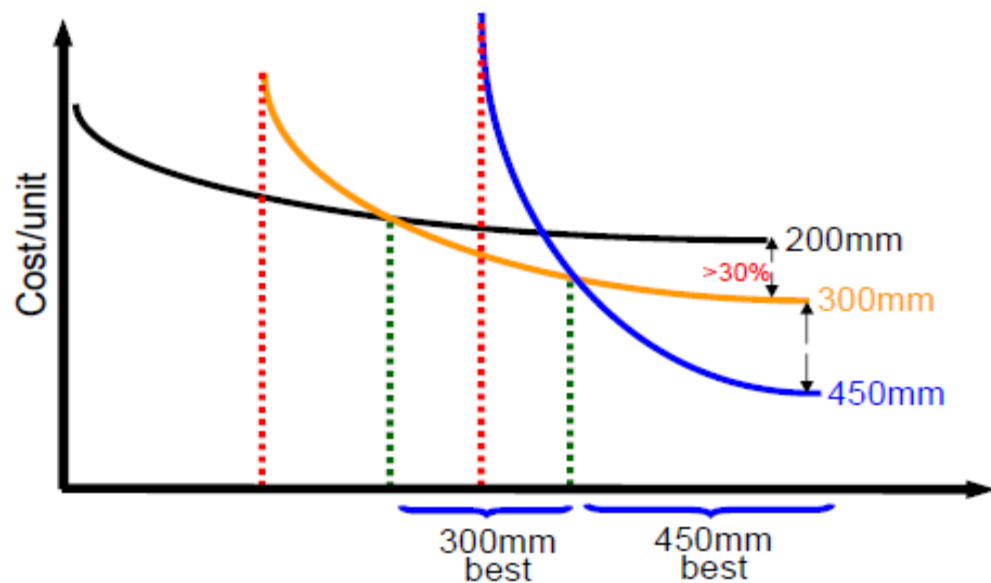
450mm FAB – Capacity Forecast





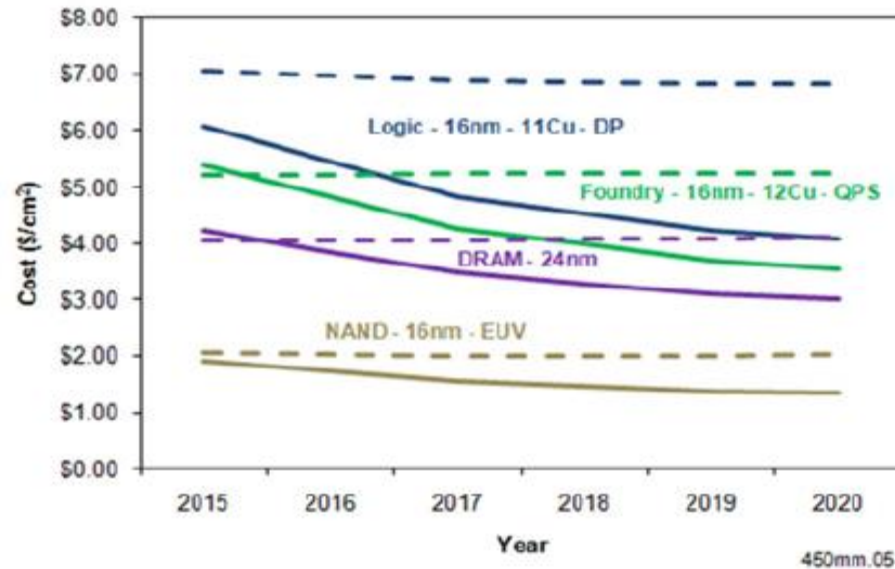
450mm FAB – Cost to Future

Production Indices Summary 300mm vs. 200mm	
Cycle Time	0.8X
Defect Density	0.4X
People Productivity	2.5X
Equipment Productivity	1.8X
Full Automation rate	Semi → Full Auto





450mm FAB – Cost to Future

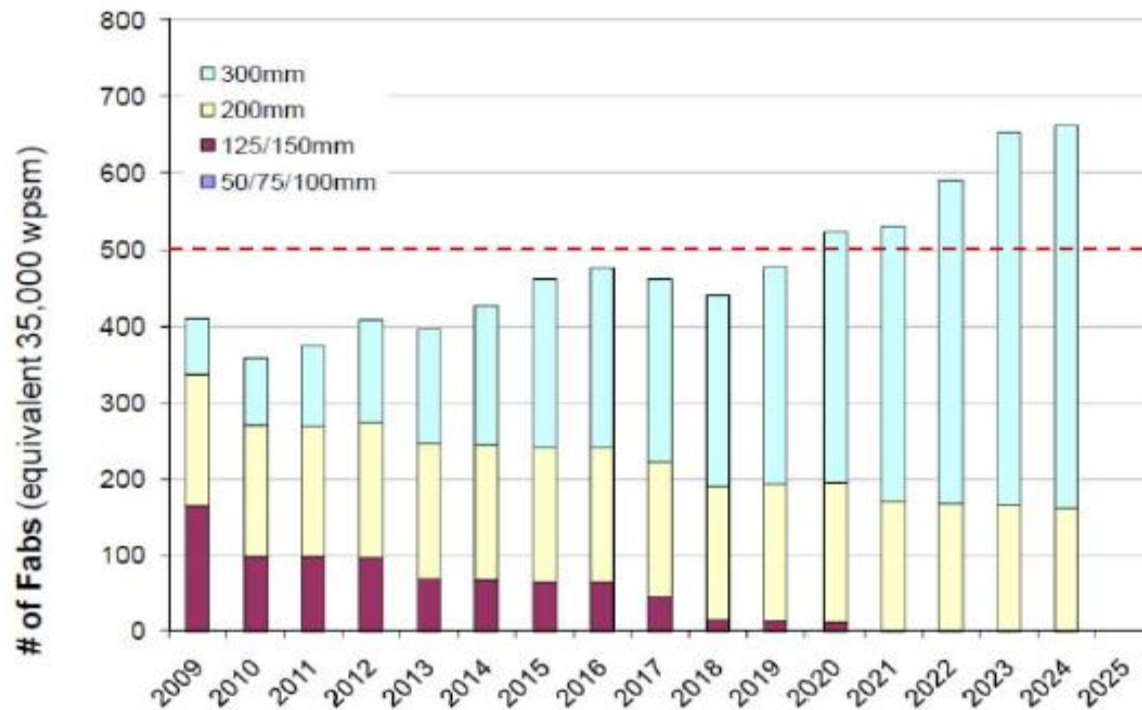


Wafer cost including starting and monitor wafer, ISMI assumptions.
Dotted line are 300mm, solid line 450mm, 20% depreciation.

