Cell Broadband Engine™

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IBMers Value

Dedication to every client's success.
Innovation that matters—for our company and for the world.
Trust and personal responsibility in all relationships.

Collaborative Innovation: Gaming Triple Crown

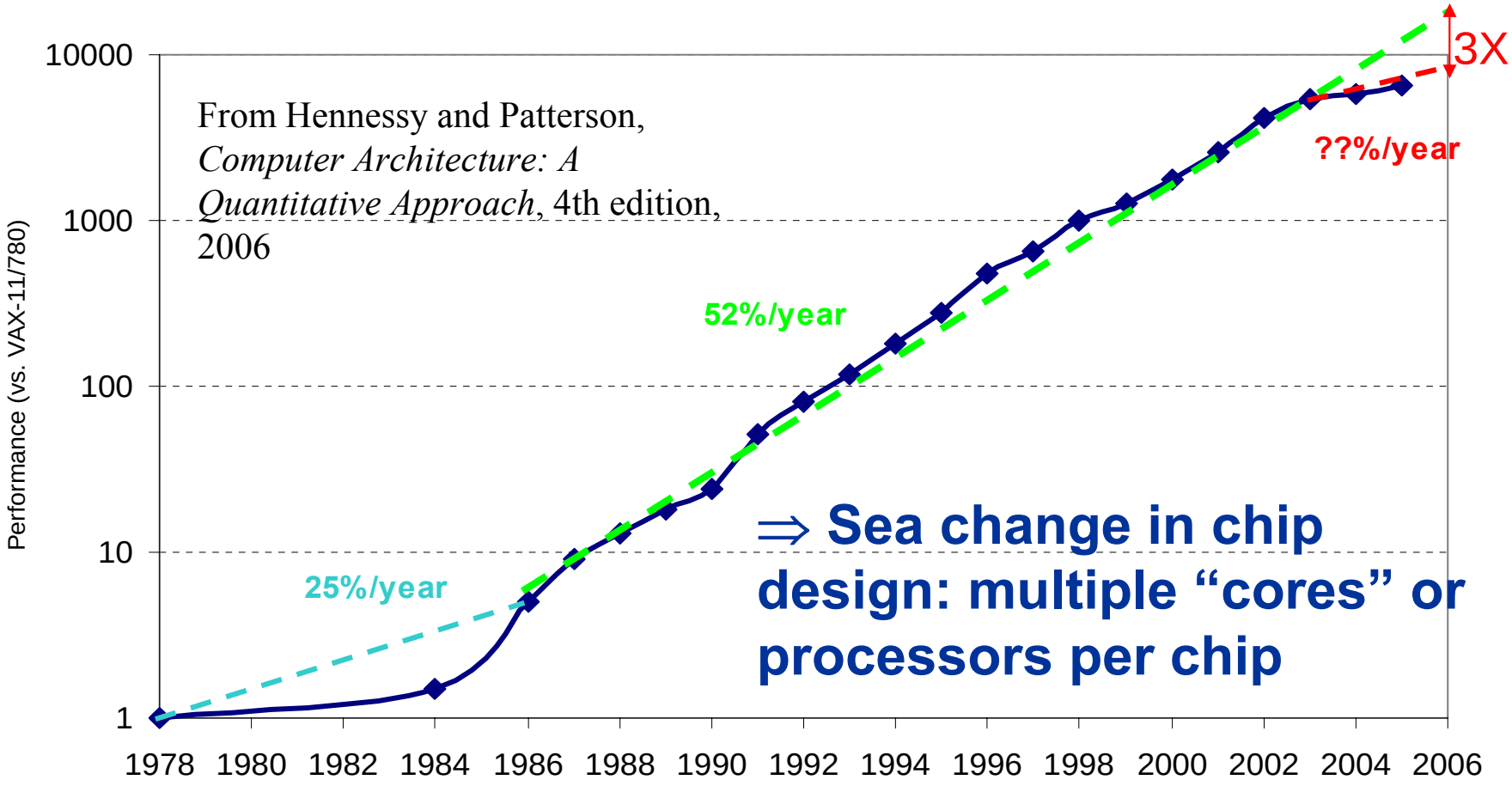
All IBM designed processors!

All Power Architecture™ based!

Motivation: Cell Goals

- Outstanding performance, especially on game/multimedia applications.
  - Challenges: Power Wall, Frequency Wall, Memory Wall
- Real time responsiveness to the user and the network.
  - Challenges: Real-time in an SMP environment, Security
- Applicable to a wide range of platforms.
  - Challenge: Maintain programmability while increasing performance
- Support introduction in 2006.
  - Challenge: Structure innovation such that 5yr. schedule can be met

