Importance of Analog in Digital World

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asQED Symposium 2013

Agenda

- Growth of Analog IC's
- "Analog" in Digital World
- Analog or Multi-Technology SoC's
- Technology Platforms and Manufacturing
- Conclusion

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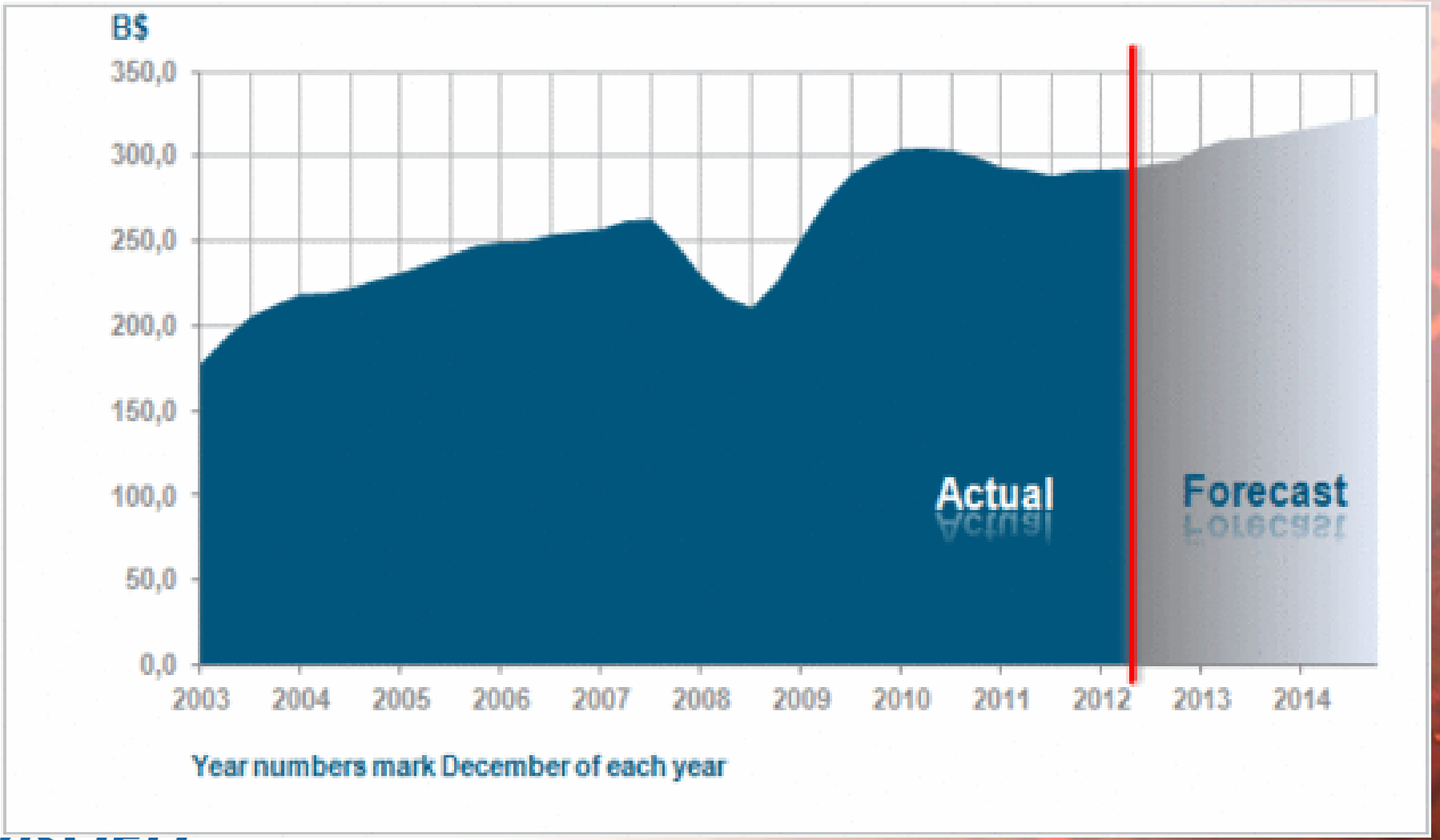
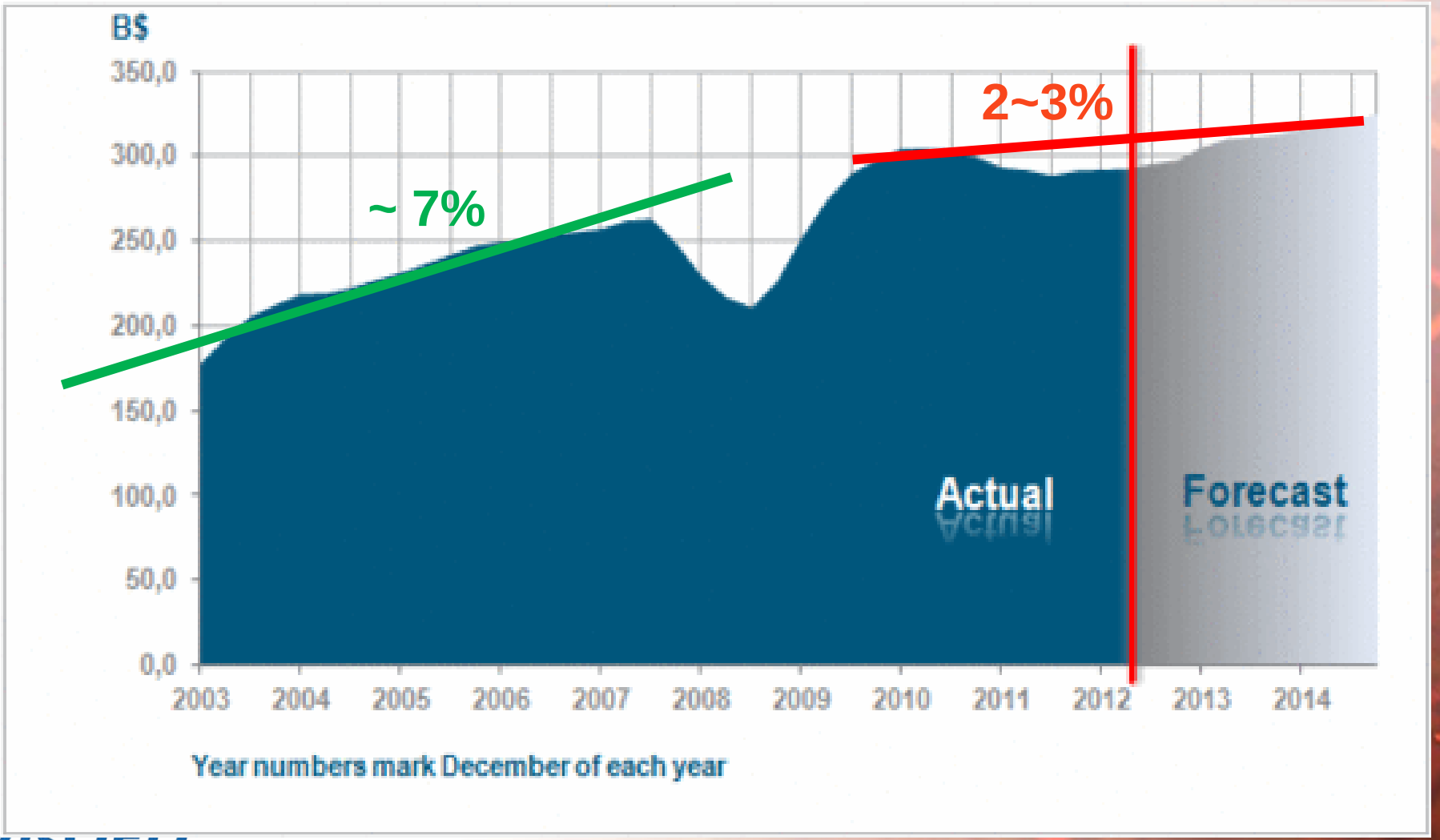
Semiconductor Industry



