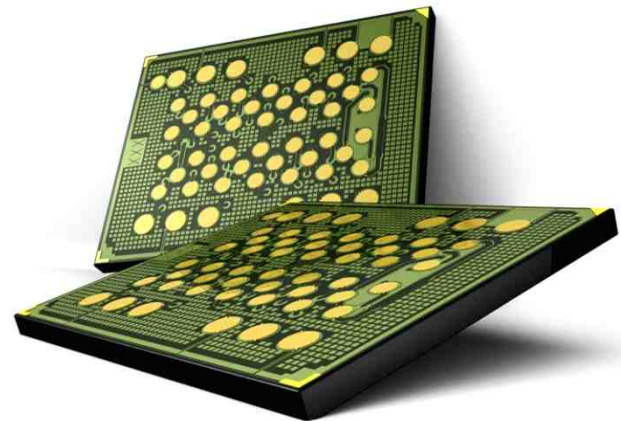


# Flash Memory: The New Technology Driver

Ed Doller

VP & Chief Memory System Architect

Flash Memory Summit - 2010



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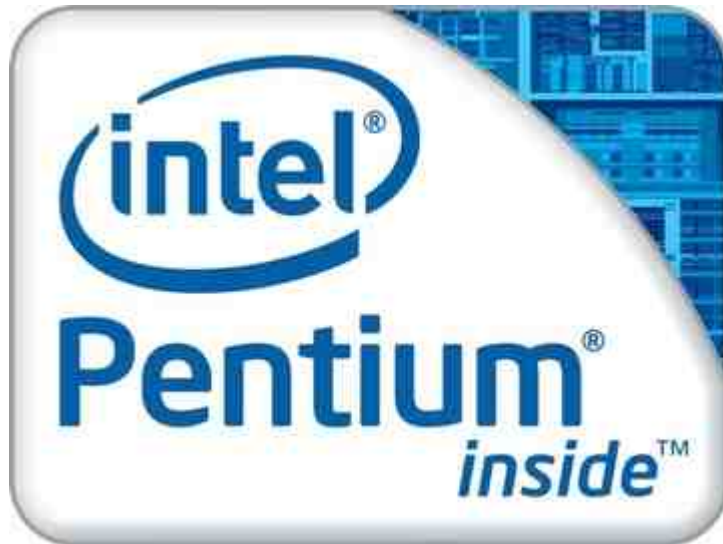
August 18, 2010

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# Technology in the 1990's & 2000's

## 1990's

it **was** all about the speeds...



**Intel PIII Pentium family**

## 2000's

it's **now** all about the feeds.



**Online Proliferation**

# 2010 – 2020: The Decade of Flash Memory



# Reason #1: Consumers are **Memory Aware**

# Consumers are **Memory Aware**



**1.86GHz**

Intel Core 2 Duo processor with  
1066MHz frontside bus

**2GB Memory**

**120GB SATA hard drive<sup>1</sup>**

NVIDIA GeForce 9400M graphics

Ships: Within 24hrs.

**Free Shipping**

**\$1,499.00**

financing available

Select



**2.13GHz**

Intel Core 2 Duo processor with  
1066MHz frontside bus

**2GB Memory**

**128GB solid-state drive<sup>1</sup>**

NVIDIA GeForce 9400M graphics

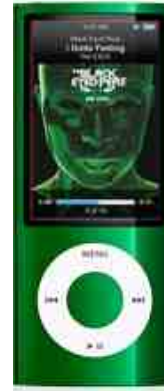
Ships: Within 24hrs.

