

IBM High Performance Computing – Products and Directions

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IBM Deep Computing
July 2006

News! Product brand name changes

- pSeries → System p
 - POWER based nodes
- xSeries → System x
 - Cluster 1350
 - Intel x86_64, AMD Opteron, PowerPC 970
- iSeries → System i
- zSeries → System z

- No more funny “e” symbol

Deep Computing Embraces a Broad Spectrum of Markets



Digital Media

Digital content creation, management and distribution

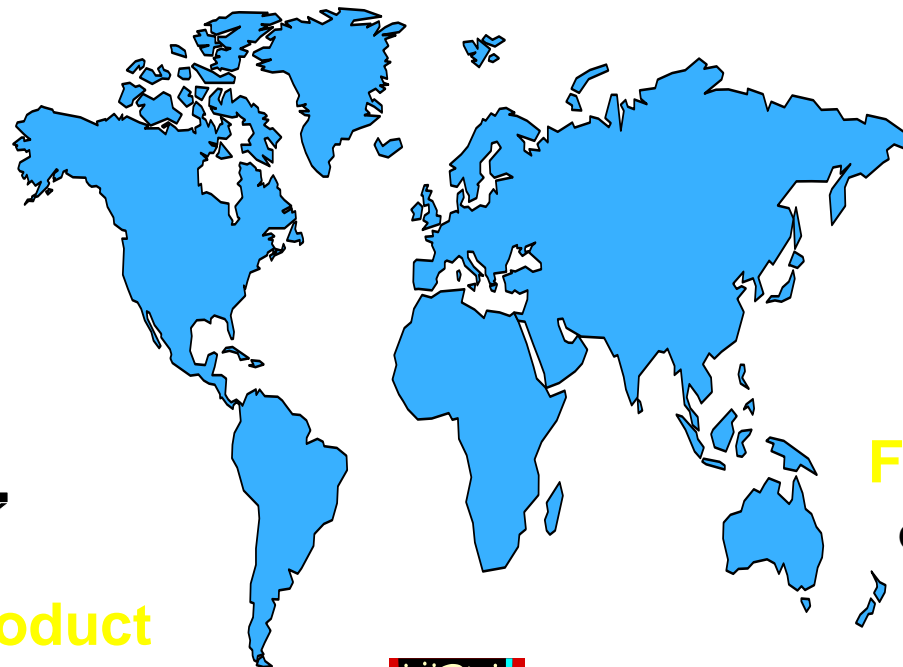
Life Sciences

Research, drug discovery, diagnostics, information-based medicine



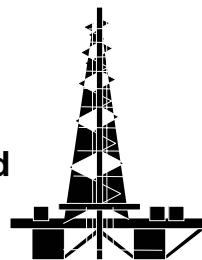
Business Intelligence

Data warehousing and data mining



Petroleum

Oil and gas exploration and production



Financial Services

Optimizing IT infrastructure, risk management and compliance, analytics

Industrial/Product Lifecycle Management

CAE, EDA, CAD/PDM for electronics, automotive, and aerospace



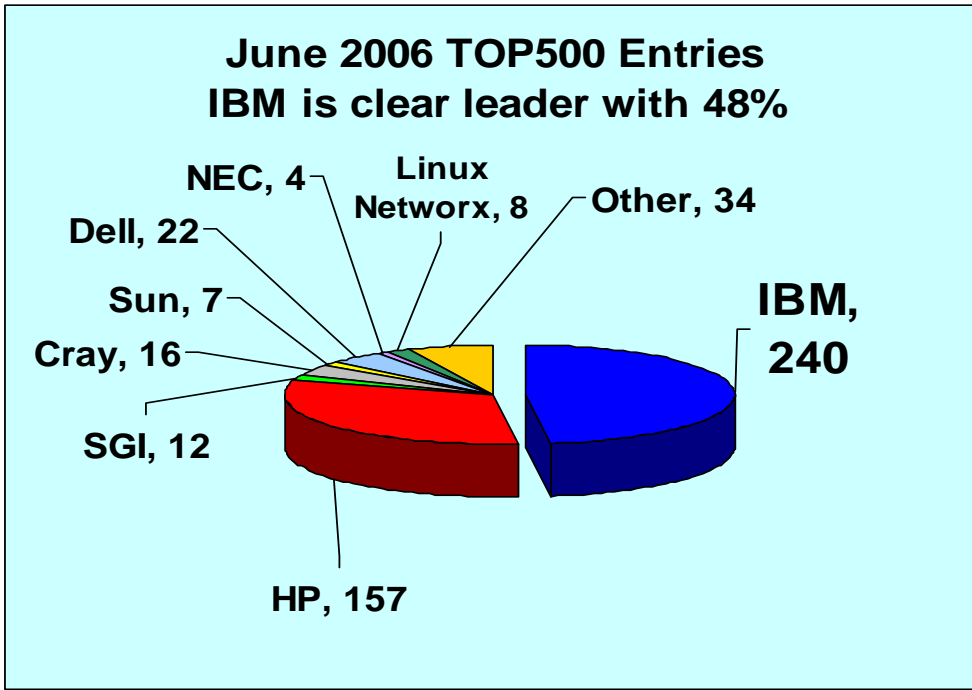
Government & Higher Education

Scientific research, classified/defense, weather/environmental sciences

IBM is clear leader in supercomputing

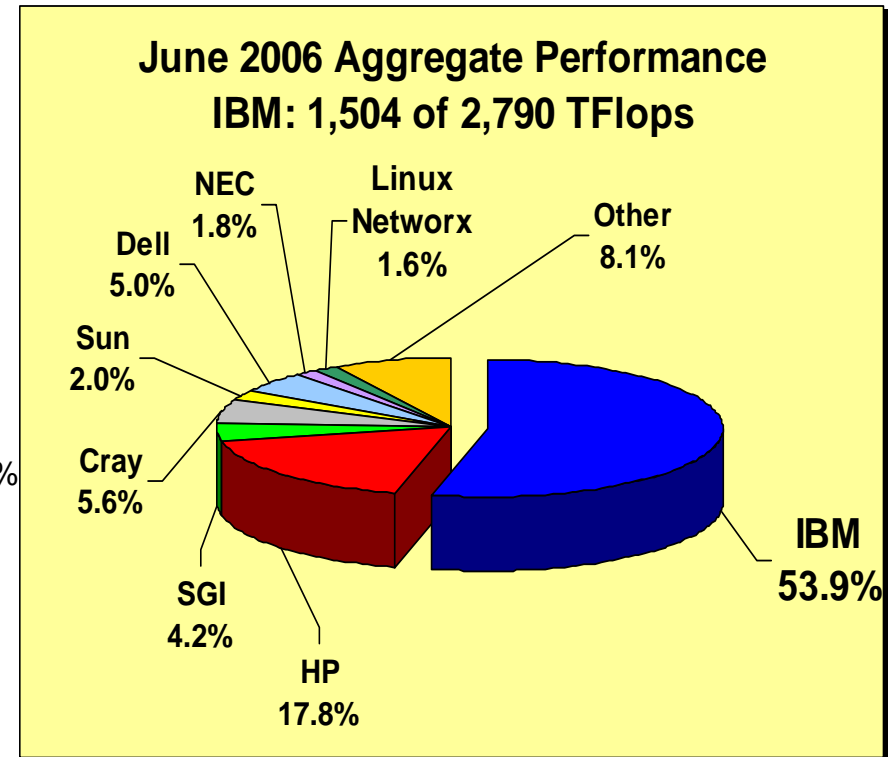


Semiannual independent ranking of top 500 supercomputers in the world



IBM is clear leader ...