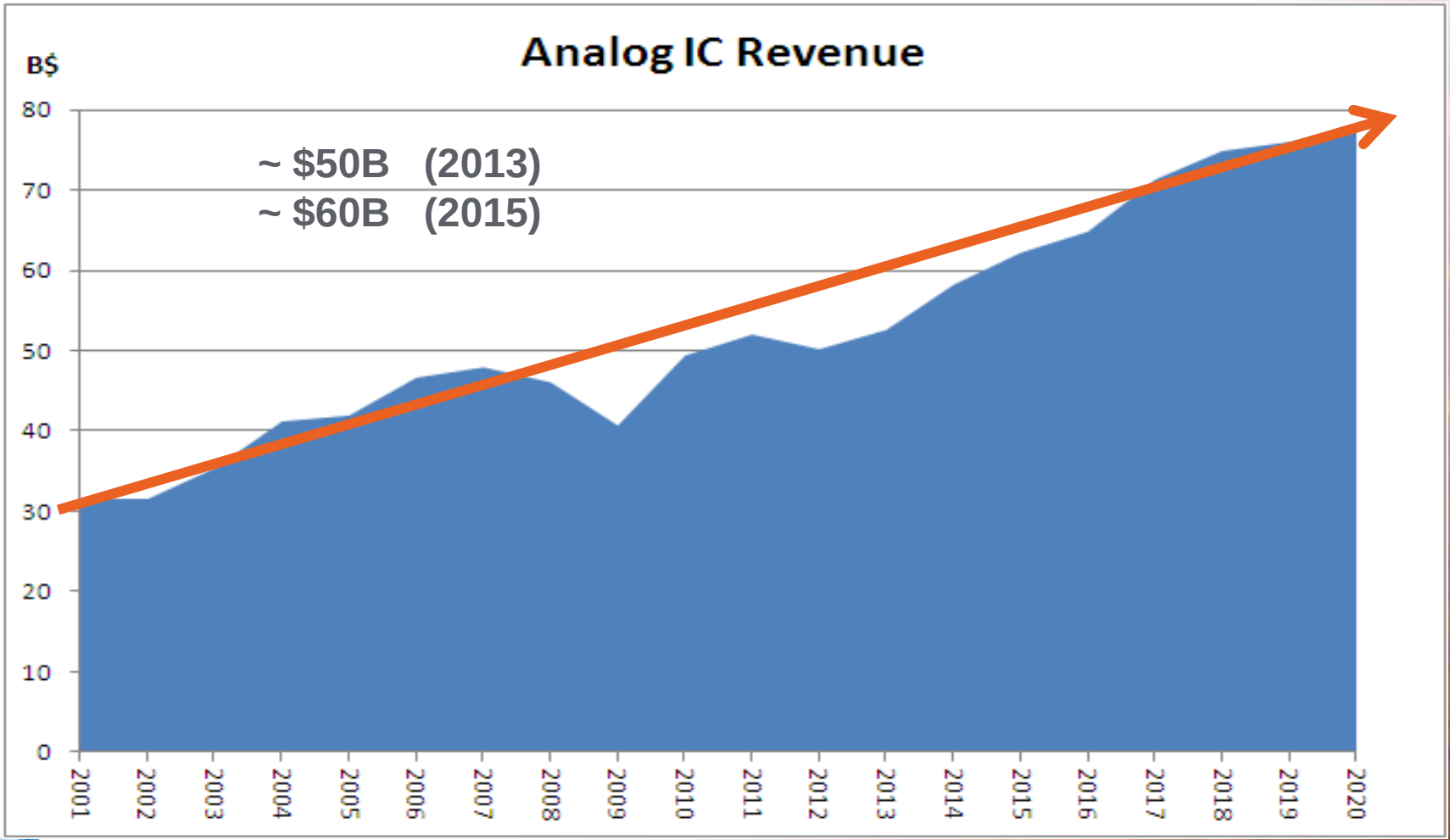
Source: WSTS

Semiconductor Industry - Maturing?



Source: WSTS

Analog Market - Growing at ~7% CAGR



Source: iSuppli, GLOBALFOUNDRIES Internal Research

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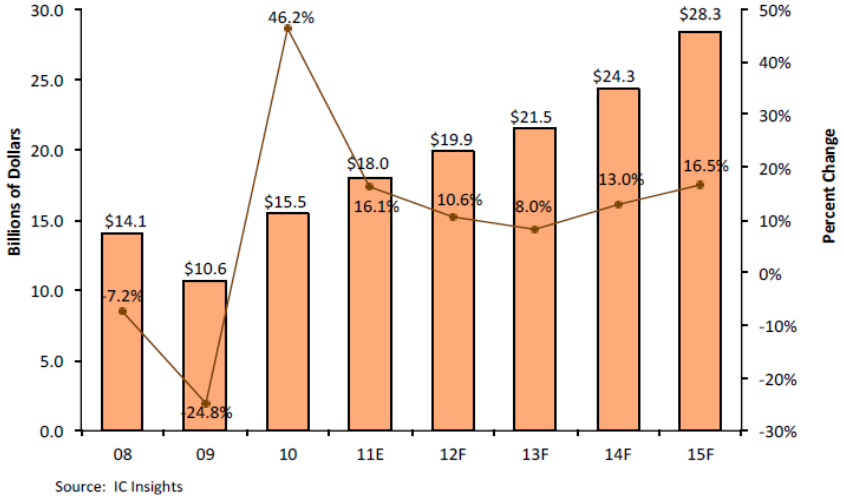
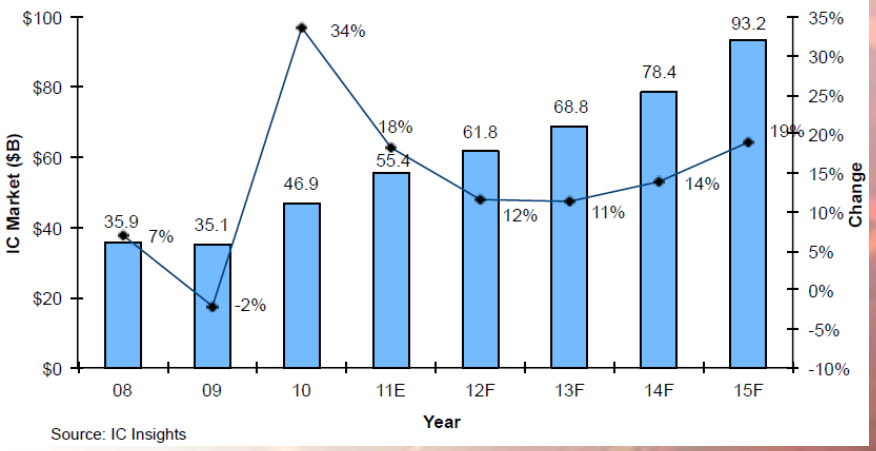
Some Market Drivers for Analog IC's