**Free Shipping**

**\$1,799.00**

financing available

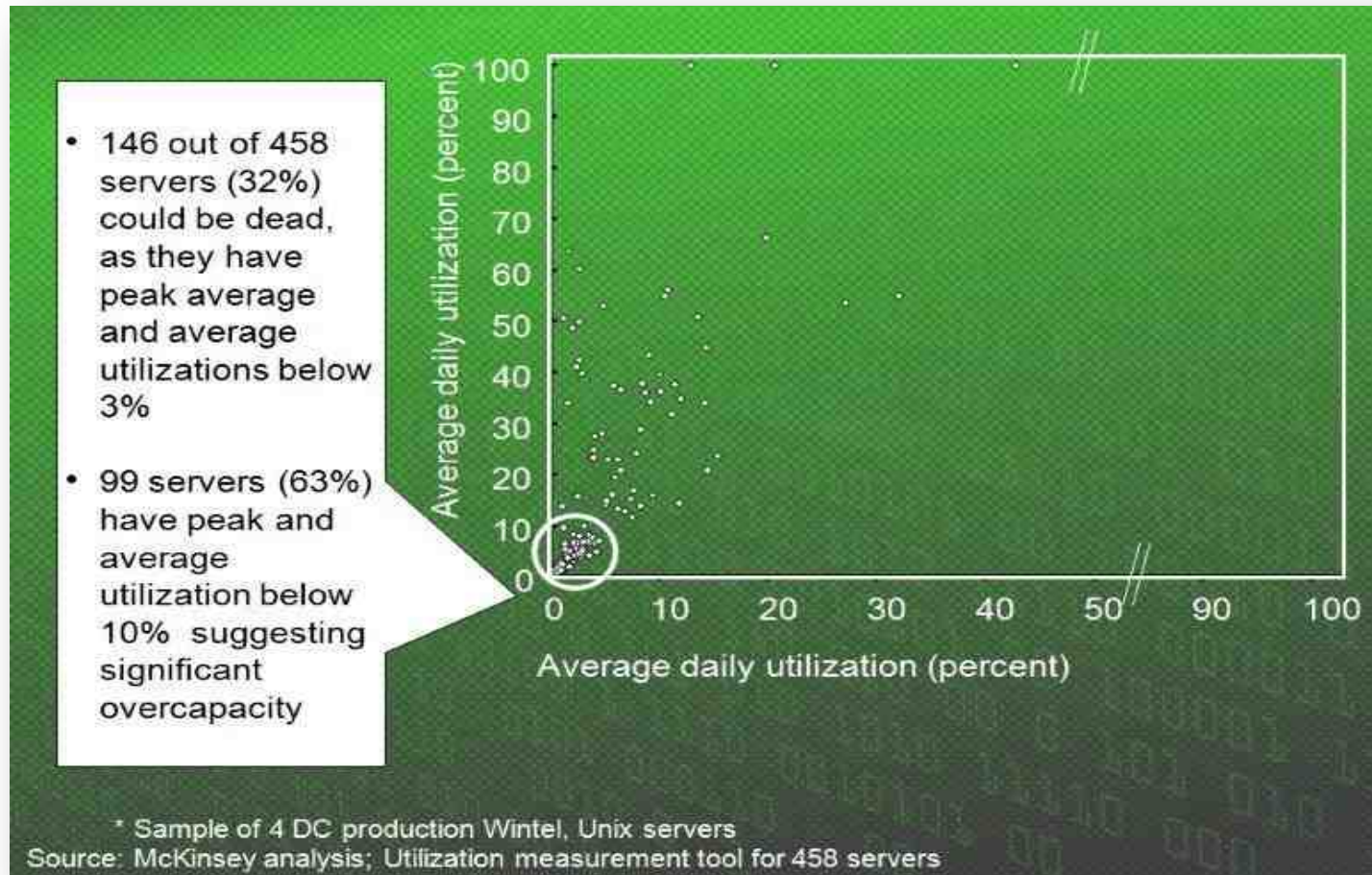
Select



When's the last time consumers **really** cared about GHz?

## **Reason #2: It's Gigabytes, not Gigahertz**

# Even Where You **Think** GHz Matters...



...it doesn't! But, **NAND Flash memory** will increase performance.