IC KNOWLEDGE LLC



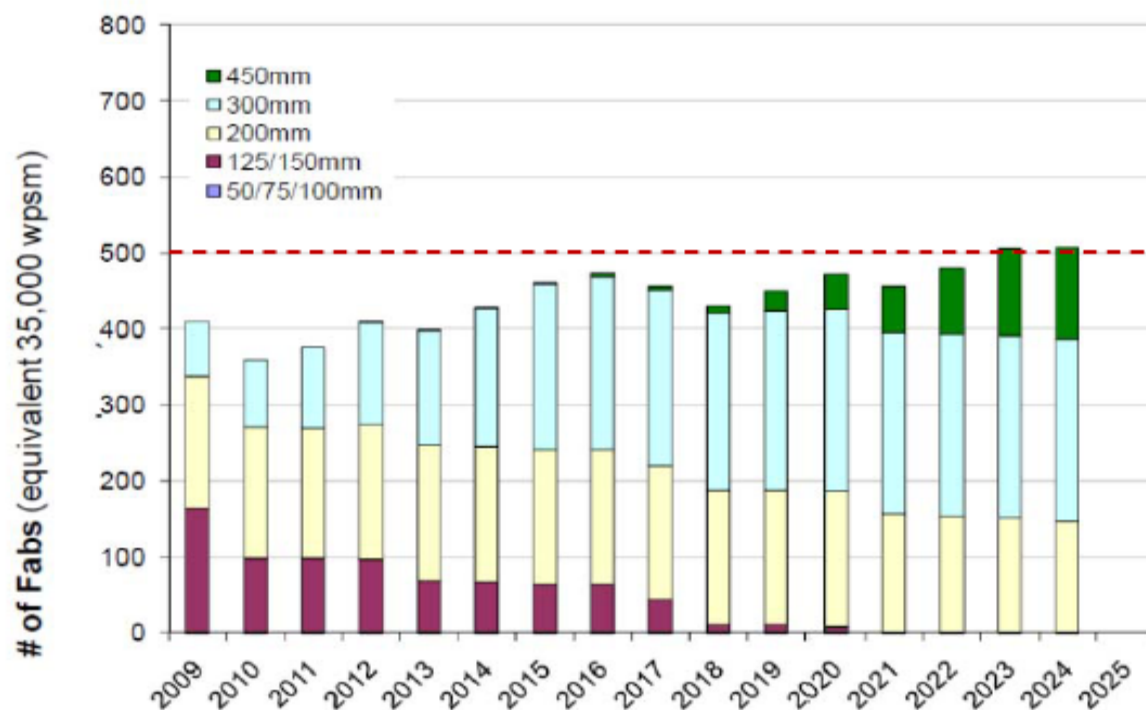
FAB Number – 300mm



Source: SEMATECH/ISMI analysis based on data from SEMI Silicon Statistics, Semico Research, VLSI Research, and IC Knowledge



FAB Number – 450mm



Source: SEMATECH/ISMI analysis based on data from SEMI Silicon Statistics, Semico Research, VLSI Research, and IC Knowledge



450mm Fab - Why

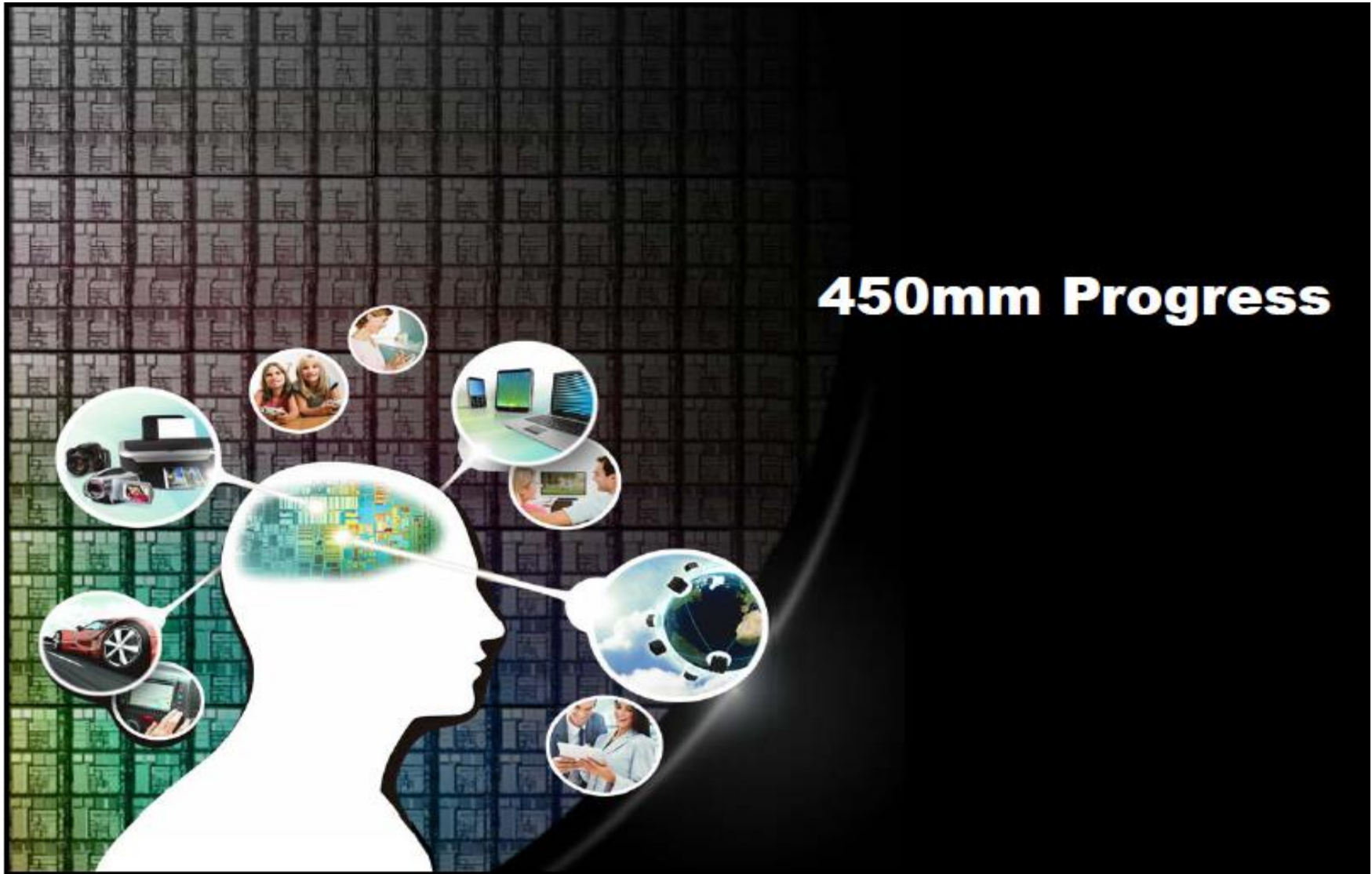
- Surface area & number of die is more than twice that of a 300mm wafer.
- More efficient use of energy, water and other resources.
- Fab automation, material handling systems & most of tool platform, 300mm to 450mm easier than 200mm to 300mm.
- 450mm Fab leads industrial growth by sharing benefit of cost reduction.