Automotive



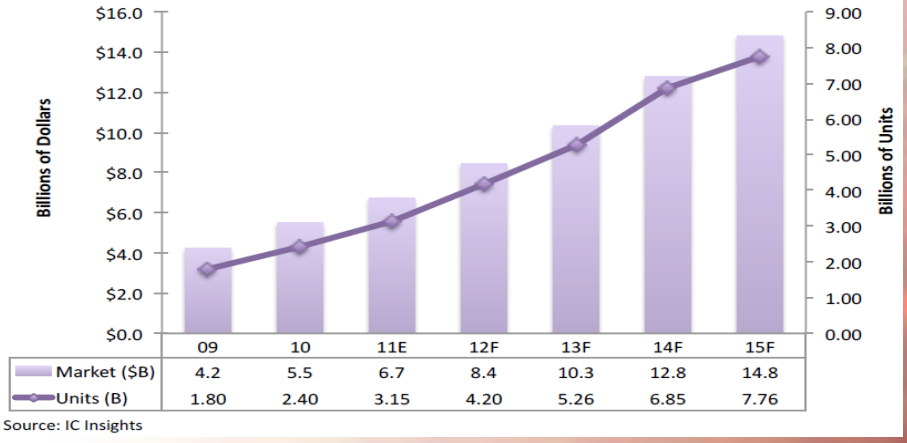
Source: IC Insights

Handset



Source: IC Insights

Wireless



Source: IC Insights

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Mega Trends that will Drive Our Economy, Technology and Semiconductors

***The Cloud** will cause upheaval in IT*

***Mobile computing** will continue to converge functions and drive compute power*

***Internet of Things** will drive mobile processing at low power with ubiquitous RF*

***Energy Efficiency** is needed for sustainability & lower cost of ownership*

*Increasing **Security** concerns at all levels: government, enterprise and personal*

*Coverage and insatiable bandwidth needs will drive **Next-Gen Wireless***

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Analog IC Ma

Semiconductor Content for Mega Trends ($B)							
Mega Trends	Cloud Computing	Mobile Convergence	Internet of Things	Nex Gen Wireless	Security Standards	Energy Efficiency	TOTAL
Memory (Volatile)	-0.2	0.6	0.2	1.7	n/a	n/a	20.3
Memory (non-Volatile)	4	10.3	1.1	2.5	0	0.1	
Microcomponenets	1.6	-0.2	6.4	2	1.2	1.9	26.6
Logic	0.8	3.9	3.5	5.4	0	0.1	
Analog	-0.8	1.8	1.8	2.2	n/a	0.1	19.8
Discretes	0.1	1.4	0.6	0.9	n/a	0.2	
Optical	0.2	2.5	2.3	1.8	n/a	3	
Sensors	-0.1	0.7	0.1	0.8	n/a	0.2	
Total	**5.6**	**21**	**16**	**17.3**	**1.2**	**5.6**	**66.7**

SOURCE: McKinsey on Semiconductors, Number 2, Autumn 2012, "Finding the Next 100 Billion $'s in Semiconductor Revenues"

Base Market + Mega Trends
$60B + $20M

Value of Analog IC in Digital Devices

- Without Analog IC
  - the Device will not turn-on
  - the Display will not work

- Many other functions won't work !

(*in case the first two problems were not big enough!!*)

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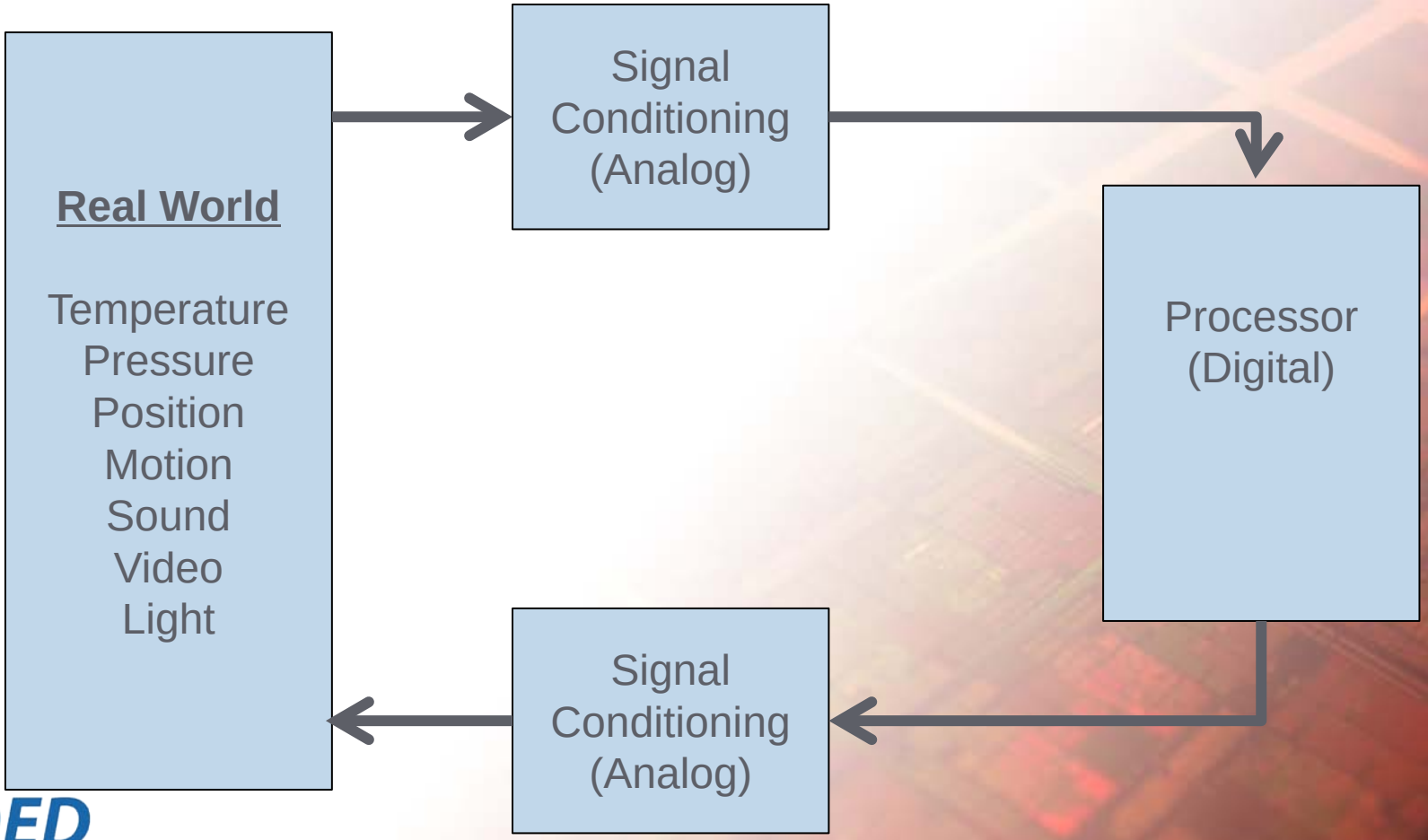
Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Where does Analog fit in this Digital World?