# Flash Memory: The New Performance Operator

**Micron Enterprise-Class  
Solid-State Drive**



**Nimbus Data S-Class  
Storage Rack, Using  
Micron Enterprise NAND**





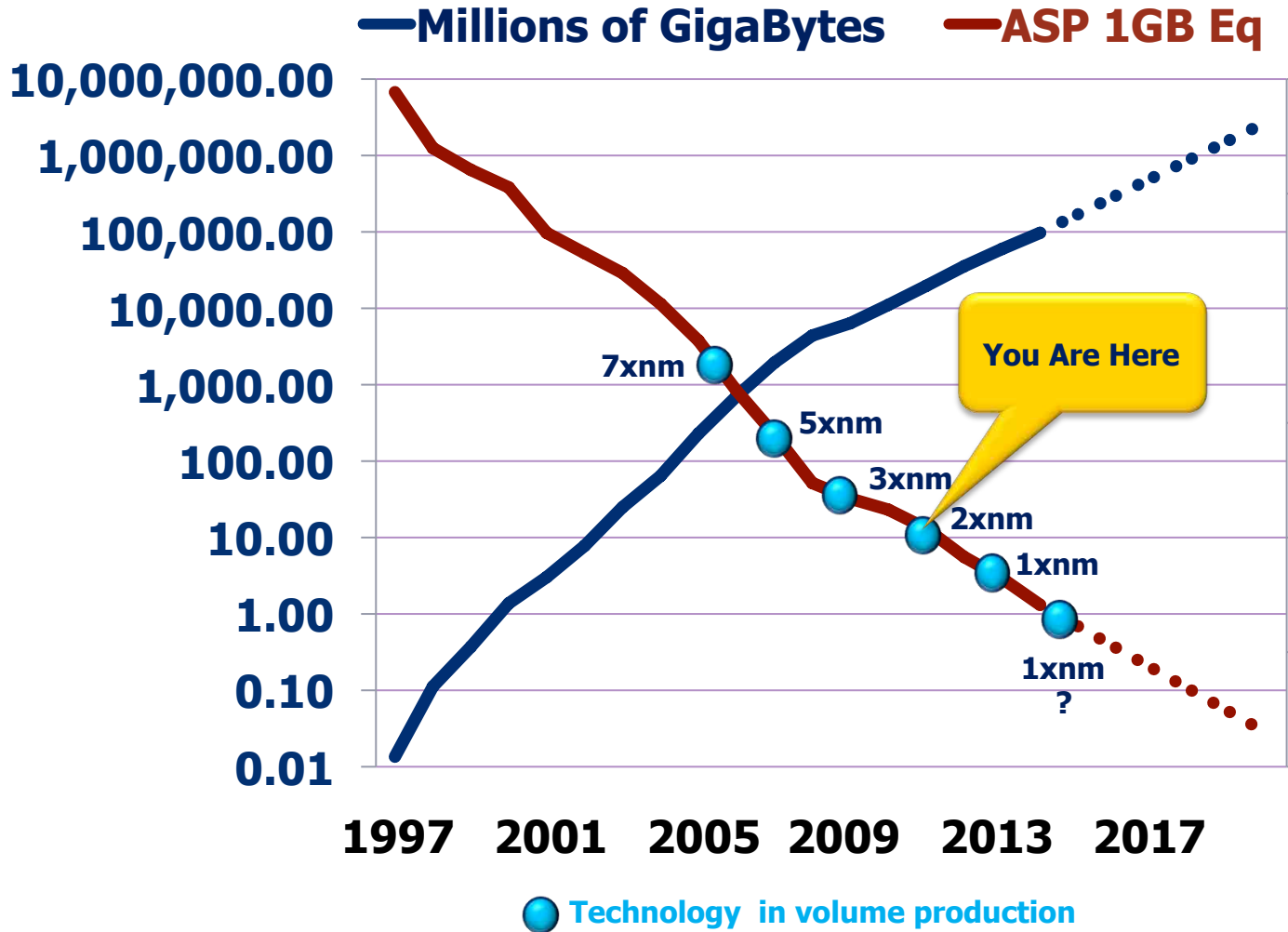
# **Reason #3:** Consumer Devices Are Becoming **Computers**



