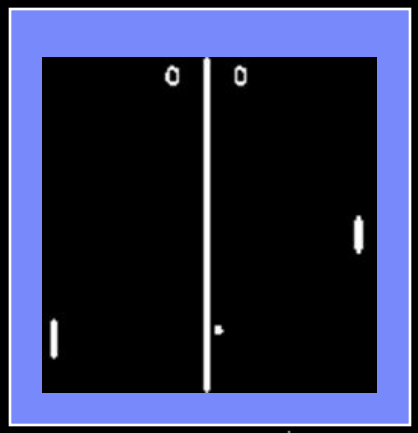
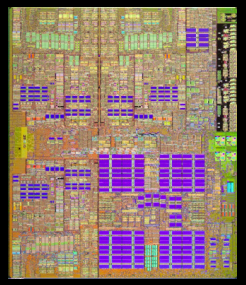
Business Unit or Product Name



IBM Is Serious About Games

John M. Cohn
IBM Fellow

Every New Game Console is Powered by IBM



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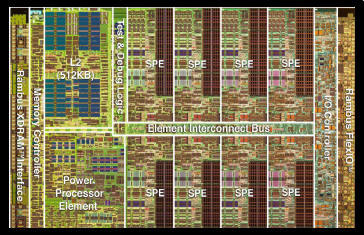
Microsoft
Xbox 360®

Sony
PlayStation®3



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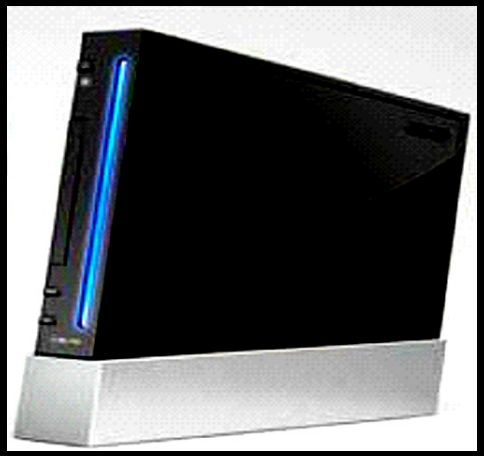
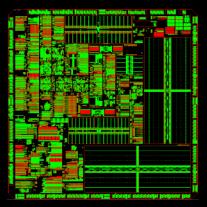


Nintendo
Wii®



*

* Chips not to scale

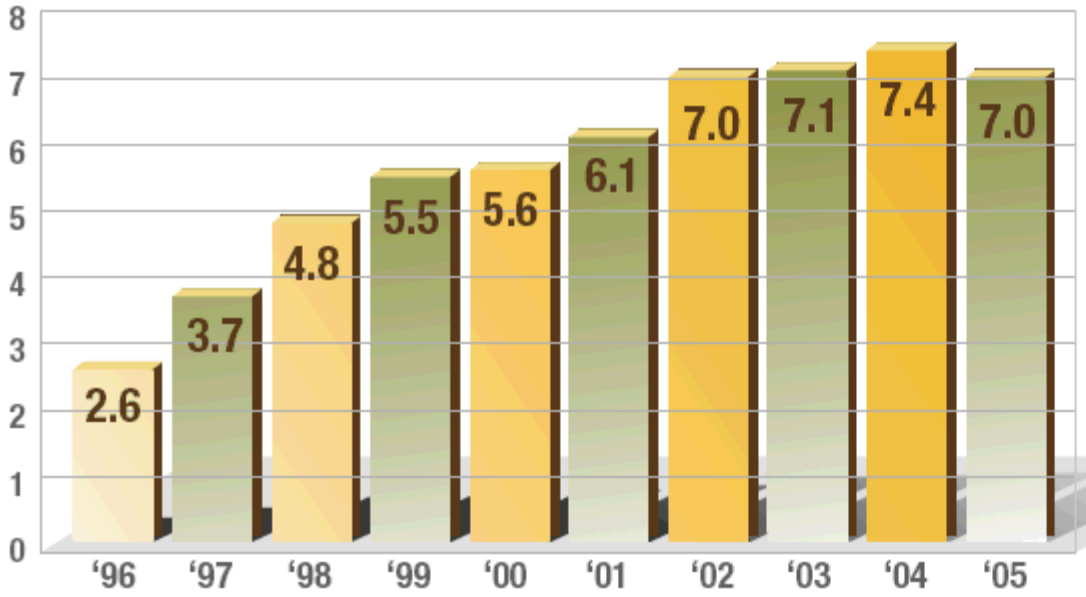
Why Does IBM Care About Games?

- **IBM makes high performance servers, so why games?**
  - Servers are high margin, but low volume
  - Technology investment for server leadership is very expensive
    - e.g. 300mm fab in East Fishkill, NY = $3B
- **Game chips are high volume**
  - Game chips expected to generate big revenue for IBM
  - Help amortize the cost of server investment
  - Provide high volume part numbers for line learning / efficiency

Games Are BIG Business

U.S. computer and video game DOLLARS sales growth

Dollars in Billions



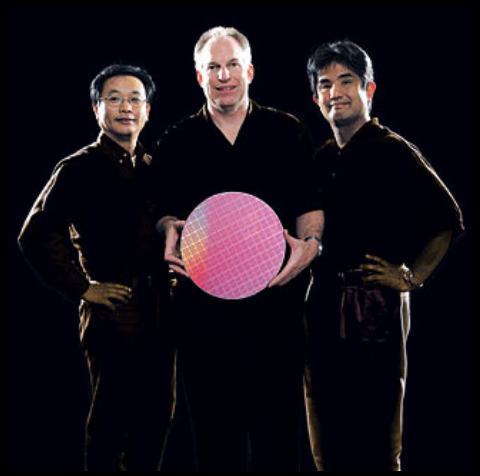
As games get more popular...

Video games sales are driven by the games-console cycle. Every five to six years, console manufacturers such as Sony, Nintendo and Microsoft introduce a new generation of equipment, triggering new growth in games sales. This year marks the start of a new console cycle. According to In-Stat/MDR, next-generation game-console shipments will hit 17m in 2006, 27m in 2007 and 33.5m in 2008.

Source: Entertainment Software Association, "Essential Facts about the Computer and Video Game Industry," 2006 sales, demographic and usage data.

Games Generate Great Press for IBM

"It was originally conceived as the microprocessor to power Sony's [PS3], but it is expected to find a home in lots of other broadband-connected consumer items and in servers too."
-- IEEE Spectrum