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Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Thus ……Analog is Everywhere !!

Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Teardown of a Common Digital Device Smartphone (iPhone 4S)

Analog

Power

Audio

Video

Display

Touch

Transmitters

Compass

Gyroscopes

Accelerometer

9 Chips

Logic/Memory

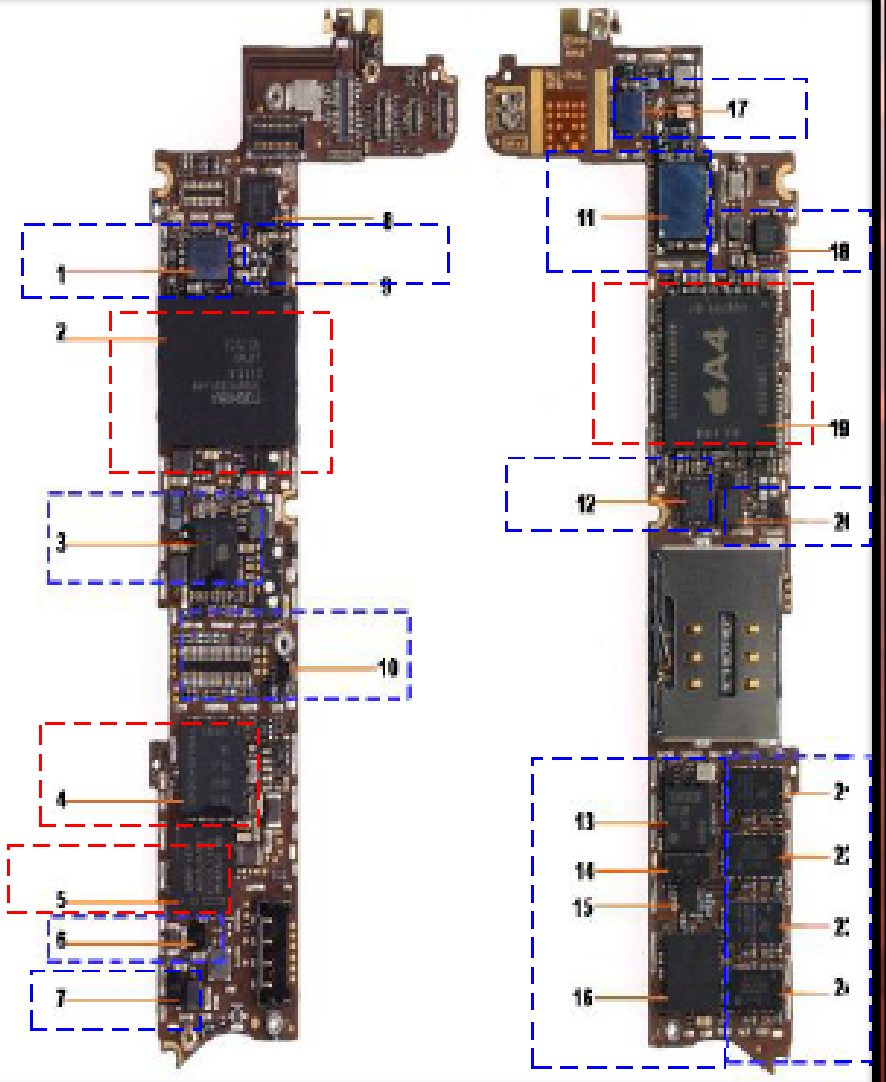
Apps Processor + DRAM

NAND Flash

NOR Flash

Quad Baseband

4 Chips



Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Difference between Digital and Analog

Digital

- Process Technology Follows ITRS Roadmap
- Major Process Differentiator is Timing & Ramp Execution
- Product Differentiation comes from Soft IP's and Software
- Technology Development is Mainly by Foundries

Analog

- No ITRS Roadmap for Process Technology
- Process Technology Remains a Critical IP
- Silicon IP is Main Differentiator
- Historically Dominated by IDMs, but Gap is Narrowing vs. Foundries

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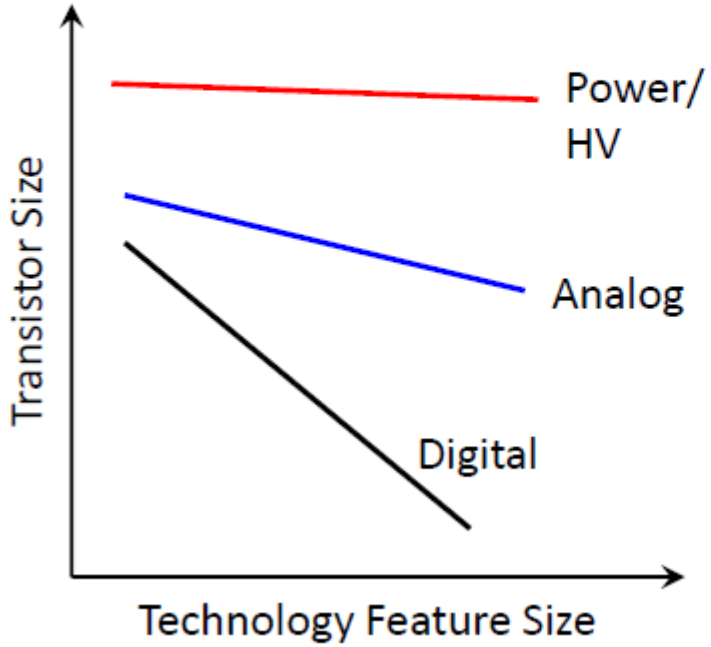
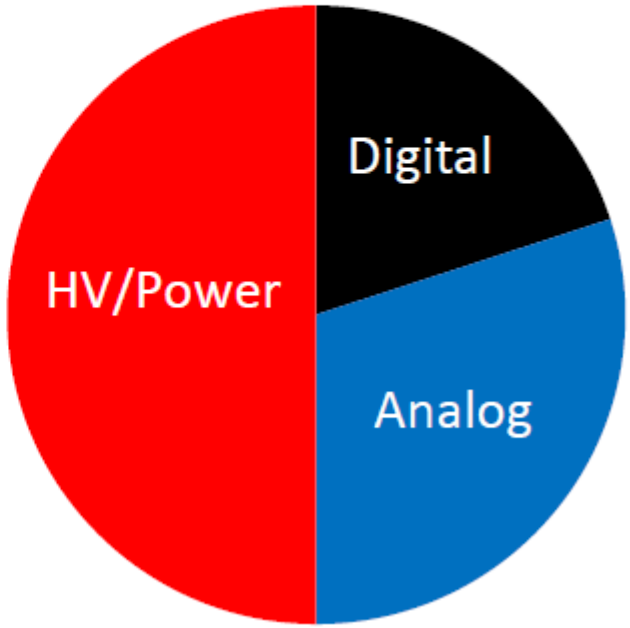
Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Scaling of Digital and Analog