- ✓ #1 System – DOE/LLNL - BlueGene/L (280.6 TF)
- ✓ Most entries on TOP500 list with 240 (48%)!
- ✓ Most installed aggregate throughput with over 1,504 Teraflops (53.9%)
- ✓ Most in TOP10 with 4 systems (40%)!
- ✓ Most in TOP20 with 11 systems (55%)!
- ✓ Most in TOP100 systems with 46 (46%)!
- ✓ Most Commodity Clusters with 177 of 364 (48.6%)!



Source: www.top500.org

IBM continues to lead the **TOP20** with 11 system. Cray with 3 is only other vendor with more than one system in TOP20.

#	Vendor	Rmax TFlops	Installation
1	IBM	280.6	DOE/NSSA/LLNL (64 racks BlueGene/L)
2	IBM	91.29	BlueGene at Watson (20 racks BlueGene/L)
3	IBM	75.76	ASC Purple LLNL (1526 nodes p5 575)
4	SGI	51.87	NASA/Columbia (Itanium2)
5	Bull	42.90	CEA/DAM Tera10 (Itanium2) New
6	Dell	38.27	Sandia -Thunderbird (EM64T/Infiniband)
7	Sun	38.18	Tsubame Galaxy TiTech (Opteron/Infiniband) New
8	IBM	37.33	FZJ – Juelich (8 racks BlueGene/L) New
9	Cray	36.19	Sandia – Red Storm (XT3 Opteron)
10	NEC	35.86	Japan Earth Simulator (NEC)

#	Vendor	Rmax TFlops	Installation
11	IBM	27.91	MareNostrum Barcelona Supercomputer (JS20)
12	IBM	27.45	ASTRON Netherlands (6 racks BlueGene/L)
13	Cray	20.52	ORNL – Jaguar (XT3 Opteron)
14	Calif Dig	19.94	LLNL (Itanium2)
15	IBM	18.20	AIST - Japan (4 rack BlueGene/L)
16	IBM	18.20	EPFL - Switzerland (4 rack BlueGene/L)
17	IBM	18.20	KEK – Japan (4 rack BlueGene/L) New
18	IBM	18.20	KEK – Japan (4 rack BlueGene/L) New
19	IBM	18.20	IBM – On Demand Ctr (4 rack BlueGene/L) New
20	Cray	16.97	ERDC MSRC (Cray XT3 Opteron)

Source: www.top500.org

IBM 10 Teraflop Club

17 Members strong

Top500	Installation	Processor	Rmax TF/s
1	DOE BlueGene/L LLNL	700 MHz PPC 440	280.6
2	BlueGene at Watson	700 MHz PPC 440	91.2
3	ASC Purple LLNL	1.9 GHz POWER5 p5 575	75.8
8	FZ J- Juelich	700 MHz PPC 440	37.3
11	Barcelona SC	2.2 GHz PPC970 JS20	27.91
12	Univ Groningen (Astron)	700 MHz PPC 440	27.45
15	AIST - Japan	700 MHz PPC 440	18.2
16	EPFL - Switzerland	700 MHz PPC 440	18.2
17	KEK - Japan	700 MHz PPC 440	18.2
18	KEK - Japan	700 MHz PPC 440	18.2
19	IBM On Demand Ctr	700 MHz PPC 440	18.2
23	Indiana University	2.5 GHz PPC 970 JS21	15.04
26	USC	Xeon/Opteron mix	13.81
27	Geoscience Company	2.2 GHz Dual Opteron LS20	12.3
31	IBM Rochester BGL DD1	500 MHz PPC 440	11.68
35	China Meteorological	1.7 GH POWER4+ p655	10.310
36	NAVO	1.7 GH POWER4+ p655	10.310



Indicates new or upgraded system

Source: www.top500.org

Deep Computing Focus Areas

- Government Research Labs
 - Energy, Defense, Security
- Weather/Environmental
 - Weather Forecasting Centers
 - Climate Modeling
- Higher Education/Research Universities
- Life Sciences
 - Pharmaceuticals, BioTech, Chemical/Materials
- Aero/Auto
- Petroleum
- Business Intelligence, Digital Media, Financial Services, On Demand HPC

IBM Deep Computing Components

- High Performance Computing Leadership
 - Deep Computing Team at IBM is the longest running dedicated team in the HPC business
 - BlueGene Consortium
 - SCICOMP/SPXXL
 - <http://www.spcomp.org>
 - <http://www.spxxl.org/>
 - Linux Cluster Institute
 - <http://www.linuxclustersinstitute.org/>
 - Linux Technology Center (LTC)
 - <http://www-128.ibm.com/developerworks/linux/ltc/>
 - 600 people devoted to furthering Linux development
- Research and Innovation (IBM Research and Development)
 - Chips, Systems, Storage, Software
- System Design
 - Power-chip, Intel/Opteron based architectures
 - Storage (Hardware and Software)
 - Networking (Hardware and Software)
- Innovative Systems
 - BlueGene, Cell