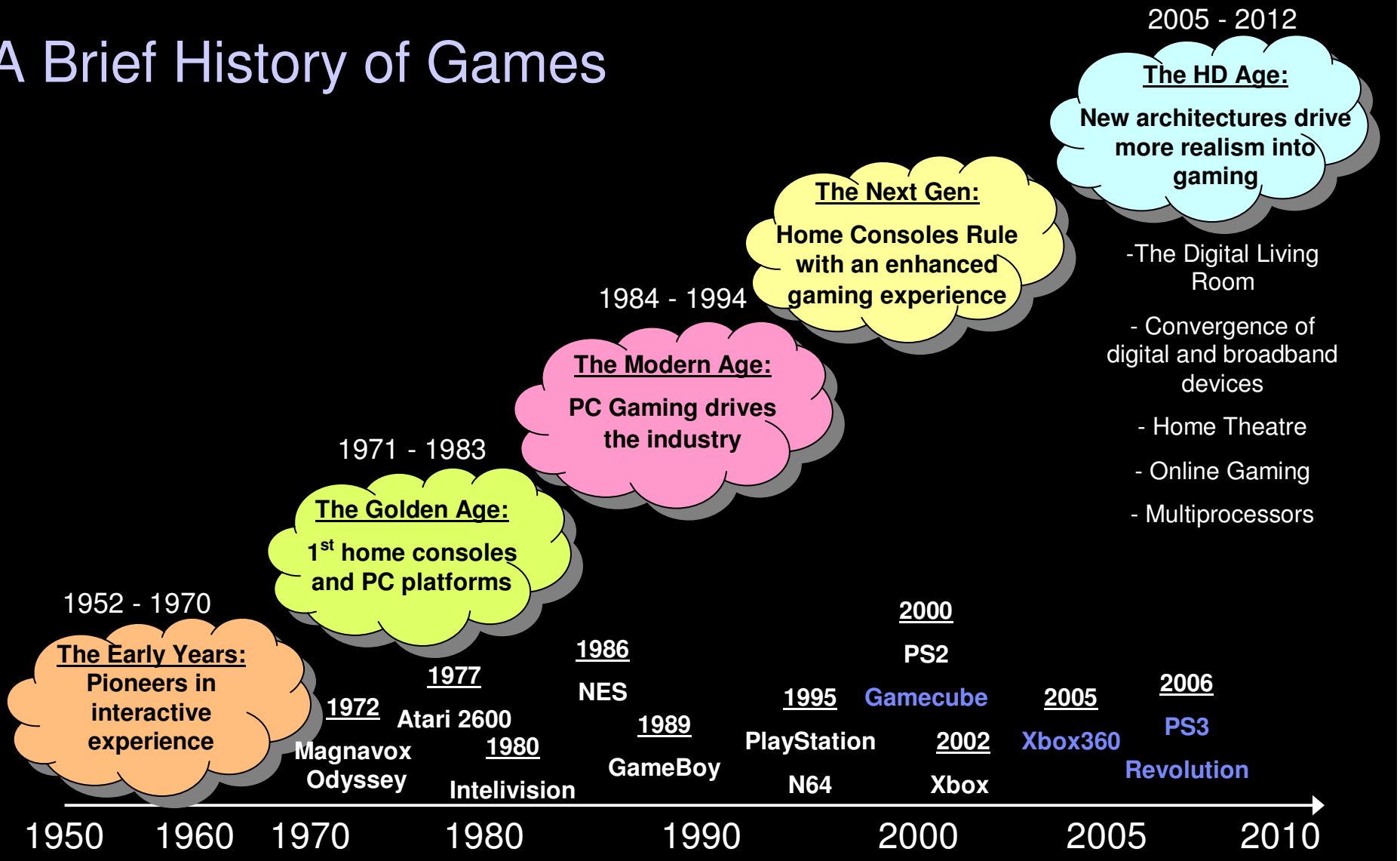


"…Cell could power hundreds of new apps, create a new video-processing industry and fuel a multibillion-dollar build out of tech hardware over ten years."
-- Forbes

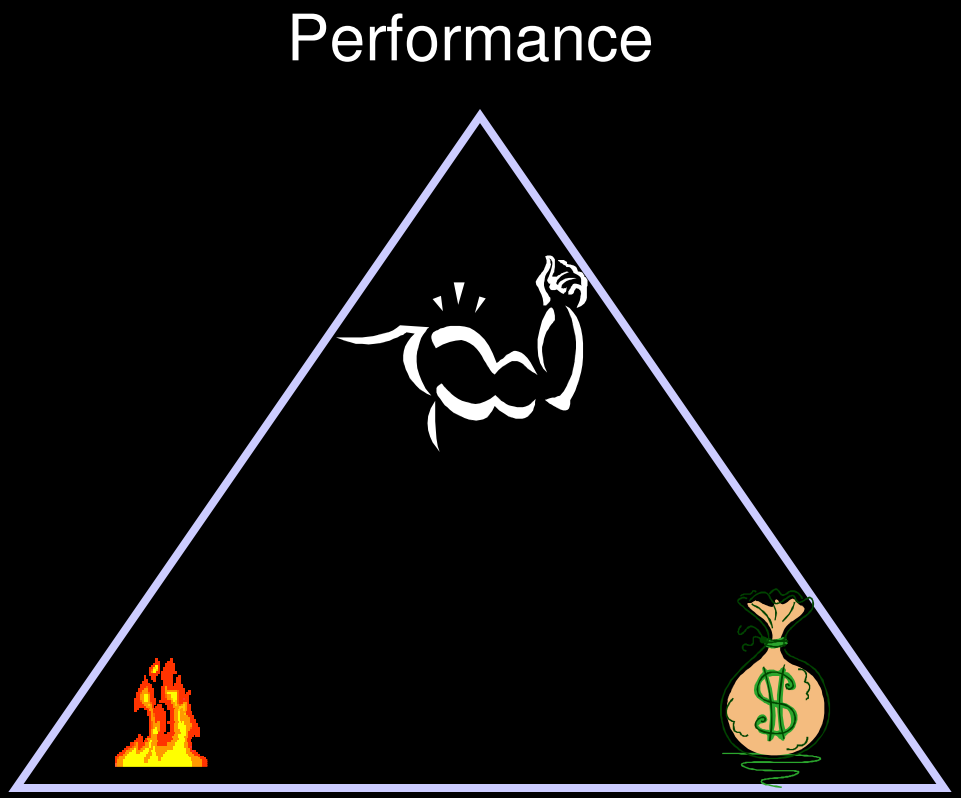
Why Did the Game Companies All Choose IBM?

- **Deep architectural and design experience**
  - 50 years of server leadership
- **Technology Leadership**
  - Industry leading Si process
  - Earliest introduction of new technologies – SOI, Cu, low-K, strained Si
- **Open architecture**
  - Power architecture is now the de facto architecture for games
  - 'We'll do it your way'
- **Platform partnership manufacturing**
  - Deep fab partnership
  - Multiple sources of supply

