Personal and Portable

The Evolving Definition

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Belief

The brave new world will be
more
Personal
and
Portable

Outline

Examples

Opportunity

Challenges

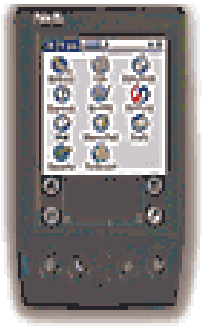
Vision

Portable

The definition of Portable in the world of Computers over the last 20 years.

Circa 1980

Circa 1990



Circa 2000

Portable

The definition of Portable in the world of Cell Phones over the last 20 years.

Circa 1980

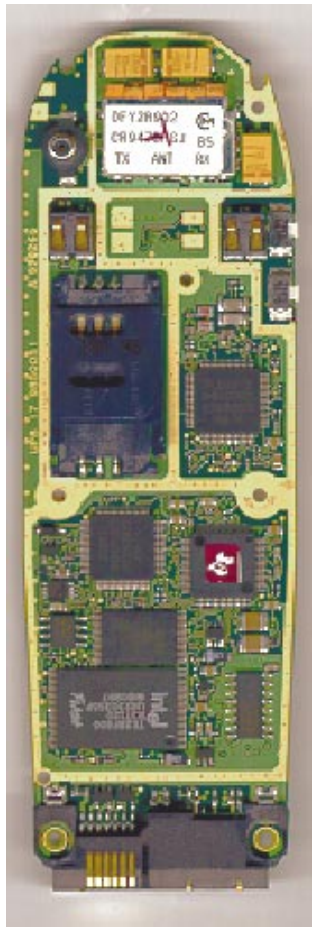
Circa 1990

Circa 1995

Circa 2000

TECHNOLOGY FOR INTERNET ERA

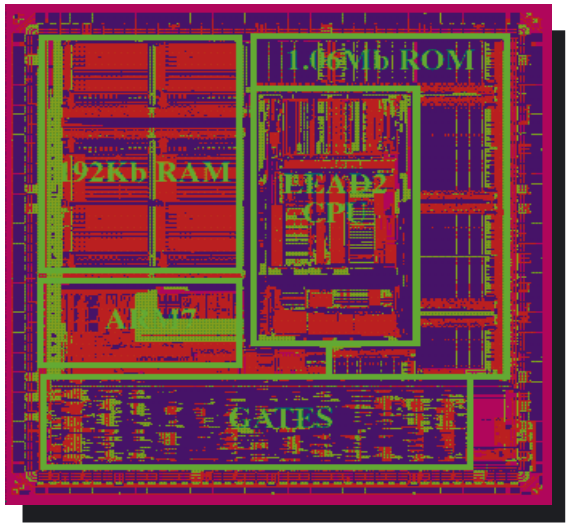
Today's Cell Phone	
ICs	12
Discretes	16
Passives	214
Other	8
Total	250



- Transistor scaling is not the most significant enabler for cost reduction
- SOC integration requires technologies for
  - DSP
  - SRAM
  - FLASH
  - Radio RF/IF
  - Analog functions
  - Power management

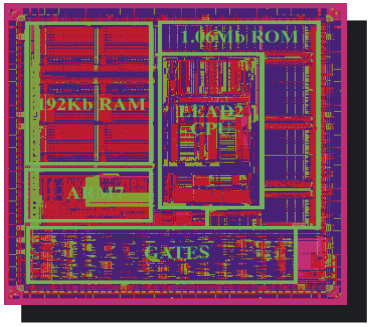
TECHNOLOGY FOR INTERNET ERA

TECHNOLOGY ENTITLEMENT



C12:
80.7 mm²

C10:
46.6 mm²



C07:
19.2 mm²

C05:
10.7 mm²

Dies Per Wafer:

