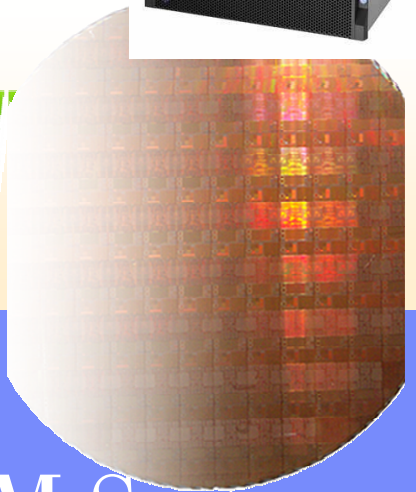
IBM System p

The POWER of 6

IBM Product Announcements for IBM System p Power6 & AIX 6



Sébastien Bérubé
System P technical specialist

August 2007

berube@ca.ibm.com

IBM Systems

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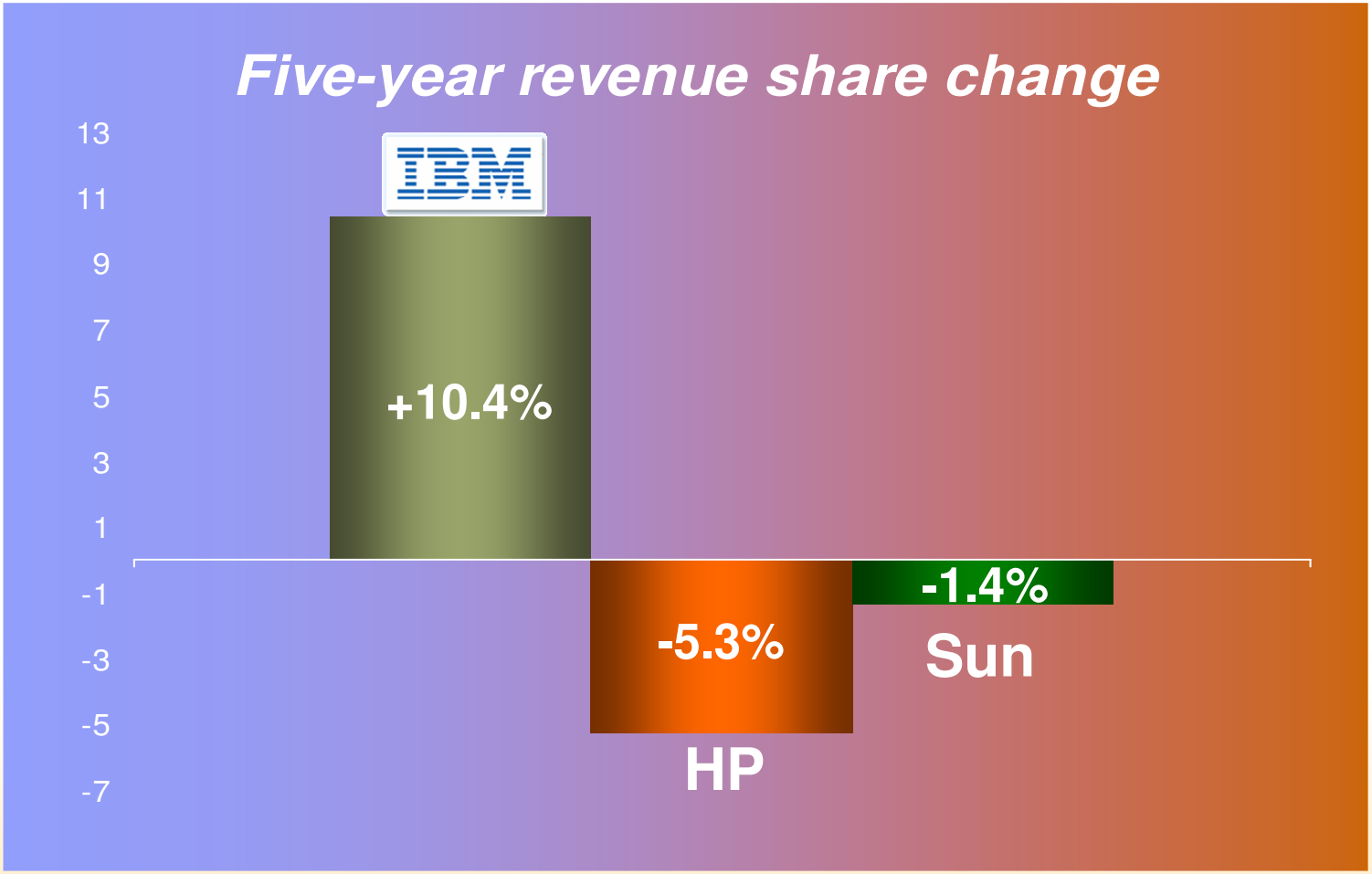
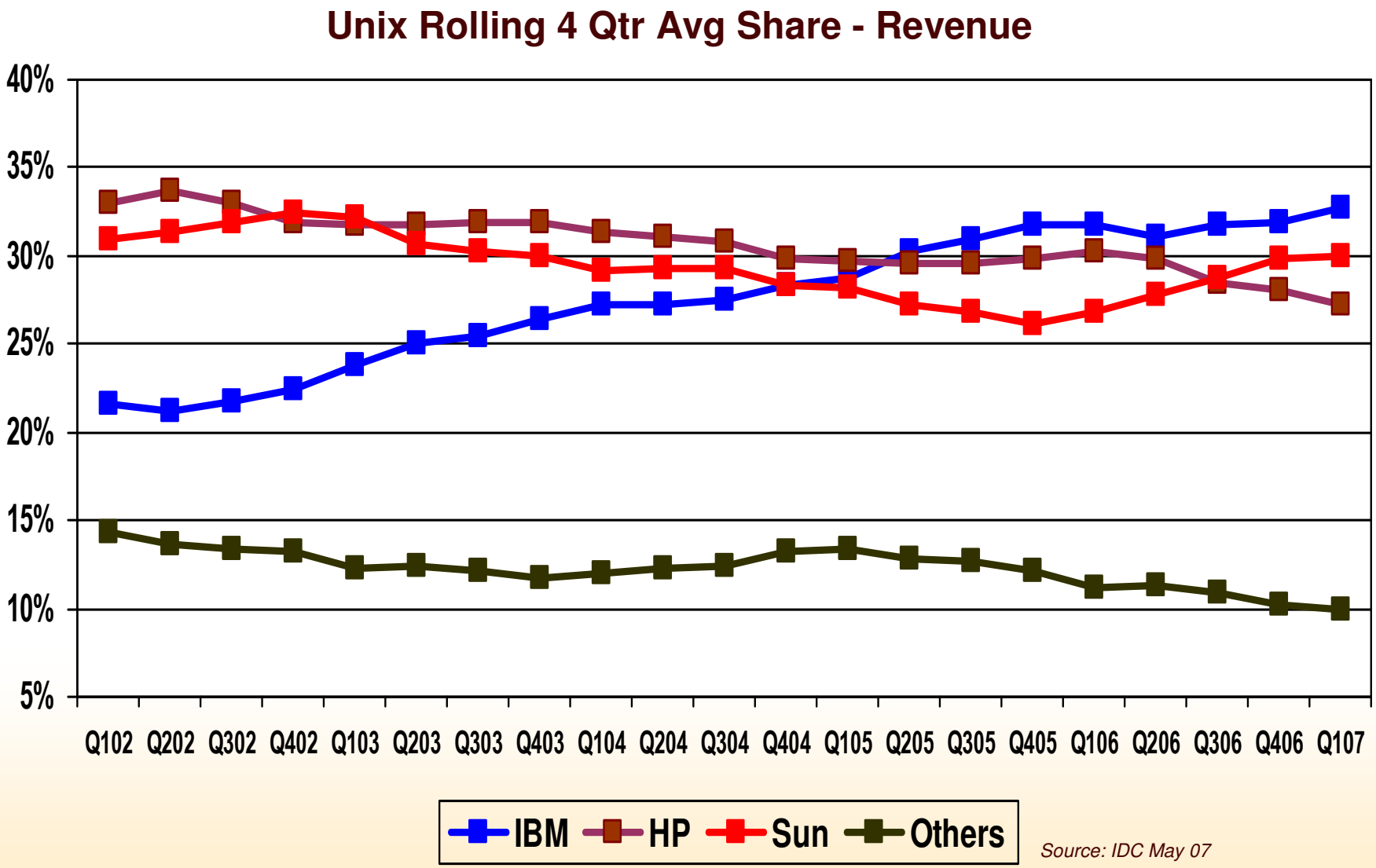
Only UNIX platform to grow over last five years