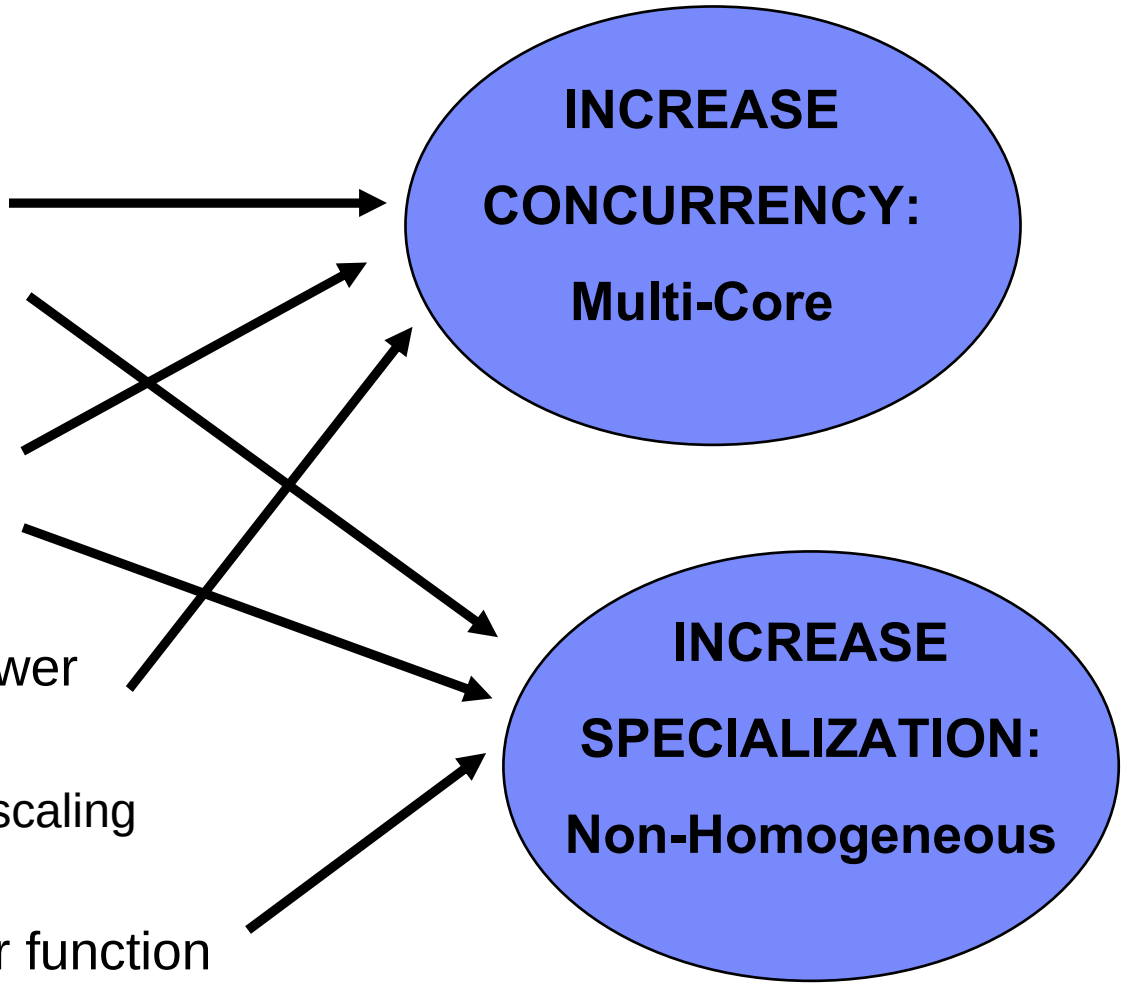
SPECINT



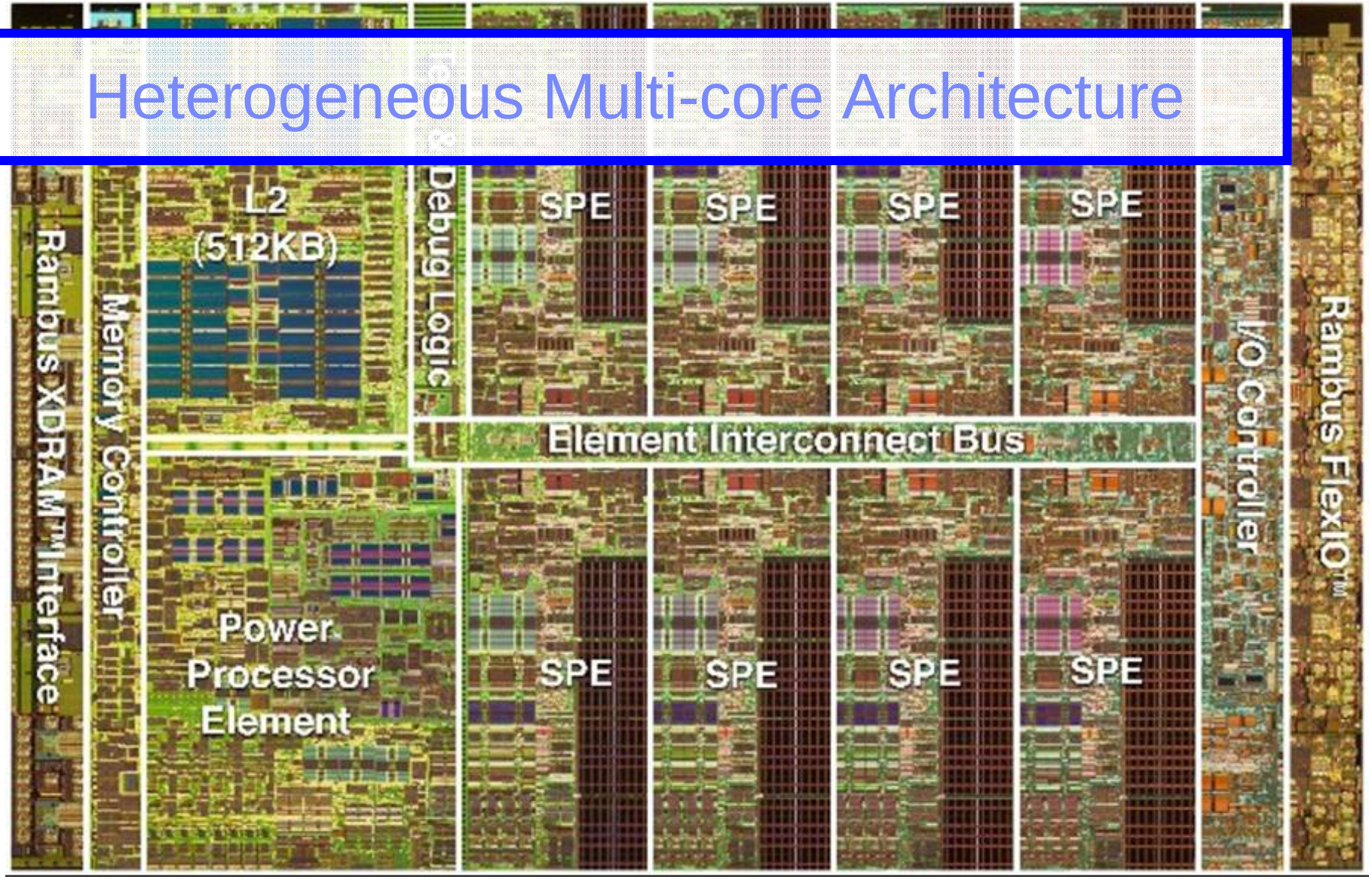
- **VAX : 25%/year 1978 to 1986**
- **RISC + x86: 52%/year 1986 to 2002**
- **RISC + x86: ??%/year 2002 to present**