450mm Fab – Why Not

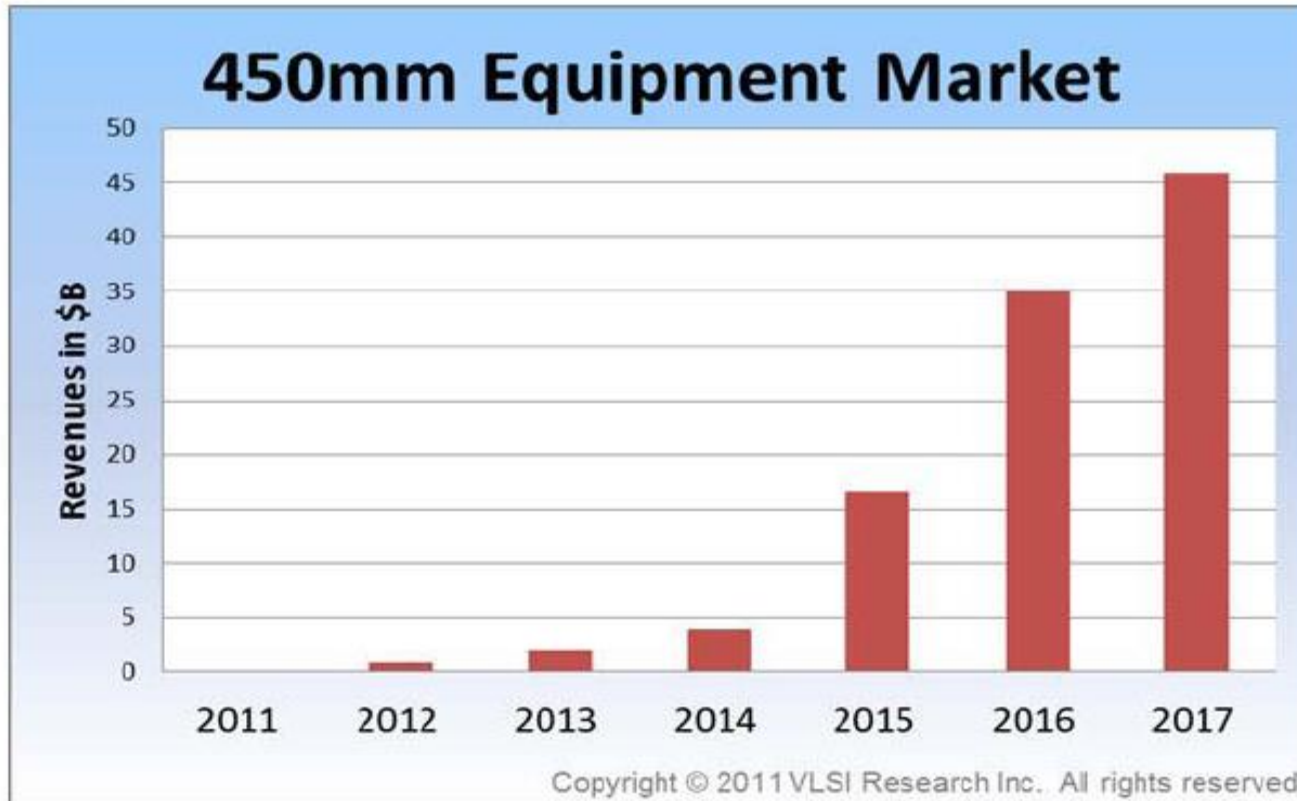
- **\$ 10 billion or more to build a new Fab**
 - \$ 100 million for an EUV scanner
 - \$ 5,000 per raw wafer initially
- **Only a handful of companies can afford it**
 - Intel, Samsung & TSMC
 - Will cause further consolidation
- **Tool suppliers are “wait-and-see” at best**
 - Burden they bore for 300mm tool development is still fresh
 - R&D funding shortfall

450mm Progress





450mm Equipment Forecast





450mm Global Activity

 COLLEGE OF NANOSCALE
SCIENCE & ENGINEERING

Funding for ISMI 450mm
Program Announced



450mm Standards
initiated - most
finished by 2010



European Commission
Funding for 450mm
development



450mm cleanroom
announcement

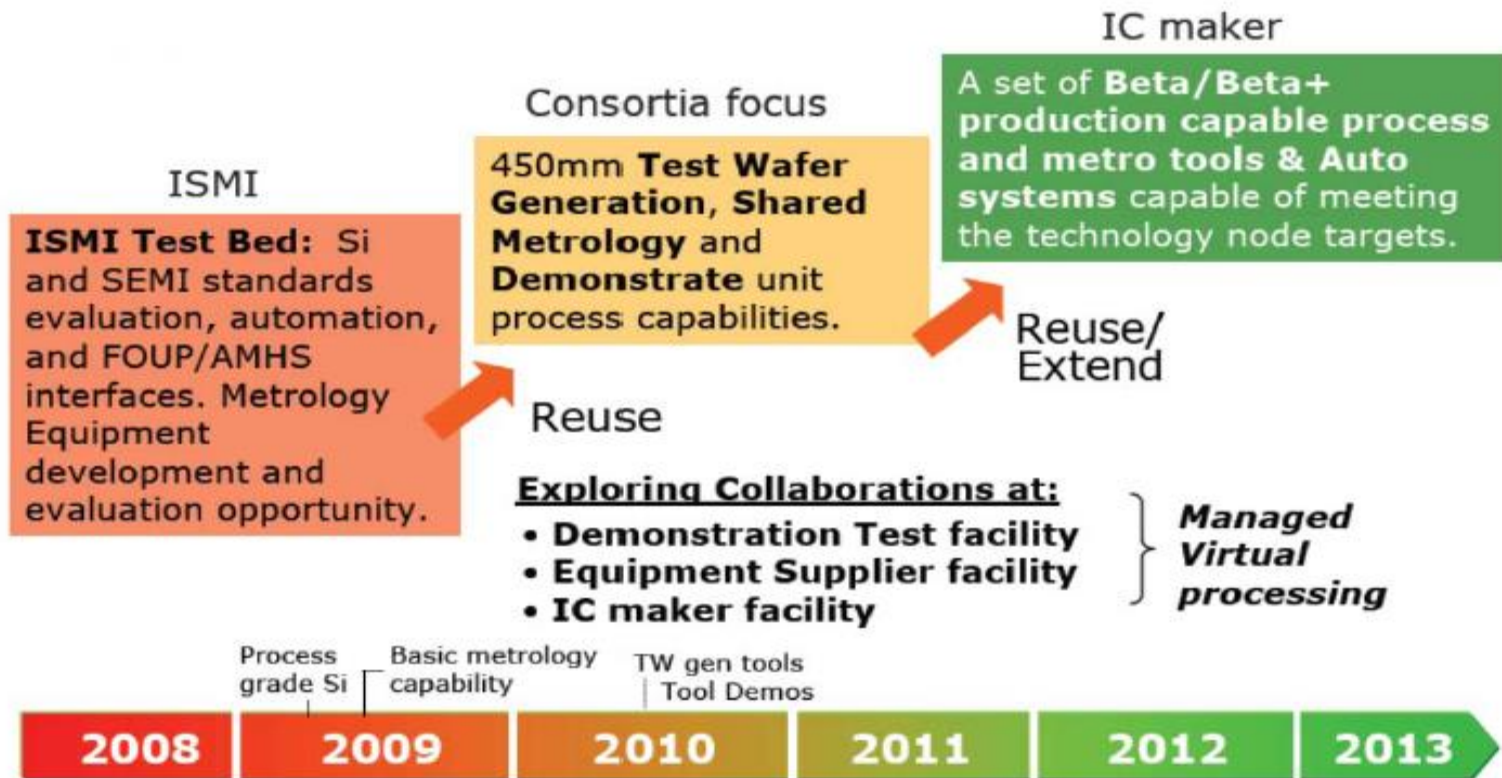
ITG-J

(Interoperability
Test Group –
Japan)