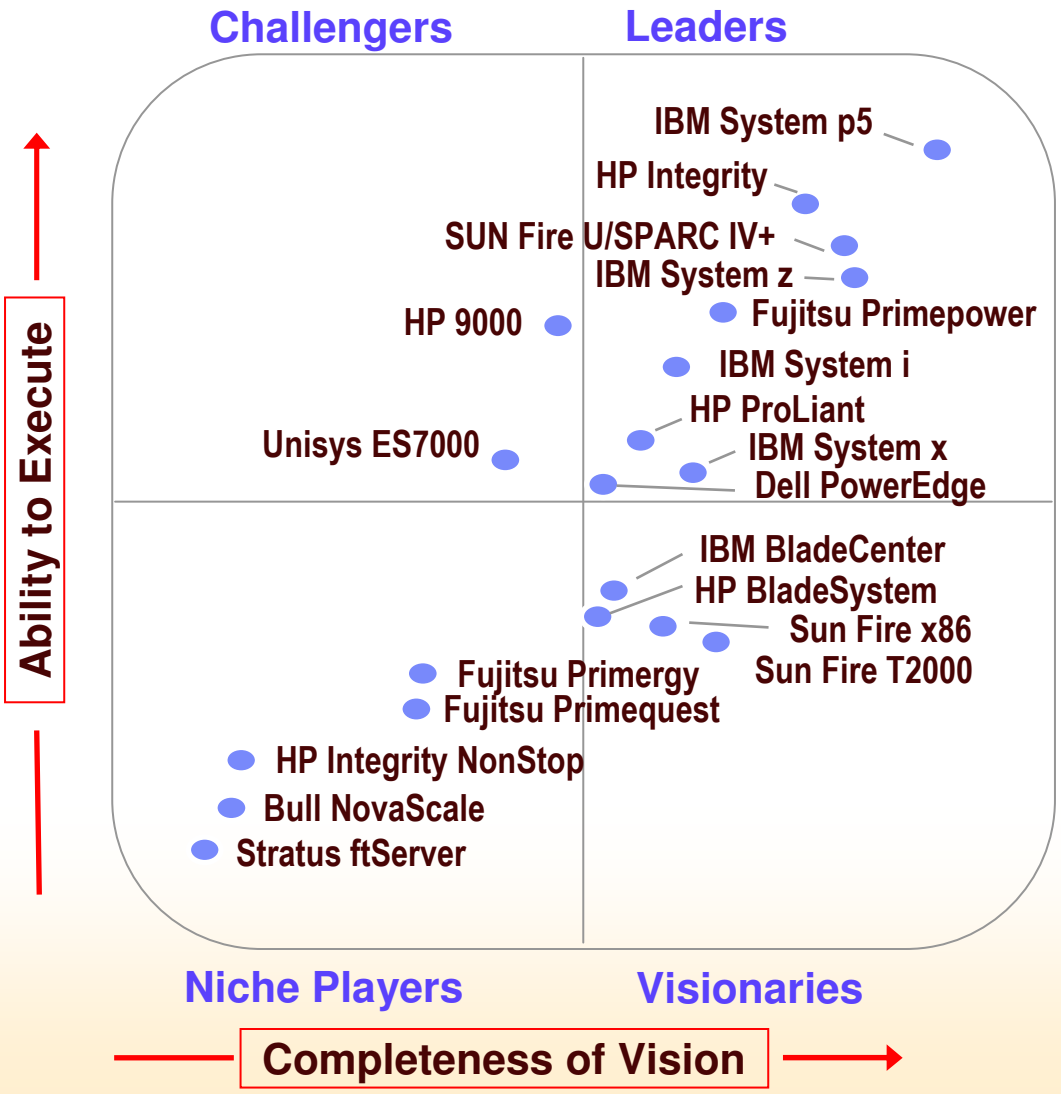
Source: IDC Server Tracker Q406 and FY06 Server Tracker, 02/24/07, rolling four quarter average

UNIX Rolling Four Quarter Revenue Share



Source: IDC May 07

Gartner Magic Quadrant for Transaction Processing



Gartner, Magic Quadrant For Enterprise Servers 2006, August 10, 2006.; Philip Dawson, Jonathon Hardcastle, Andrew Butler, Donald Feinberg, Paul McGuckin.
ID Number: G00139934
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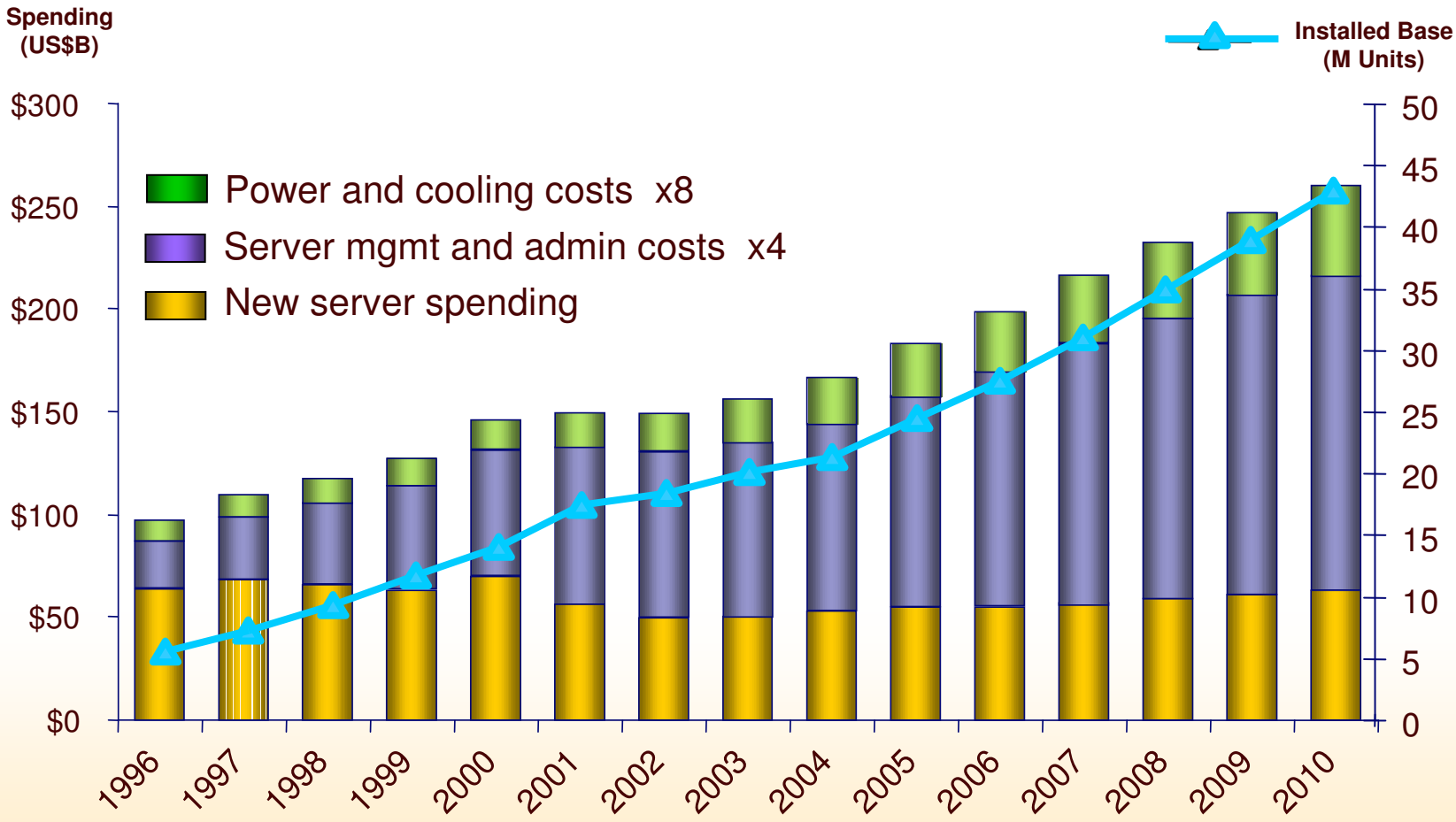
Half of every dollar today is spent on energy for hardware