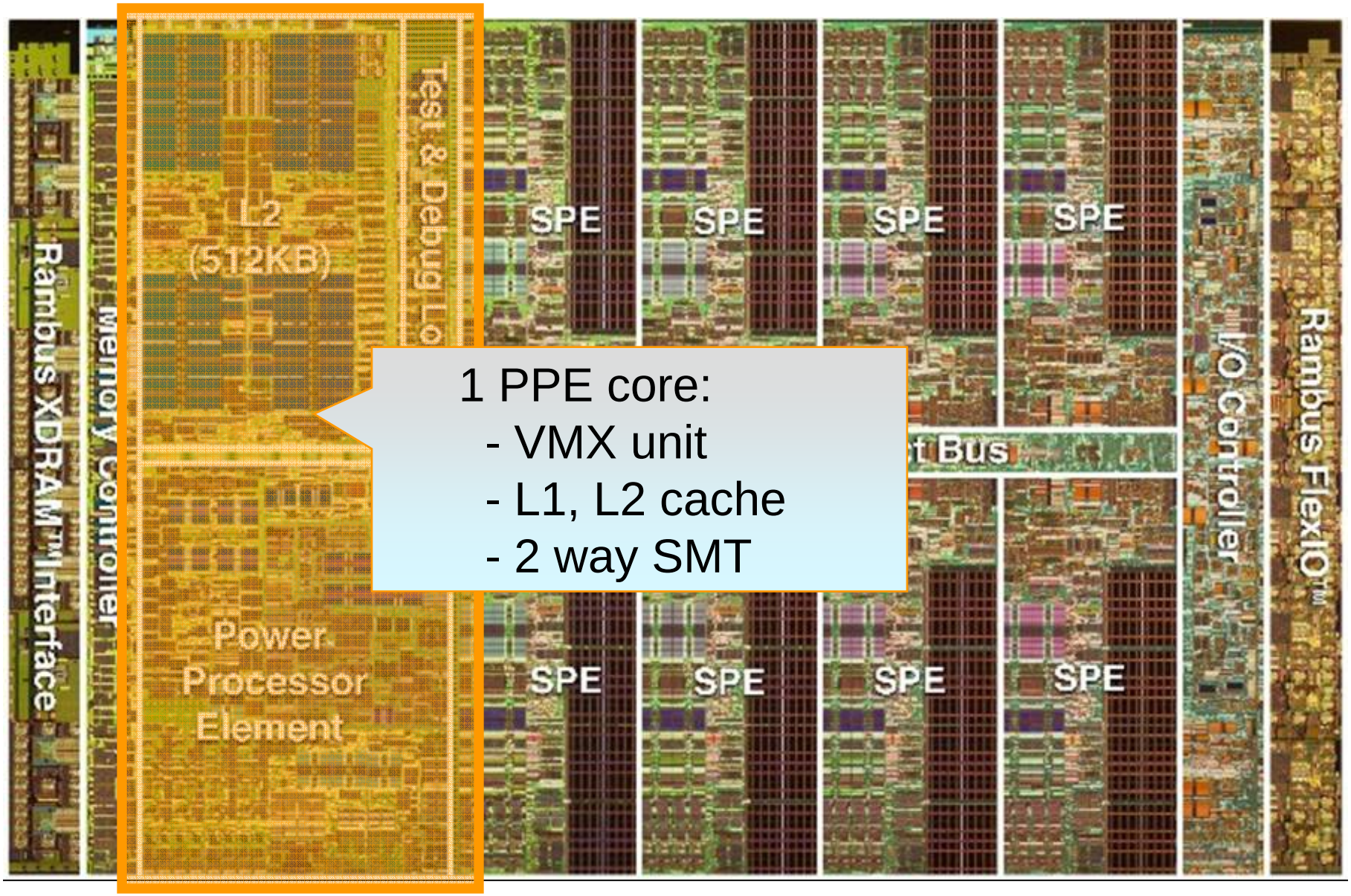
Solutions

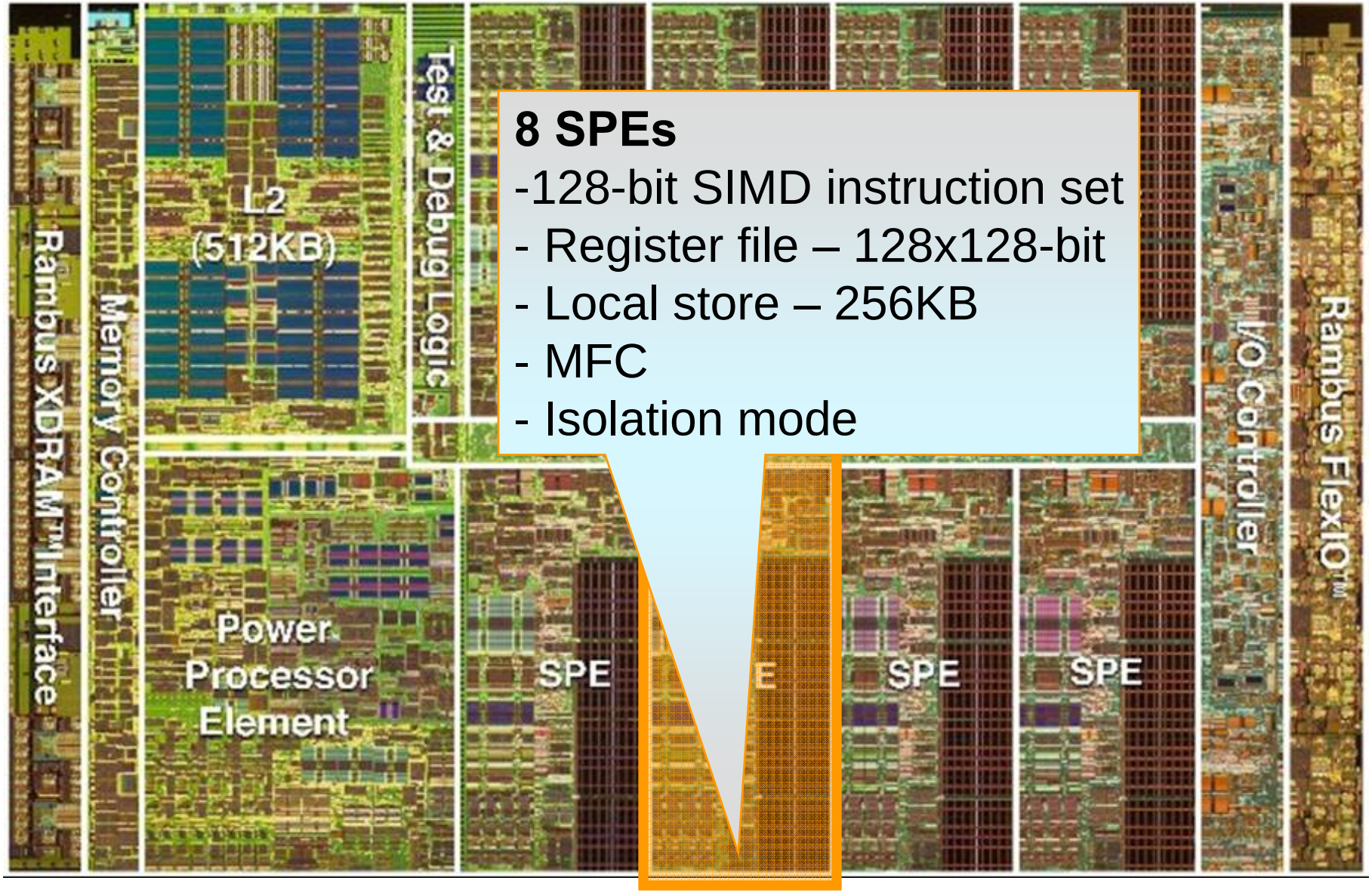
- Memory wall:
  - More slower threads
  - Asynchronous loads
- Efficiency wall:
  - More slower threads
  - Specialized function
- Power wall:
  - Reduce transistor power
    - operating voltage
    - limit oxide thickness scaling
    - limit channel length
  - Reduce switching per function