310	558	1435	2616

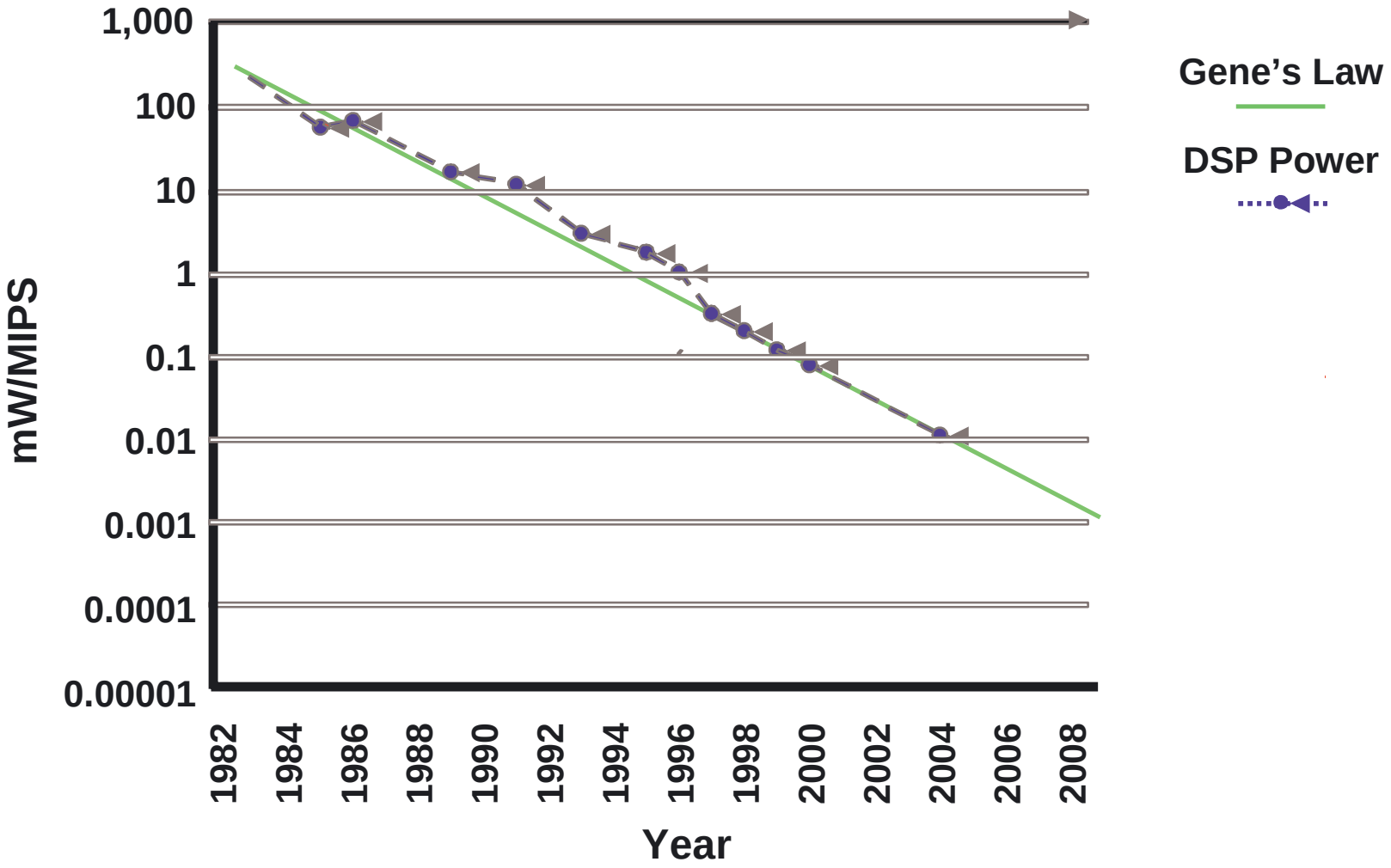
800% increase in dpw

Two Decades of Integration

TYPICAL DEVICE CAPABILITIES

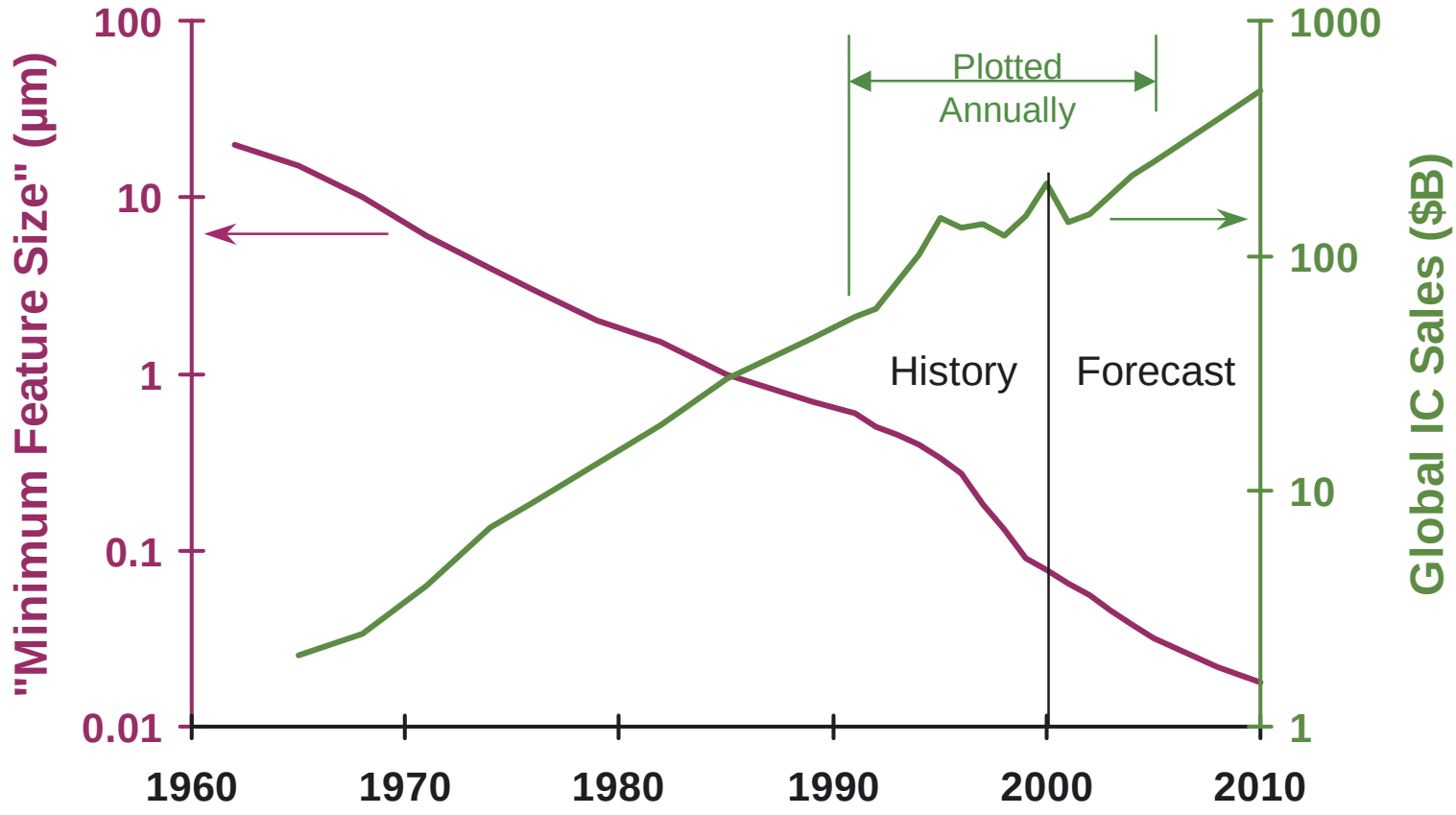
	1980	1990	2000	2010
Die size (mm)	50	50	50	5
Technology (uM)	3	0.8	0.1	0.02
MIPS	5	40	5,000	50,000
MHz	20	80	1,000	10,000
RAM (bytes)	256	2K	32K	1M
Price	$150.00	$15.00	$5.00	$0.15
Power (mW/MIPS)	250	12.5	0.1	0.001
Transistors	50K	500K	5M	50M
Wafer size	3"	6"	12"	12"