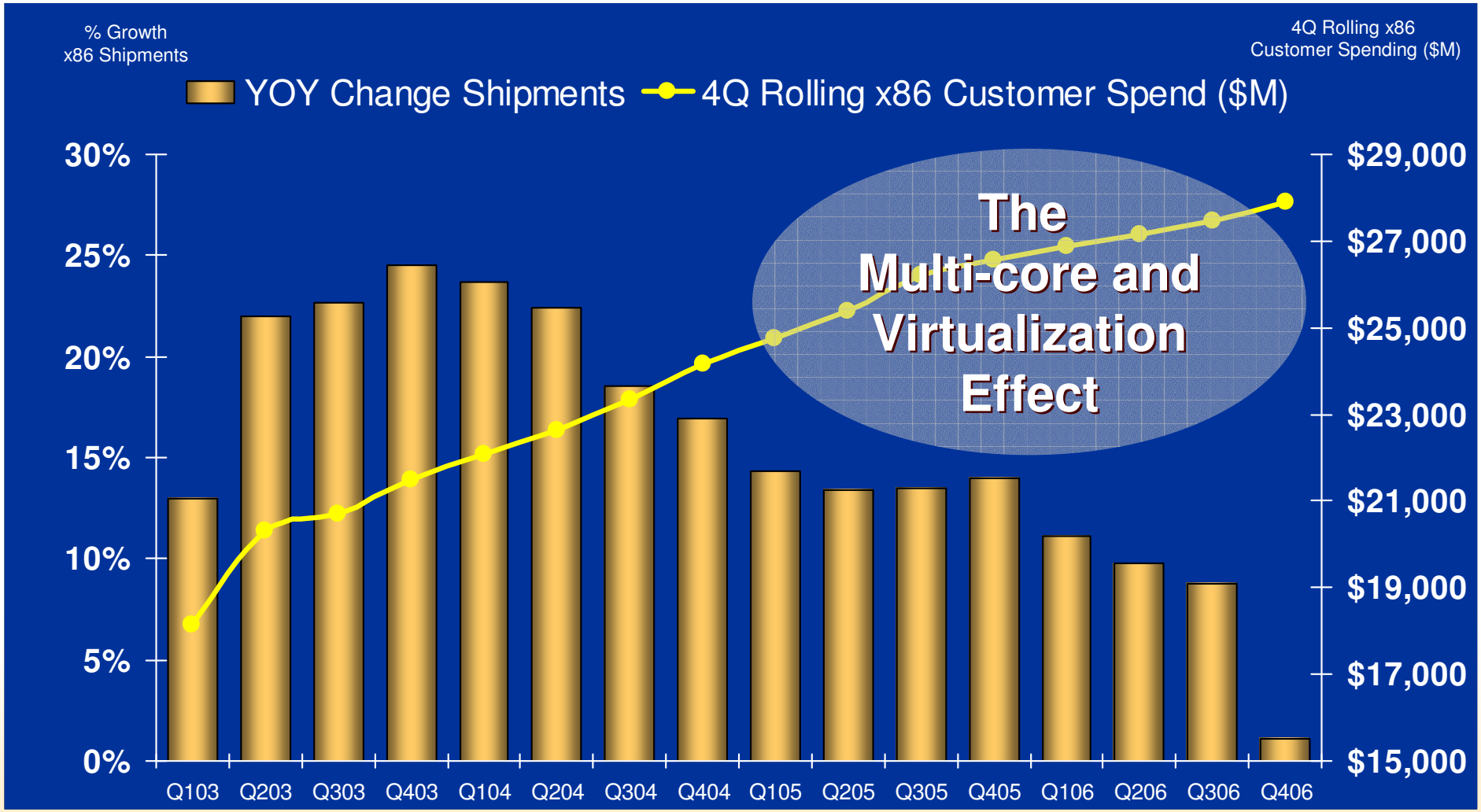
This is expected to increase by 54% over the next four years



Source: IDC, Virtualization 2.0: The Next Phase in Customer Adoption, Doc #204904, Dec 2006

Source: IDC, Virtualization 2.0: The Next Phase in Customer Adoption, Doc #204904, Dec 2006

The virtualization effect



Source: IDC, "Virtualization and Multicore Innovations Disrupt the Worldwide Server Market," 3/07

Today, we are announcing…THE POWER OF SIX

IBM System p 570 . . .with POWER6™ technology!

More than twice the performance* and modular flexibility

System p Virtualization. . .with Live Partition Mobility*!

Extending the most complete virtualization offering for UNIX and Linux

IBM AIX 6 . . . with binary compatibility!

The next evolution of UNIX with new workload partitions, manageability and security

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IBM System p

IBM System p Enterprise Technical Excellence

IBM Systems

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Revised January 9, 2003

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Revised September 26, 2006

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Revised April 17, 2007

Notes on Benchmarks and Values

The IBM benchmarks results shown herein were derived using particular, well configured, development-level and generally-available computer systems. Buyers should consult other sources of information to evaluate the performance of systems they are considering buying and should consider conducting application oriented testing. For additional information about the benchmarks, values and systems tested, contact your local IBM office or IBM authorized reseller or access the Web site of the benchmark consortium or benchmark vendor.

IBM benchmark results can be found in the IBM System p and BladeCenter Performance Report at http://www.ibm.com/systems/p/hardware/system_perf.html.

All performance measurements were made with AIX or AIX operating systems unless otherwise indicated to have used Linux. For new and upgraded systems, AIX Version 4.3 or AIX were used. All other systems used previous versions of AIX. The SPEC CPU2000, LINPACK, and Technical Computing benchmarks were compiled using IBM's high performance C, C++, and FORTRAN compilers for AIX and Linux. For new and upgraded systems, the latest versions of these compilers were used: XL C Enterprise Edition V7.0 for AIX, XL C/C++ Enterprise Edition V7.0 for AIX, XL FORTRAN Enterprise Edition V9.1 for AIX, XL C/C++ Advanced Edition V7.0 for Linux, and XL FORTRAN Advanced Edition V9.1 for Linux. The SPEC CPU95 (retired in 2000) tests used preprocessors, KAP 3.2 for FORTRAN and KAP/C 1.4.2 from Kuck & Associates and VAST-2 v4.01X8 from Pacific-Sierra Research. The preprocessors were purchased separately from these vendors. Other software packages like IBM ESSL for AIX, MASS for AIX and Kazushige Goto's BLAS Library for Linux were also used in some benchmarks.

For a definition/explanation of each benchmark and the full list of detailed results, visit the Web site of the benchmark consortium or benchmark vendor.

TPC	http://www.tpc.org
SPEC	http://www.spec.org
LINPACK	http://www.netlib.org/benchmark/performance.pdf
Pro/E	http://www.proe.com
GPC	http://www.spec.org/gpc
NotesBench	http://www.notesbench.org
VolanoMark	http://www.volano.com
STREAM	http://www.cs.virginia.edu/stream/
SAP	http://www.sap.com/benchmark/
Oracle Applications	http://www.oracle.com/apps_benchmark/
PeopleSoft - To get information on PeopleSoft benchmarks, contact PeopleSoft directly	
Siebel	http://www.siebel.com/crm/performance_benchmark/index.shtm
Baan	http://www.ssaglobal.com
Microsoft Exchange	http://www.microsoft.com/exchange/evaluation/performance/default.asp
Veritest	http://www.veritest.com/clients/reports
Fluent	http://www.fluent.com/software/fluent/index.htm
TOP500 Supercomputers	http://www.top500.org/
Ideas International	http://www.ideasinternational.com/benchmark/bench.html
Storage Performance Council	http://www.storageperformance.org/results

Revised December 12, 2006

Notes on Performance Estimates

rPerf

rPerf (Relative Performance) is an estimate of commercial processing performance relative to other IBM UNIX systems. It is derived from an IBM analytical model which uses characteristics from IBM internal workloads, TPC and SPEC benchmarks. The rPerf model is not intended to represent any specific public benchmark results and should not be reasonably used in that way. The model simulates some of the system operations such as CPU, cache and memory. However, the model does not simulate disk or network I/O operations.

rPerf estimates are calculated based on systems with the latest levels of AIX and other pertinent software at the time of system announcement. Actual performance will vary based on application and configuration specifics. The IBM eServer pSeries 640 is the baseline reference system and has a value of 1.0. Although rPerf may be used to approximate relative IBM UNIX commercial processing performance, actual system performance may vary and is dependent upon many factors including system hardware configuration and software design and configuration.

All performance estimates are provided "AS IS" and no warranties or guarantees are expressed or implied by IBM. Buyers should consult other sources of information, including system benchmarks, and application sizing guides to evaluate the performance of a system they are considering buying. For additional information about rPerf, contact your local IBM office or IBM authorized reseller.