450mm wafer handling
evaluations



ISMI 450mm Program Model





450mm – Guideline Released

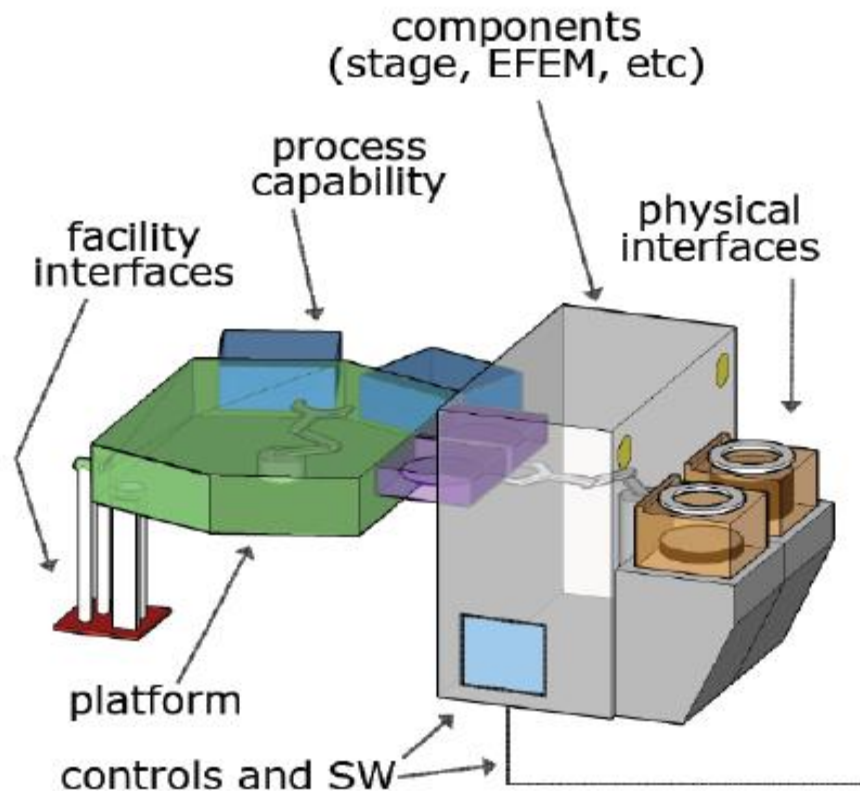
- Inside IC Fab Wafer Physical Contact Guidelines
- 450mm FOUP Manual Handling Design Guideline
- 450mm FOSB Architecture Guideline
- 450mm AMHS Guidelines
- 450mm PGV Guidelines
- Building Re-Use from 300mm to 450mm



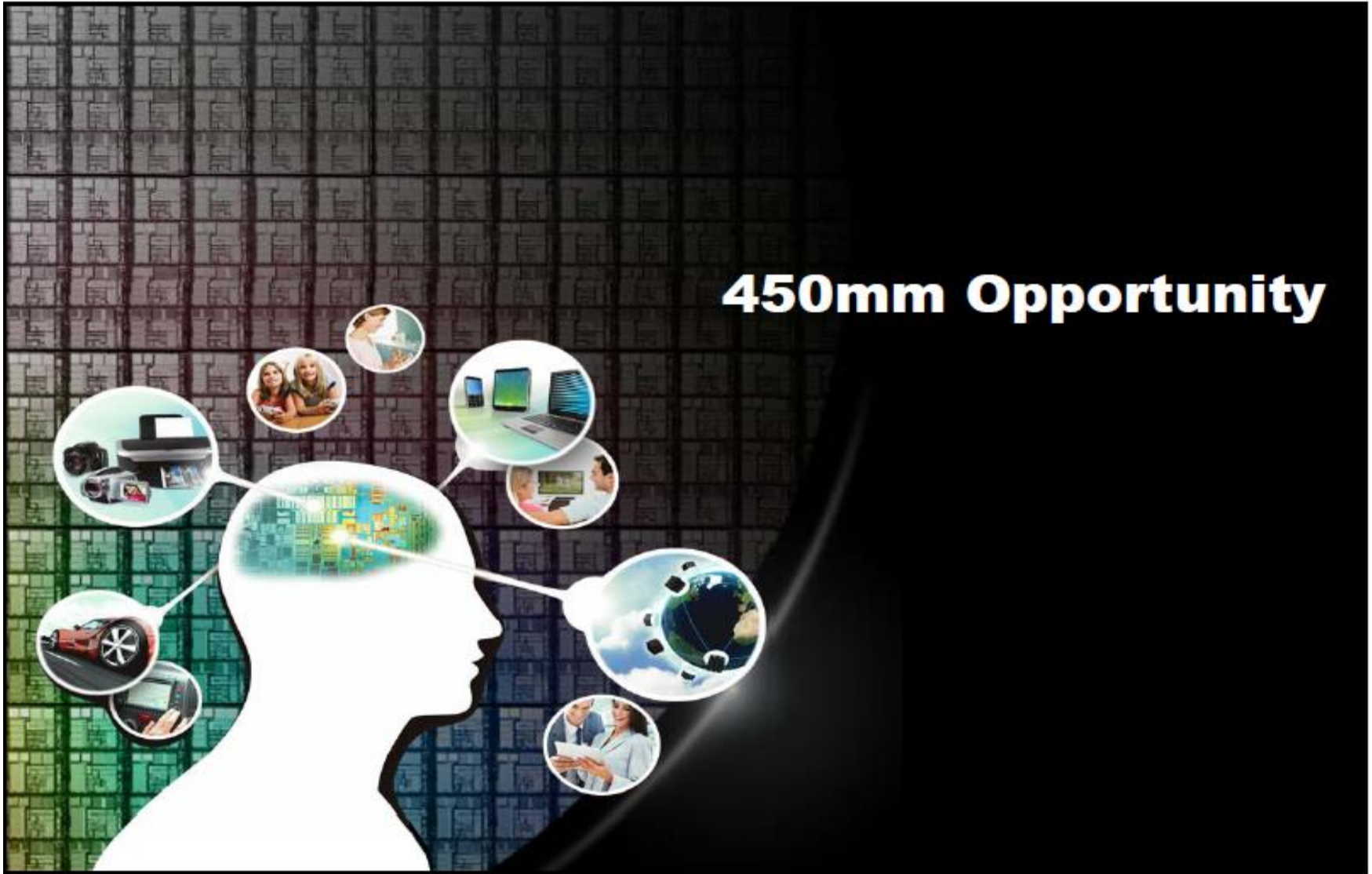
450mm Tool Collaboration

Can your 300mm platform be extended to 450mm?

- Consider extendibility during next generation equipment design to maximize reuse.
- Equipment that can support 300mm and 450mm may have cost and capability advantages.