Power Dissipation Trends

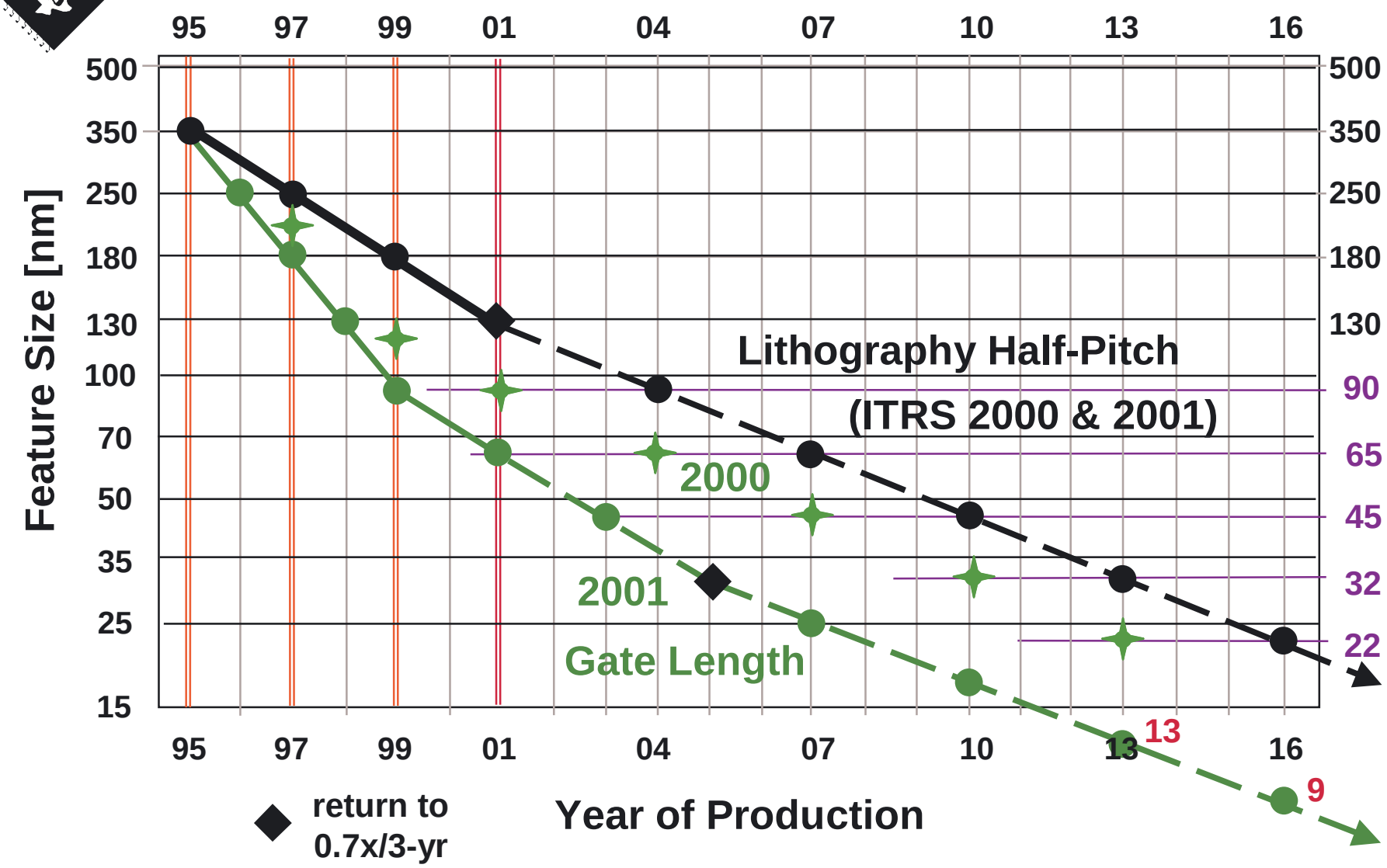


The Key Driver of Chip Manufacturing:

"Smaller Features ➔ Lower Cost/Function ➔ Larger Market"

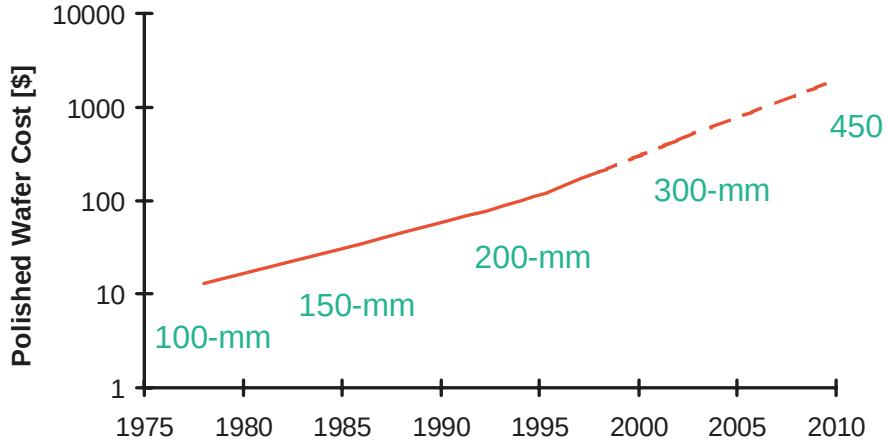


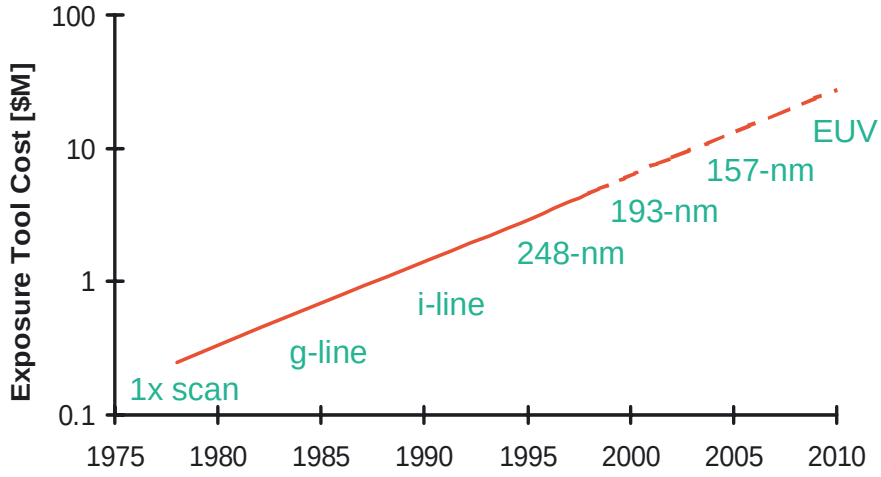
How Small ? -- Litho and Sub-Litho Mfg.