Revised April 27, 2006

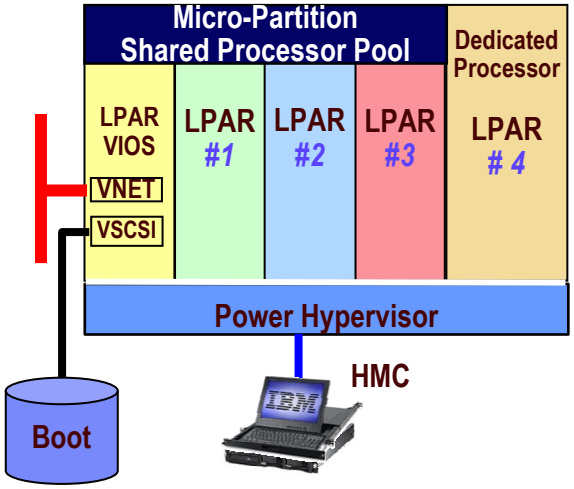
POWER6 System Highlights

IBM POWER6™ Processor Technology

- 5th Implementation of multi-core design
- ~100% higher frequencies
- 4X increase in L2 Cache

POWER6 System Architecture

- New generation of servers
- New IO
  - PCIe, SAS / SATA
  - New IO Drawers
- Enhanced power management



Enhanced Virtualization

- Live Partition Mobility (SoD)
- Dedicated Shared Processors
- Integrated Virtual Ethernet

Availability

- New RAS features
  - Processor Instruction Retry

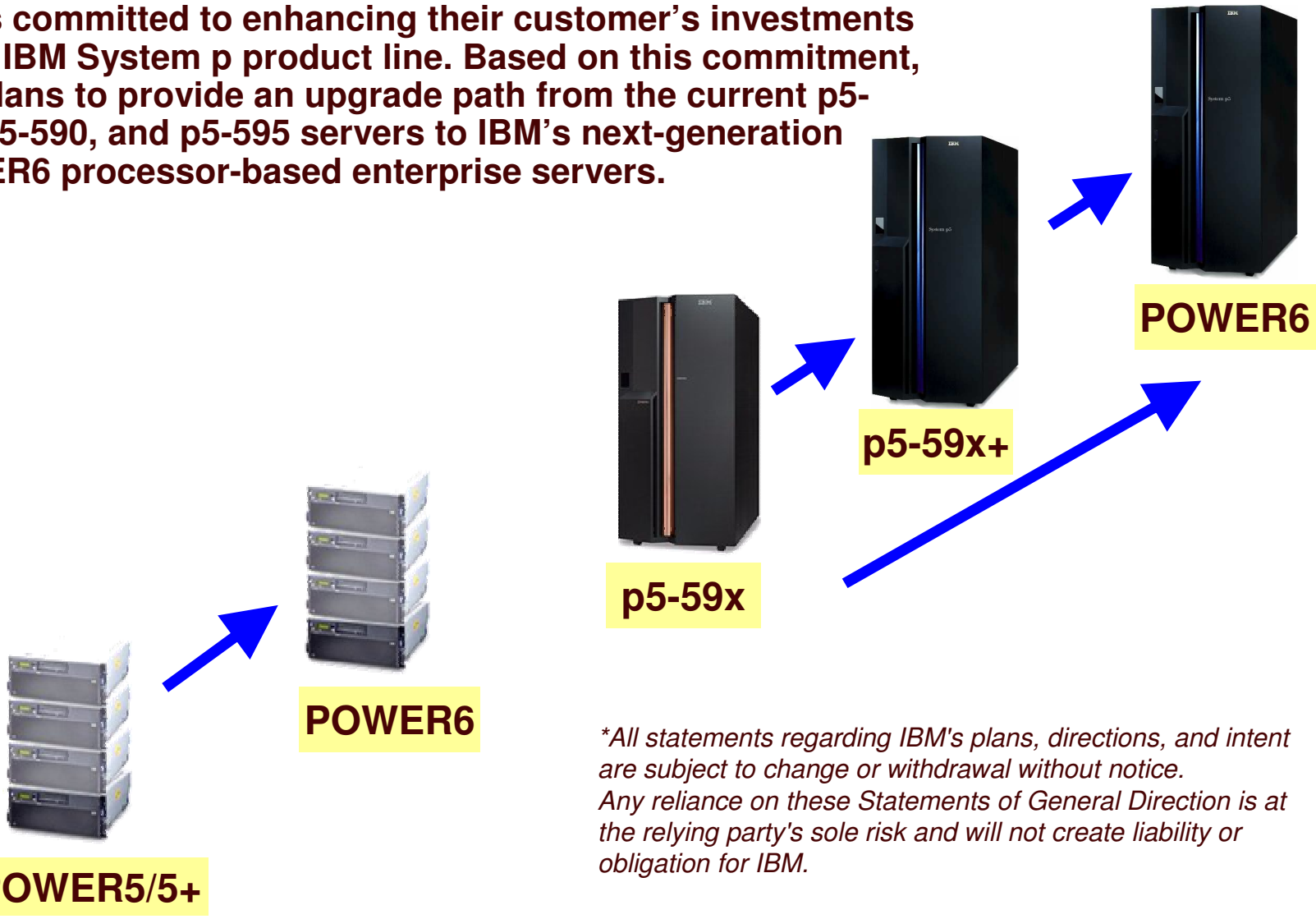
IBM System p Enterprise Servers

	IBM System p5™ 570	IBM System p 570	IBM System p5 575	IBM System p5 590	IBM System p5 595
					
Footprint, Packaging	19-inch 4U rack	19-inch 4U rack	24-inch frame by node	24-inch frame	24-inch frame
Processor	POWER5+™	POWER6	POWER5+	POWER5+	POWER5+
# of processors (# of cores)	2, 4, 8, 12, 16	2, 4, 8, 12, 16	8 , 16	8 to 32	16 to 64
GHz clock	1.9, 2.2	3.5, 4.2, 4.7	1.9, 2.2	2.1	2.1, 2.3
DDR2 GB memory	2 to 512	2 to 768	1 to 256	8 to 1TB	8 to 2TB
Internal storage*	73GB – 79.2TB	73GB – 79.2TB	146.8GB – 2.9TB	146.8GB – 18.7TB	146.8GB – 28.1TB
Maximum rPerf	95.56	134.35	N/A	202.88	393.55
PCIe PCI-X slots PCI-X 266 slots GX bus slots	0 6 to 163 0 1 – 4	4 to 16 0 to 140 2 to 128 2– 8	0 4 to 24 0 2	0 20 to 160 0 6 – 12	0 20 to 240 0 6 – 24
Max I/O drawers	20	32	1	8	12
Max micro-partitions	160[1]	160[1]	160[1]	254	254
System Cluster 1350	No	No	No	No	No
System Cluster 1600	Yes	Yes	Yes	Yes	Yes
HACMP™ (AIX® V5.3 and Linux)	Yes	Yes	Yes	Yes	Yes
AIX support	5.3, 5.2	5.3, 5.2	5.3, 5.2	5.3, 5.2	5.3, 5.2
Linux support	RHEL 4.5 SLES 9 or 10	RHEL 4.5 SLES 9 or 10	RHEL 4.5 SLES 9 or 10	RHEL 4.5 SLES 9 or 10	RHEL 4.5 SLES 9 or 10

1 Requires purchase of optional feature to support micro-partitions *With maximum I/O drawers Optional

POWER5/5+ to POWER6 Upgrade SOD

IBM is committed to enhancing their customer's investments in the IBM System p product line. Based on this commitment, IBM plans to provide an upgrade path from the current p5-570, p5-590, and p5-595 servers to IBM's next-generation POWER6 processor-based enterprise servers.