# iCompute

# How Did We Get Here?

# How Did We Get Here?



Source: Gartner

# How Small is Small?

US One Dollar bill cross section  
(2.8 Billion Physical Bits)



2.61"  
(1.3Mc)





# How Small is Small?



**Every** Led Zeppelin song & Beatles song **ever** produced...  
(and still have room left over)

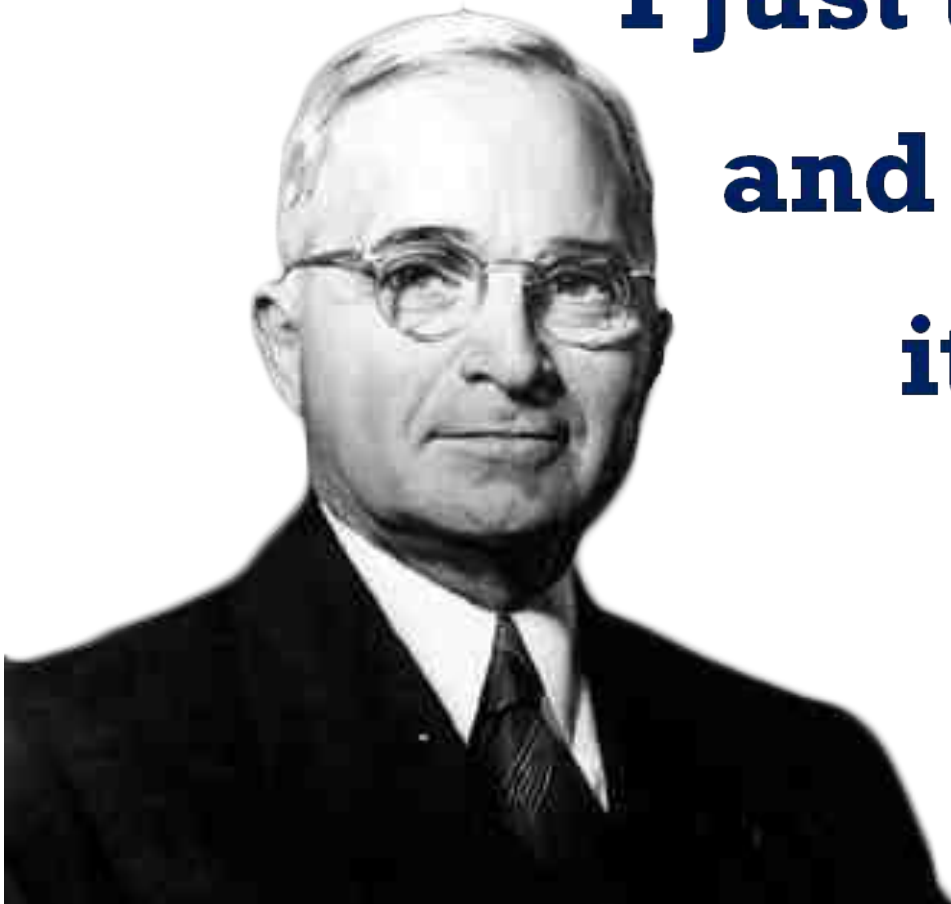