Analog & Power Scale Slower



Not Much Digital on a Typical Analog ICs



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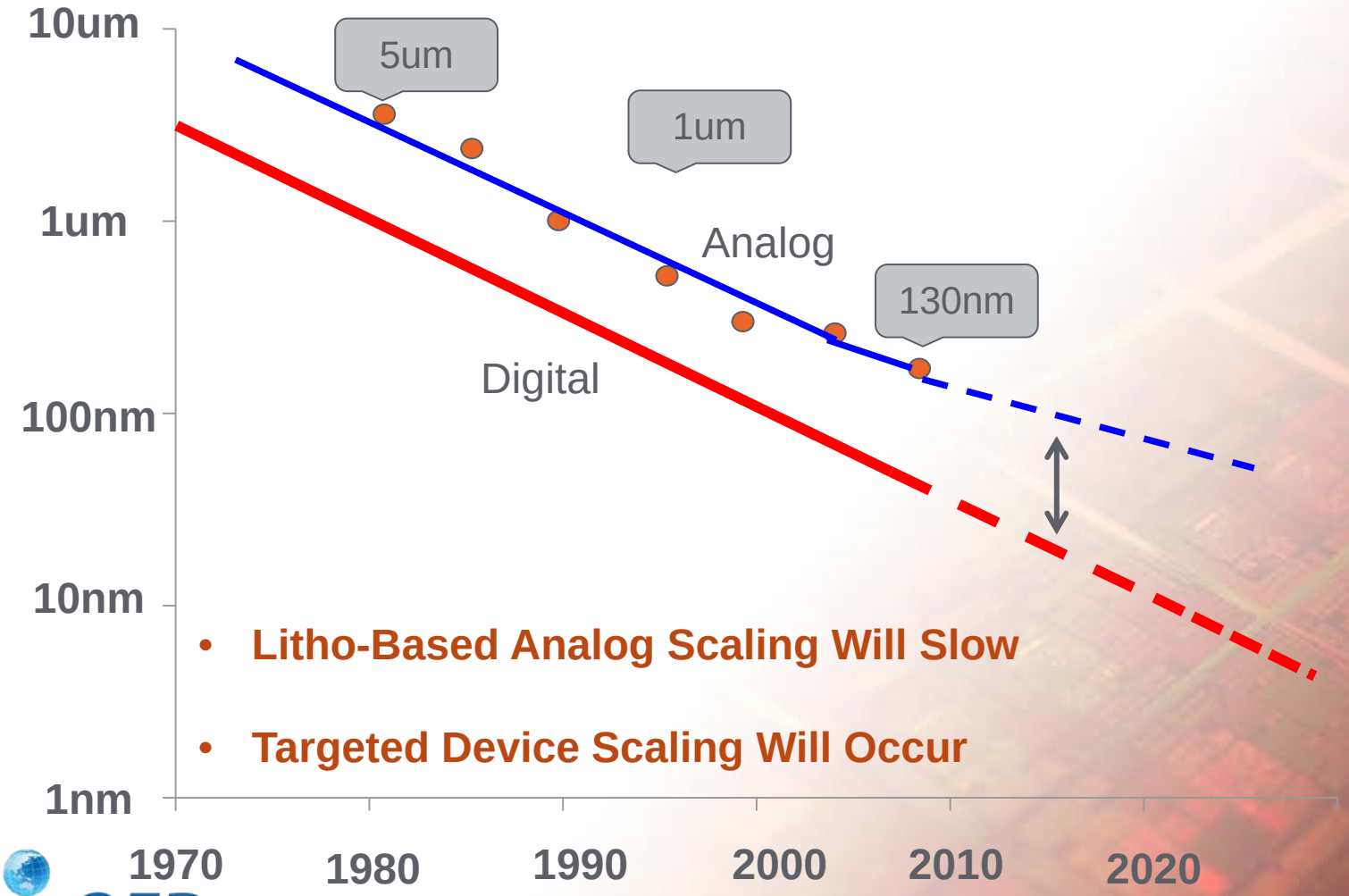
Ref: L. Hutter; Analog Leaders Forum, Korea 2012

And … Analog Scaling will be Even Slower



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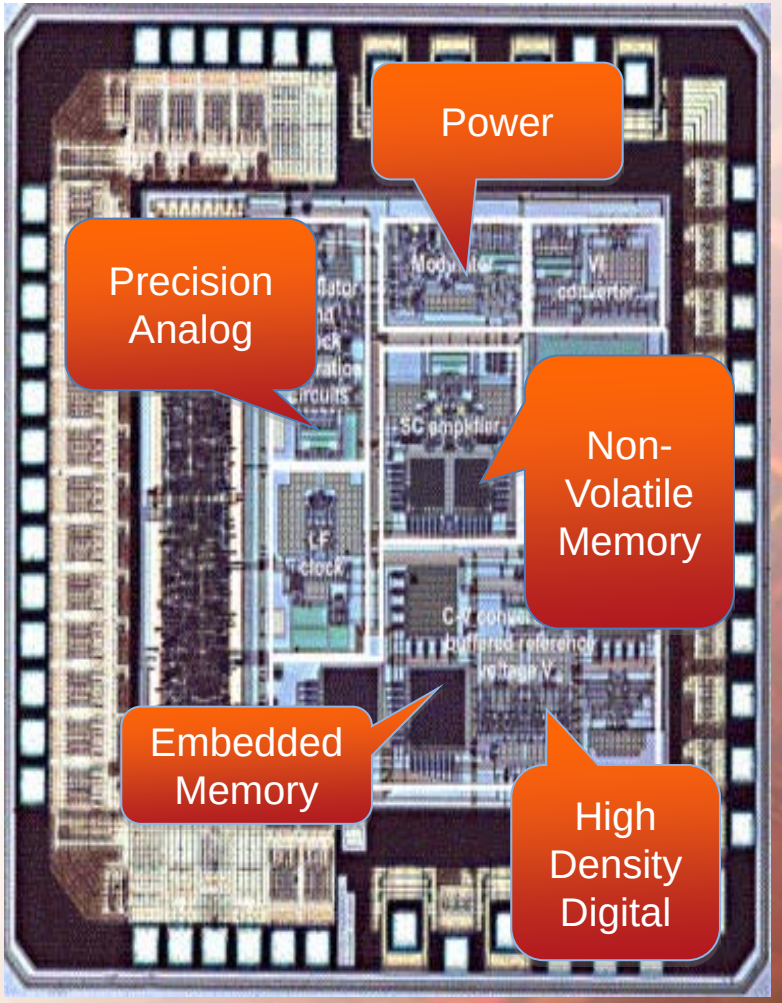
Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Hence… Mixed-Technology SoC's

Applications
Audio
Display
Power Management
Others…….