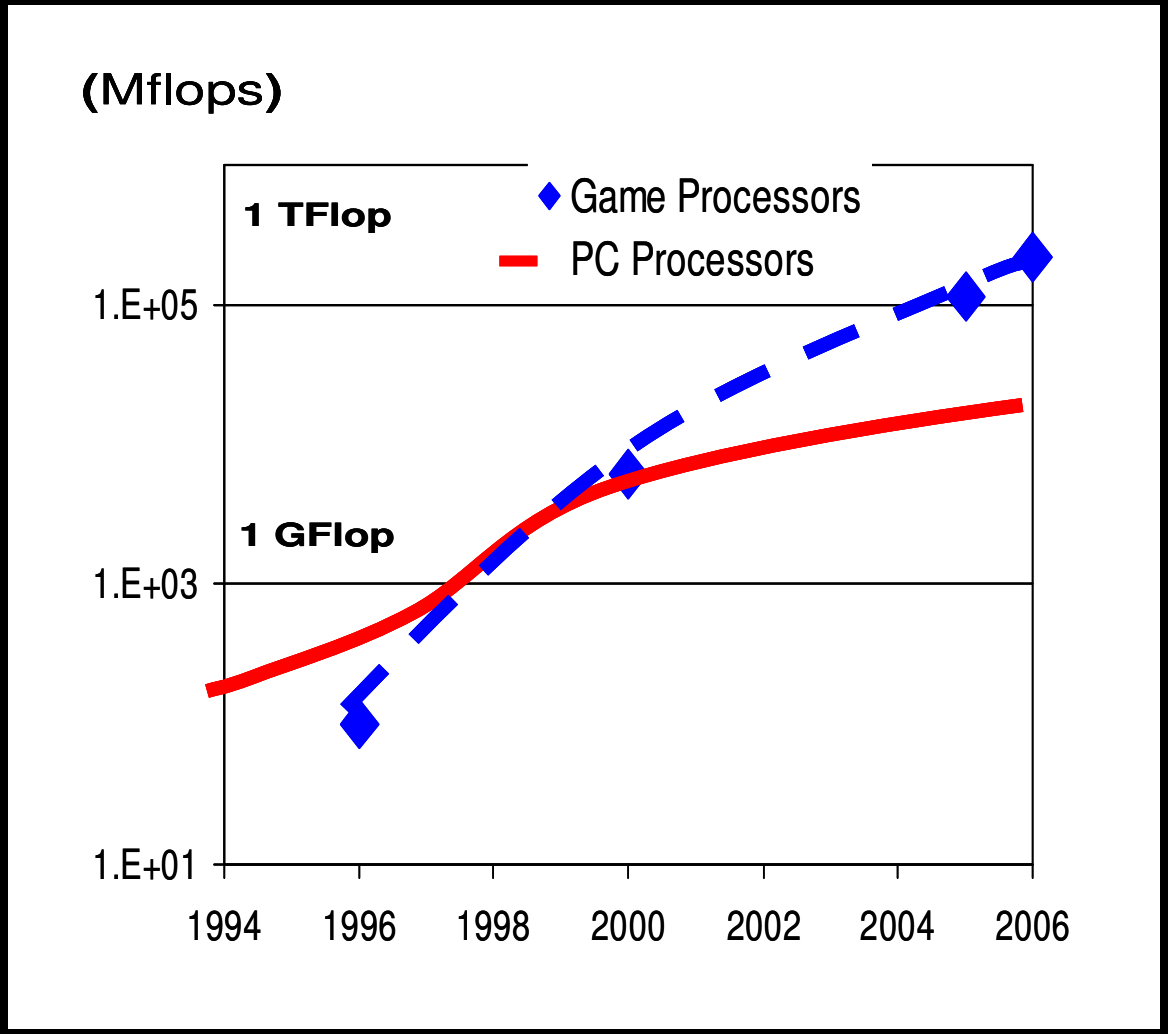
A Brief History of Games



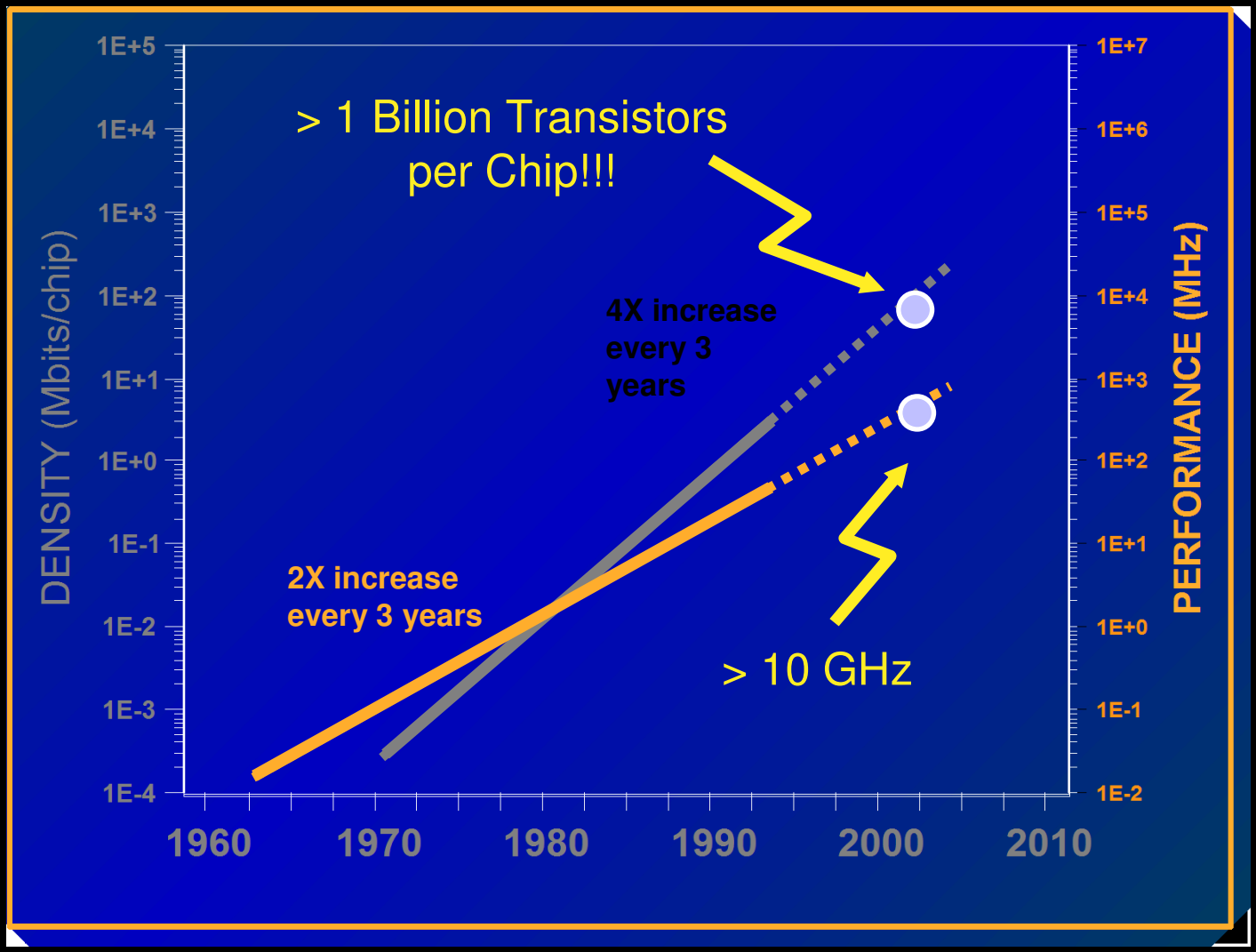
Technical Challenges of Games



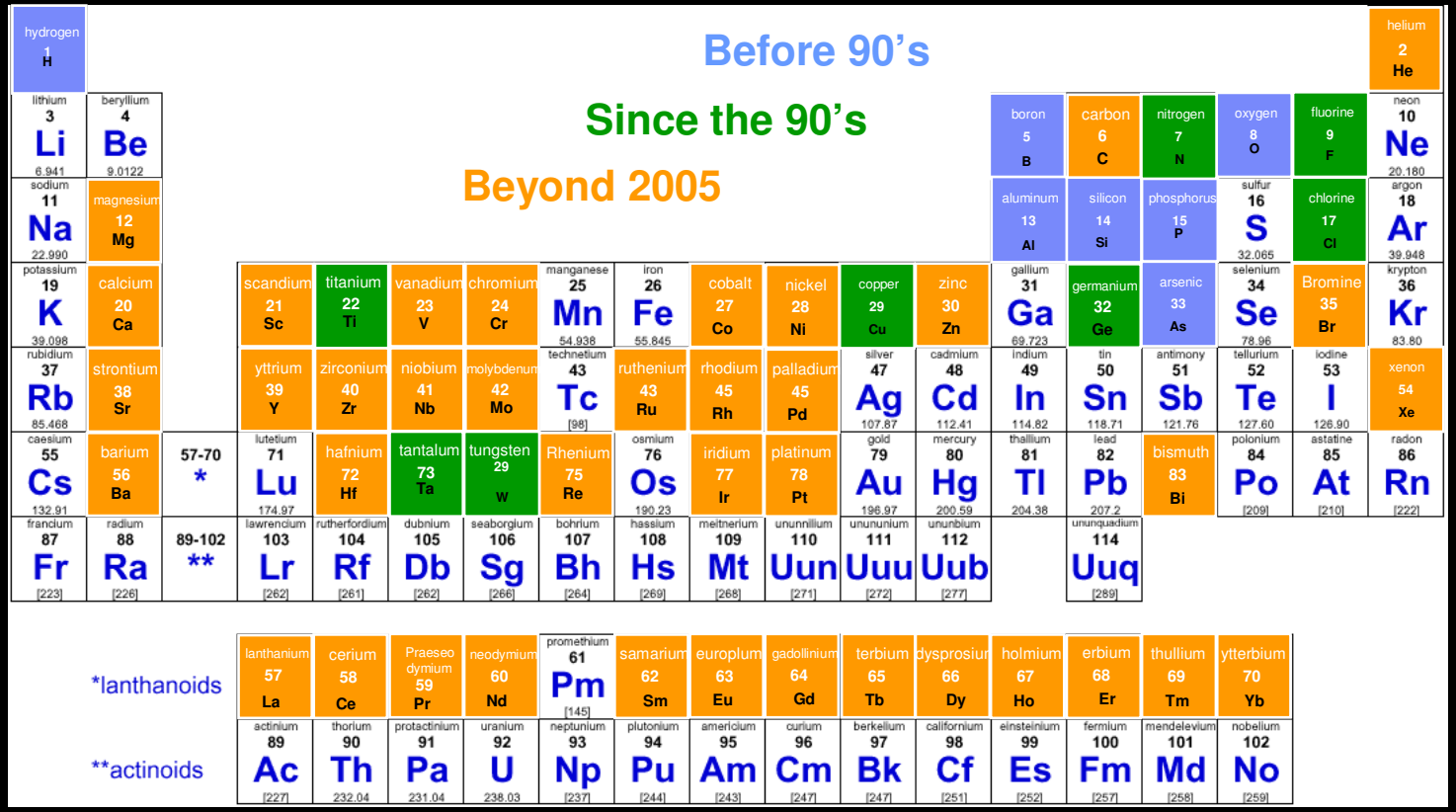
Performance is Everything !