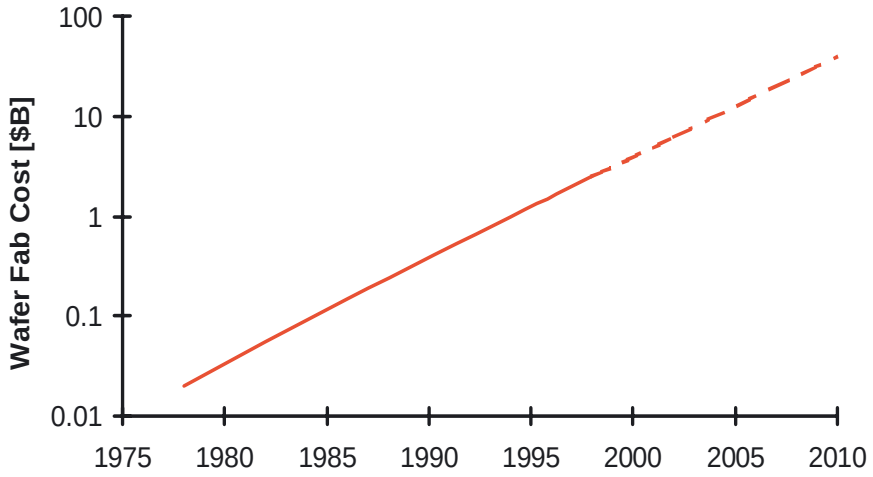


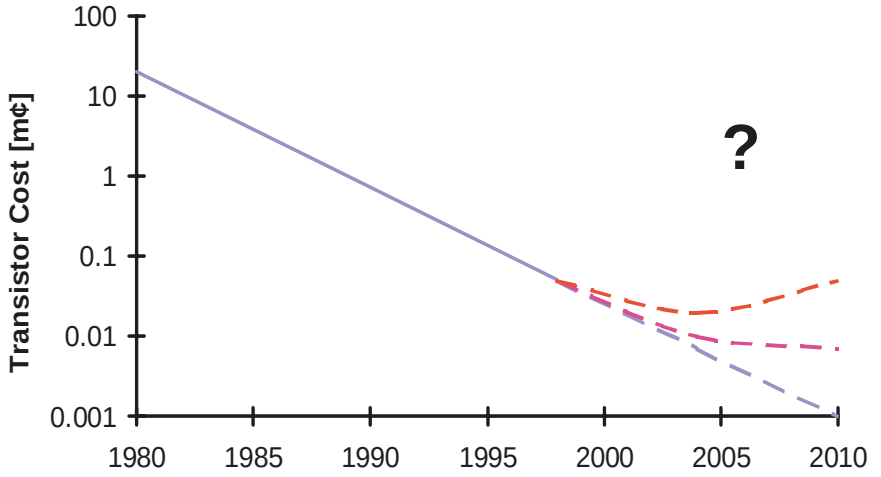
Source: 2001 ITRS

The Ultimate Scaling Challenge:
Manufacturing Affordability

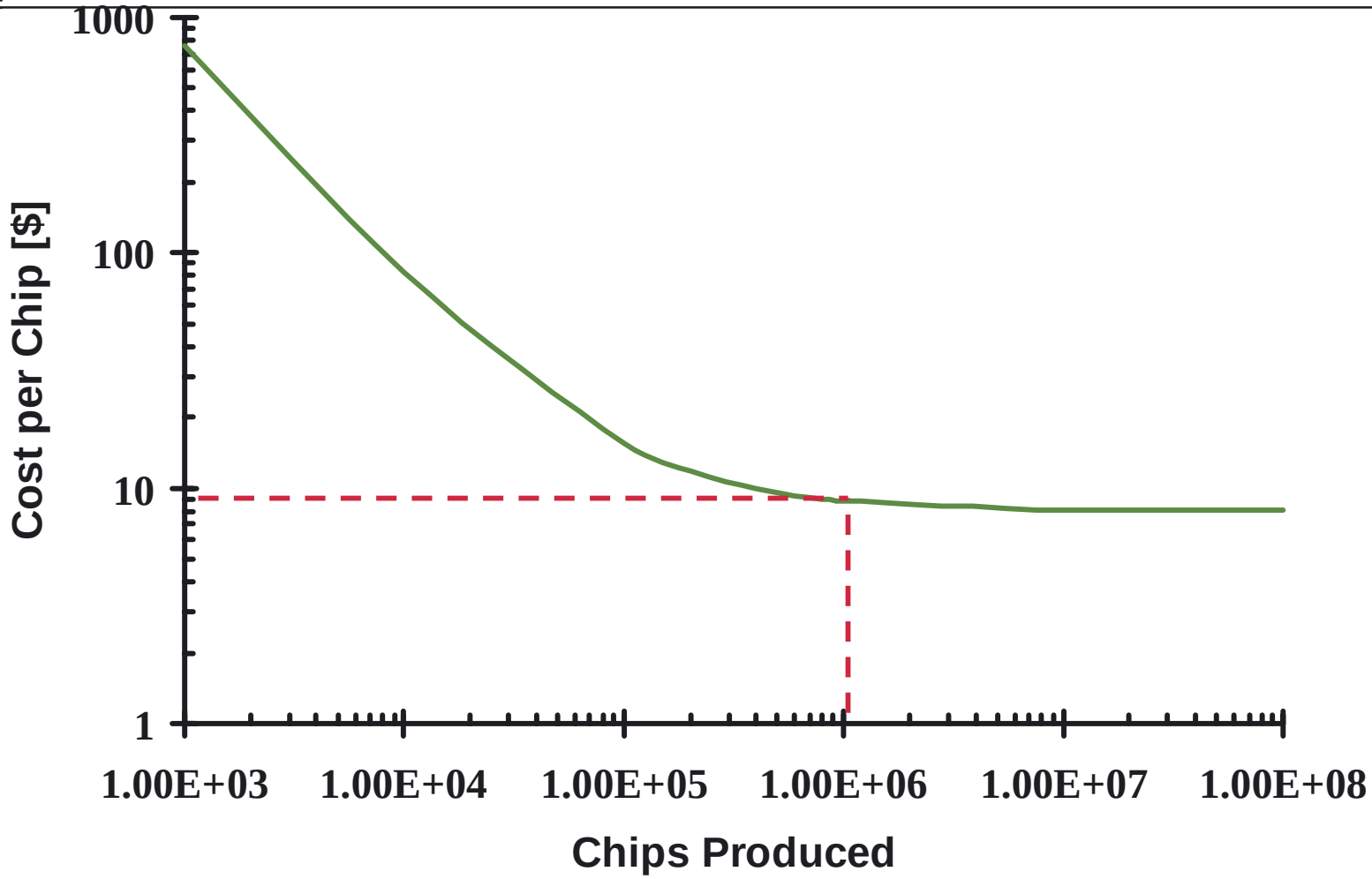