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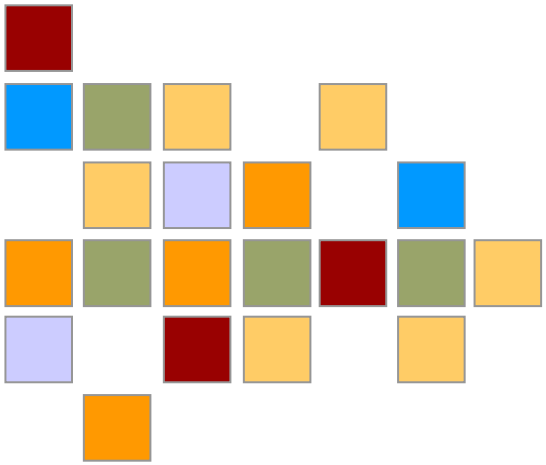
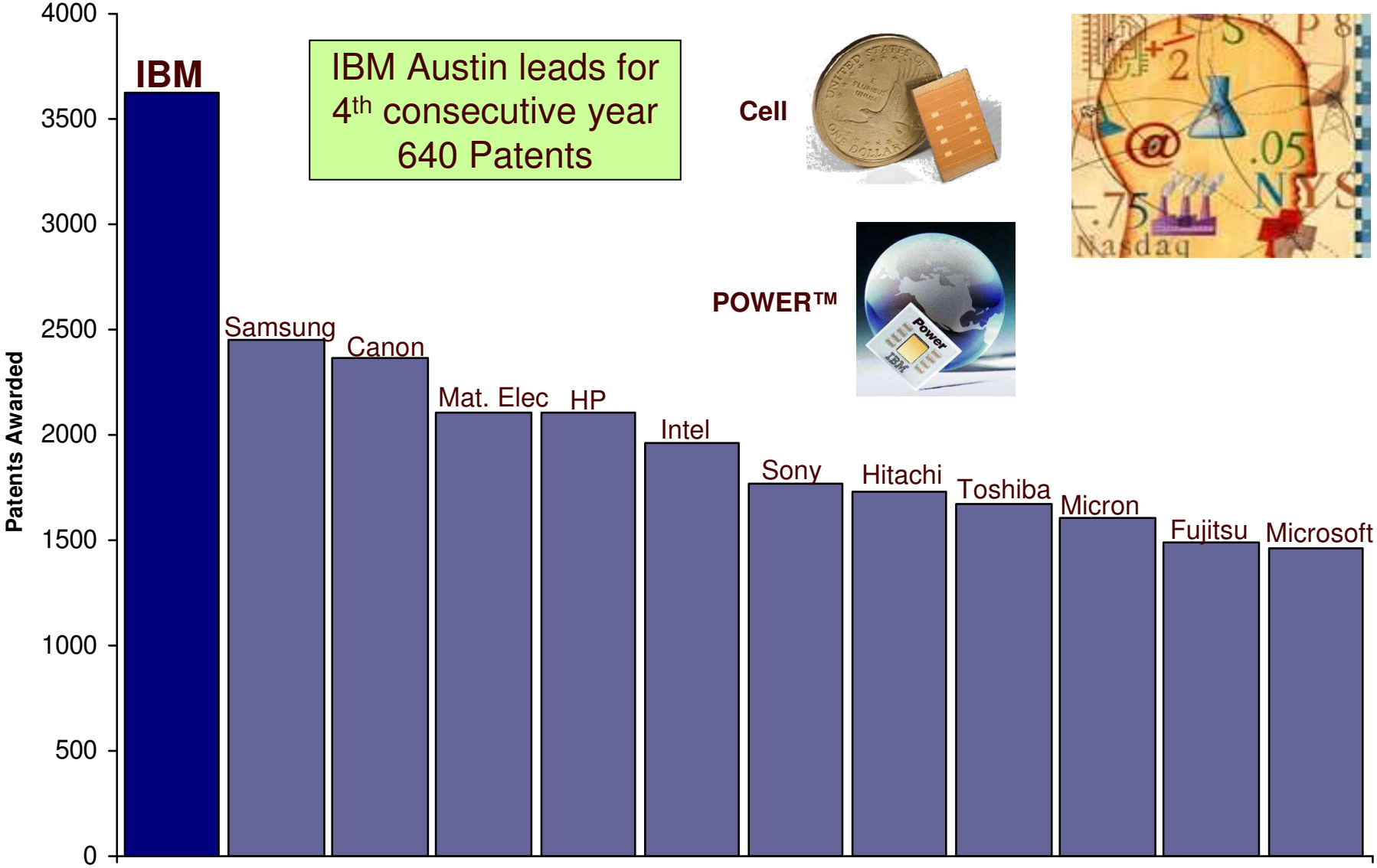


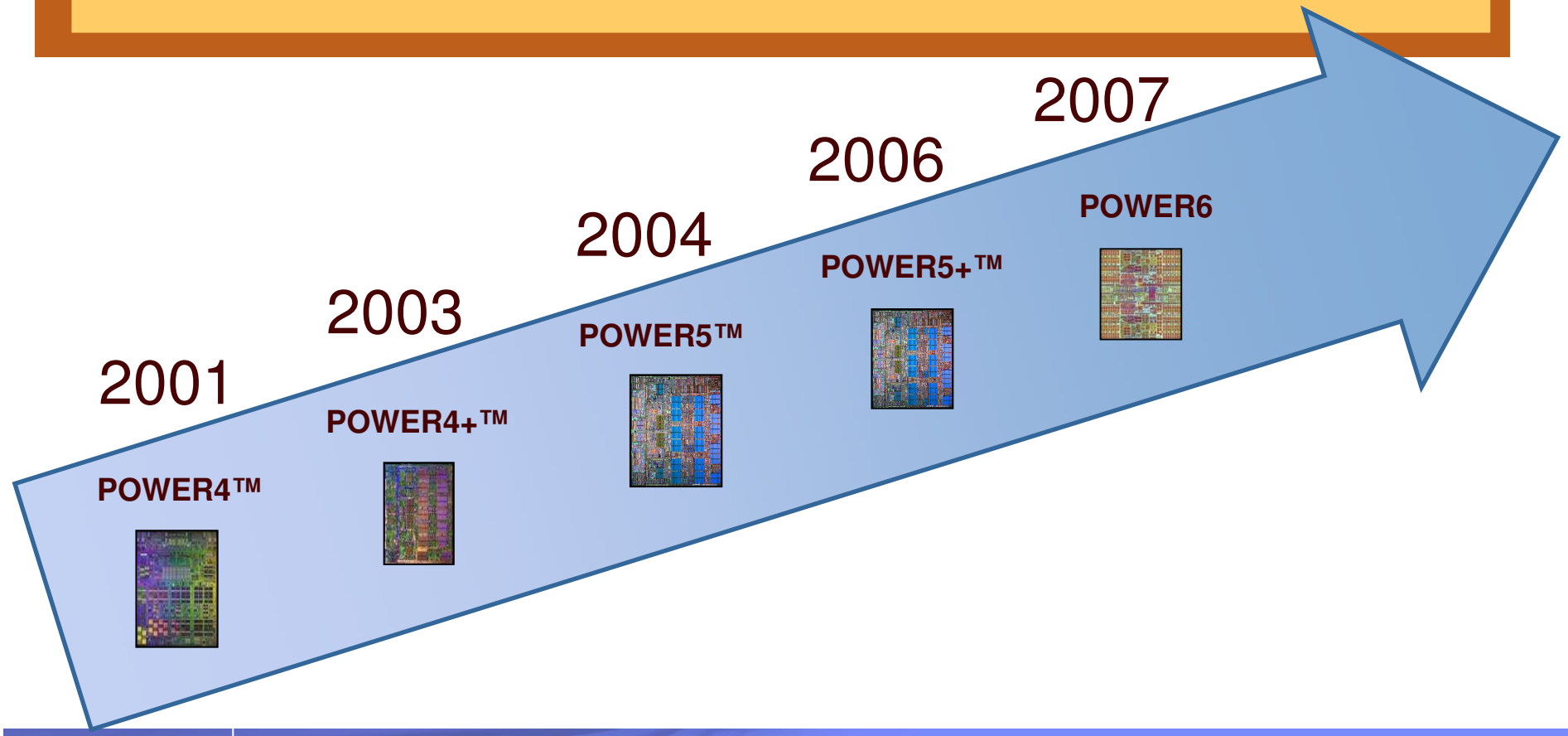
Processors

IBM's 2006 Patent Total: 14 Years of Leadership



IBM POWER Systems

Consistent Predictable Delivery

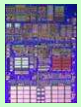


The IBM Power Architecture™ Roadmap*

System p will combine these POWER™ processor engines into systems to deliver higher-levels of customer value.

Throughput / Transaction Optimized


POWER4


PowerPC™ 970MP


POWER5 / 5+

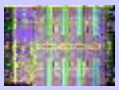

POWER6*

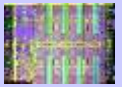

POWER7*

Specialty Engines


PowerPC 405


PowerPC 440


Cell


Cell +*

2002 2004 2006 2008 2010

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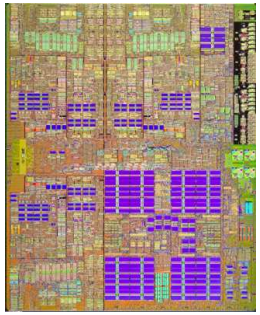
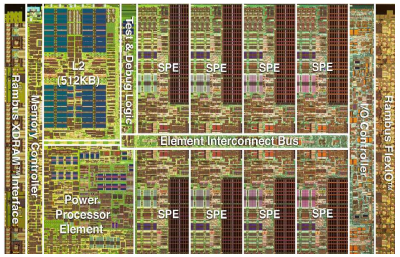
IBM POWER Technology