Performance - Moore's Law of Semiconductors



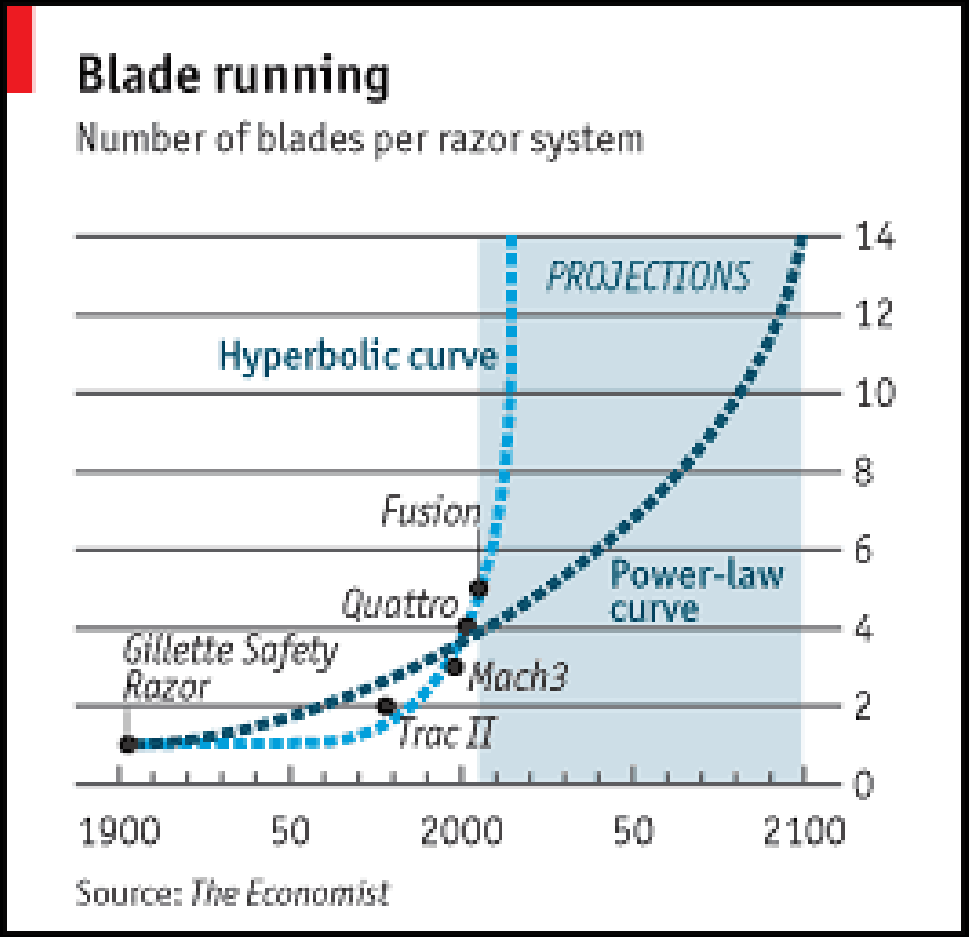
Materials Innovations to Keep Up



To Put That In Perspective …

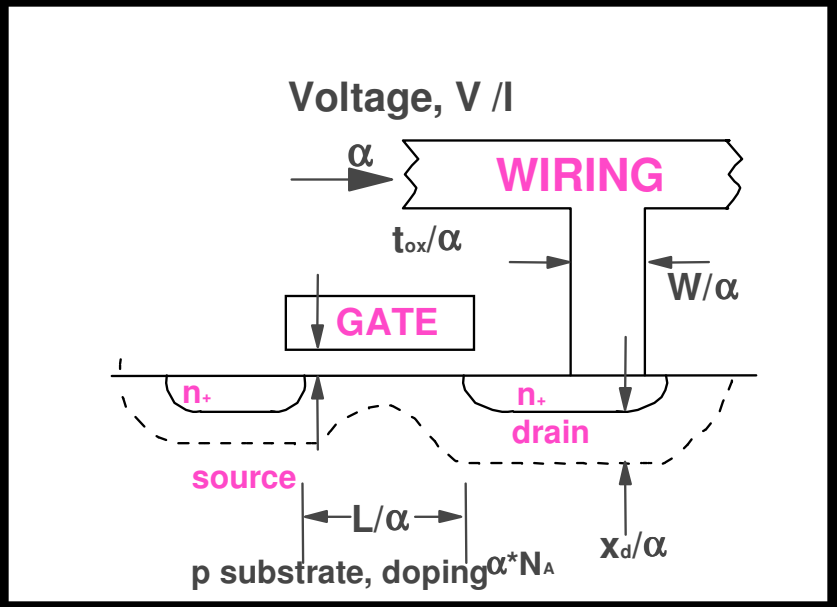
- **If cars had advanced at that rate:**
  - A Rolls Royce would cost $0.18
  - It would go 176,000 MPH
  - Get 64,000 MPG
- **If planes had advanced at that rate**
  - It would take 5.5 seconds to fly from L.A. to NYC
  - … and would reboot randomly and fall out of the sky

But …. Can It Go On Forever ?



Scaling - The Way it Was

- **The smaller you get**
  - If lithography dimensions, gate thickness and supply voltage go down by a factor of ~1.4 every 2 years
- **The faster you go**
  - Your chip will run 1.4 X faster
  - Be ~ ½ the size
  - And burn roughly half the power



SCALING:

Voltage:	V/α
Oxide:	t_{ox}/α
Wire width:	W/α
Gate width:	L/α
Diffusion:	x_d/α
Substrate:	$\alpha * N_A$

RESULTS:

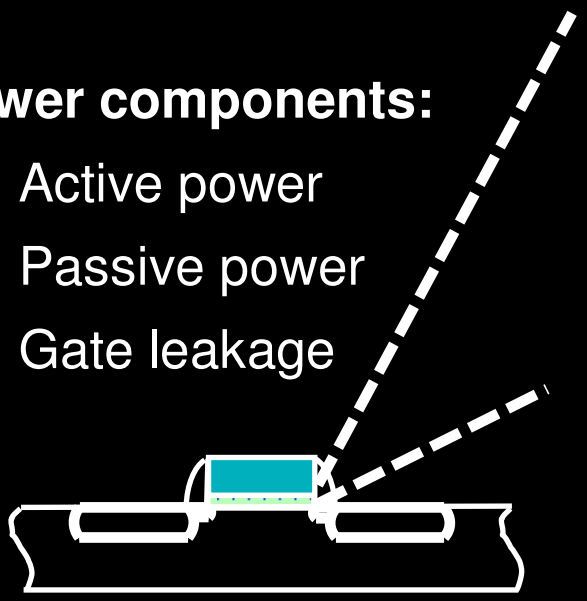
Higher Density:	$\sim a^2$
Higher Speed:	$\sim a$
Power/ckt:	$\sim 1/a^2$