Heterogeneous Multi-core Architecture



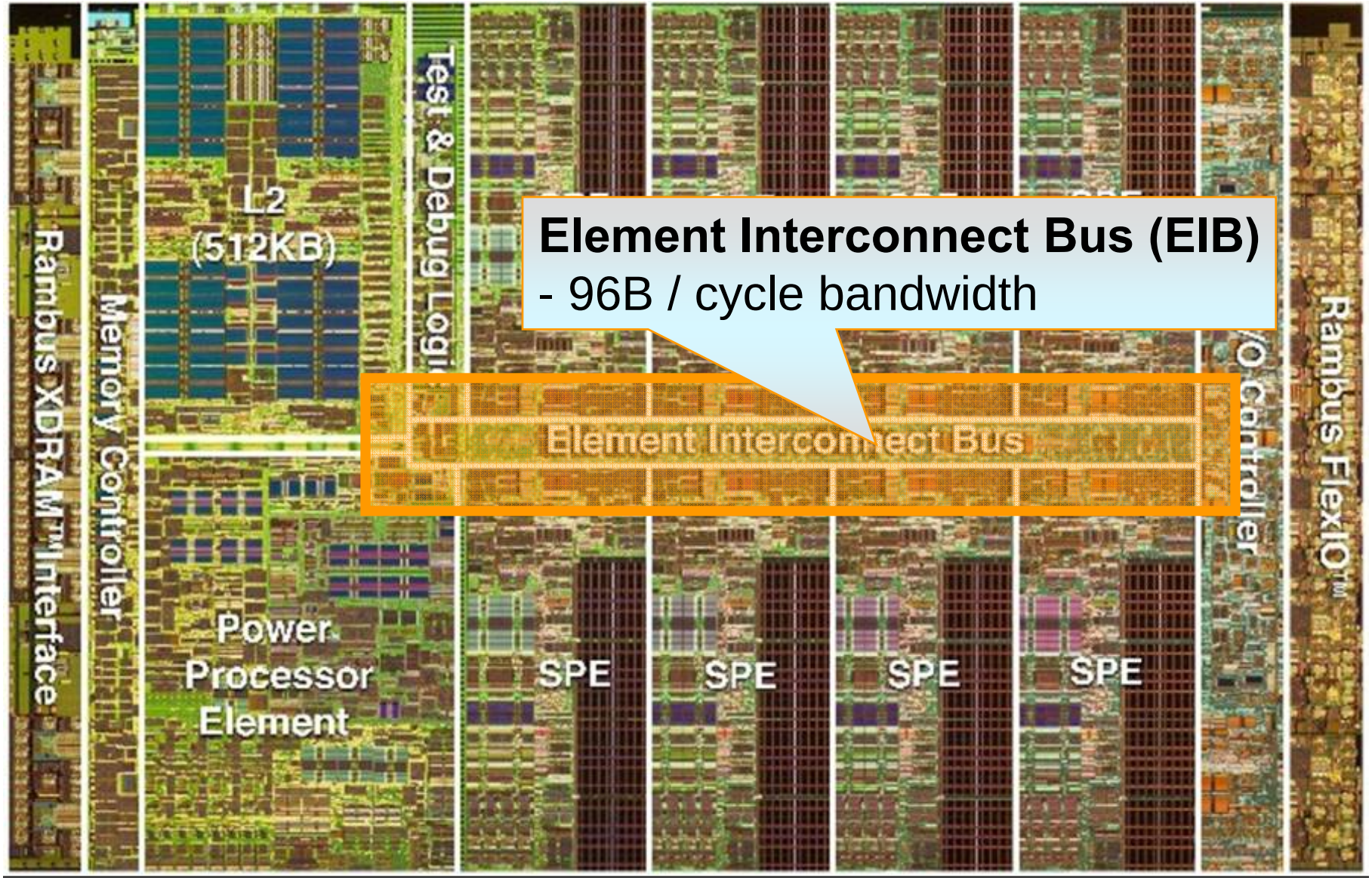


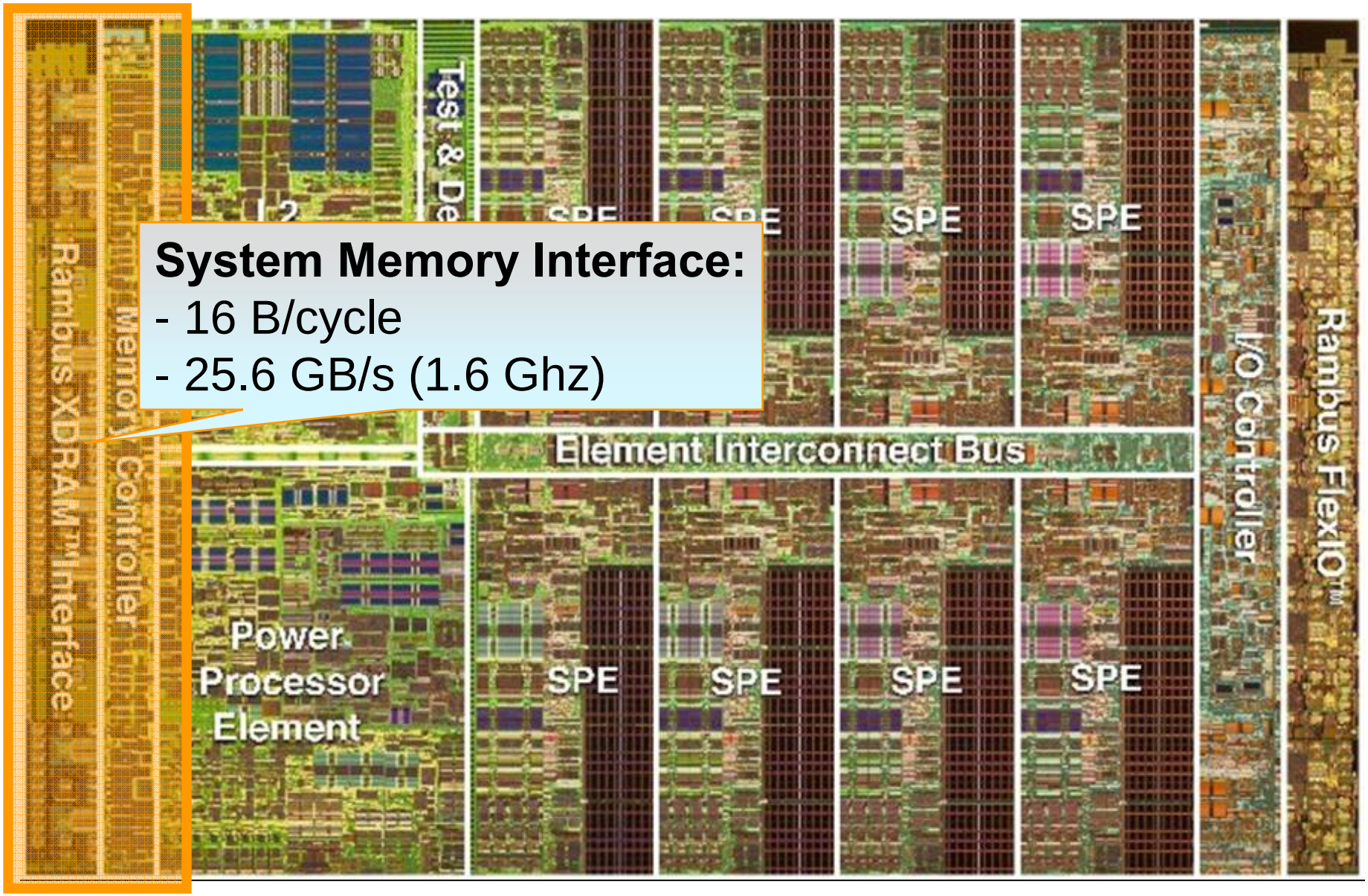


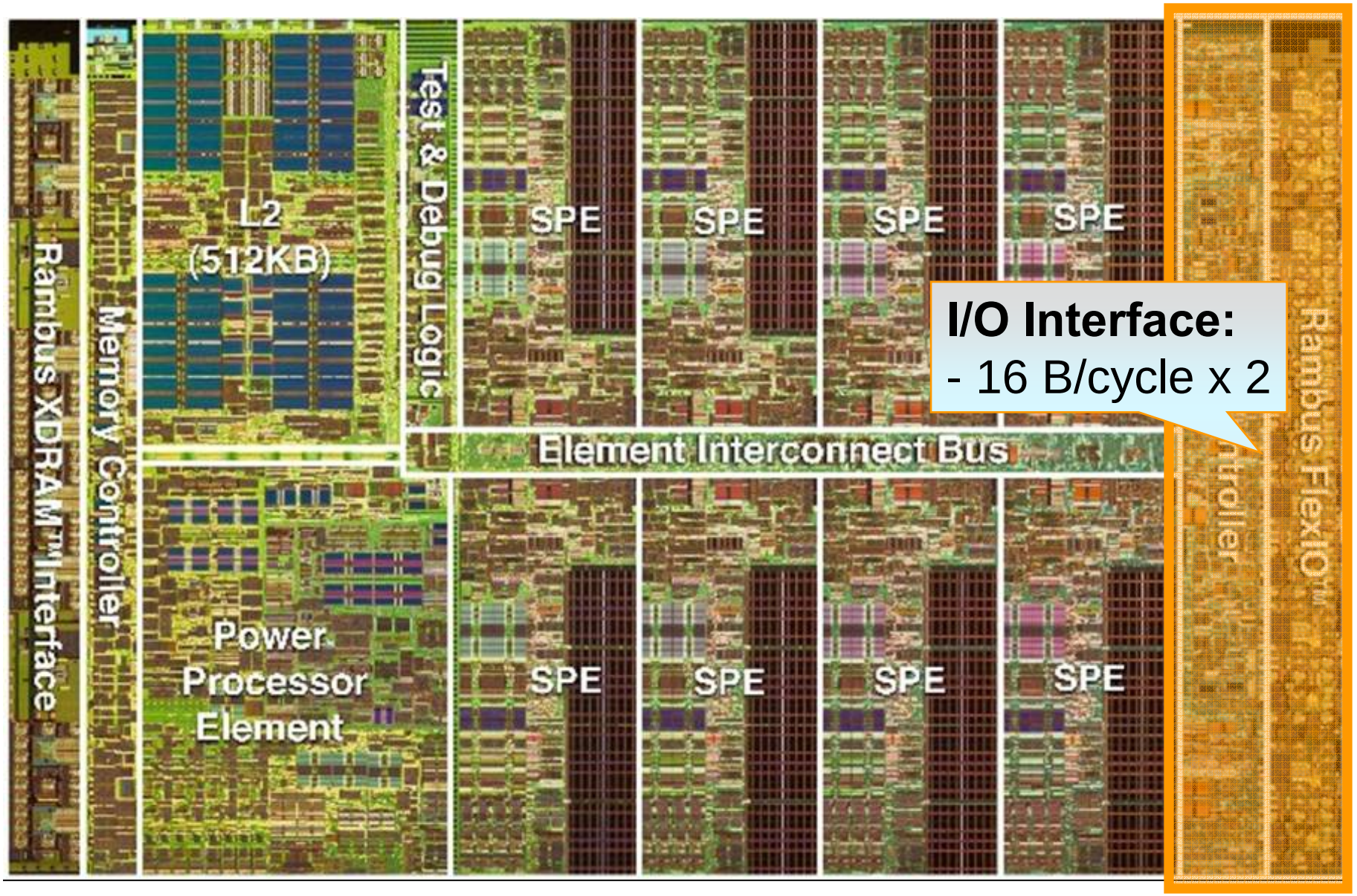
8 SPEs

-128-bit SIMD instruction set

- Register file – 128x128-bit
- Local store – 256KB
- MFC
- Isolation mode







Reed Electronics Group

MICROPROCESSOR REPORT

www.MPRonline.com

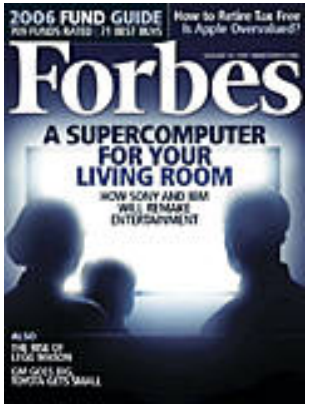
THE INSIDER'S GUIDE TO MICROPROCESSOR HARDWARE

MICROPROCESSOR REPORT ANALYSTS' CHOICE
Best High-Performance Embedded Processor
STI Cell BE

Cell Processor Isn't Just for Games.

Innovative Chip is best high-performance embedded processor of 2005

We chose the Cell BE as the best high-performance embedded processor of 2005 because of its innovative design and future potential....Even if the Cell BE accumulates no more design wins, the PlayStation 3 could drive sales to nearly 100 million units over the likely five-year lifespan of the console. That would make the Cell BE one of the most successful microprocessors in history.