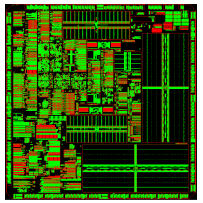


Microsoft Xbox 360®

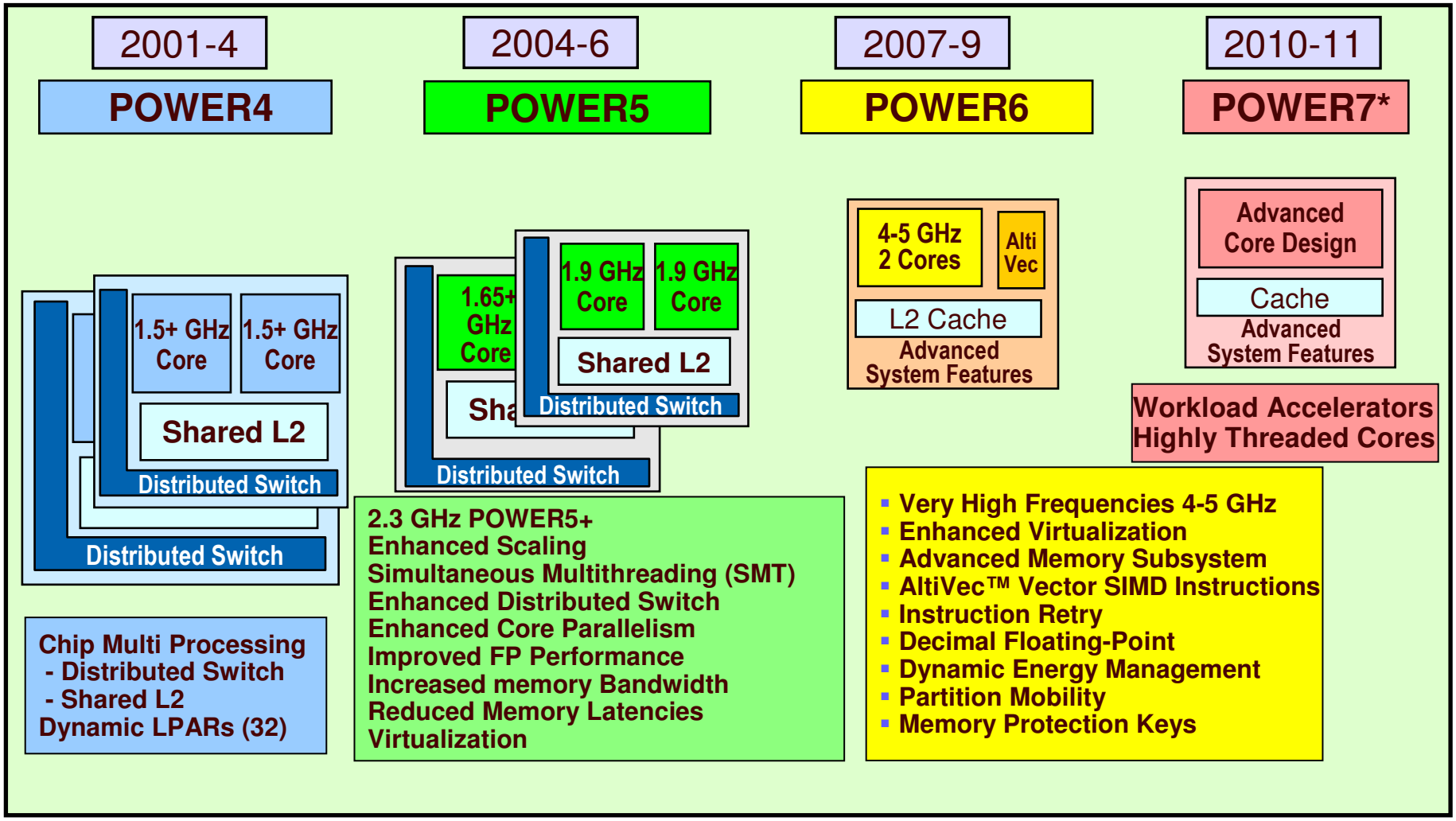
Sony PlayStation®3



Nintendo Wii®



POWER Technology



BINARY COMPATIBILITY

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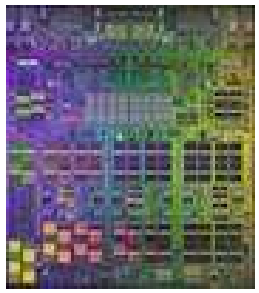
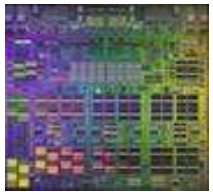
Processor History - 2001 - 2007

Dual-Core
1 GHz
Distribute Switch

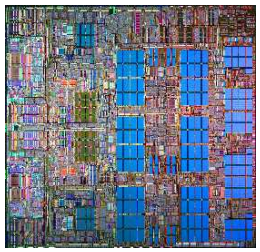


POWER4
414 mm²
1.1 – 1.3 GHz

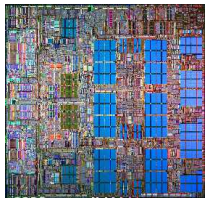


POWER4+
267 mm²
1.5 – 1.9 GHz

Multithreading
Memory Cntrl on Chip

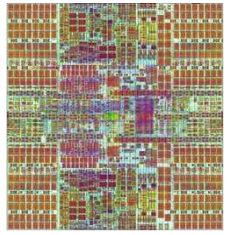


POWER5
389 mm²
1.65 – 1.9 GHz



POWER5+
245 mm²
1.9 – 2.3 GHz

Enhanced Multithreading
Memory Cntrl on Chip
>4 GHz



POWER6
341 mm²
3.5 – 5.0 GHz

2001 2002 2003 2004 2005 2006 2007 2008

Power Architecture Continues to Deliver for Performance

POWER6 Characteristics

Ultra-high frequency Dual-Core chip: > 3.5 GHz

- *7-way superscalar, 2-way SMT core*
  - *Up to five instructions for one thread, up to two for other*
- *Nine execution units*
  - *2LS, 2FP, 2FX, 1VMX, 1DP, BCX*
- *790M transistors, 341 mm^2 die*
- *Up to 64-core SMP systems*
- *2 x 4 MB on-chip L2 – point of coherency*
- *On-chip L3 directory and controller*
- *Two memory controllers on-chip*