Power Density:~Constant

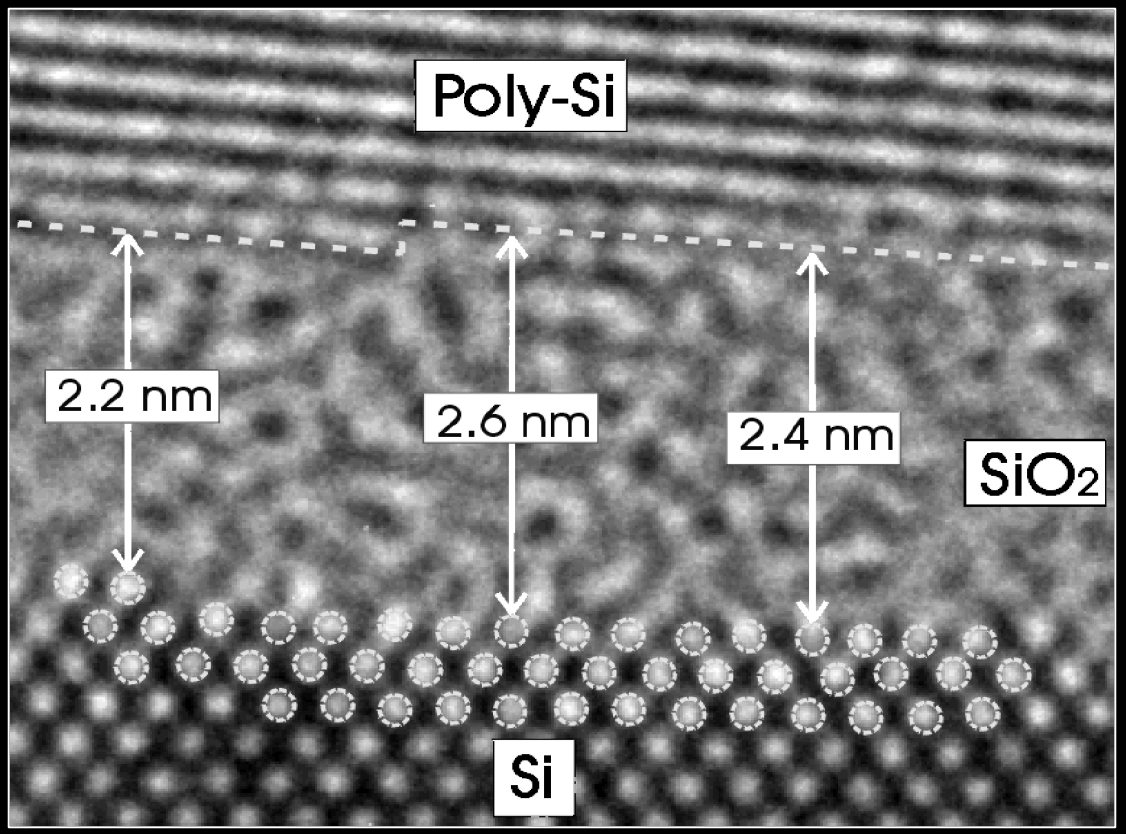
Power – The Emerging Discontinuity

- **Passive power continues to explode**

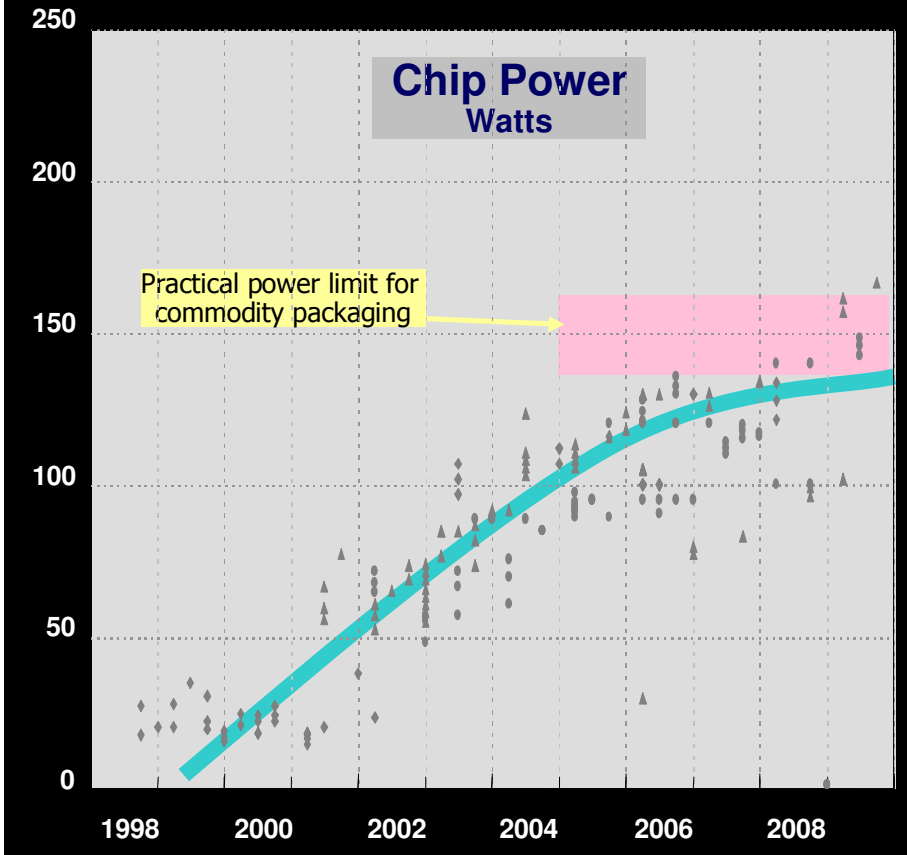
- **Power components:**
  - Active power
  - Passive power
  - Gate leakage

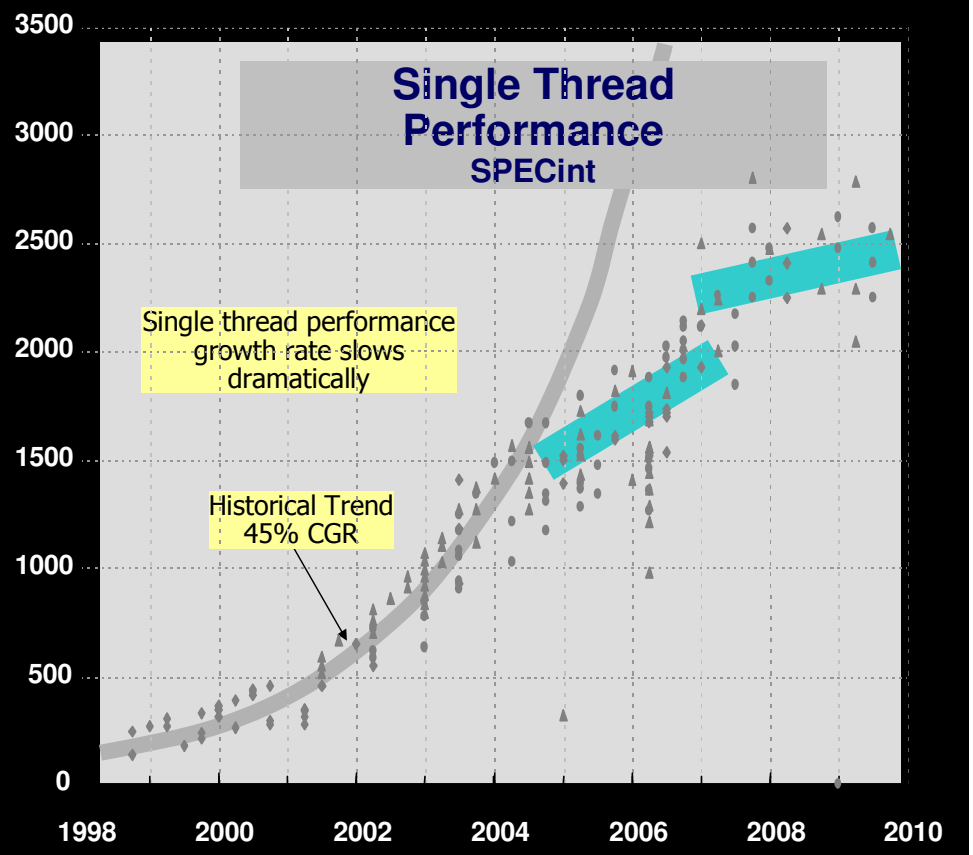


silicon bulk field effect transistor (FET)



Power Impacts Performance





Further Impacts of Power

- **Power is a major concern as it drives heat, reliability, fan noise**
- **So we design cores for power constrained performance**