Technologies
180nm – mainstream
130nm – leading edge
55nm – bleeding edge



PMIC for Samsung GALAXY – S3 Smartphone

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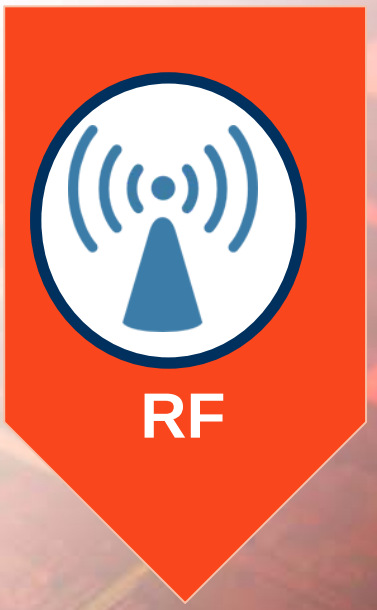
Mixed Technologies for Analog SoC's



- Innovation and Differentiation is "In-Silicon"
- "Analog-Mind-Set" for Manufacturing

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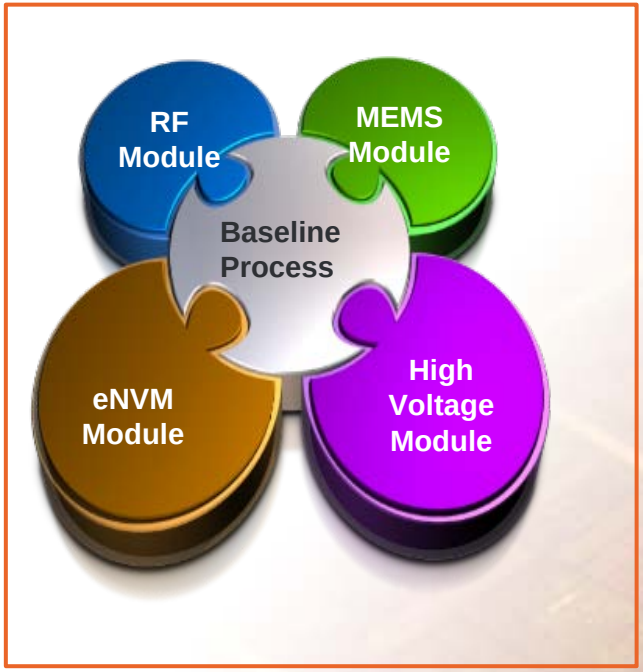
Strategy must be Centered on Modular Technology Platforms

Customizable

- Options for customer specific devices



Modular

- Add or Subtract mask-layers / devices
- Replace devices (e.g. 5V with 3.3V OR 1.8V with 2.5V)
- Add different type of isolation (e.g . DTI)

Portable IP

- One Set IP's for Platform
- IP's can be developed by customer

Benefits

Flexibility

- Innovate in Silicon
- Create value for both Customer\ Foundries

Scalability

- Multiple technologies
- Modular and extendable
- Multiple markets/ applications

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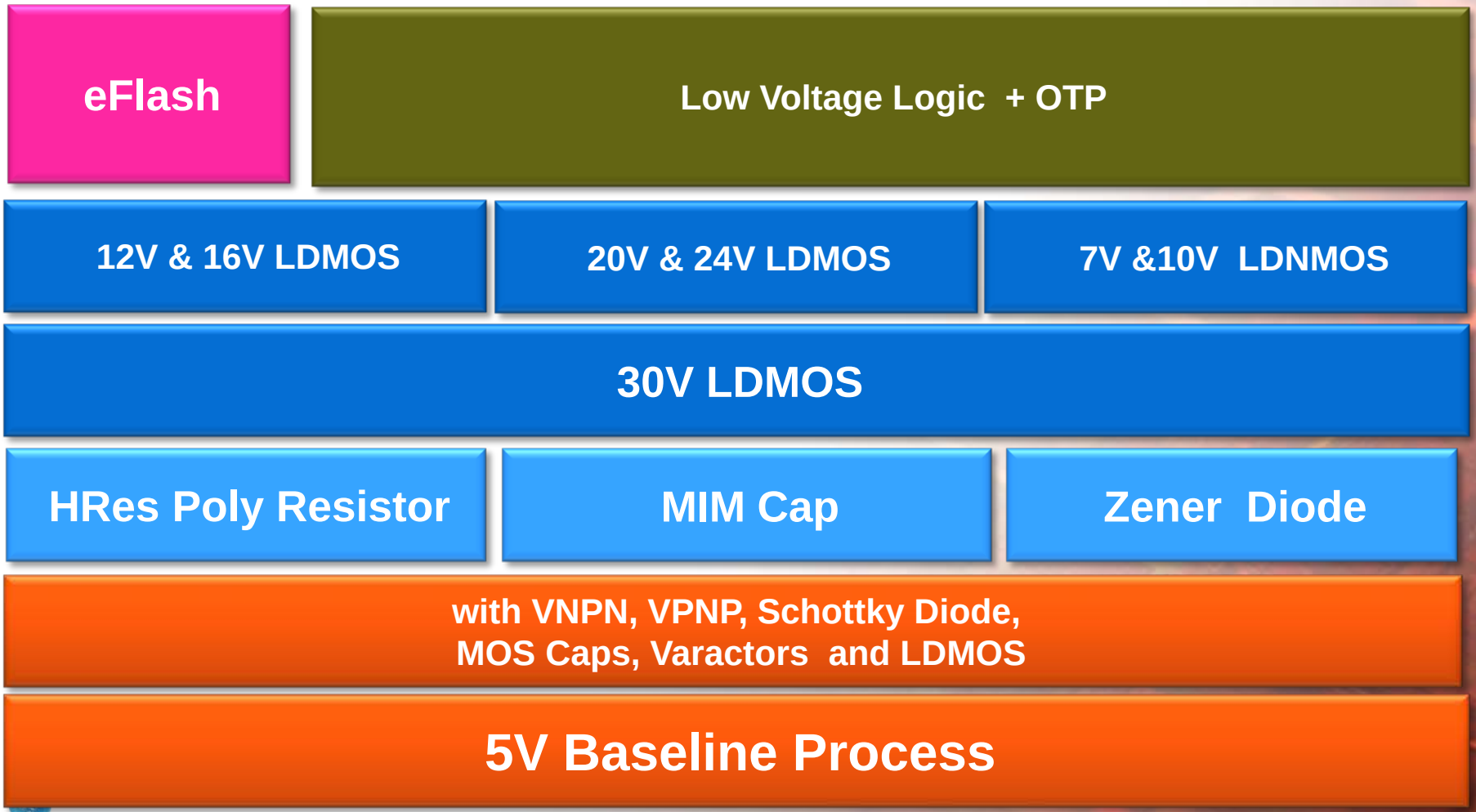
Modular Technology Platform for Analog SoC's