Deep Computing Teams

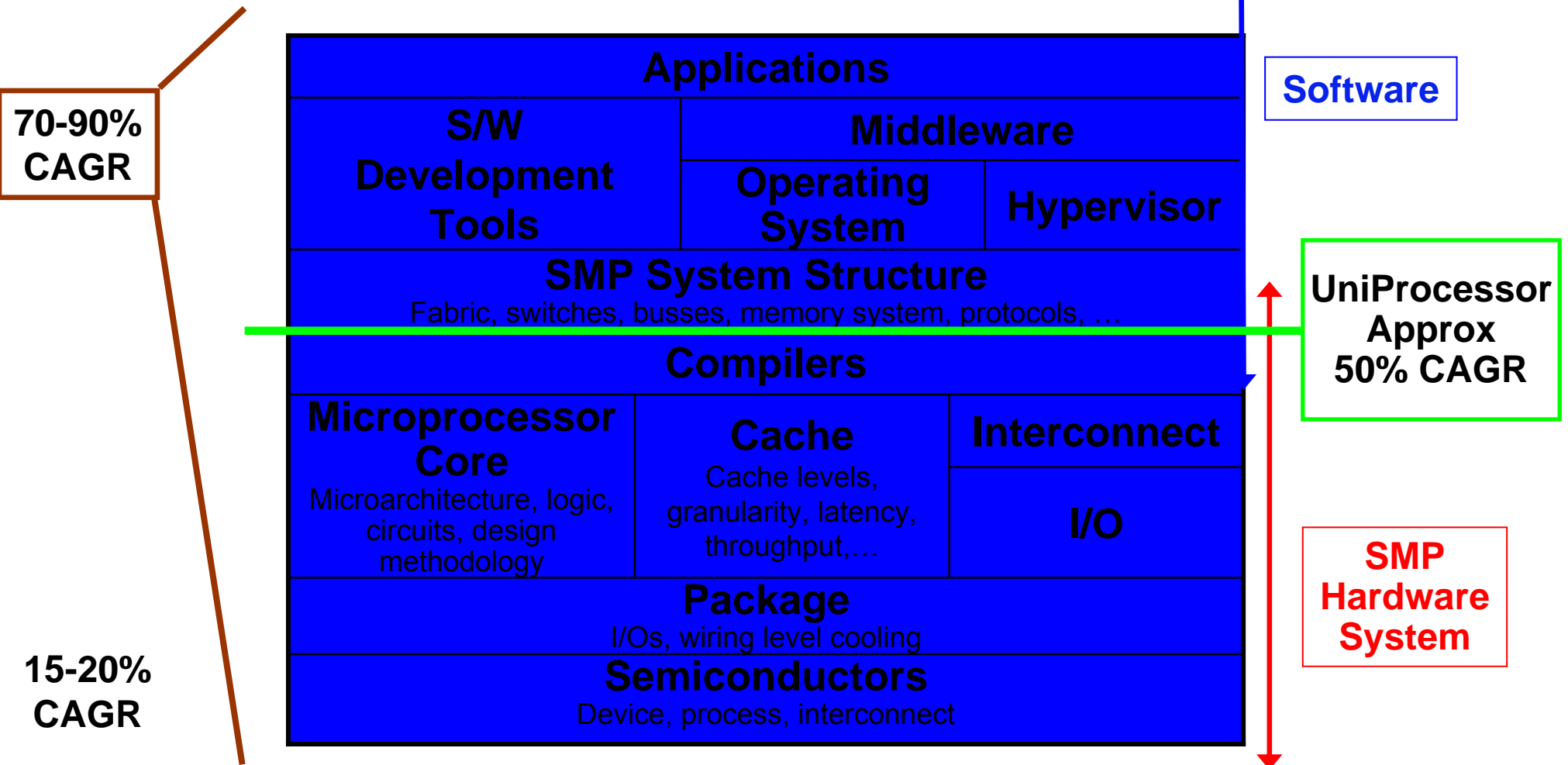
- IBM Deep Computing Technical Support (Kent Winchell)
 - 18 Application Specialists (3 Specialists with DOD Clearance)
- Deep Solutions Enablement (Bruce Hurley, ISV Support)
 - 5 Applications Specialists
- XL Compiler Teams (Toronto)
 - >300 people in Development/Test/Service
- Austin Server Performance Team (Power and PPC)
 - 5 Applications Specialists
- Poughkeepsie Benchmarking Center
 - 5 Applications Specialists
- BlueGene Applications
 - 5 Applications Specialists (SIMDization and Parallelization work)

Directions

System Performance Improvements

System performance gains of 70-90% CAGR (Compound Annual Growth) derive from far more than semiconductor technology alone

Performance improvements will increasingly require system level optimization



Processor Directions

■ Power Architectures

- Power4 → Power5 → Power6 →
 - Power has been dual-core since Power4
- PPC970 → PPC970MP dual core →
 - IBM BladeCenter Deployment
- BlueGene/L → BlueGene/P →
- Cell Architectures (Sony, Toshiba, IBM)
 - IBM BladeCenter Deployment

■ Intel

- IA32 → EM64T (NOCONA) → dual-core (Woodcrest)
 - IBM BladeCenter or 1U deployment

■ AMD Opteron

- Single-core → dual-core → multiple-core
 - IBM BladeCenter or 1U deployment

■ Power has been dual-core since 2001

■ Multi-core, Specialized Accelerators, System-on-a-Chip

IBM System p5 / eServer Product Line



Linux

Workstations



IntelliStation

Mdl 285,
185

Midrange

p5 570
p5 560



High-end



p5 575



p5 590



p5 595

Entry Towers



p5 550
QCM & Std



p5 520



p5 510



Entry Rack

p5 505

Blades

JS21



POWER5+
Systems

PPC970+
Systems

POWER5
Systems

System p5 “Nodes” – partial list

Model	Processors	Clock Rate (GHz)	Max Memory (x 2 ³⁰ byte)
p5 595	16-64	1.65, 1.9	2000
p5 590	8-32	1.65	1000
p5 575	8-16	1.9, 2.2*	256
p5 570	2-16	1.9, 2.2*	512
p5 560Q	4-16	1.5*	128
p5 520	1,2	1.65, 1.9*	32
p5 505	1,2	1.5, 1.65*	32

* - POWER5+

System x changes

- Example 1u dual socket Opteron node:
 - eServer 325 → eServer 326 → eServer 326m → System x 3455
- Several new options will be announced soon.


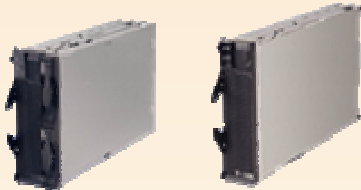

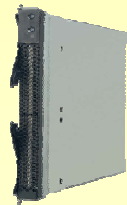
High Speed BladeCenter: BladeCenter H

- Enables new workloads: high bandwidth, data intensive, low latency
 - **Earth/Life Sciences**
 - **Data Intensive, Commercial Analytics**
 - **Next generation network applications**

- Up to 10X increase in bandwidth
 - **Accomplished via new 10Gb fabric support to each blade**
 - **Supports 4 10Gb channels to each blade**
 - **4X InfiniBand, 10Gb Ethernet**



Blade portfolio continues to build

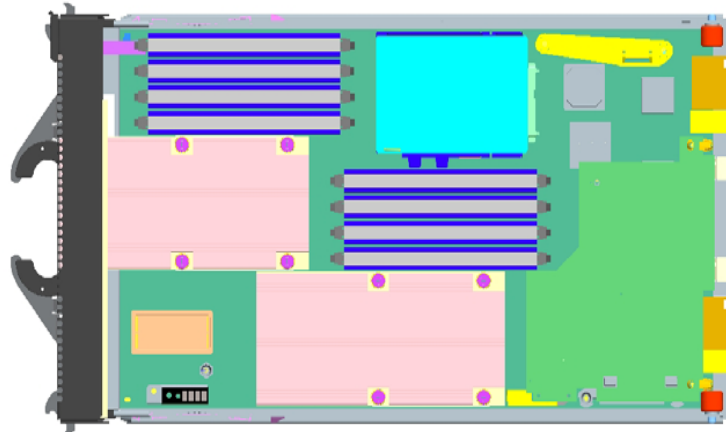
	HS20 2-way Xeon	HS40 4-way Xeon		AMD Opteron LS20
Feature	<ul style="list-style-type: none"> Intel Xeon DP EM64T Mainstream rack dense blade High availability apps Optional HS HDD 	<ul style="list-style-type: none"> Intel Xeon MP processors 4-way SMP capability Supports Windows, Linux, and NetWare 	<ul style="list-style-type: none"> Two PowerPC® 970 processors 32-bit/64-bit solution for Linux & AIX 5L™ Performance for deep computing clusters 	<ul style="list-style-type: none"> Two socket AMD Single and Dual core Similar feature set to HS20
Target Apps	<ul style="list-style-type: none"> Edge and mid-tier workloads Collaboration Web serving 	<ul style="list-style-type: none"> Back-end workloads Large mid-tier apps 	<ul style="list-style-type: none"> 32- or 64-bit HPC, VMX acceleration UNIX server consolidation 	<ul style="list-style-type: none"> 32- or 64-bit HPC High memory bandwidth apps 
Common Chassis and Infrastructure				