**I never give them hell.**

**I just tell the truth**

**and they think**

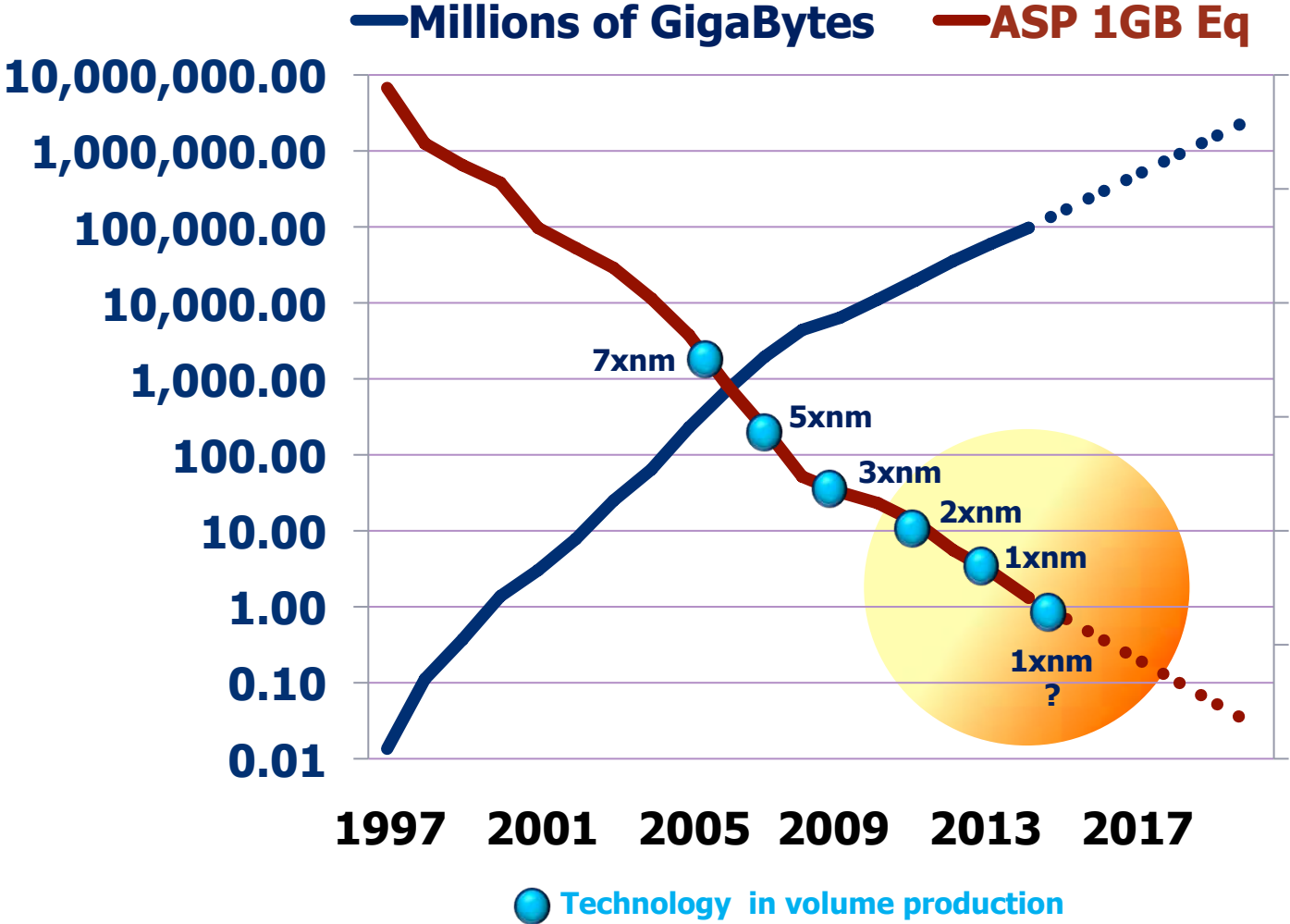
**it's hell.**

**- Harry S. Truman**





# Fragmentation, Differentiation, Innovation and of course Aggravation

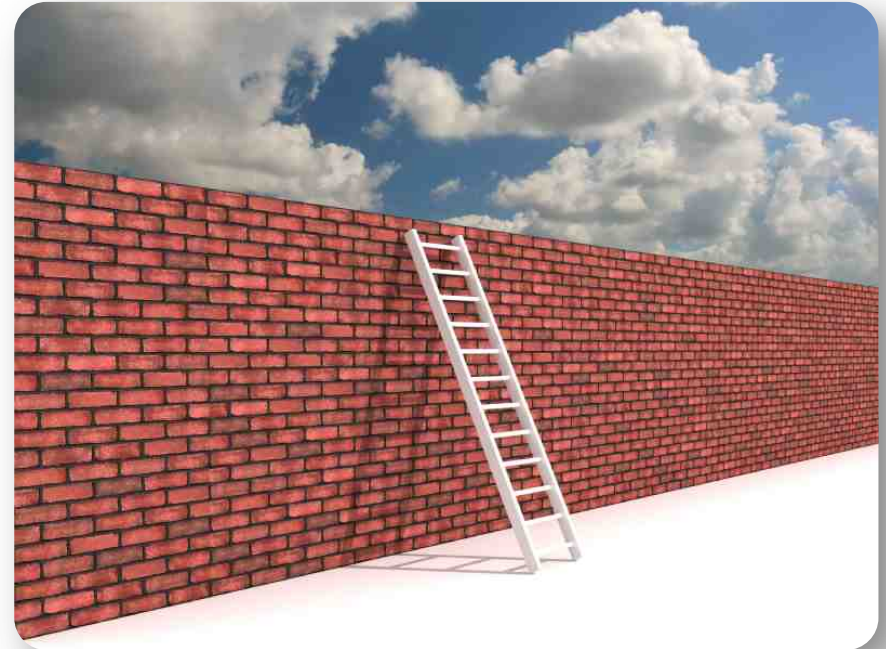
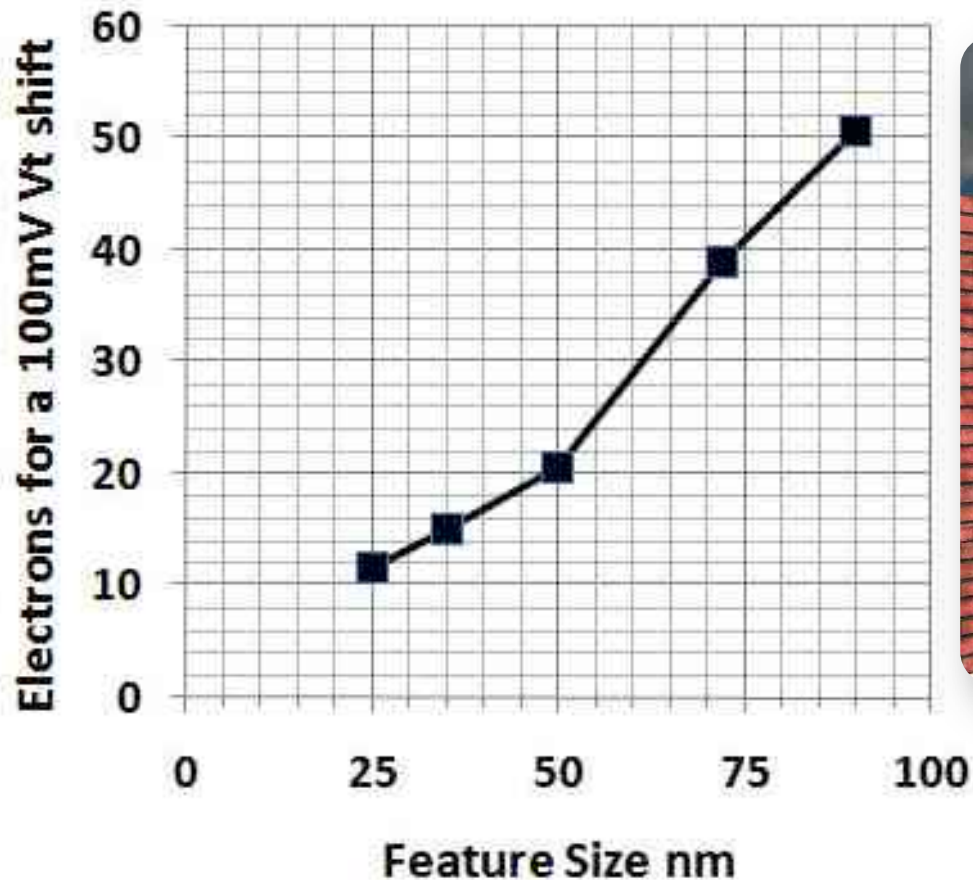