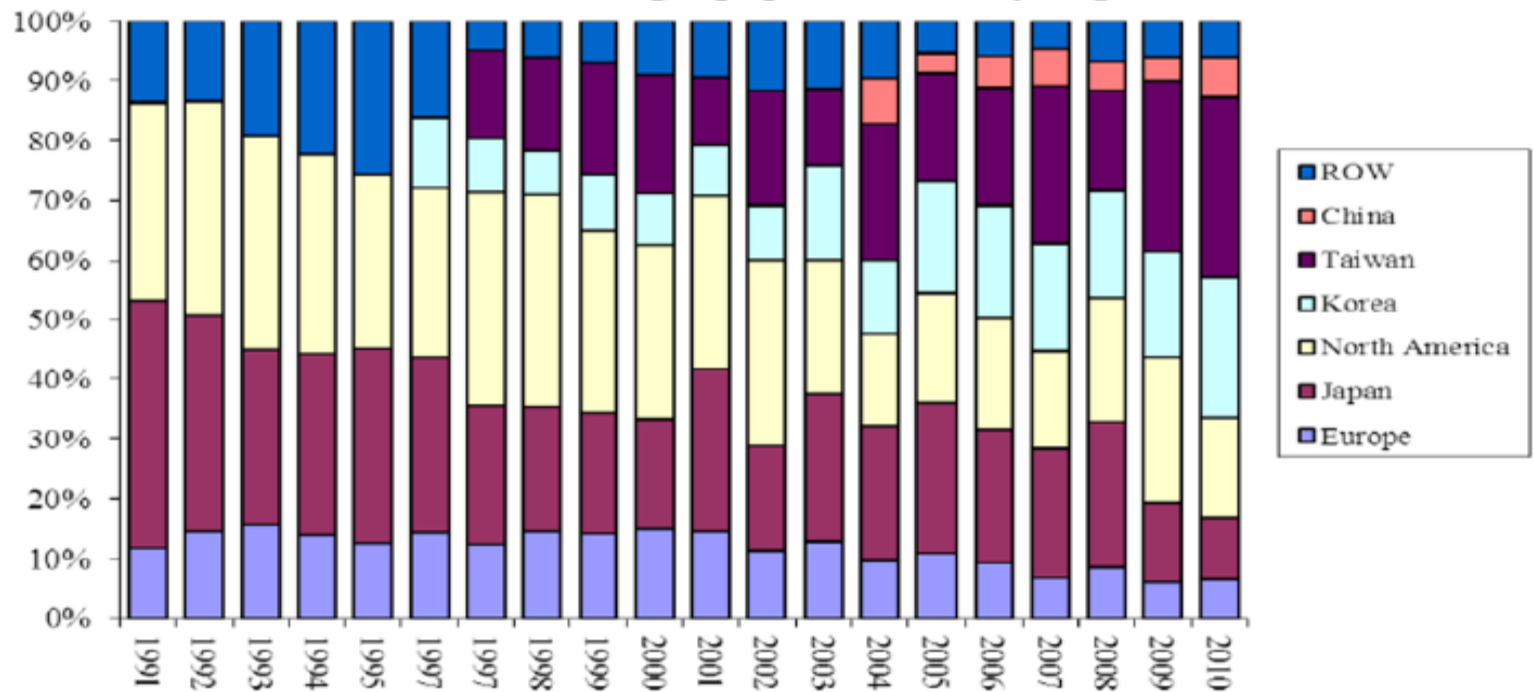
450mm Opportunity





Taiwan SC Market Cap.

Wafer Processing Equipment Sales By Region





Taiwan SC Market Cap.

- Global semiconductor revenue is still on growth trend.

- Taiwan Semiconductor Market:
 - Material Market, NT\$ 330 Billion in 2011
 - Equipment Market, NT\$ 260 Billion in 2011



450mm - TAIWAN



Funding for ISMI 450mm Program Announced

TAIWAN



450mm Standards initiated - most finished by 2010



European Commission Funding for 450mm development

ITG-J

(Interoperability Test Group – Japan)

450mm wafer handling evaluations



450mm cleanroom announcement

450mm 晶圓世代 挑戰 與 機會

- 450mm Overview
- 450mm Opportunity
- 450mm Progress

Summary



450mm - TAIWAN



Funding for ISMI 450mm Program Announced



European Commission Funding for 450mm development



450mm cleanroom announcement

TAIWAN



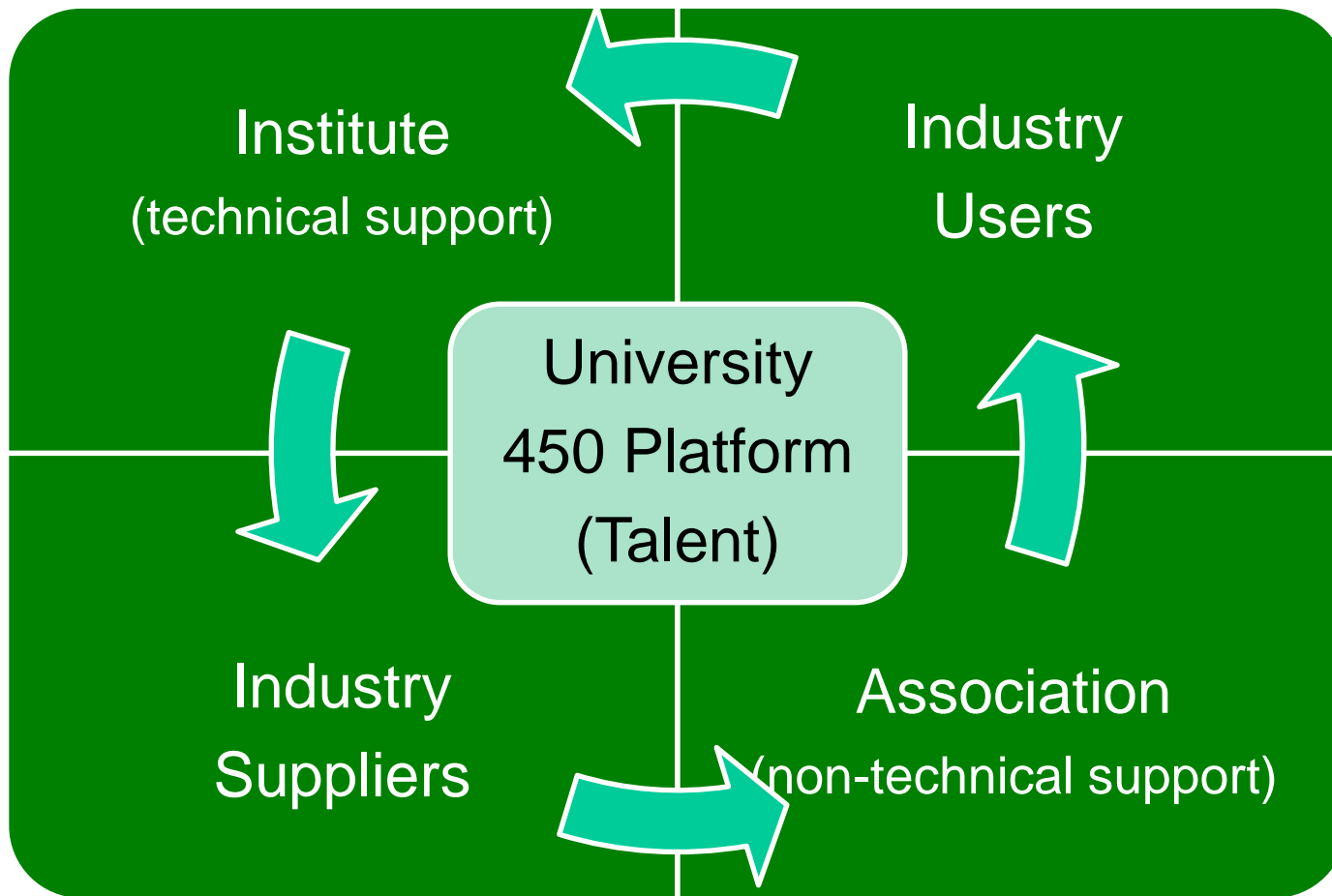
450mm Standards initiated - most finished by 2010

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(Interoperability Test Group - Japan)