JS21 Blade Overview

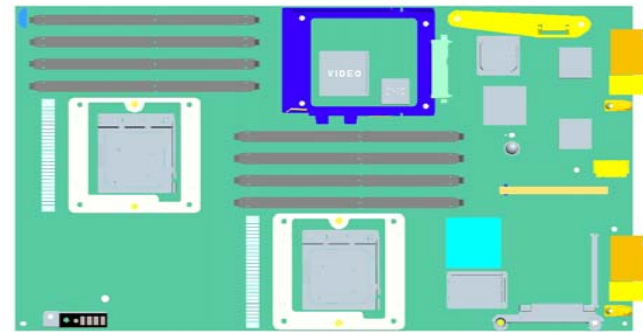
- 4-core SMP @2.5GHz with 4 Flops/cycle PPC970
 - 40GF/Blade Peak
- 10GB/sec memory bandwidth
- Daughter card fabric support possible
 - Myrinet10G or IB supported with topspin PCI-E to IB 4X card
- Dual Gb ethernet
 - Image Support
 - GPFS

Introducing LS21/LS41

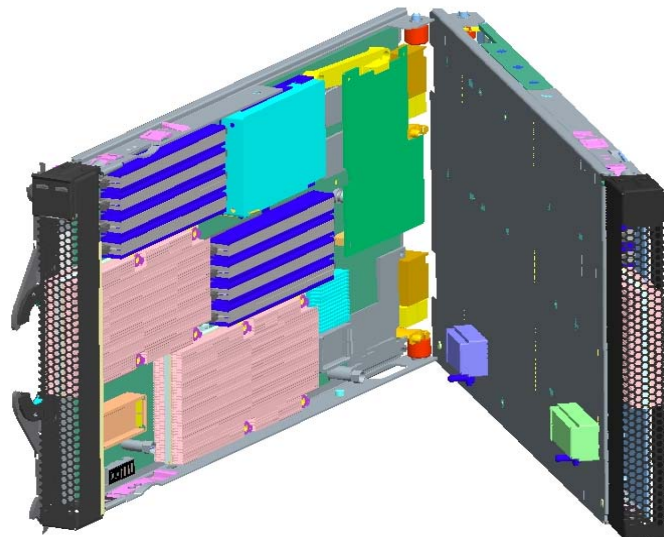
Click to see true **On Demand** in action