Source: Gartner

## **Reason #4:**

Where there are challenges, there are  
**opportunities**

# NAND Scaling: Getting Closer to the Wall



When the going gets **tough**,  
vertical integration becomes a **necessity!**

# What Happens Once We Reach the Wall?



# NAND Scaling: Breaking Through the Wall



# Let's Look at Our Options

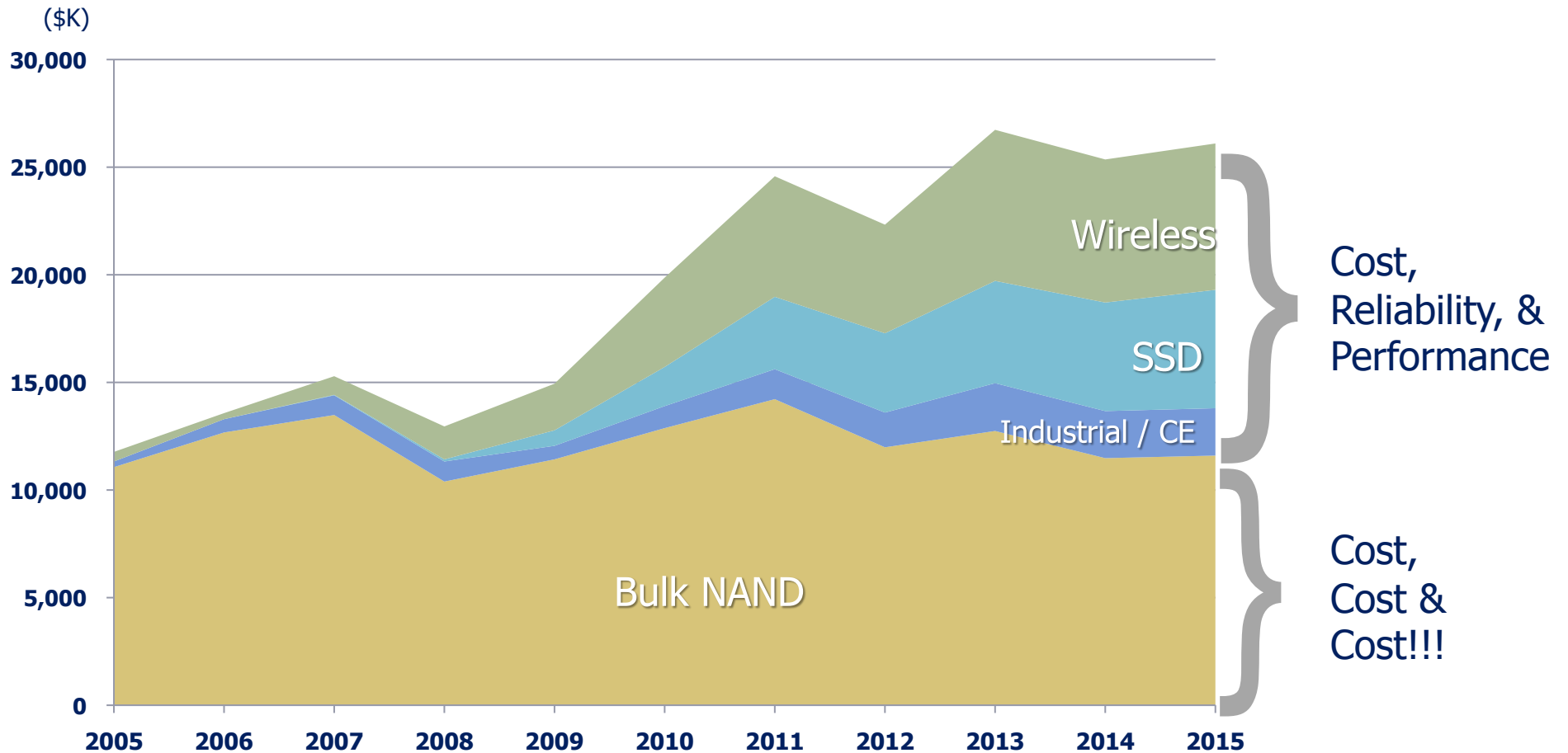
	FeRAM	MRAM	FBRAM	TRAM	PCM
Read Performance	Yes	Yes	Yes	Yes	Yes
Write Performance	Yes	Yes	Yes	Yes	No
Unlimited Writes	No	Yes	Yes	Yes	No
Non-Volatile	Yes	Yes	No	No	Yes
Cost	>>DRAM	>DRAM	<DRAM	<DRAM	<DRAM
Theoretically Scalable	With New Materials	With New Materials	Yes	Yes	Yes
Production Today	Yes	Yes*	No	No	Yes

\* Current production not scalable, New Materials required for scalability

Each technology has specific strengths and weaknesses enabling entry into differing markets