Technology

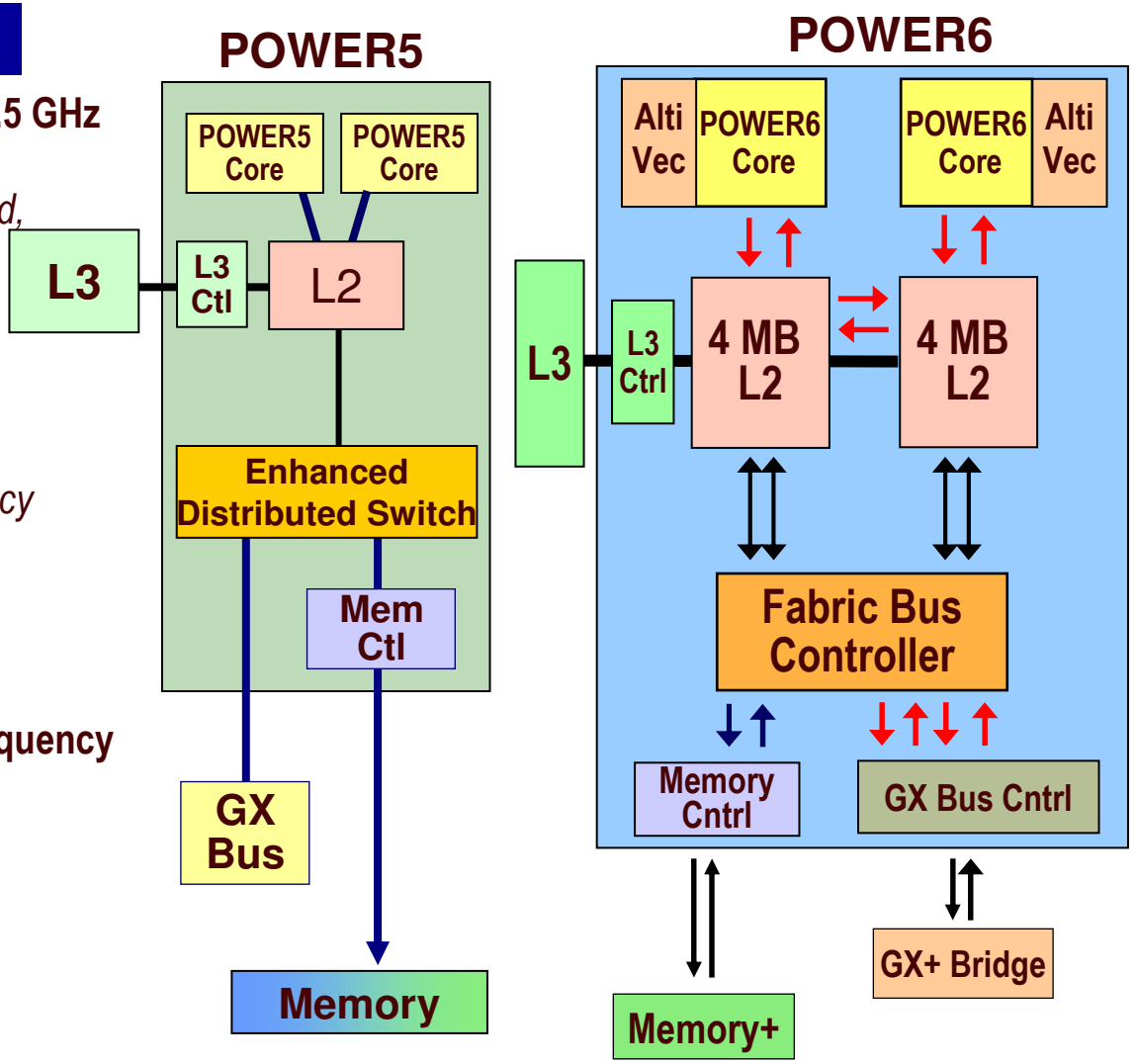
- *CMOS 65nm lithography, SOI Cu*

High-speed elastic bus interface at 2:1 frequency

Full error checking and recovery

Dynamic power saving

- *Advanced clock gating*



POWER6 Architecture

POWER Design	3.5 – 4.7 GHz	>750M transistors	.065 micron

POWER6 Characteristics

Ultra-high frequency Dual-Core chip: > 3.5 GHz

- *7-way superscalar, 2-way SMT core*
  - *Up to five instructions for one thread, up to two for other*
- *Nine execution units*
  - *2LS, 2FP, 2FX, 1VMX, 1DP, BCX*
- *790M transistors, 341 mm² die*
- *Up to 64-core SMP systems*
- *2 x 4 MB on-chip L2 – point of coherency*
- *On-chip L3 directory and controller*
- *Two memory controllers on-chip*

Technology

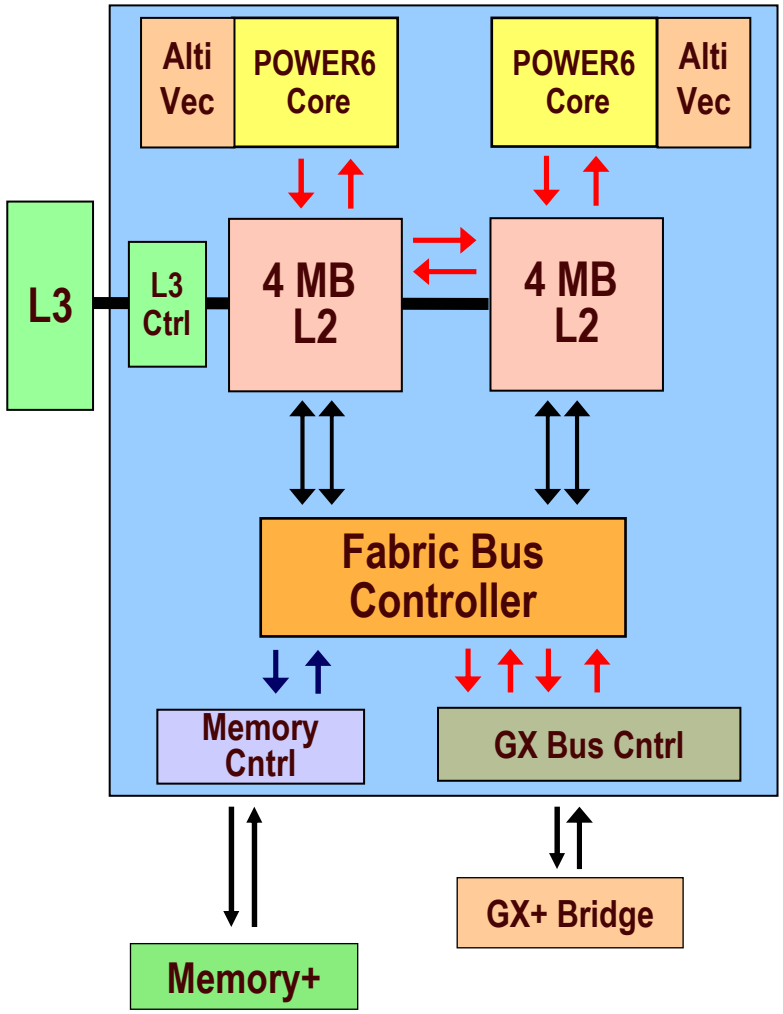
- *CMOS 65nm lithography, SOI Cu*

High-speed elastic bus interface at 2:1 frequency

Full error checking and recovery

Dynamic power saving

- *Advanced clock gating*



POWER5+ and POWER6 Hierarchy

	POWER5+	POWER6
L1 Cache		
ICache capacity, associativity	64 KB, 2-way	64 KB, 4-way
DCache capacity, associativity	32 KB, 4-way	**64 KB, 8-way**
L2 Cache		
Capacity, line size	1.9 MB, 128 B line	**2 x 4 MB, 128 B line**
Associativity, replacement	10-way, LRU	8-way, LRU
Off-chip L3 Cache		
Capacity, line size	36 MB, 256 B line	32 MB, 128 B line
Associativity, replacement	12-way, LRU	**16-way, LRU**
Memory	2 TB maximum	4 TB maximum
Memory bus	2x DRAM frequency	**4x DRAM frequency**

Processor Design

	POWER5+	POWER6
Style	General out-of-order execution	Mostly in-order with special case out-of-order execution
Units	2FX, 2LS, 2FP, 1BR, 1CR	2FX, 2LS, 2FP, 1BXU, 1DP,1VMX
Threading	Two SMT threads Alternate ifetch Alternate dispatch (up to five instructions)	Two SMT threads Priority-based dispatch **Simultaneous dispatch from two threads (up to seven instructions)**

POWER6 AltiVec Vector Technology

Dramatic application performance gains

SIMD (Single Instruction, Multiple Data) Extension to PowerPC Architecture™, jointly developed by Apple, Motorola, IBM

Targets High Performance Computing and Deep Computing applications

Benefit to ISVs / clients:

Provides highly parallel operations

Dramatically better performance for highly “vectorized” code

Development / test environment:

Current support: IBM BladeCenter® JS21 or IBM IntelliStation® POWER™ 185 Express

- Supported by AIX® and Linux releases

IBM XL C/C++ Enterprise Edition V8.0 for AIX (October 2005) provides

- Support for the AltiVec instruction set
- Support for the AltiVec programming model and APIs

IBM XL Fortran Enterprise Edition V10.1 for AIX (October 2005) can

- Automatically enable SIMD vectorization at higher levels of optimization

Additional compiler support for AltiVec™ vectorization extensions will be available in XL C/C++ V9.0, with Automatic SIMD vectorization

Redbook: http://www.redbooks.ibm.com/abstracts/redp3890.html

Processor Instruction Retry and Recovery

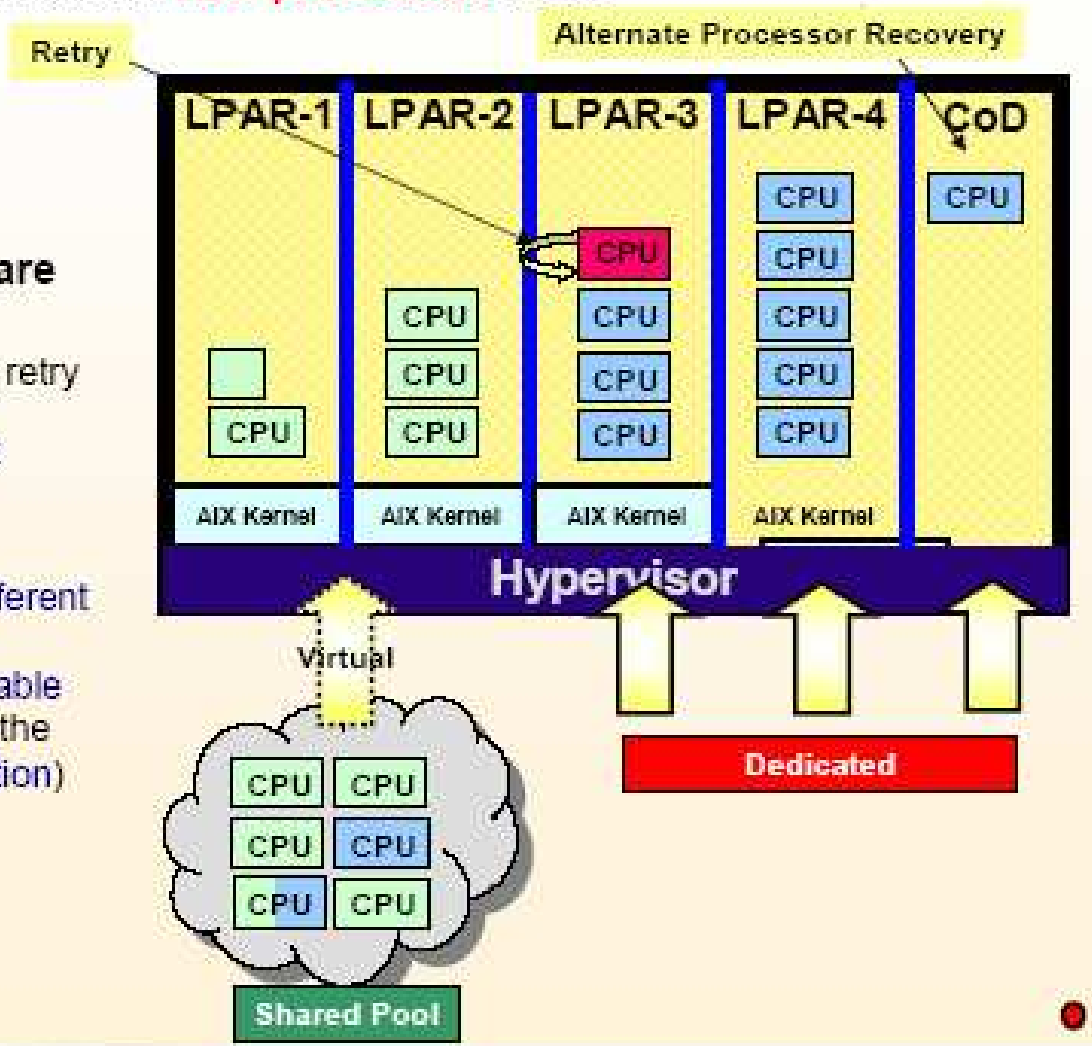
General: Hardware recovery from some non-predicted errors