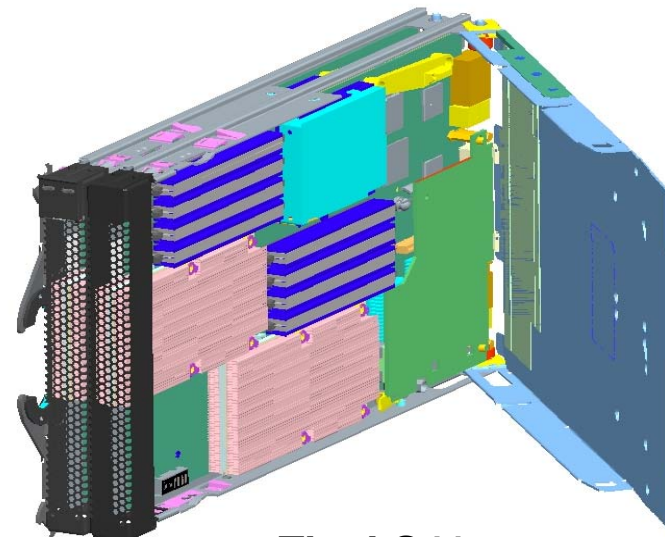
The LS21



The MP Expansion Unit



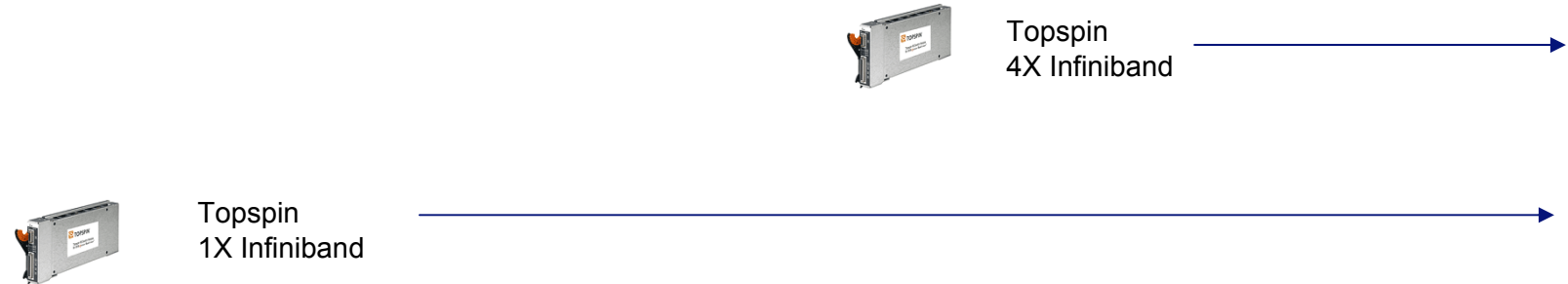
Assembling the parts



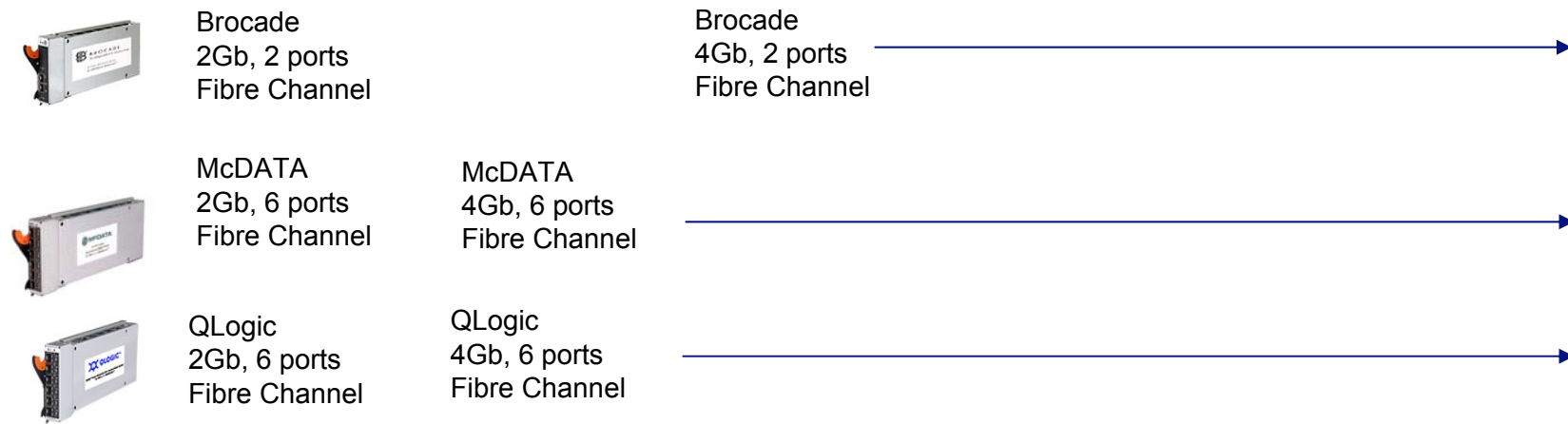
The LS41

BladeCenter Storage Networking Directions

Infiniband



Fibre Channel



3Q05

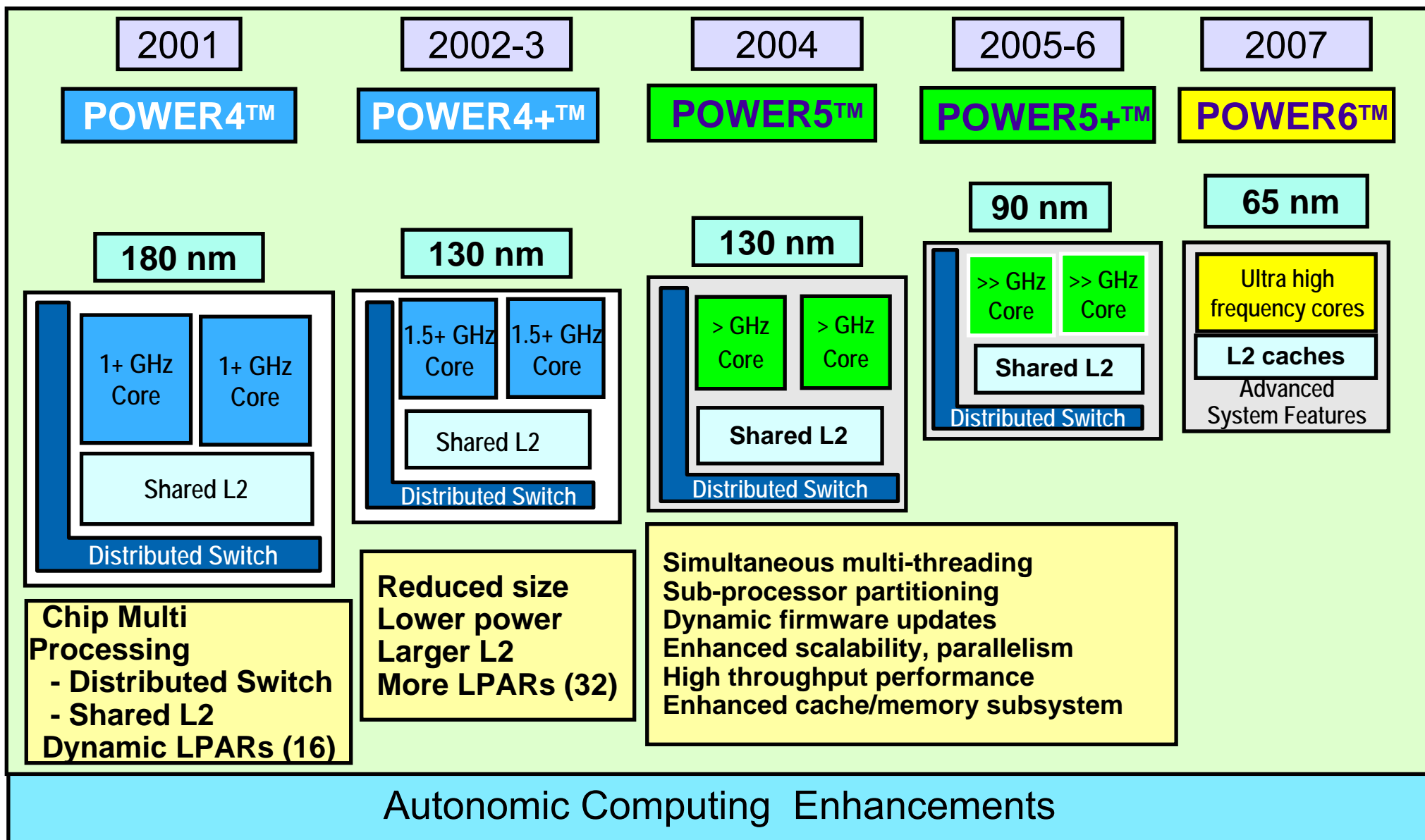
4Q05

1H06

2H06

IBM Power Technology

POWER Processor Roadmap



Servers

Server Roadmap

2004

2005

2006

2007 - 2009

P690++



8-32w
1.9GHz

**PCI-X
HPS**

p5-595



16-64
cores
1.90 GHz

**PCI-X
IB / HPS**

p5-595+



16-64
cores
2.2 GHz

**PCI-266
IB / HPS**

POWER6



Up to
64 core
4+ GHz

**PCIe-SDR
IB-2 / HPS**

POWER6+



Up to 64
core
≥4+ GHz

**PCIe-DDR
IB-2**

P655++



8/16w
1.9GHz

**PCI-X
HPS**

p5-575



8 core
1.9GHz
16 core
1.5GHz
Up to 12
Nodes

**PCI-X
IB / HPS**

p5-575+



8 core
2.2 GHz
16 core
1.9 GHz
Up to 14
Nodes

**PCI-X
IB / HPS**

POWER6 IH



16 core
32 core
4+ GHz
3+ GHz
Up to 16
Nodes

**PCIe-SDR
IB-2 / HPS**

POWER6+ IH



16 core
32 core
≥ 4+ GHz
≥ 3+ GHz
Up to 16
Nodes

**PCIe-DDR
IB-2**

p5-550

4 core
1.65GHz



**PCI-X
10 Gb E**

p5-550+/550Q

4 / 8 core
1.9 GHz



**PCI-266
IB**

p5-550+/550Q

4 / 8 core
2.0 GHz



**PCI-266
IB**

**POWER6
HV8**

8 core
4 GHz



**PCIe - SDR
IB-2**

**POWER6+
HV8**

8 core
≥ 4+ GHz



**PCIe - DDR
IB-2**

10TF Architectures (estimates for Today)