450mm wafer handling evaluations

450mm – Taiwan Platform



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Progress on 450mm

Frank Robertson

SEMI 450mm Transition Forum

December 6, 2012

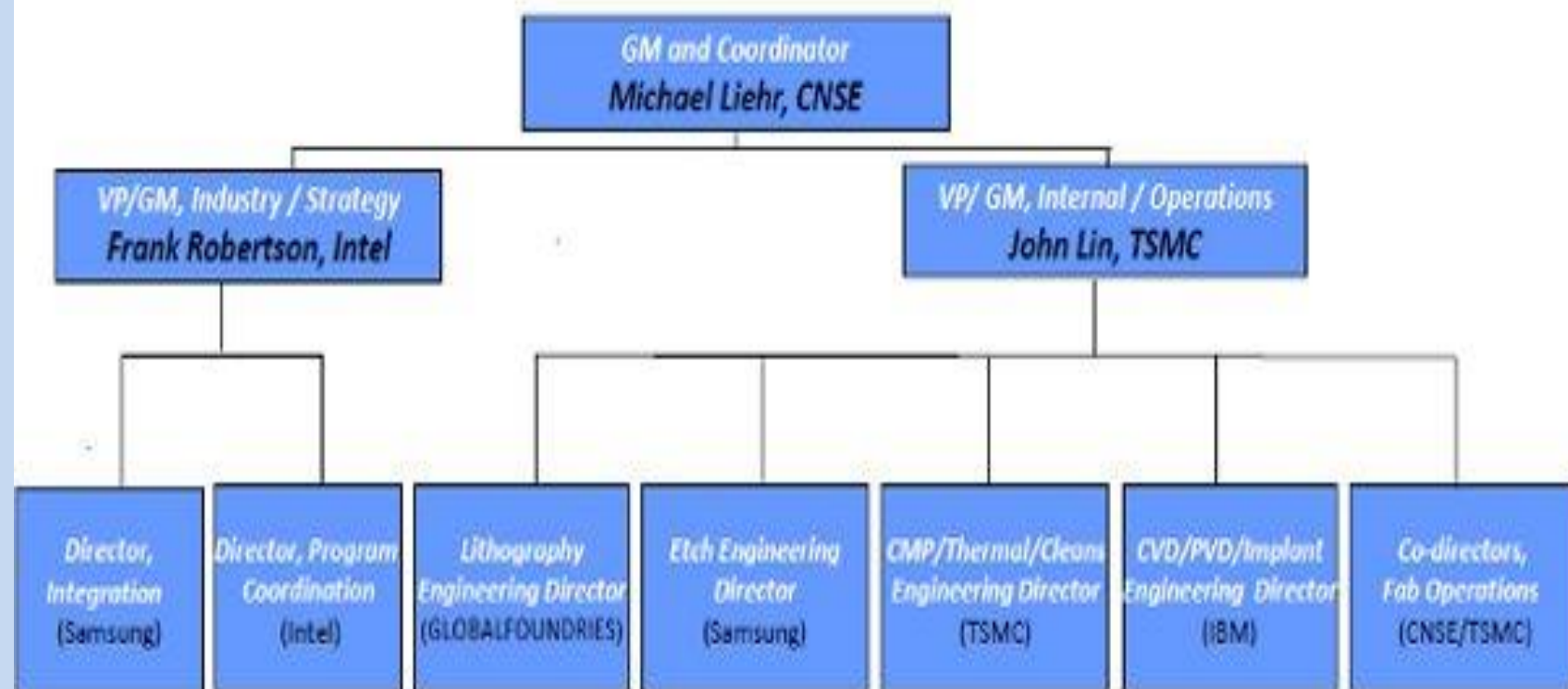


Global 450mm Consortium

- A public/private program based at the College of Nanoscale Science and Engineering in Albany, NY
- Driving effective industry 450mm development
 - Coordinate test wafer capability supporting development
 - Demonstrate unit process tool performance
 - Improve tools with Suppliers to ready for customer operations
- G450C Members
 - CNSE / Research Foundation
 - GLOBALFOUNDRIES
 - Intel
 - IBM
 - Samsung
 - TSMC