10W * 100M * ¼ = 250MW ½ nuclear reactor

Assume you could save 10W per chip

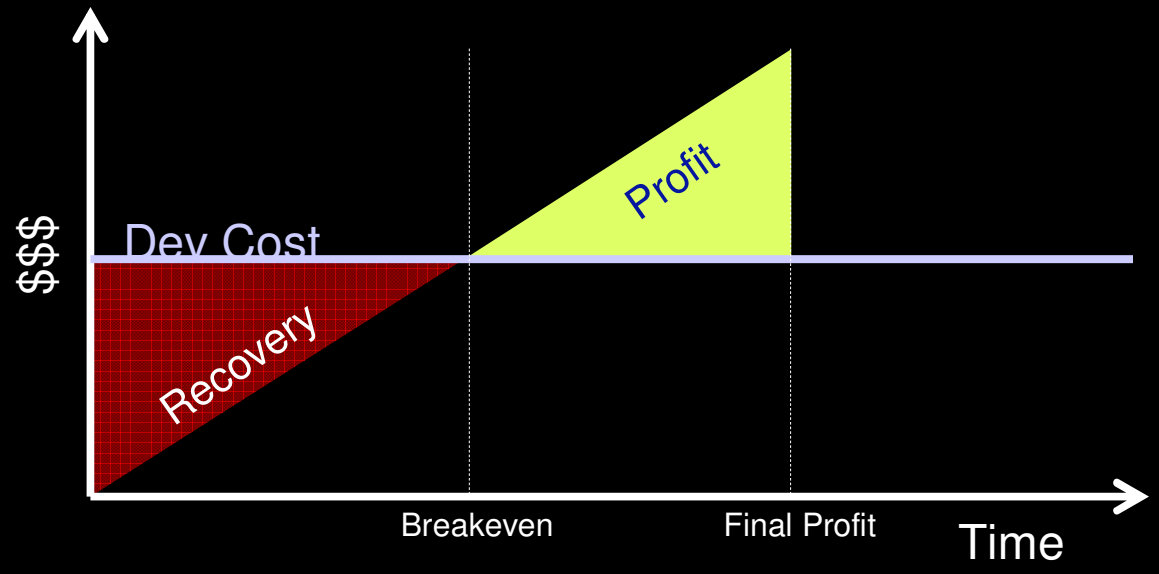
# of consoles projected

Assume 25% of units are powered on at any one time

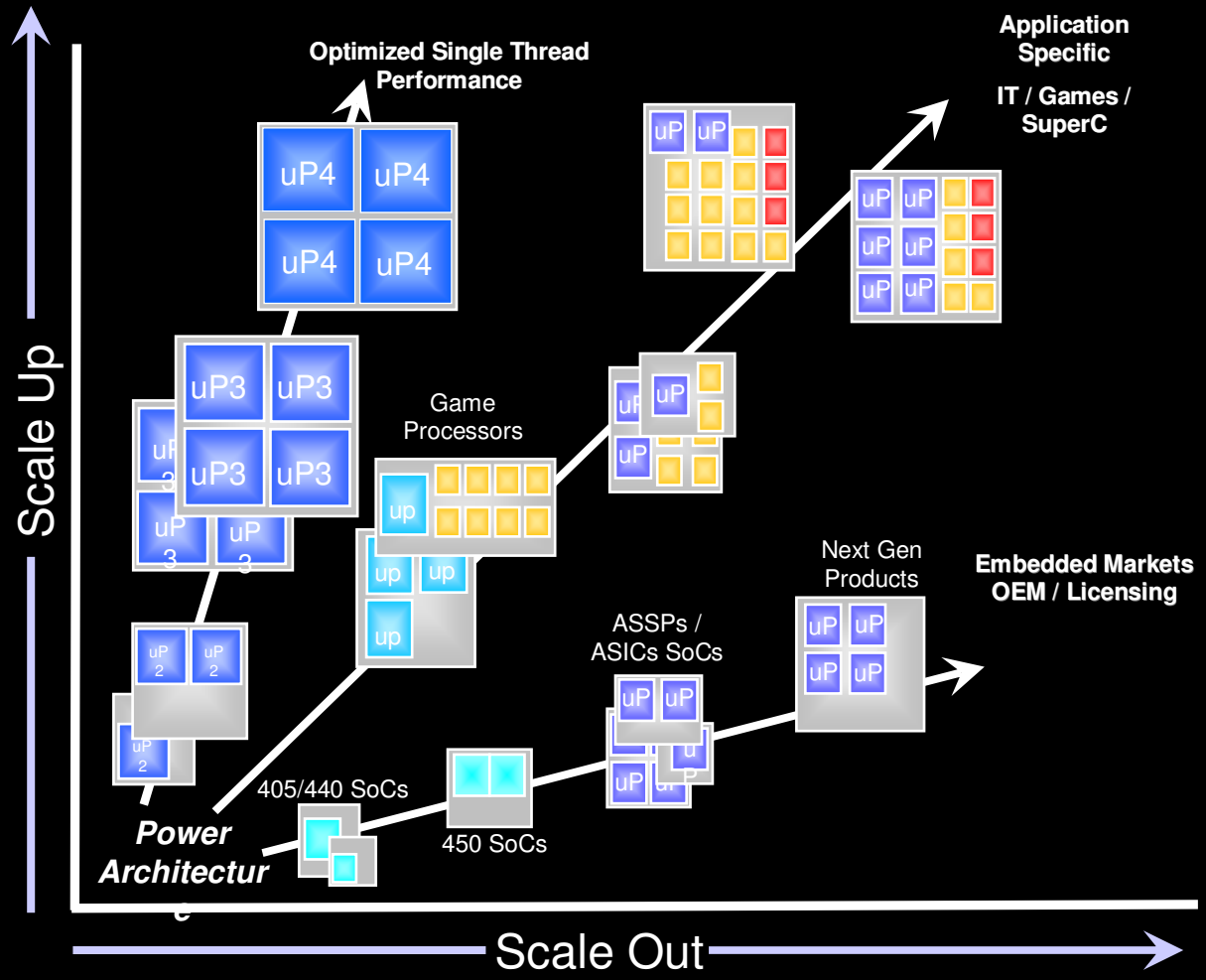
Vermont Yankee Nuclear Power Plant 535MW

Why Is Cost So Important?

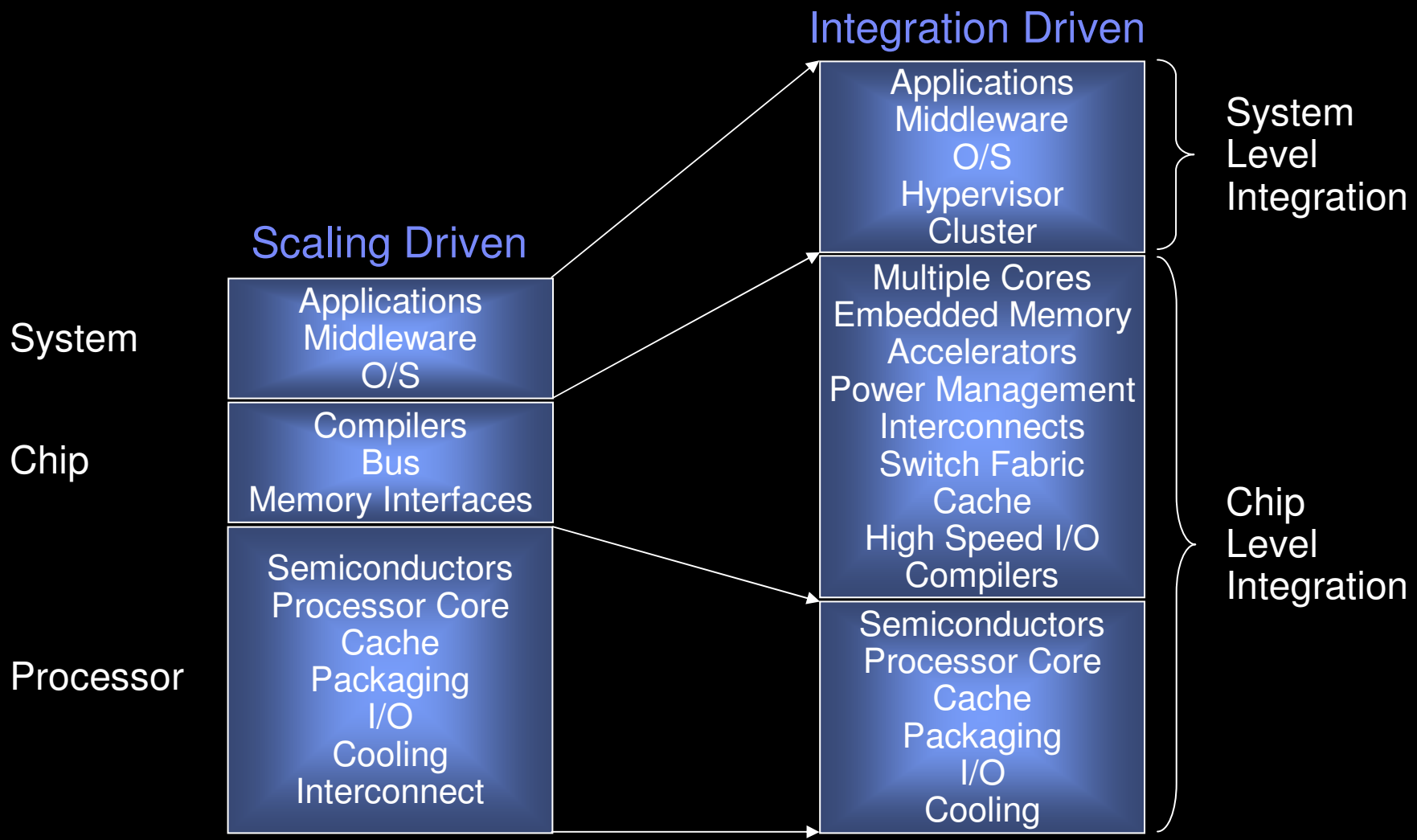
- **Chip development costs are significant**
  - e.g. Building Cell took $400M (STI), 5 years and 450 people
  - Development costs must be recovered by software sales
  - Drives longer product lifecycle ⌘ 5 years