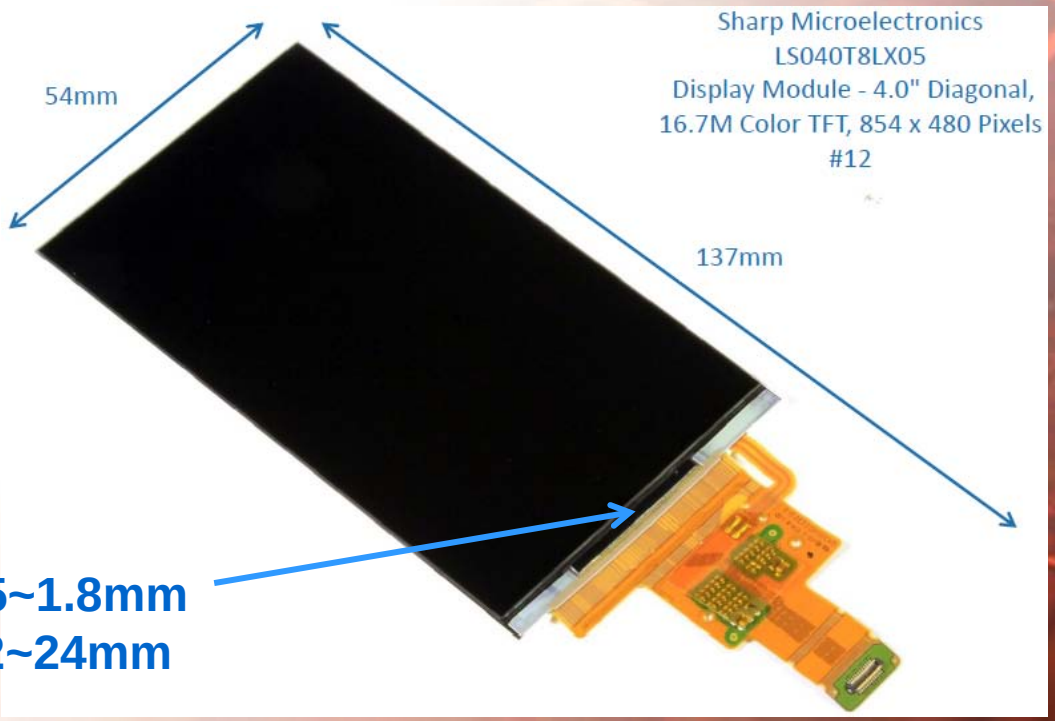


Benefit of Modular Platform – An Example

Availability of 5V and 6V CMOS

Parameters	5V CMOS		6V CMOS	
	NMOS	PMOS	NMOS	PMOS
VT [V]	0.72	0.77	0.76	0.79
Idsat [µA/µm]	540	280	600	315
BVdss (min) [V]	**7.5**	**7.5**	**8.5**	**8.5**
Ioff (typ) [pA/µm]	0.8	0.8	0.5	0.5
Rdson [mohm-mm^2]	2.02	6.03	2.75	7.5

High Resolution Smartphone Display Drivers



Chip size:
Height 1.5~1.8mm
Length 22~24mm

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Requirements for HD Display Drivers

- Voltages
  - TFT: 1.2V; 6V and 32V
  - AMOLED: 1.2V; 8V and 20V
- OTP
  - Configurable Parameter for Picture Quality w/ High Reliability
- SRAM
  - Smallest SRAM cell Implemented for High Density Memory
- Embedded -Flash
  - Allows Integration of Display Driver and Touch Panel Controller

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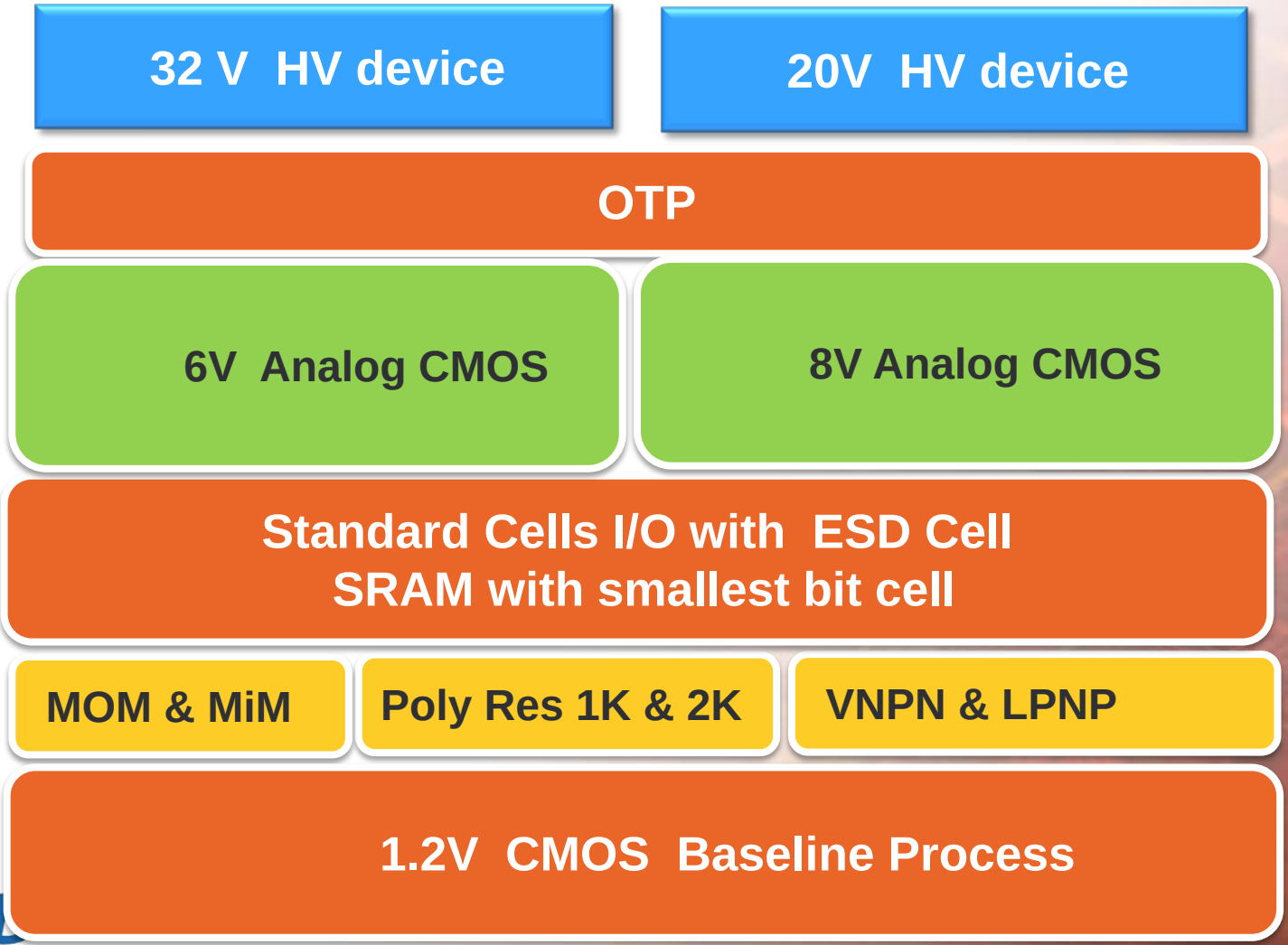
HD Display Driver Technology Platform