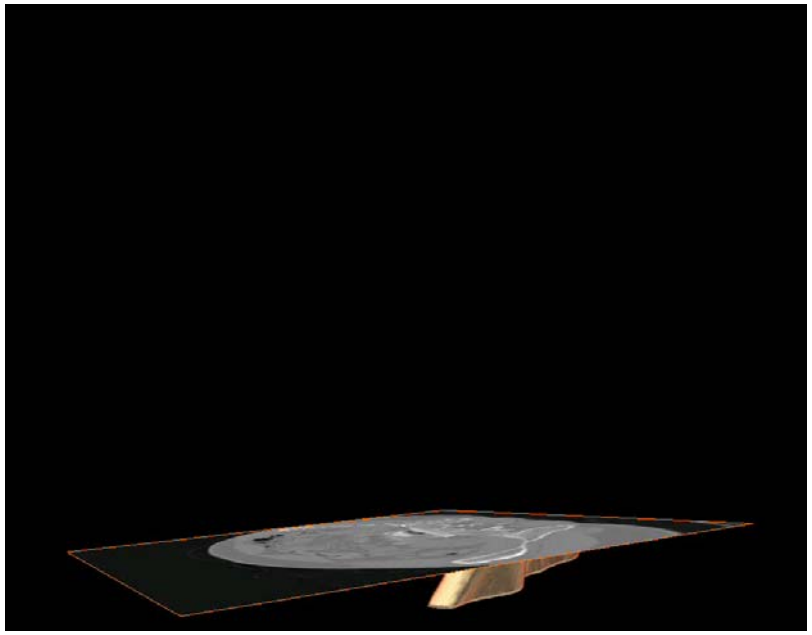
"…Cell could power hundreds of new apps, create a new video-processing industry and fuel a multibillion-dollar build out of tech hardware over ten years."
-- Forbes

"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

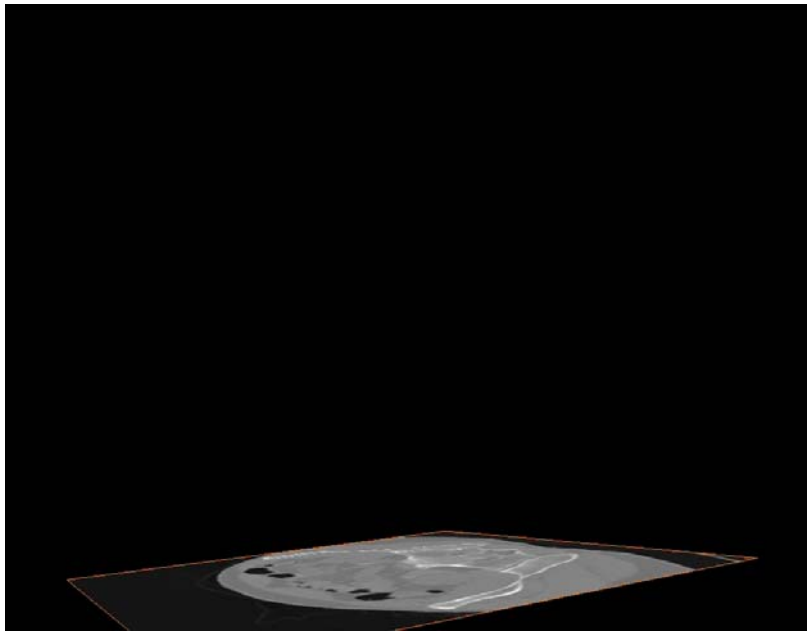
PC vs Cell

3D Visualization via Volumetric Rendering for Medical Images
Mercury Computer Systems Solution

A single scan can result to in 2,000 – 3,000 2D images, shown below is CT Reconstruction in a side by side comparison of exactly the same problem on a High End PC solution, and the Cell Solution



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



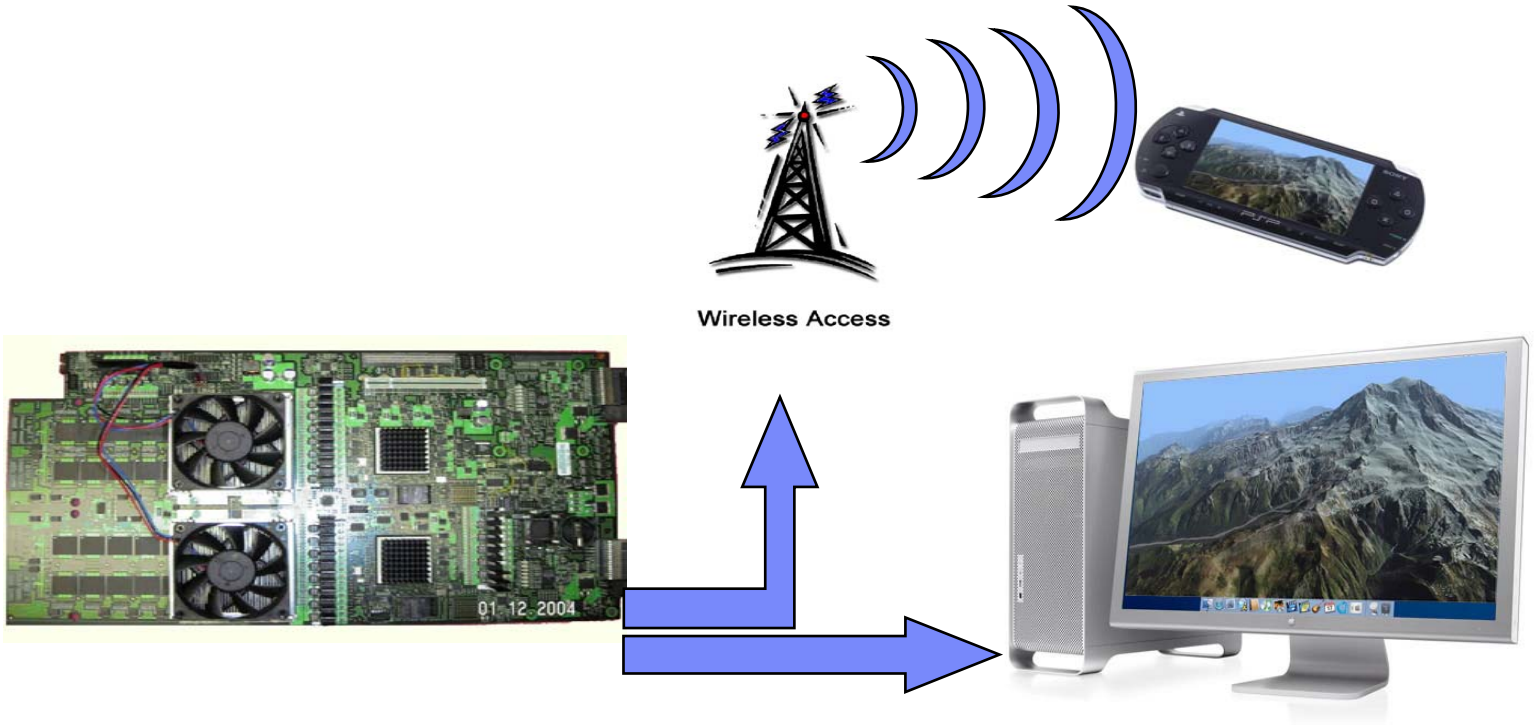
Cell Solution
~2 seconds to render entire volume

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

Example: Raytracing

- ***Texturing*** maps images onto 3-D surfaces
- ***Cube environment mapping*** reflects image data from 1 of 6 surrounding texture maps
- ***Fresnel reflection & refraction*** increase realism, complexity of texture look up
- ***Animated 3-D Julia Set Fractal*** Demo