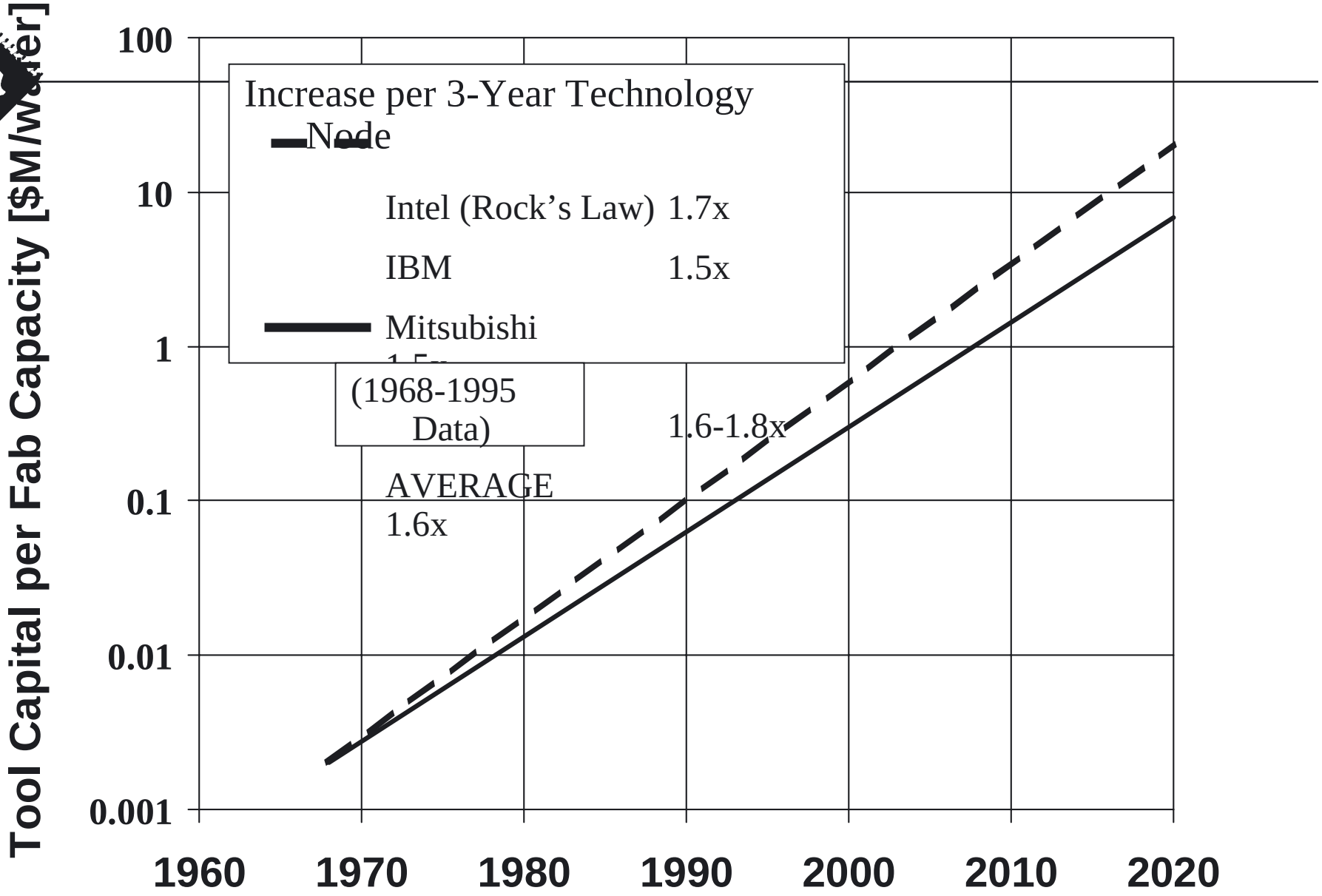




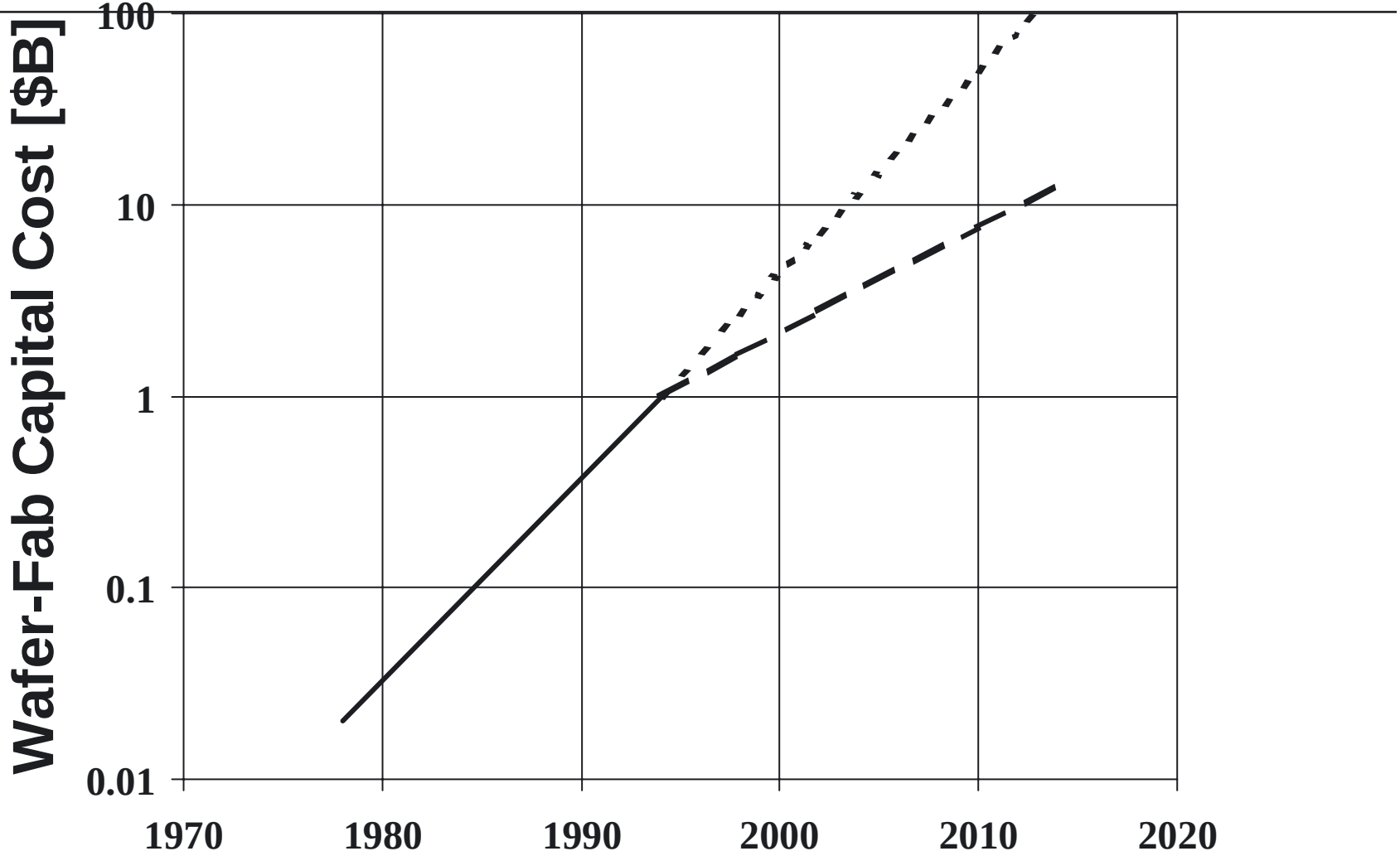
Amortization of Mask Cost



~ 1 million units required to get within 10% of asymptotic cost !
(and getting worse with continued scaling)