How Do We Beat Scaling ?

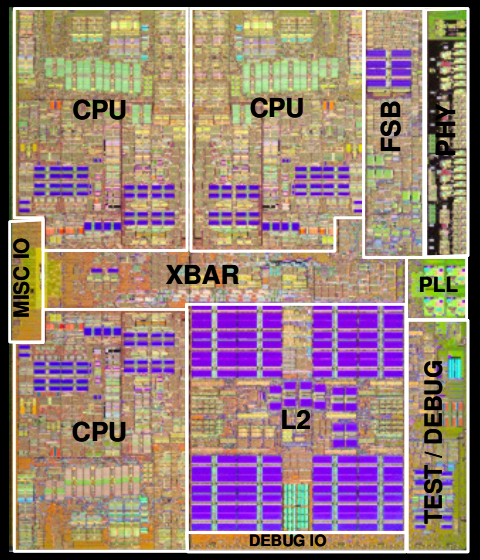


System Design



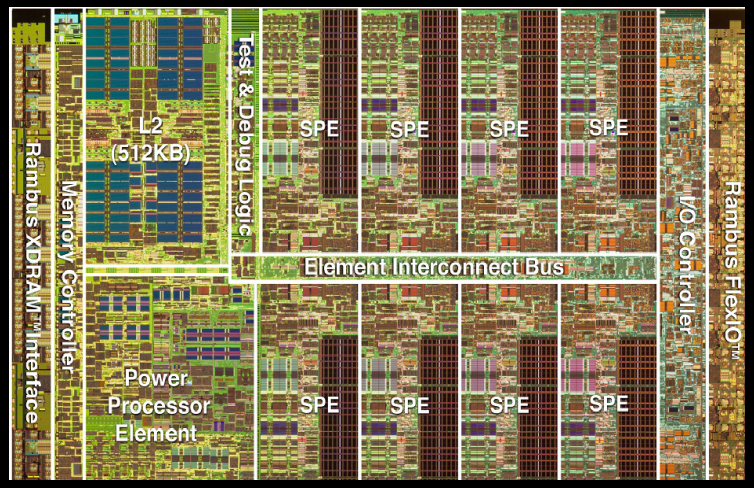
E.g.: Microsoft Xbox 360

- **3-Way Symmetric Multi-Processor**
  - IBM PowerPC Architecture®
  - Specialized Function VMX
  - 3.2GHz
  - Multithreading
- **Firsts:**
  - First 3-way SMP in volume production
  - Silicon tape-out to > 1 million parts in less than one year
  - Highest frequency IBM Power Architecture™ core shipped at the time



E.g.: Cell Processor

- **250M transistors … 235mm2**
- **Top frequency >4GHz in lab**
- **> 200 GFlops (SP) @3.2GHz**
- **> 20 GFlops (DP) @3.2GHz**
- **Up to 25.6 GB/s memory B/W**
- **Up to 70+ GB/s I/O B/W**
  - Practical ~ 50GB/s
- **100+ simultaneous bus transactions**
  - 16+8 entry DMA queue per SPE

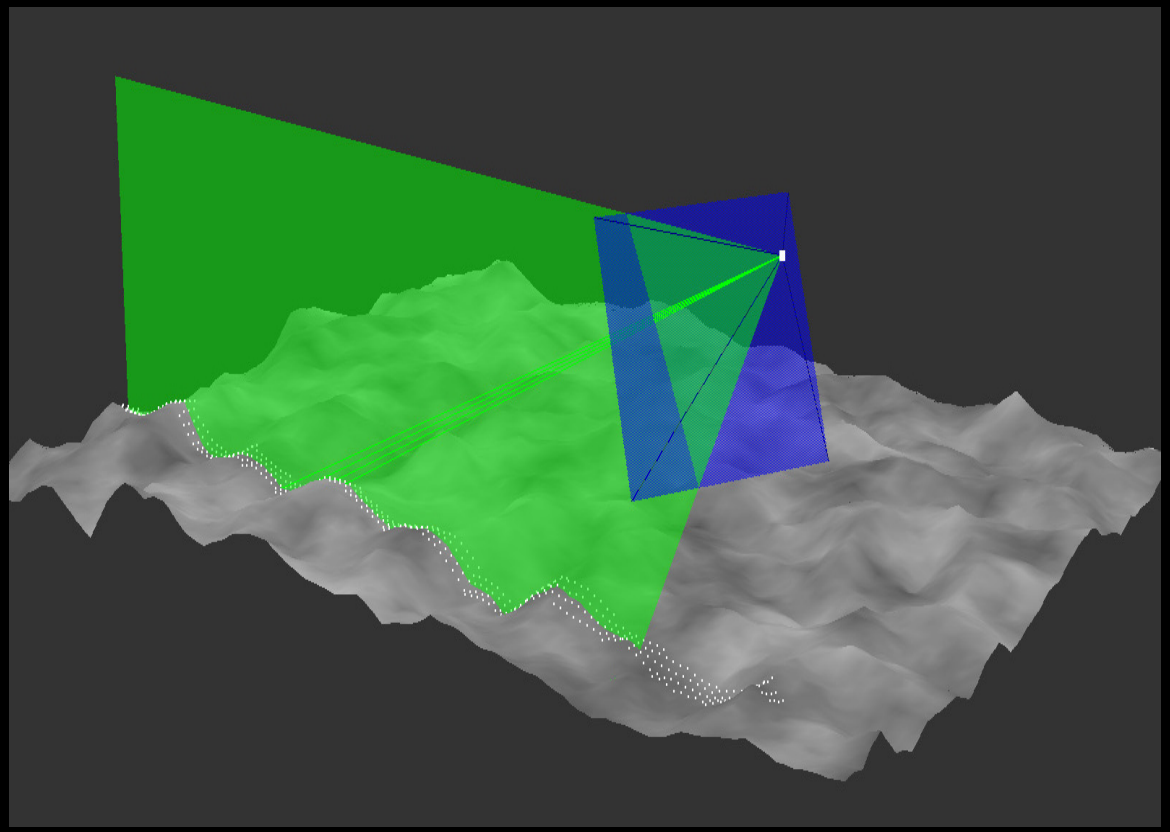


What Does Multi-Core Really Buy You?