Terrain Rendering Engine (TRE) Application Example



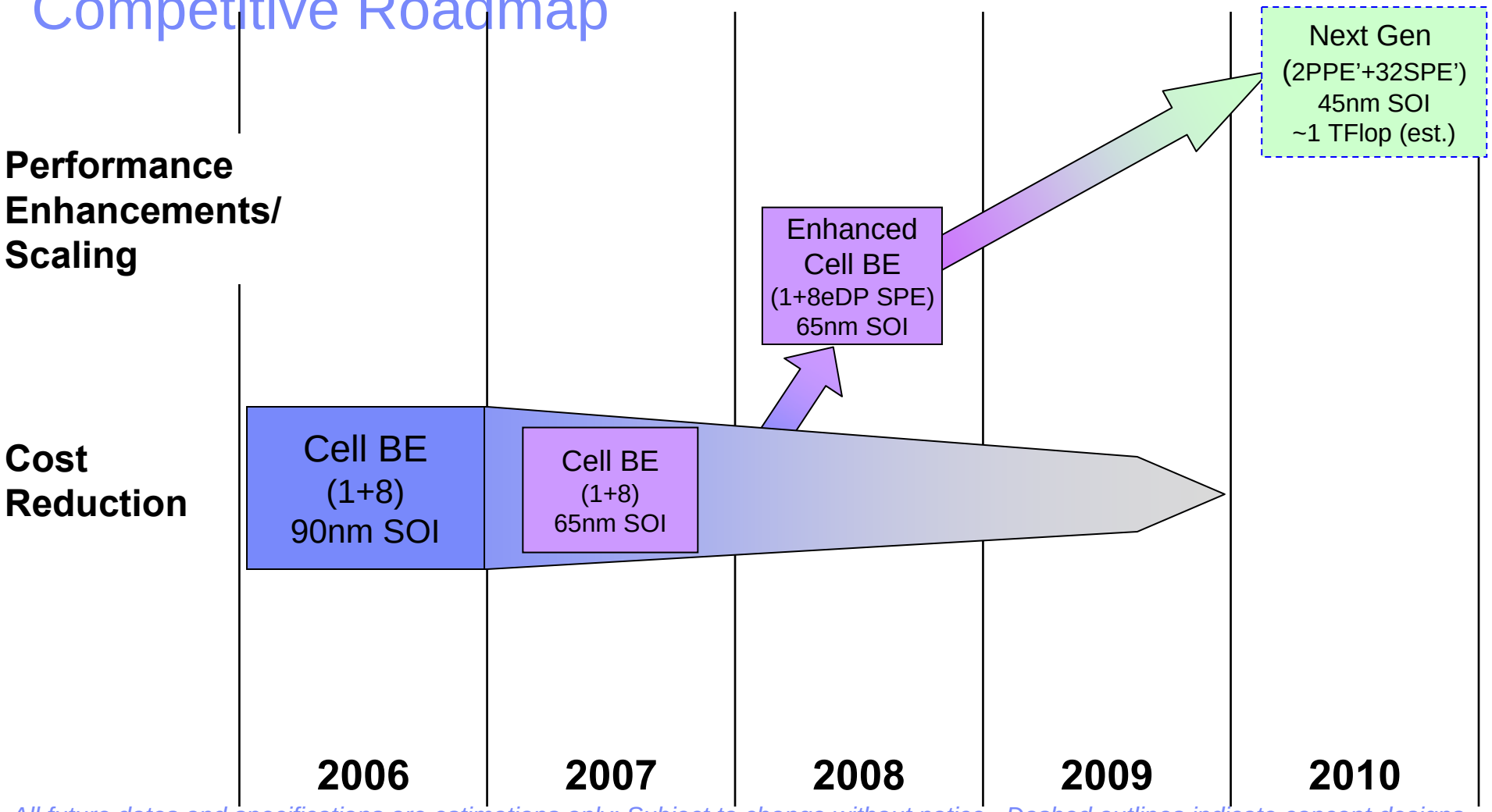
Cell Processor Based Blade System

Network

Clients

Cell BE based Systems: SCEI, Mercury, … and IBM!

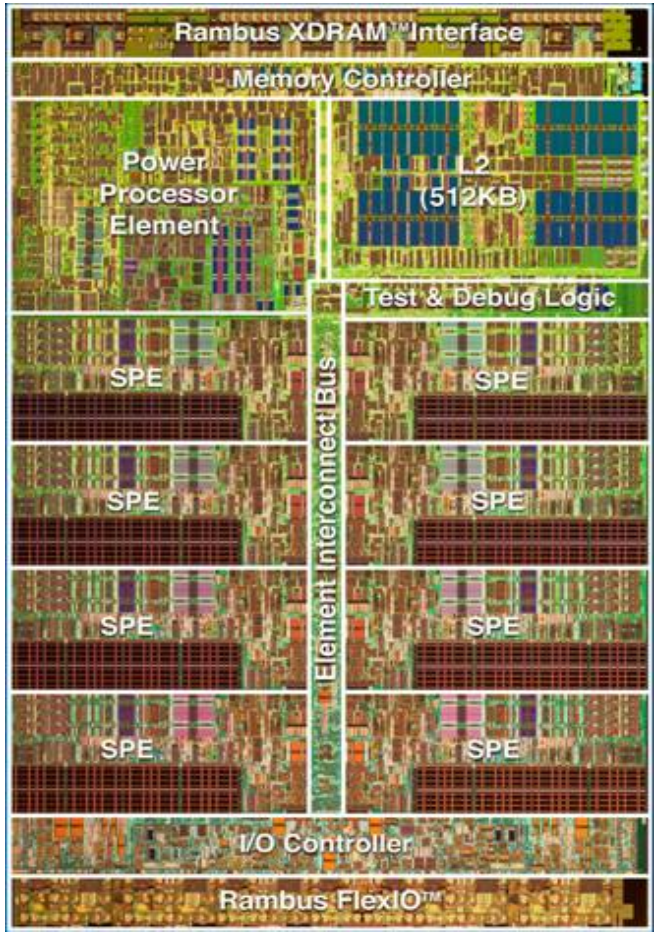
Cell Broadband Engine Architecture™ (CBEA) Technology Competitive Roadmap

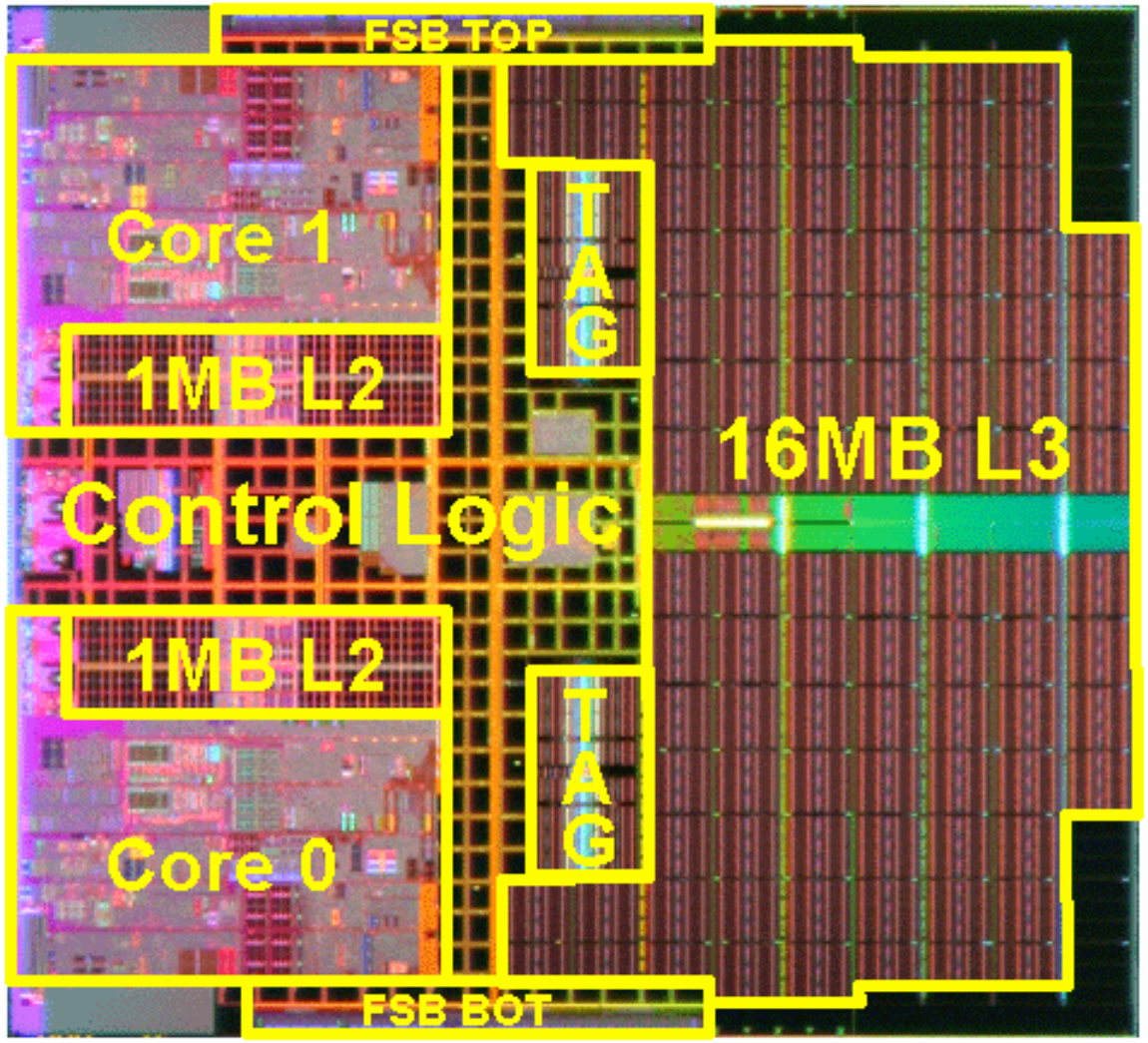


All future dates and specifications are estimations only; Subject to change without notice. Dashed outlines indicate concept designs.