Processing the Digital World

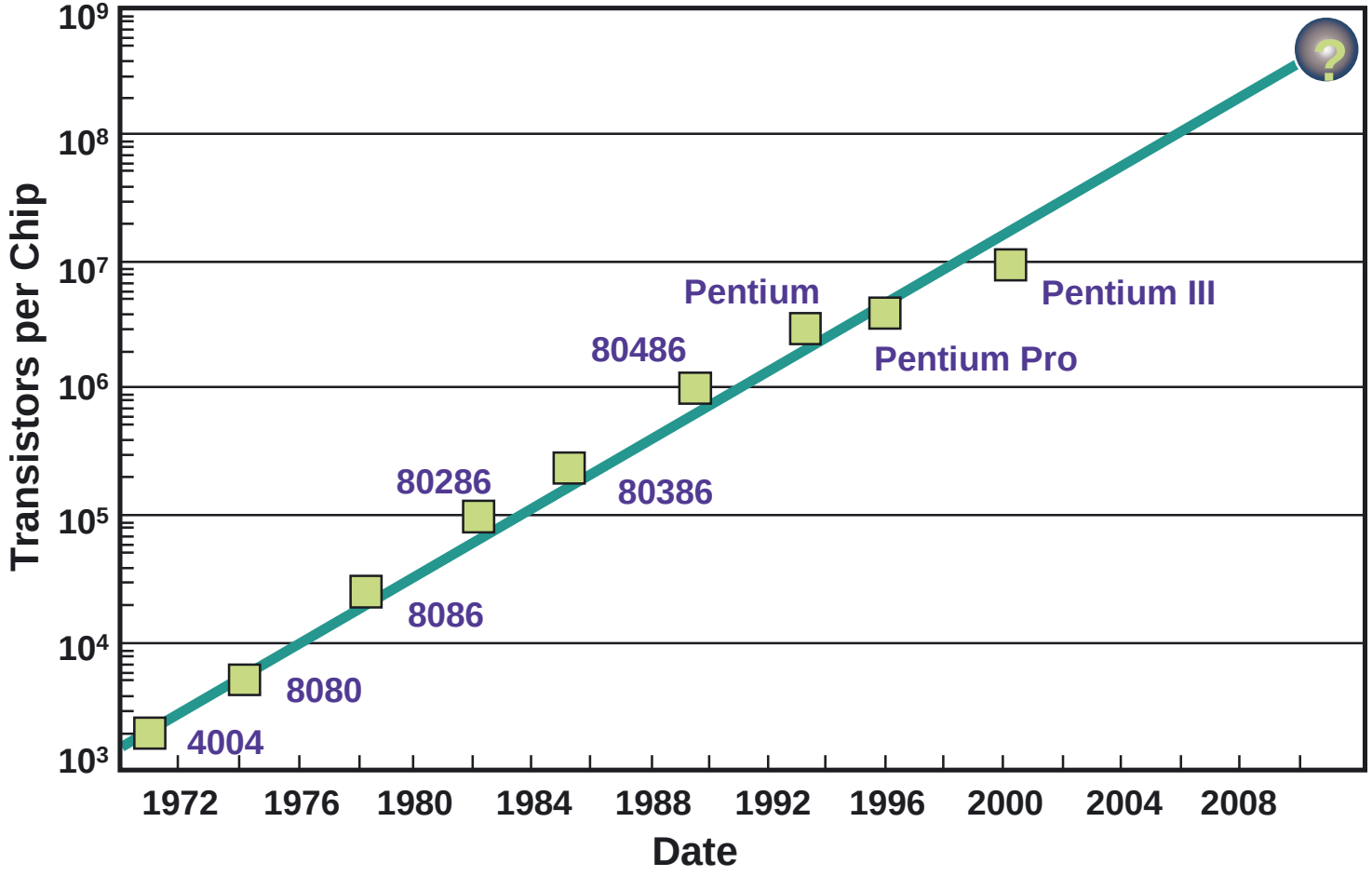


Shrinking Process

Device	Year	Transistors	Process
32010	1983	50,000	3.0um NMOS
32020	1984	100,000	2.4um NMOS
320C30	1988	500,000	1.0um CMOS
320C50	1990	1,200,000	0.8um
320C5510	2000	22,000,000	0.18um
320C556x	2002	180,000,000	0.13um