	BG/L	Blade (JS21)	1U Cluster	Power5+
Architecture	PowerPC	PowerPC/Blade	Opteron/1U	Power/p575
Target Processor Speed	0.7	2.5	2.6	1.5
Core/Socket	2	2	2	2
DP ops/cycle	2	4	2	4
Sockets	2	2	2	8
Peak GF/node	5.6	40	20.8	96
Nodes/Rack	1024	56	32	12
TF/rack	5.73	2.24	0.67	1.15
Nodes/10TF	1786	250	481	105
Racks/10TF	2	5	16	9
# processors	3,572	1,000	1,924	1,680
SWITCHING				
switch links/node	builtin	1	1	2
adapters	builtin	250	481	105
1st layer switch(approx)	builtin	16	31	7
2nd layer switch(approx)	builtin	8	16	4
total switches	builtin	24	47	11
POWER				
Rough Est. Power (w/o switching, storage)	50.00	125.00	400.00	315.00

Comparing 120TF Power6 System to ASCI Purple

	ASCI Purple System	Power6 System
Tflops	78	120
Assumed GHz	1.9	3.5
Processors	10240	8512
Compute Nodes	1,280	266
Compute Racks	107	23
Switches	~300	~132
Power	3700+KW	805+KW

Dramatic improvements in Performance, Space, and Power Efficiencies

Innovative Architectures

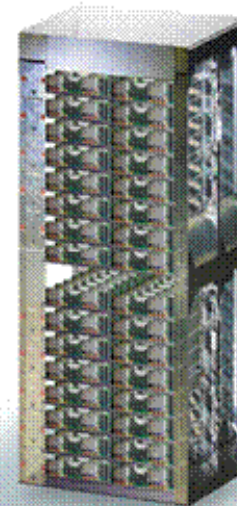
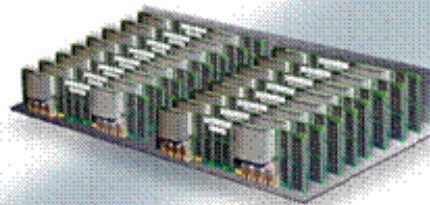
BlueGene and Cell BE

Blue Gene System Architecture

Compute Card
2 BGL Chips
Up to 1 GB Memory
(512MB per Node)
Up to 11.2 GF/s

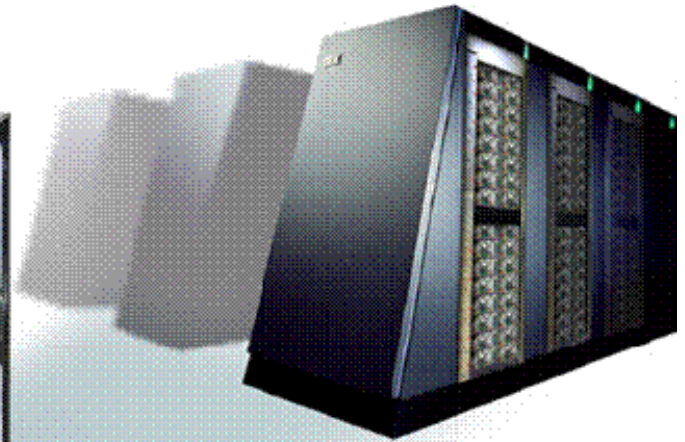
BGL Chip
Dual 700MHz CPUs
4 MB L3
Up to 5.6 GF/s

Node Card
16 Compute Cards (32 Compute Nodes)
Up to 16 GB Memory
Up to 2 IO Cards (4 IO Nodes)
Up to 180 GF/s



Rack
1024 Compute Nodes
Up to 512 GB Memory
Up to 128 IO Nodes
Up to 5.6 TF/s

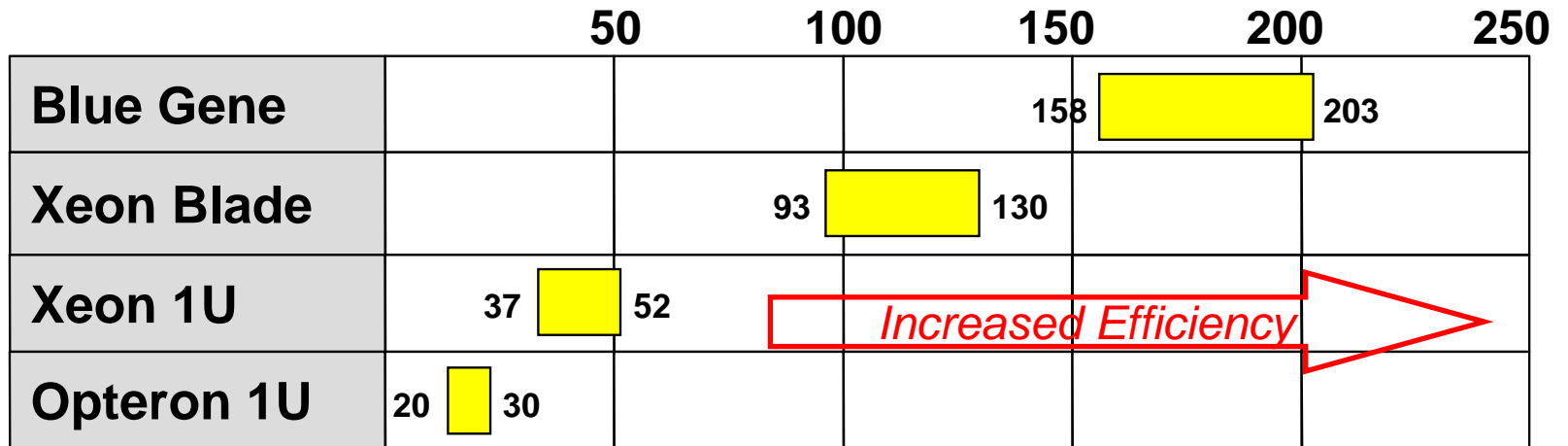
System
Up to 64 Racks
Up to 65,536 Compute
Nodes with 32 TB Memory
(64x32x32 Torus)
Up to 360 TF/s



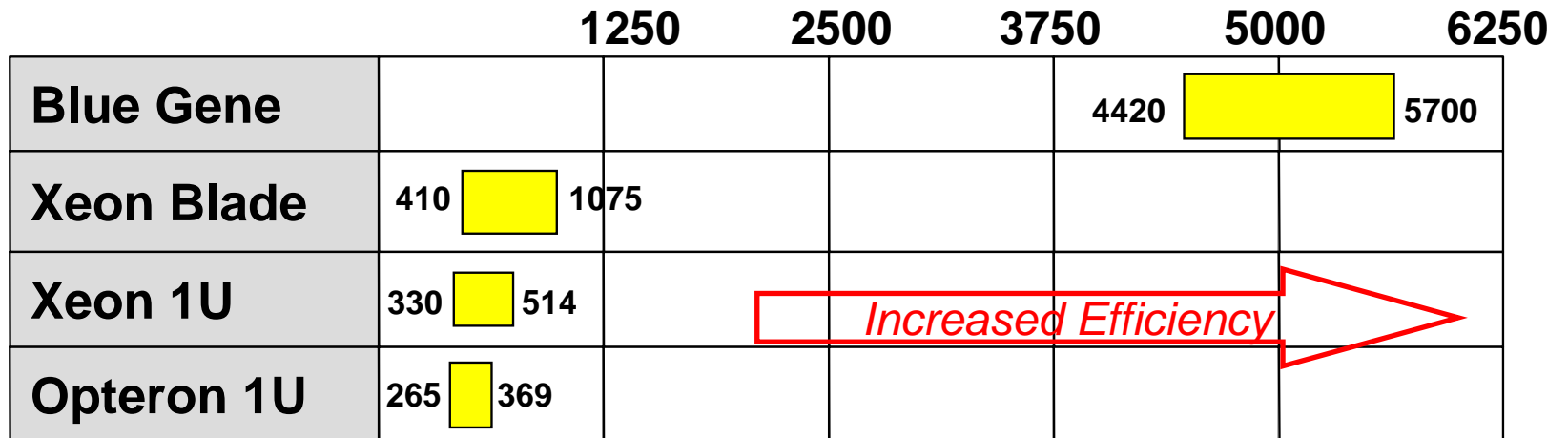
*To be offered in 1Q06 with 2GB Memory
(1GB per Node)*