G450C Program Organization

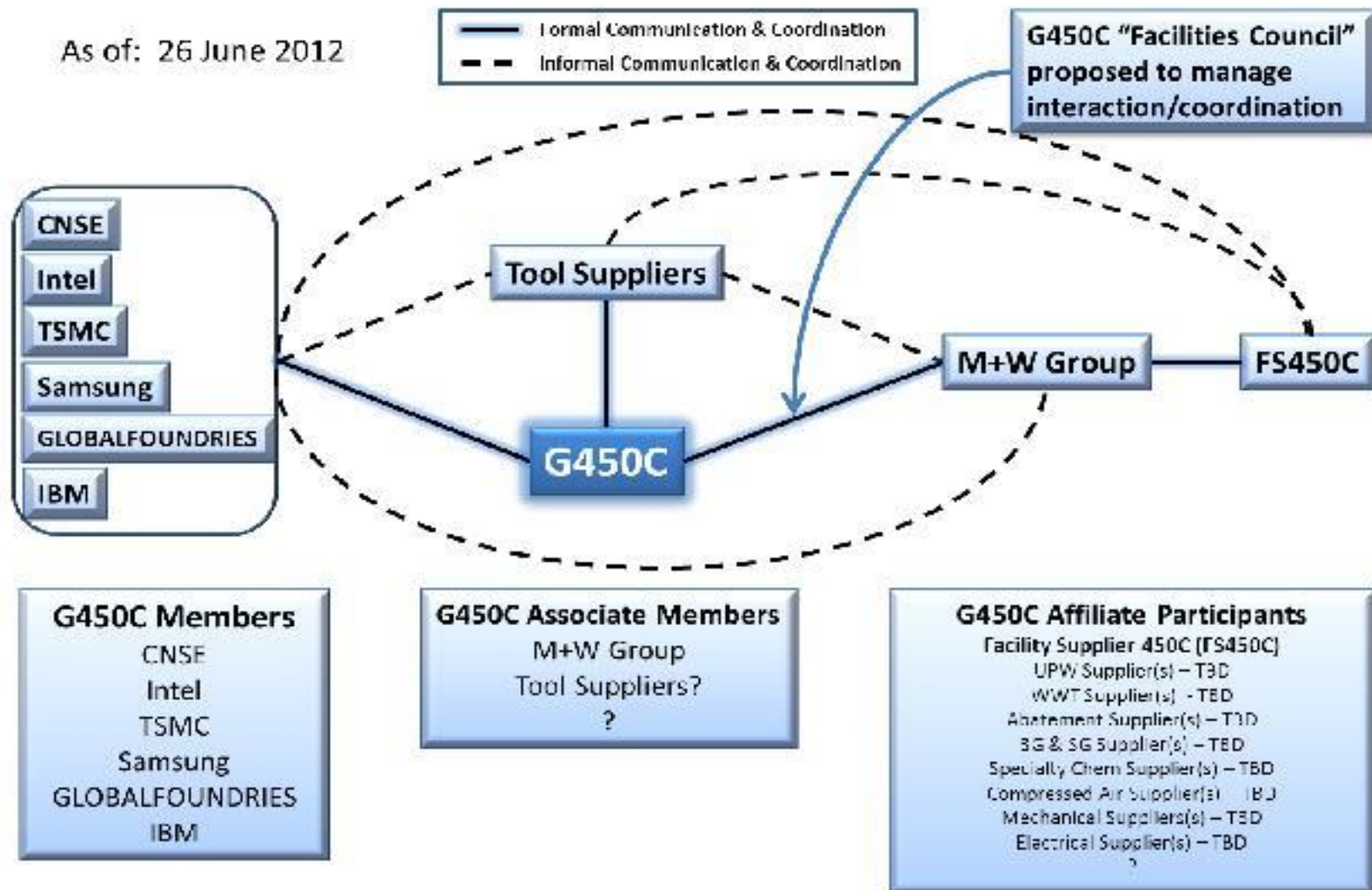


Communication Between G450C Members & Participants



M+W GROUP

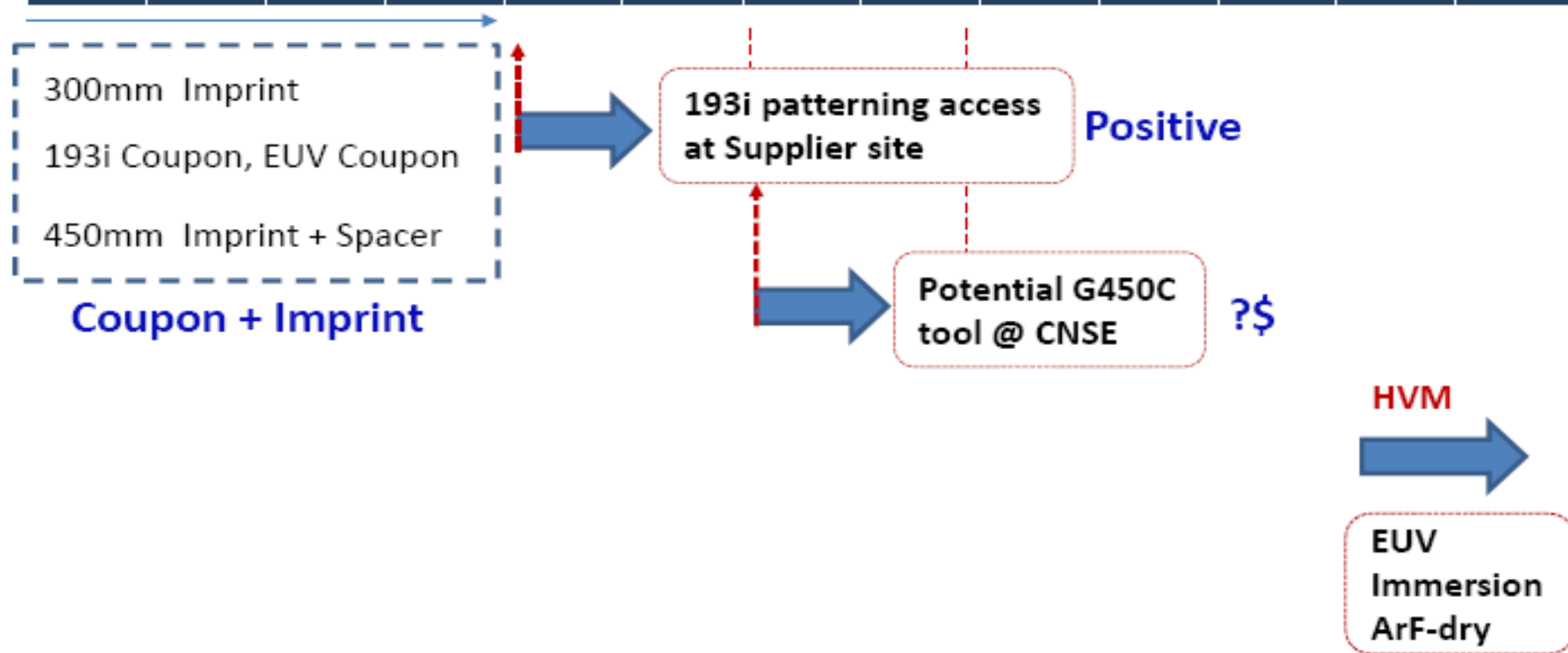
As of: 26 June 2012



G450C Lithography Tool Roadmap

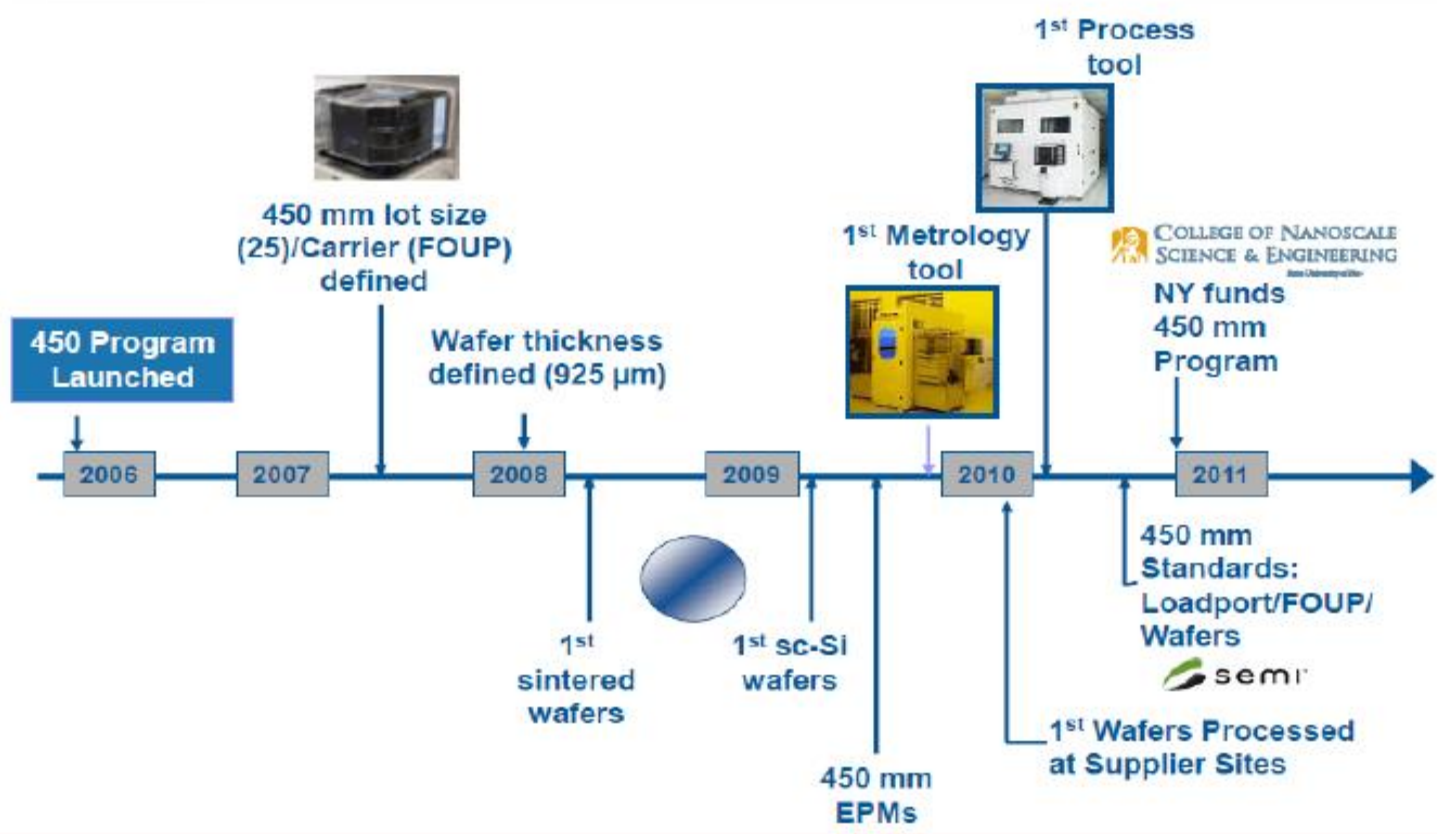


2012		2013		2014		2015		2016		2017		2018	
2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	1H	2H	