ANALOG/MIXED SIGNAL INTEGRATION

Moore's Law

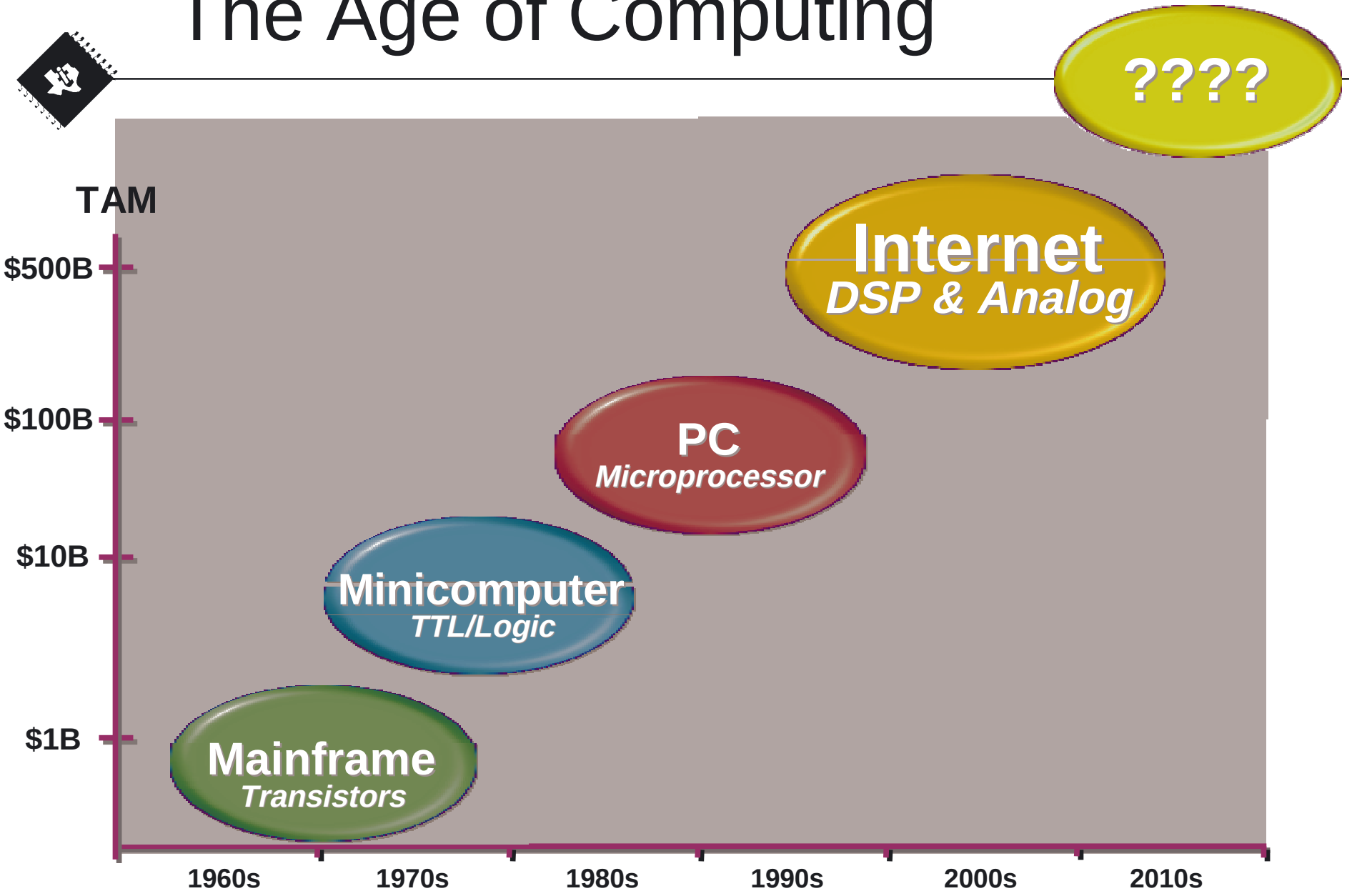


Source: Stan Williams, Hewlett Packard

Technology Trends

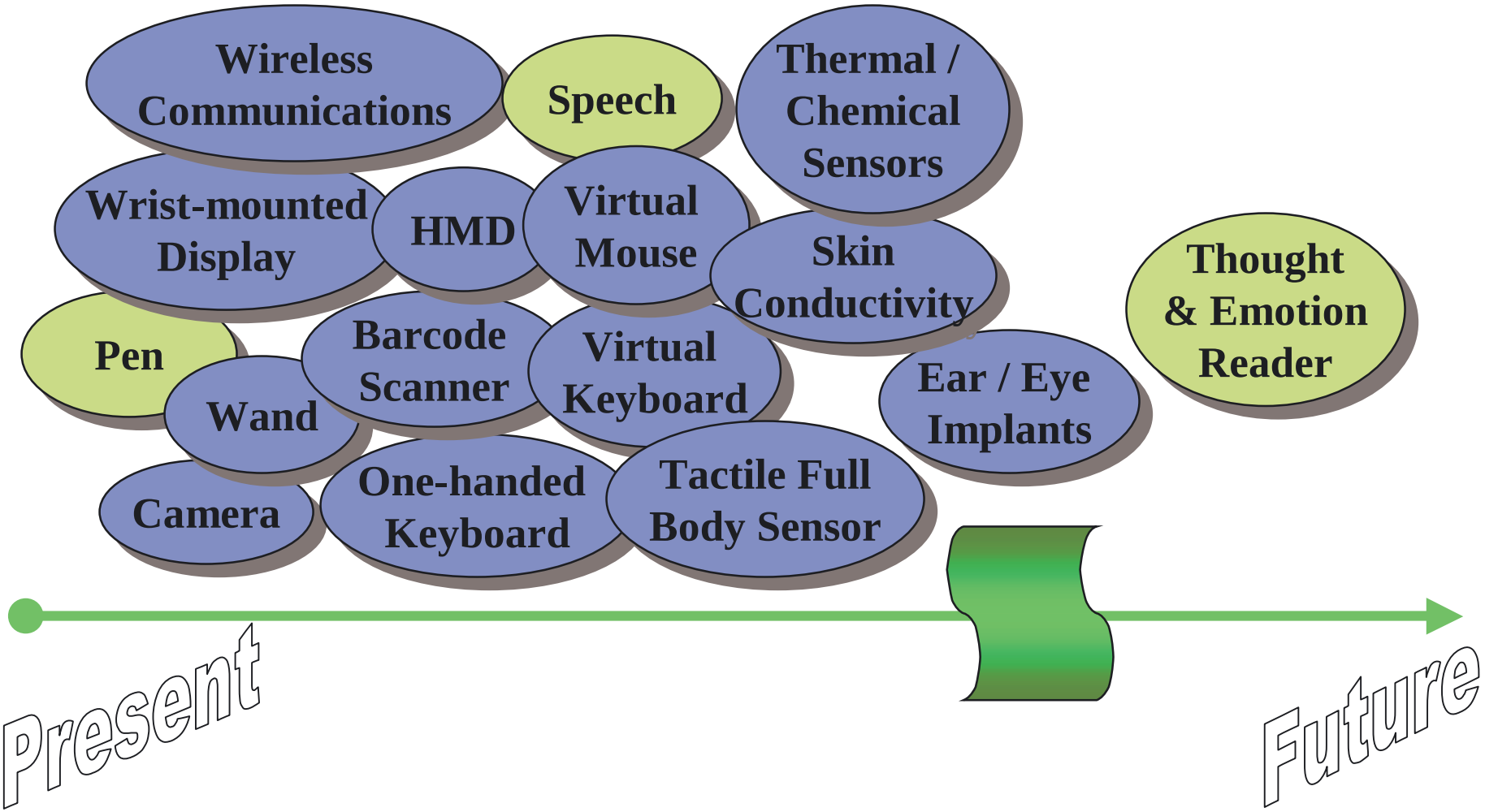
-Transistors moving from microns to nanometers
-Gates per square millimeter going from tens of thousands to hundreds of thousands
-Die sizes shrinking from tens of square millimeters to units of square millimeters
-Wafer size moving to 300 millimeter
-Dies per wafer increasing from thousands per wafer to tens of thousands per wafer
-Tooling costs going from hundreds of thousands of dollars to millions of dollars
-Fab cycles increasing from two months to six months

The Age of Computing



I/O Needs

HANDS › **HANDS - FREE** › **AUTOMATIC**

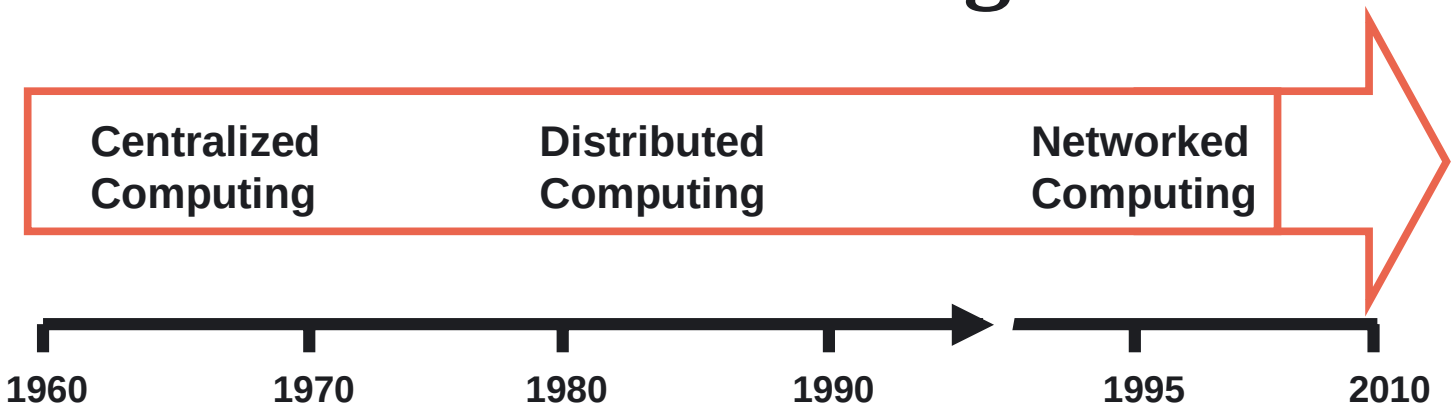


What does this all Mean?

-Innovation will move from silicon to software
-Everything is going in our favor for lower cost, higher performance, portable products
-So, now what?