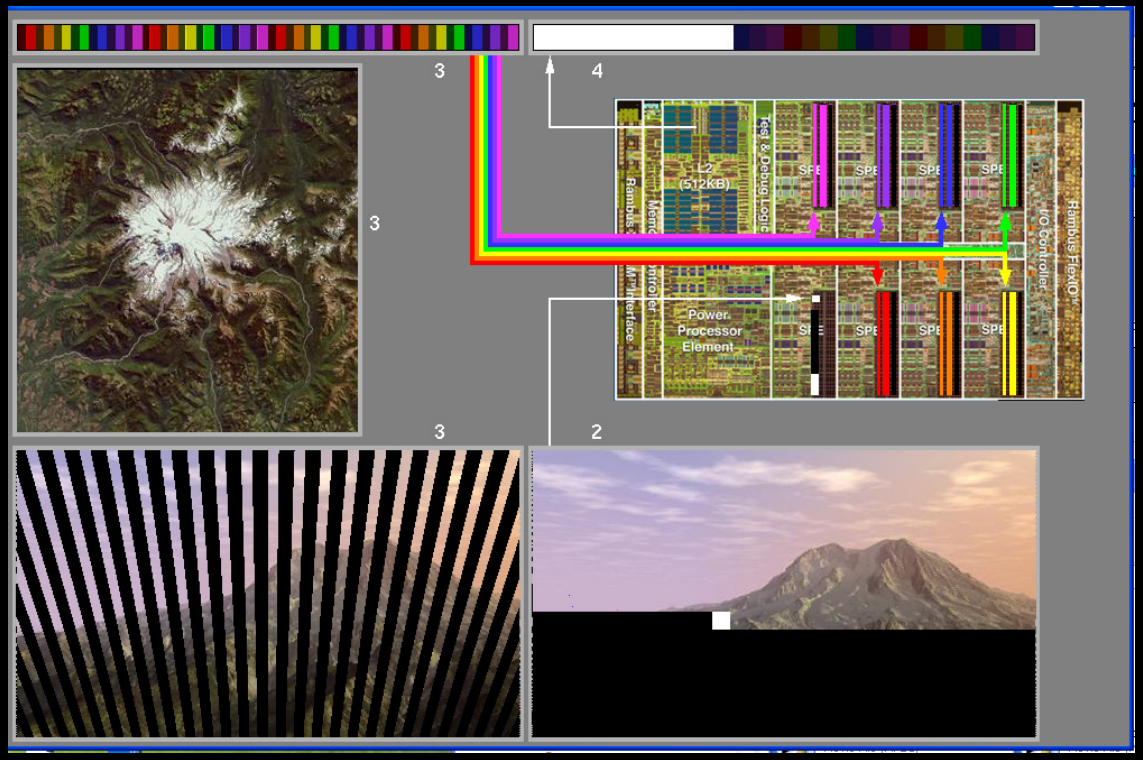
Terragen
Intel Pentium

Terrain Rendering Engine
STI Cell

Ray Casting

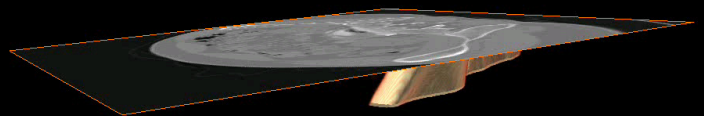


Cell B.E. Chip

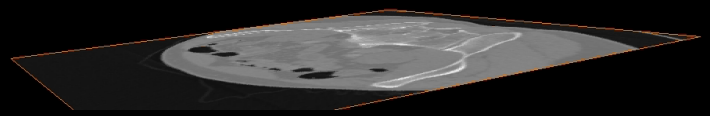


Building New Businesses from Game Processors

3D Visualization via Volumetric Rendering for Medical Images



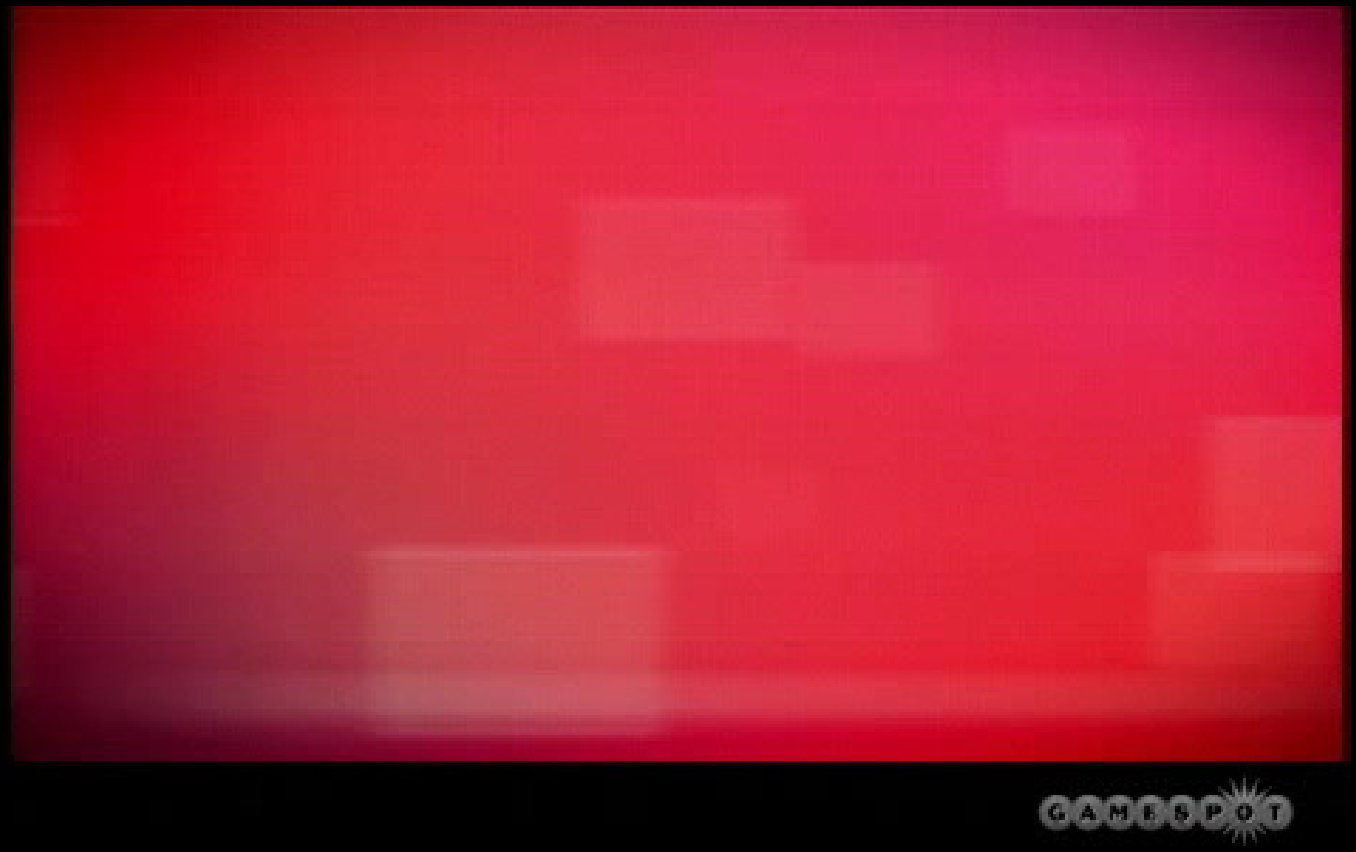
PC Solution
~6 minutes to render entire volume
~2 seconds per slice



Cell Solution
~2 seconds to render entire volume

Courtesy of Mercury Computer Systems
http://www.mc.com/cell/media/medium.cfm

It’s Just Ducky



Summary

- **IBM has locked down the games industry**
  - We're working hard to keep it
- **Innovations are aimed at managing performance, cost, power**
  - Multi-core, cost efficient, low power designs
- **Leveraging investment in game λP to create new opportunities**
- **So What?**
  - IBM Innovation made these chips possible
  - Spread the word – Video games are cool and so are we!
  - What could you use a small, fast supercomputer for?