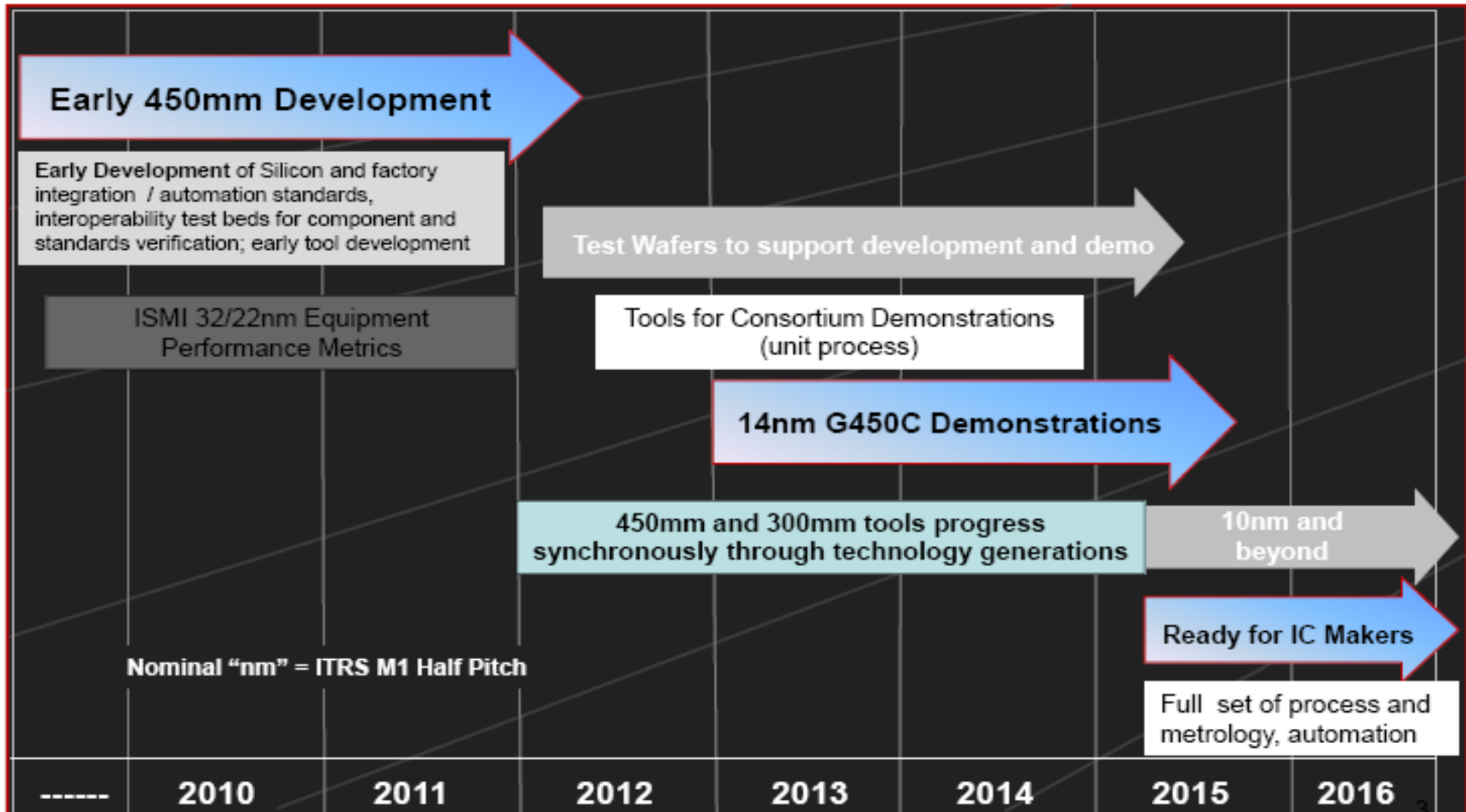
ISMI 450 Consortium



Development and Technology Intercept Targets



← G450C Program →



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HI
BILL GATES

GUESS WHERE
I'M CALLING
YOU FROM?



iCloud

DELIGNE
caglecartoons.com

MOSES, MEET STEVE.
HE'S GONNA UPGRADE
YOUR TABLETS...





TO BE HONEST, MR. JOBS, THE LAST TIME AN APPLE CAUSED SO MUCH EXCITEMENT AROUND HERE INVOLVED ADAM, EVE AND A SNAKE...

WHEN IS THE
LAST TIME THIS DEVICE WAS
UPGRADED? IT REALLY NEEDS TO
BE MORE USER FRIENDLY.
WHO'S IN CHARGE
OF INNOVATION
UP HERE? IS THIS
AVAILABLE IN
OTHER
COLORS?



STEVE JOBS
1955-2011

FITZSIMMONS ©
THE ARIZONA DAILY STAR 2011
ASIS/ARTIST/STYLING

Jo Heller 02/11
GREEN BAY PRESS-GAZ.



iCame, iSaw, iConquered

10 years ago the USA had Steve Jobs,

Bob Hope and Johnny Cash.

Now the USA has no Jobs, no Hope and no Cash.

Industry

	品牌	處理器		顯示卡/網路通訊		面板		記憶體	組裝	軟體
		設計	製造	設計	製造	設計	製造			
Mobile Cell Phone	Apple	Samsung	Samsung	高通	TSMC	Samsung/LG/AUO/奇美		Samsung	富士康	Apple
	Samsung	高通	TSMC	高通	TSMC	Samsung/LG/AUO/奇美		Samsung	富士康	Google
	HTC	高通	TSMC	高通+Nvidia	TSMC	Samsung/LG/AUO/奇美		Samsung	富士康	Google
	Motolora	高通	TSMC	聯發科	TSMC	Samsung/LG/AUO/奇美		Samsung	富士康	Google
	Nokia	高通	TSMC	聯發科	TSMC	Samsung/LG/AUO/奇美		Samsung	富士康	Google
High Pref. NB	Ienovo	Intel	Intel	Nvidia	TSMC	Samsung/LG/AUO/奇美		Samsung	廣達/仁寶	Software
	HP	Intel	Intel	Nvidia	TSMC	Samsung/LG/AUO/奇美		Samsung	廣達/仁寶	Software
	Asus	Intel	Intel	Nvidia	TSMC	Samsung/LG/AUO/奇美		Samsung	廣達/仁寶	Software
	Acer	Intel	Intel	Nvidia	TSMC	Samsung/LG/AUO/奇美		Samsung	廣達/仁寶	Software

結論

- 18吋晶圓時代已經來臨
- 18吋廠10奈米有成本及技術上之優勢
- 台灣半導體產業正面臨更極烈之競爭
- 半導體製造產業對於台灣經濟發展具有舉足輕重之影響，要持續領先優勢，其廠房設施之配合更是製造過程中不可或缺的重要環節

Acknowledge

Many slides in this presentation are sourced and/or provided by Dr. Tzu-Sou Chuang, Dr. Frank Roberson, Dr. Charley Carter, and Dr. Ming Han Liao.

The presenter appreciates their contribution very much.

感謝