Blue Gene power and space efficiency

Linpack and Peak GF
per KW



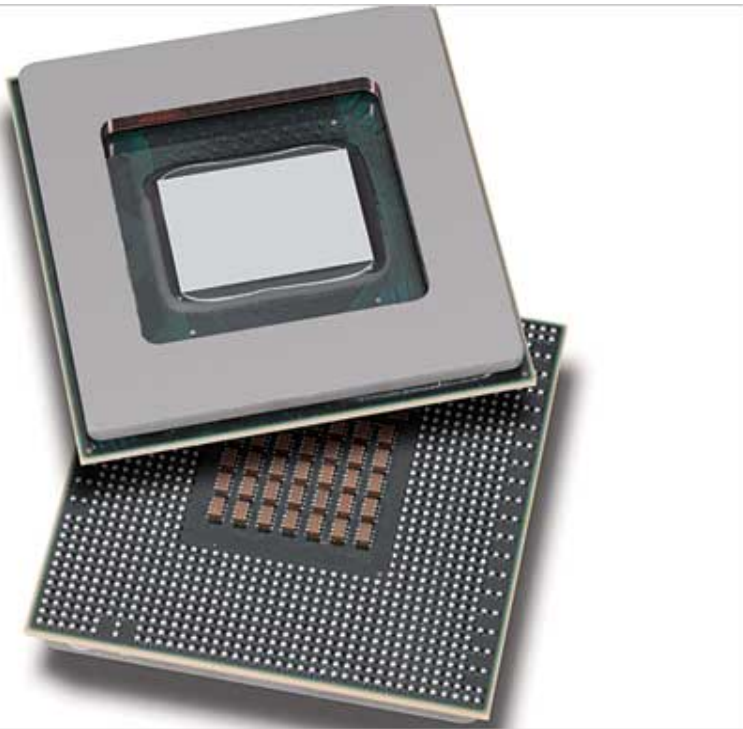
Linpack and Peak GF
per Rack



Linpack GF Peak GF

Popular Science – “Best of What’s New 2005”

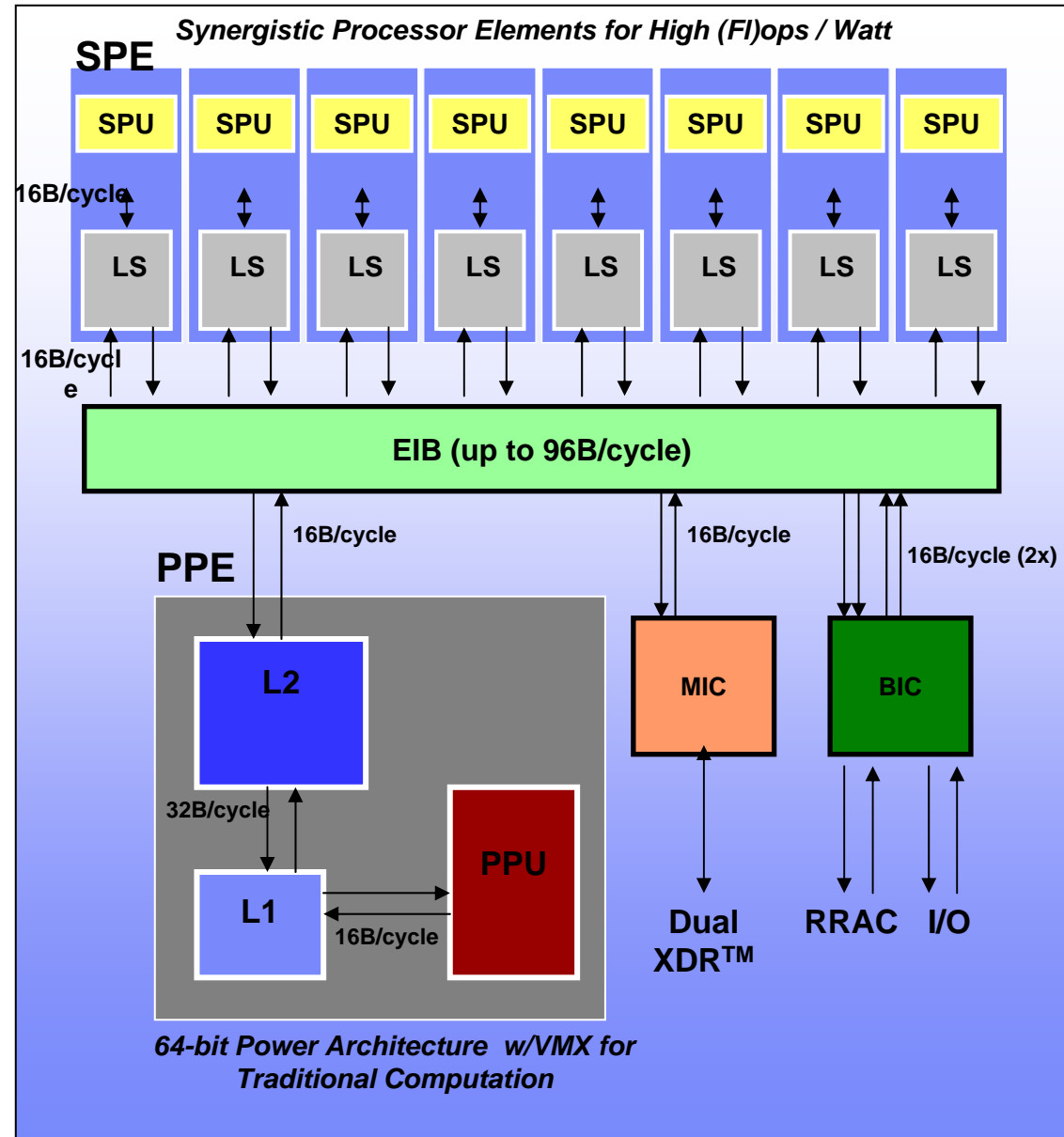
IBM/SONY/TOSHIBA Cell Chip Supercomputing power on a single chip



With nine processors and 234 million transistors, the Cell is the powerhouse of Sony's forthcoming PlayStation 3 console. The four-plus-gigahertz (depending on its application) chip calculates an unmatched 256 billion operations per second, making it 35 times as fast as the PS2's chip. The upshot: Characters react more realistically (like flinching when bullets whiz by). Next year Toshiba will offer an HDTV set that uses the chip to decode high-def signals.