Design Infrastructure to Support Analog SoC's

EDA/IP Solutions		0.18µm BCDlite™	0.13µm BCDlite™
Standard Cells		1.8V: ARM-SAGE-9T 1.8V: RM-Metro-7T	1.5V: ARM-SAGE-9T
Standard Cells		(5V&6V): ARM -9T	--
Memory Compiler	SP SRAM	Synopsys	ARM
	DP SRAM	Synopsys	ARM
	ROM	Synopsys	ARM
I/O		1.8V ARM	--
5V I/O		GLOBALFOUNDRIES	GLOBALFOUNDRIES
OTP		eMemory	eMemory
eFuse		GLOBALFOUNDRIES	GLOBALFOUNDRIES
eFlash		--	SST
Spice Model*		BSIM4.5	BSIM4.5/HiSIM (for HV)
PDKs		Cadence	Cadence
DRC/LVS		Mentor	Mentor
RCX		Mentor / Synopsys / QRC	Mentor / Synopsys
ESD Library		GLOBALFOUNDRIES	GLOBALFOUNDRIES

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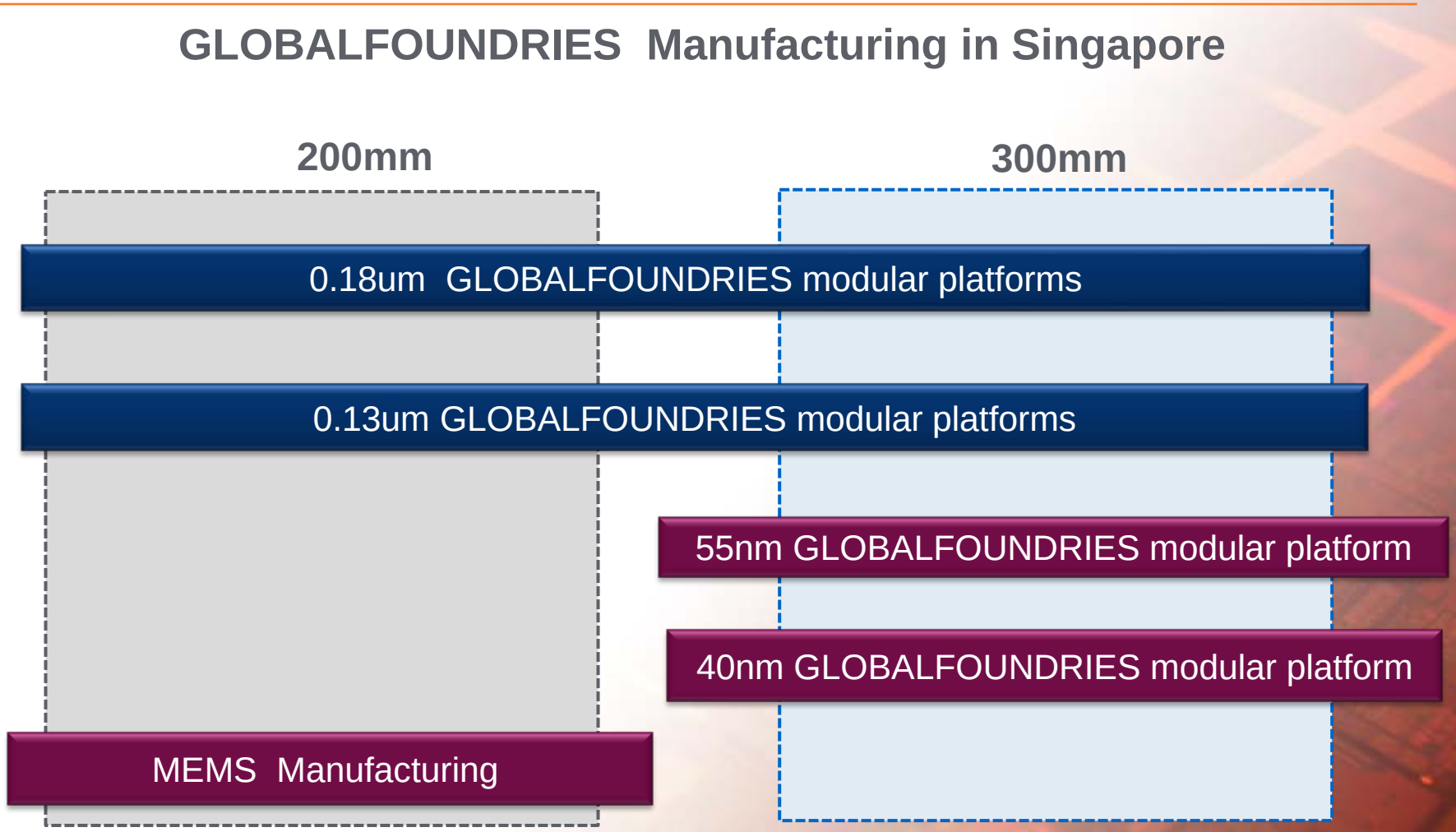
Analog Companies with Internal Manufacturing

> 0.35um	180nm	130nm
Analog Devices	Atmel	Fujitsu
Atmel	Bosch	Infineon
Bosch	Freescale	Samsung
Diodes –	Fujitsu	ST Microelectronics
Fairchild Semiconductor	IBM Corporation Burlington	Texas Instruments
Freescale	Infineon	Toshiba
Fujitsu	Maxim	
IBM Corporation	NXP	
Infineon	ON Semiconductor	
Intersil	Panasonic Semiconductor	
Linear	Renesas Electronics Corporation	
Maxim	Samsung	
Micrel	Seiko Epson	
Microchip Technology	ST Microelectronics	
Mitsumi Electric	Texas Instruments	
NXP	Toshiba	
ON Semiconductor		
Panasonic Semiconductor		
Renesas Electronics		
Rohm		
Samsung		
Sanken Electric		
Seiko Epson		
Sharp		
ST Microelectronics		
Texas Instruments		
Toshiba		

Foundries Serving Analog IC Manufacturing

> 0.35um	180nm	130nm
Altis	Altis	GLOBALFOUNDRIES
AMS	GLOBALFOUNDRIES	PowerChip Technology
ASMC	Grace	SMIC
GLOBALFOUNDRIES	Lfoundry	TSMC
Grace	MagnaChip	UMC
MagnaChip	PowerChip Technology	
Micrel	Silterra	
OKI	SMIC	
PowerChip Technology	Sekio Epson	
Silterra	TowerJazz	
Sekio Epson	TSMC	
SMIC	UMC	
TowerJazz	Vanguard	
TSMC	X-Fab	
UMC		
Vanguard		
Yamaha		
X-Fab		

Manufacturing Scalability for Analog Products



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The Analog Mindset

Silicon Accuracy

- Rich Component Set
- Tight Parametric Distributions
- Exhaustive Device Characterization
- 2nd Order Effects – Noise, Matching, ….

Simulation Accuracy

- Thorough PDK That Works
- SPICE Models That Match Silicon
- Robust ESD Solutions
- Proven IP Blocks for Key Functions

Manufacturability

- Electrical Failure Analysis, ESD Reviews
- Zero Defects, DPPM Focus
- Flexibility – Handle Unusual Requests
- Eco-System

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Ref: L. Hutter; Analog Leaders Forum, Korea 2012

Conclusion

- Analog IC is a Growth Market
- Analog is Everywhere !
- Analog - SoC’s are here….
- “Analog Mindset” for Manufacturing

THANK YOU

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