Specialized Purpose Processor vs. Traditional General Purpose Processor

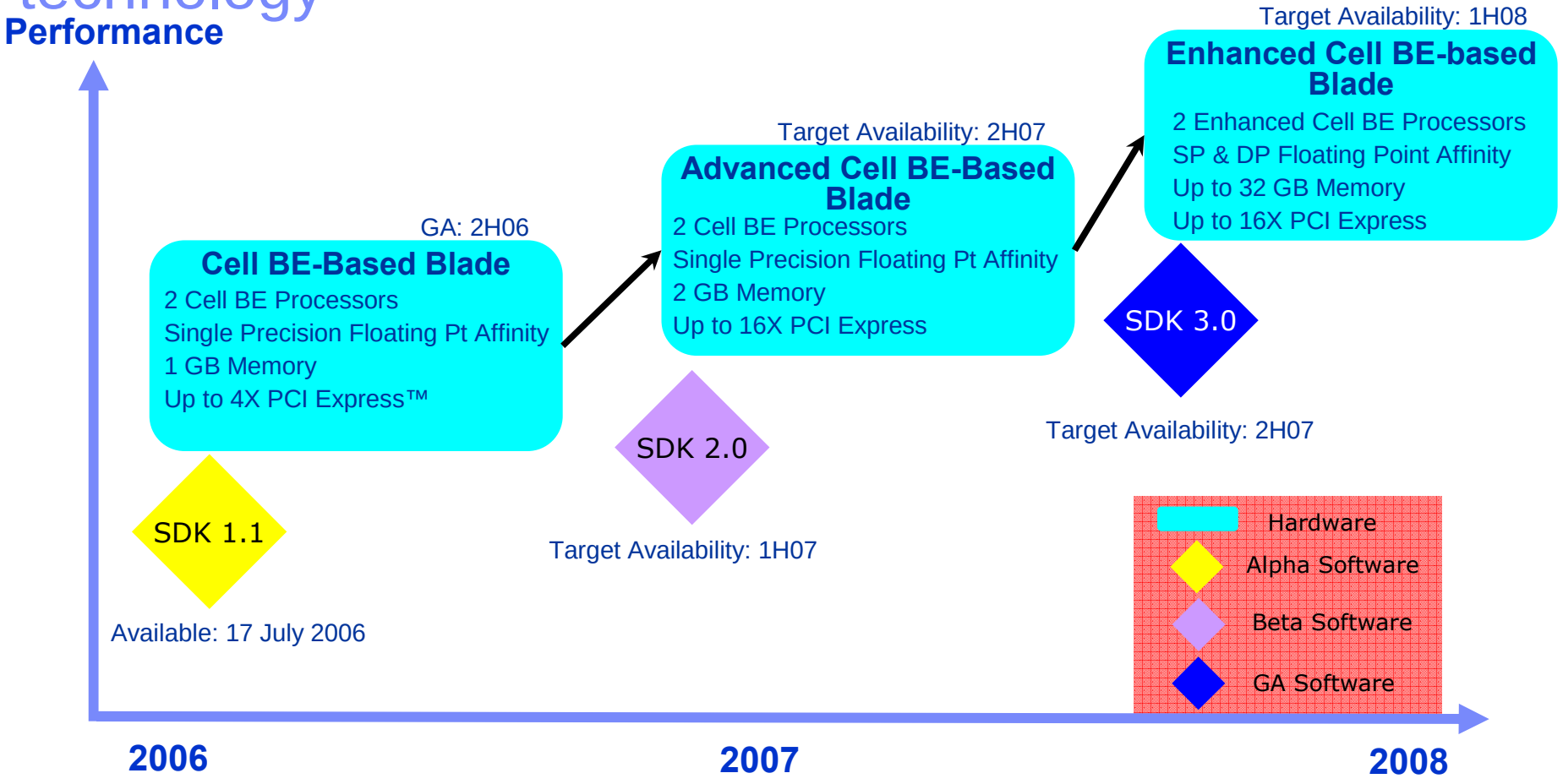
3.2 GHz
~230 SP GFlops





3.4 GHz
~54.4 SP GFlops

Cell Broadband Engine™ Blade – The first in a line of planned offerings using Cell Broadband Engine technology



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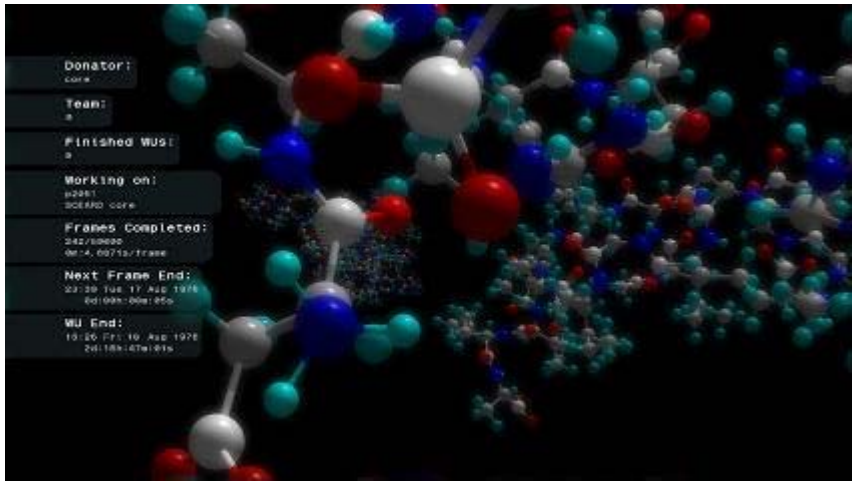
Programming Cell BE

Three Phases

- Vertical/embedded applications
  - Applications mostly written from scratch
- Library/API based: Cell as an accelerator
  - Physics/Math libraries
  - Device-like APIs
  - User-specific libraries
  - Will get a big boost from Roadrunner
- New programming paradigms
  - Rapidmind, IBM Octopiler, OpenMP/tasks, Sequoia, PeakStream, X10(?)

Folding@home distributed computing



ADVANCED FEATURES FOR THE PS3

While the Cell microprocessor does most of the calculation processing of the simulation, the graphic chip of the PLAYSTATION 3 system (the RSX) displays the actual folding process in real-time using new technologies such as HDR and ISO surface rendering. It is possible to navigate the 3D space of the molecule using the interactive controller of the PS3, allowing us to look at the protein from different angles in real-time.

www.digitalmedics.de

Multigrid Finite Element Solver.

First of its kind technology with Cell BE™ processing power.

Researchers at Digital Medics and the University of Dortmund developed the first ever Finite Element solver on the revolutionary Cell BE™ microprocessor manufactured by STI.

The solver is capable of computing dynamic non-linear problems from solid mechanics using a Newton-Krylov Multigrid algorithm with unprecedented performance. For example, on medium- to large-scale problems, the solver reached a sustained floating-point performance of 52 GFLOPS per second on a single processor (using all 8 SPUs at once). Possible applications for the solver are in biomechanics, classical civil and mechanical engineering. Work on a fluid-dynamics solver has also been started and is expected to be finished in the next two months.

(NY Times Sep. 7 2006)

I.B.M. to Build Supercomputer Powered by Video Game Chips

By JOHN MARKOFF

Published: September 7, 2006

SAN FRANCISCO, Sept. 6 — The Department of Energy said Wednesday that it had awarded I.B.M. a contract to build a supercomputer capable of 1,000 trillion calculations a second, using an array of 16,000 Cell processor chips that I.B.M. designed for the coming PlayStation 3 video game machine.