Key Features

- The first generation CELL processor consists of:
 - A Power Processor Element (PPE)
 - 8 Synergistic Processor Elements (SPE)
 - A high bandwidth Element Interconnect Bus (EIB)
 - Two configurable non-coherent IO interfaces (BIC)
 - A Memory Interface Controller (MIC)
 - A Pervasive unit that supports extensive test, monitoring, and debug functions



Cell BE Blade Overview

Blade

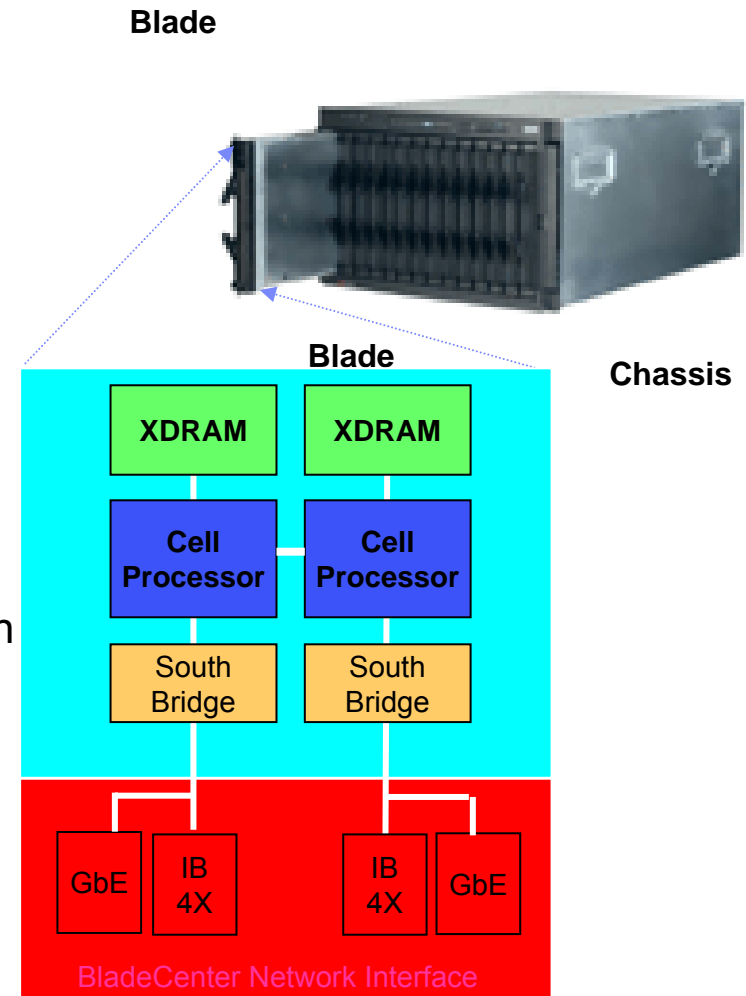
- Two Cell Processors (SMP) and Support Logic
- 1GB XDRAM
- BladeCenter Interface (Based on IBM JS20)
- Infiniband 4x (10Gbps) interconnect

Chassis

- Standard IBM BladeCenter form factor with:
 - 7 Blades (for 2 slots each) with full performance
 - 2 switches (1Gb Ethernet) with 4 external ports each
- Updated Management Module Firmware.
- External Infiniband Switches with optional FC ports.

Typical Configuration

- eServer 25U Rack
- 7U Chassis with Cell BE Blades, OpenPower 710
- Nortel GbE switch
- GCC C/C++ (Barcelona) or XLC Compiler for Cell (alphaworks)
- SDK Kit on <http://www-128.ibm.com/developerworks/power/cell/>



HPC Software

HPC Software Stack

The Cluster 1350 and 1600 supports a broad range of HPC stack software from leading 3rd party ISVs. This software is available directly from the ISVs.

Functional Area	Software Product	Comments
Operating System	AIX, SLES, RH	
Cluster System Management	CSM, XCAT	
File Systems	GPFS, NFS	GPFS in SAN, Cluster or Multicluster mode
Workload Management	Loadleveler, OpenPBS, LSF, Maui Scheduler	
Compilers	XLF/XLC	Power5,6,PowerPC, BG/L
	PGI Fortran 77/90; C/C++	
	Intel Fortran/C/C++	
	NAG Fortran/C/C++	
	GCC	
Debugger/Tracer	IBM HPC Toolkit, TotalView	
Math Libraries	ESSL, MASS ACML (AMD Core Math Libraries)	
Message Passing Libraries	POE, MPICH, MPICH-GM/MX, Scali MPI Connect™	Interconnect Dependent for Performance

Sanger-IBM, Example of a Partnership

- Sanger seeks HW platforms for HMMR, WU-Blast, Genewise, SSAHA, etc.
- Sanger installs 360 AlphaServers (2000)
- Installs 768 node RLX Cluster, moves to Debian Linux (2002)
- IBM Deep Computing Team Begins looking at Arachne and SSAHA applications at Whitehead and Sanger (2002)
- Database Contention problems at Sanger(2003)
- **Installs IBM Blade Center, 168 Xeon blades (2004)**
- **IBM Deep Computing works with Sanger on GPFS issues. (2004)**
- Upgrades to 280 Xeon blades (2004)
- IBM Deep Computing Team Profiles Applications on Power, Opteron and Intel Solutions (2005)
 - **Sanger installs >300 Opteron Blade nodes. (2005)**
- http://www.hpcf.cam.ac.uk/cluster_meeting/Cutts.pdf

End

Special Notices

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Many of the pSeries features described in this document are operating system dependent and may not be available on Linux. For more information, please check:

http://www.ibm.com/servers/eserver/pseries/linux/whitepapers/linux_pseries.html.

Prices do not include tax or shipping and are subject to change without notice. Starting price may not include a hard drive, operating system or other features. Price may include applicable discounts. Reseller prices may vary. Unless otherwise specified, pricing information is current as of original publication of this document.

MB, GB, and TB = 1,000,000, 1,000,000,000 and 1,000,000,000,000 bytes, respectively, when referring to storage capacity. Accessible capacity is less; up to 3GB is used in service partition. Actual storage capacity will vary based upon many factors and may be less than stated. Some numbers given for storage capacities give capacity in native mode followed by capacity using data compression technology.

Maximum internal hard disk and memory capacities may require the replacement of any standard hard drives and/or memory and the population of all hard disk bays and memory slots with the largest currently supported drives available. When referring to variable speed CD-ROMs, CD-Rs, CD-RWs and DVDs, actual playback speed will vary and is often less than the maximum possible.

Any performance data contained in this document was determined in a controlled environment. Actual results may vary significantly and are dependent on many factors including system hardware configuration and software design and configuration. Some measurements quoted in this document may have been made on development-level systems. There is no guarantee these measurements will be the same on generally-available systems. Some measurements quoted in this document may have been estimated through extrapolation. Users of this document should verify the applicable data for their specific environment.

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