And different market timing based on maturity

# What **Really** Matters?

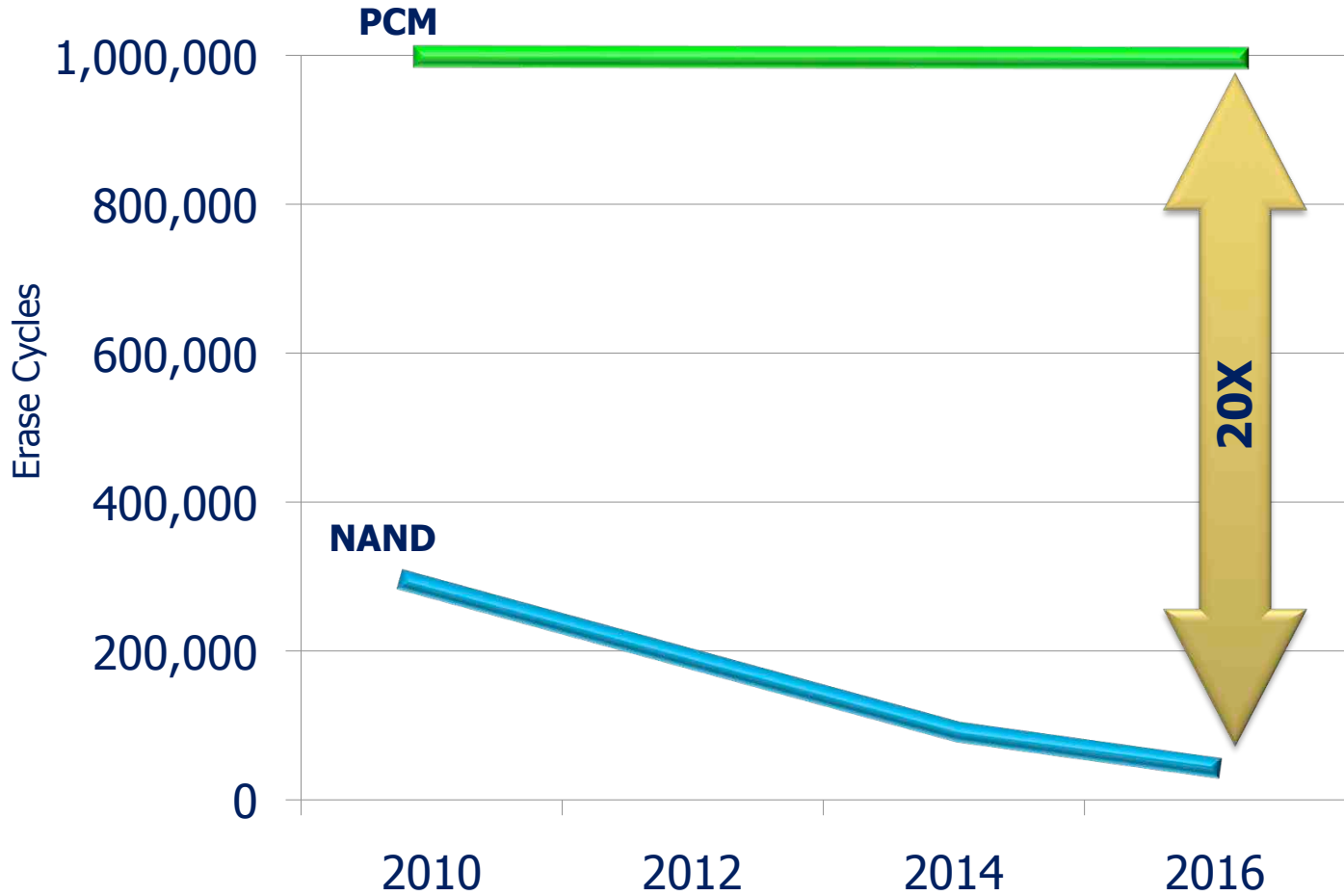


Source: iSuppli Application Market Forecast Tool , June 2010

TAM expansion in markets that will **challenge** technology capability

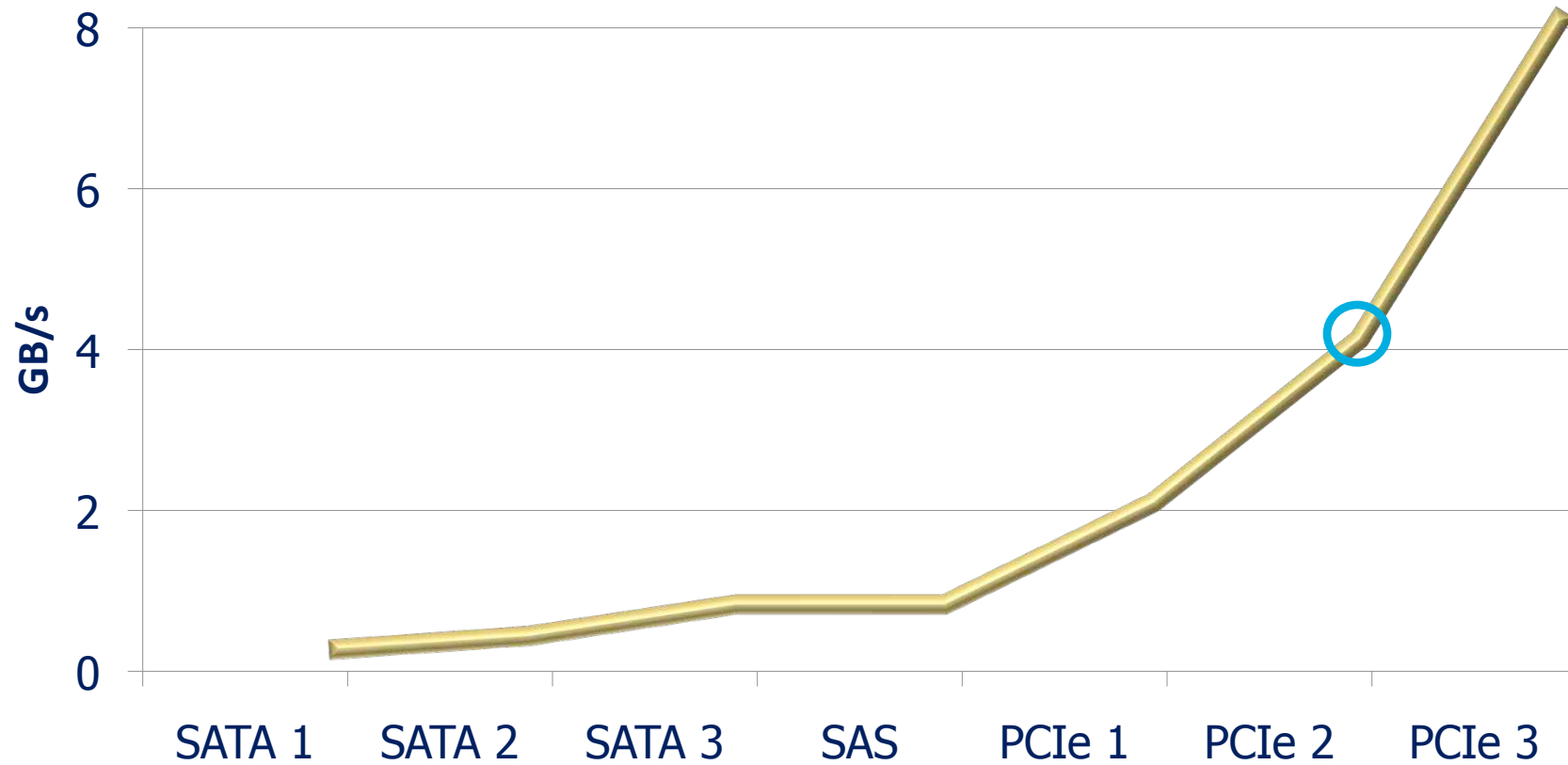