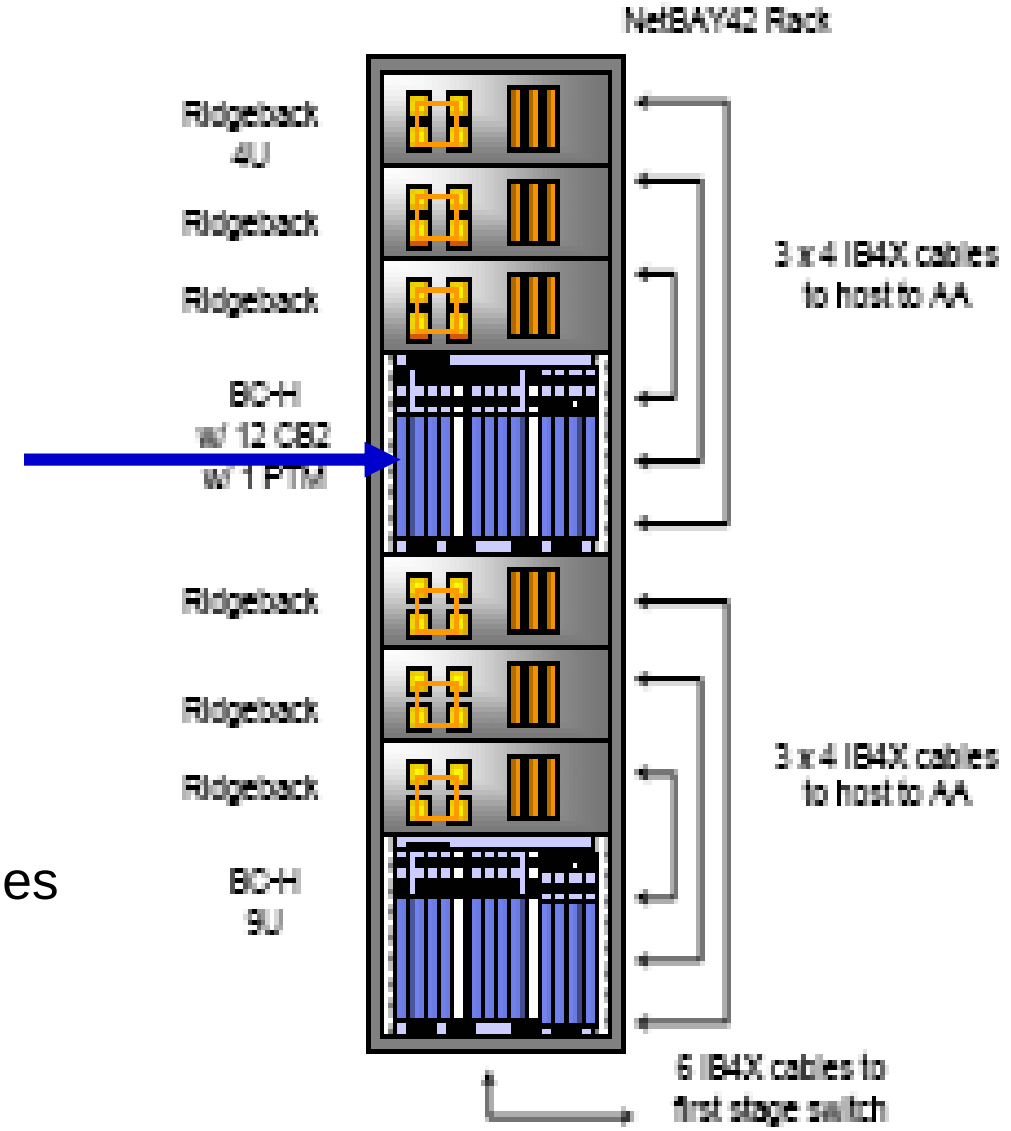
The initial phase of the contract will be for $35 million. There will be two more construction phases through the completion and installation of the system in 2008. The total cost is expected to be $110 million.

The choice of the Cell chip, which was initially designed with Sony and Toshiba for video game and animation applications, is indicative of how much the computer industry has been transformed in the last decade. It is now being driven largely by technologies originally intended for home and consumer applications.

Compute Rack

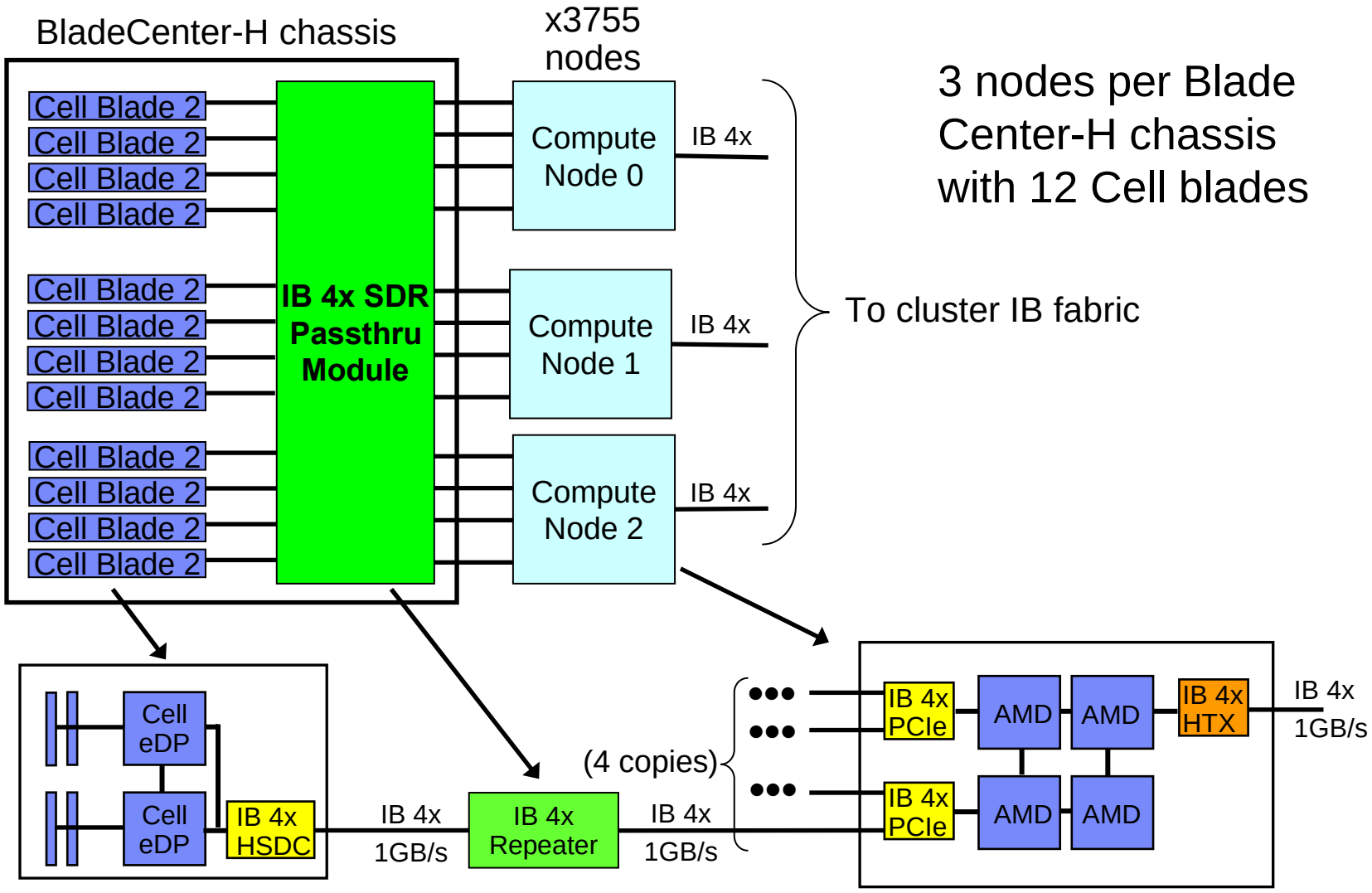
12 blades

BladeCenter-H



~16 KW per rack
~1 KW per x3755 Ridgeback
~5 KW per BC-H w/ 12 Cell Blades

Cell Blade Attachment (plan of record …)



Selected other work

- Visualization
  - Fraunhofer PV4D
  - Slusallek & IBM Raytracing
  - …
- Medical imaging
  - Mercury
  - IBM/Mayo Clinic
  - …
- Fluid-dynamics
  - At least three different teams, not including IBM
  - First port of commercial code started

Picking up fast ….

More information at

- www.ibm.com/developerworks/power/cell
  - Full Architecture Spec
  - Full System Simulator
  - Gcc & XLC compiler
  - Example applications and libraries
- All Free!

- TIME TO GET IN THE GAME !!

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