ANALOG/MIXED SIGNAL INTEGRATION

Scale of Change



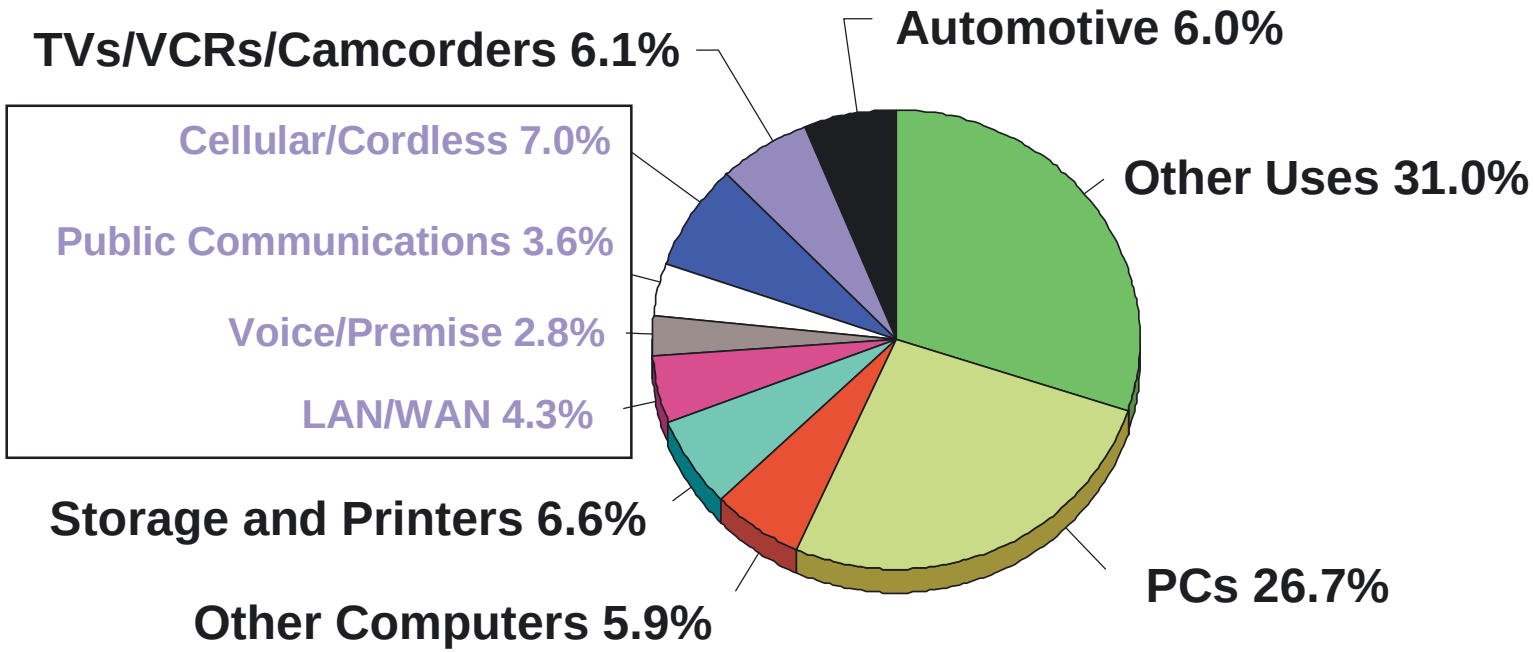
Moore's Law *Metcalf's Law*

Currency:	Data	Text	Images/Multimedia
Platform:	Mainframe	Microprocessor/PC	Internet/WWW
Value:	Hardware	Software	Communication & "Content"

Proprietary Systems ***Open Systems***

ANALOG/MIXED SIGNAL INTEGRATION

The Semiconductor Pie in 1998



Semiconductor Market = $136 Billion

Source: Dataquest Gartner Group

ANALOG/MIXED SIGNAL INTEGRATION

What's in an Ericsson 1900 PCS Phone?

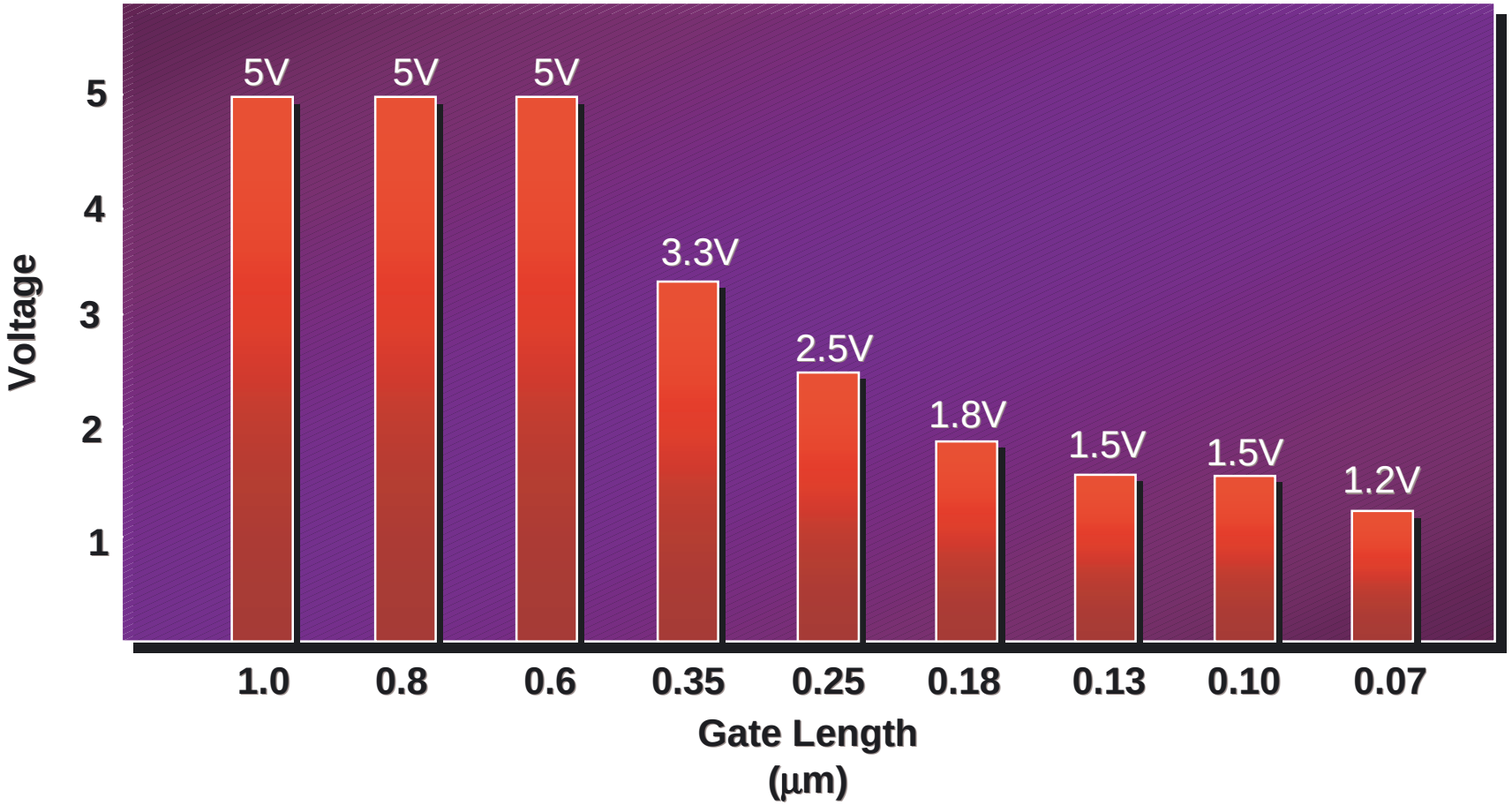
Total number of electronic components	**380**
Passive components	**322**
Semiconductors	**46**
Discretes	**21**
ICs	**15**
Optoelectronic components	**10**
Other electronic components	**12**

"Transistor scaling" is not the most significant enabler for this integration challenge

Source: Dataquest Gartner Group

ANALOG/MIXED SIGNAL INTEGRATION

Vanishing Voltage Dilemma



TECHNOLOGY FOR INTERNET ERA

300 mm

Did you know...

Roughly the size of three football fields, DMOS6 will be TI's largest fab

Fast Facts:

300mm Project Capital: $2.2B

Final Wafer Size: 300mm

Final Capacity: 30K wfs/month

Final Tech Mix: C035/C027 Cu

Clean Room Space: 135K sq ft

Key dates:

- **Shell constructed: 1996**
- **Cleanroom complete: 7/2000**
- **300mm production: 11/2001**

Location: Dallas

TECHNOLOGY FOR INTERNET ERA

Lowest Cost