# Endurance Scalability



Source: Micron Research

# Interfaces Getting Faster



4GB/s at 90/10 Read/Write equates to 34TB's per day

Note: PCIe x8

# System Solutions Endurance vs. Density

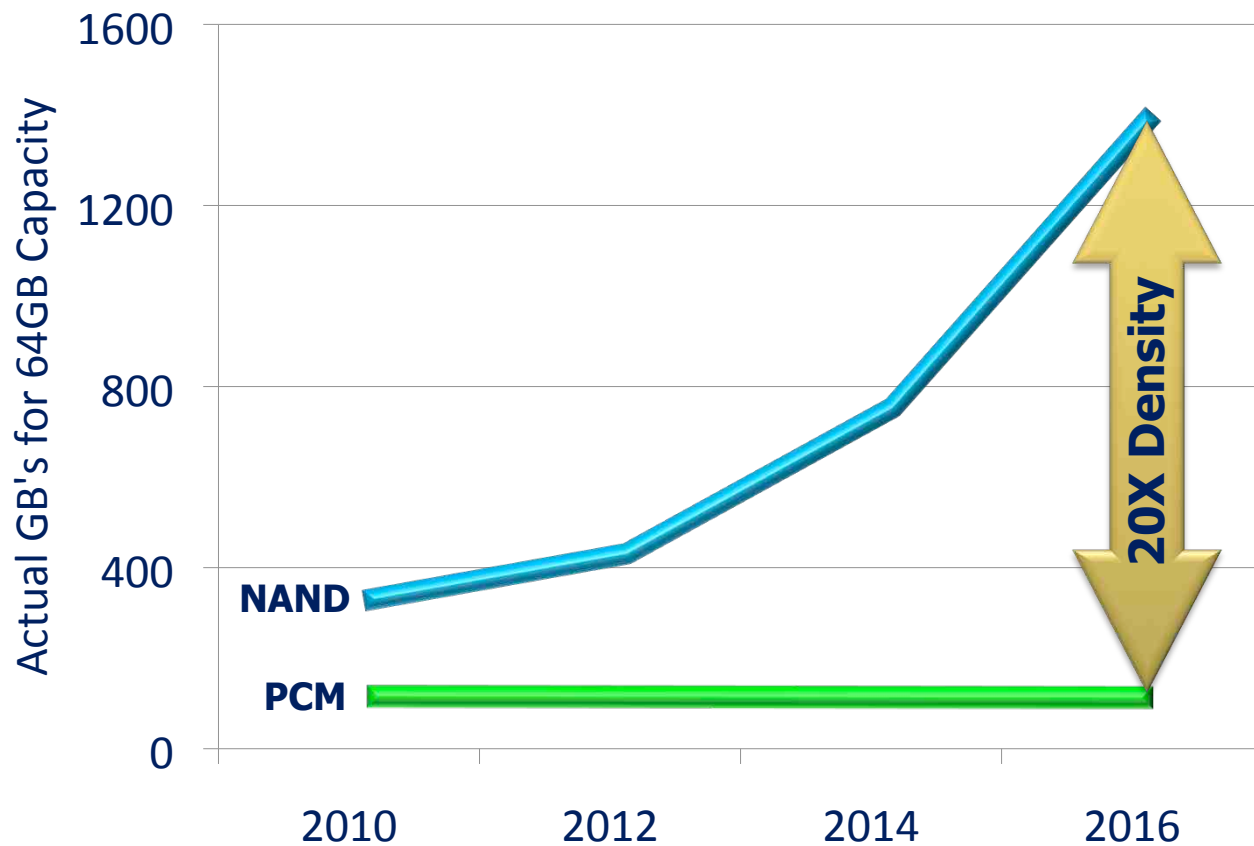
PCIe2



90R/10W



5 yrs



# What Does This Mean to You?

## Consumers



## OEMs