Internal Checkpoint within each processor core

- Capable of preserving the state of processing operations

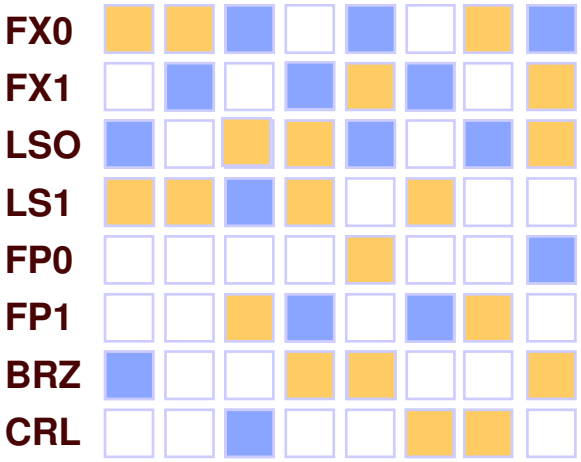
When certain unrecoverable faults are detected

- Previous checkpoint can be reloaded to retry operation from the last checkpoint
  - Recovers transparently from transient errors
- If retry is unsuccessful
  - Checkpoint can be reloaded into a different processor core
  - Spare processor may be used if available
  - Else Checkstop can be limited to just the processor w/error (partition fault isolation)



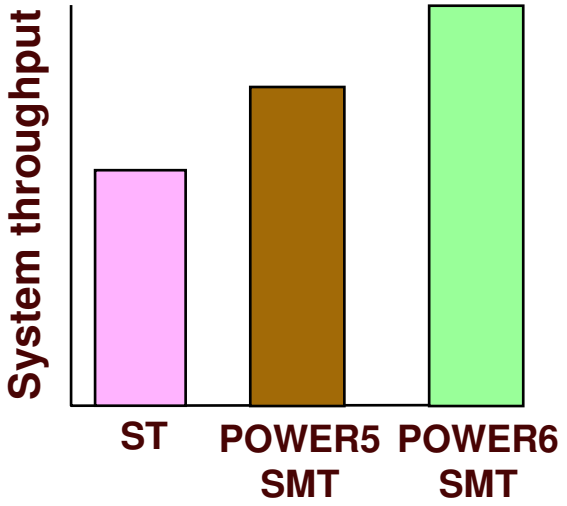
POWER6: Simultaneous Multithreading

POWER5 Simultaneous Multithreading



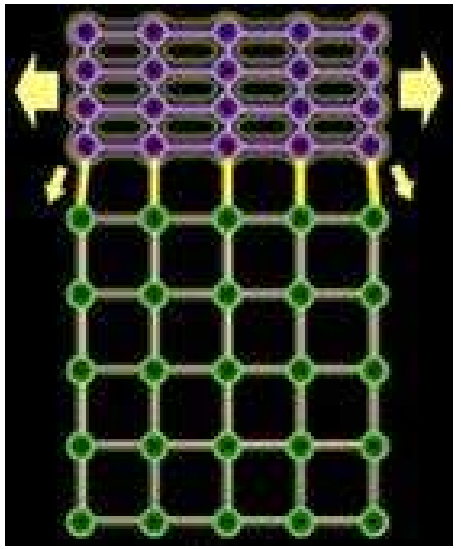
Thread0 active
No thread active
Thread1 active

Appears as four CPUs per chip to the operating system (AIX V5.3 and Linux)



- Utilizes **unused execution** unit cycles
- **Reuse of existing transistors vs. performance from additional transistors**
- Presents symmetric multiprocessing (SMP) programming model to software
- Dispatch two threads per processor: *"It's like **doubling** the number of processors."*
- Net result:
  - ***Better performance***
  - ***Better processor utilization***

Dual Stress Technology

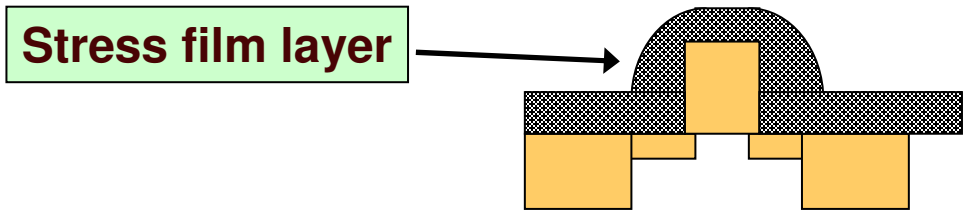


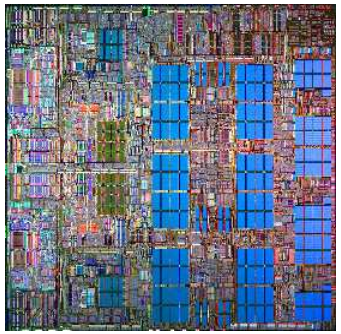
What is it?

- Incorporated into POWER5+ processor technology
- Strained Silicon on Silicon-on-Insulator technology
- Stretches and compresses transistors
  - Stress film technology
  - Provides more efficient flow of electrons
- No special materials required

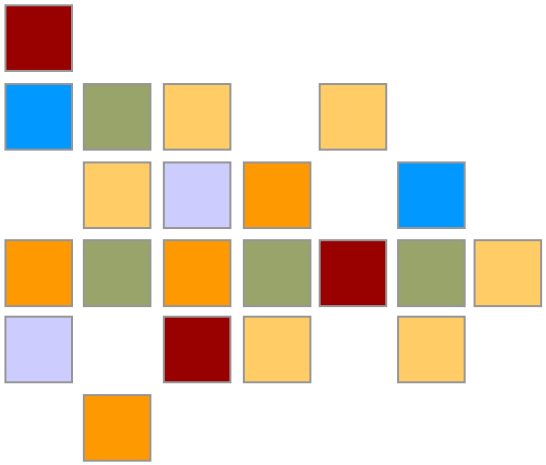
Benefit

- Increase transistor speeds by up to 20% without increasing power consumption
- Reduce electric current leaks
- Greater performance without increasing power and heat





POWER5+



System p 570

POWER6

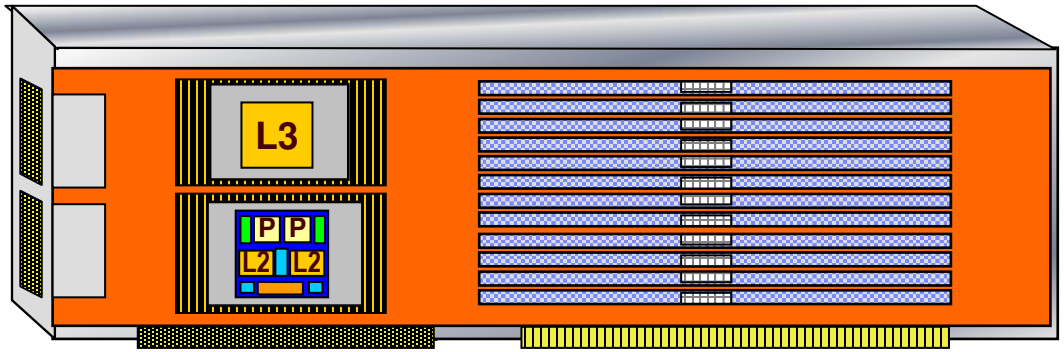
System p 570

Warranty:
1-year NBD

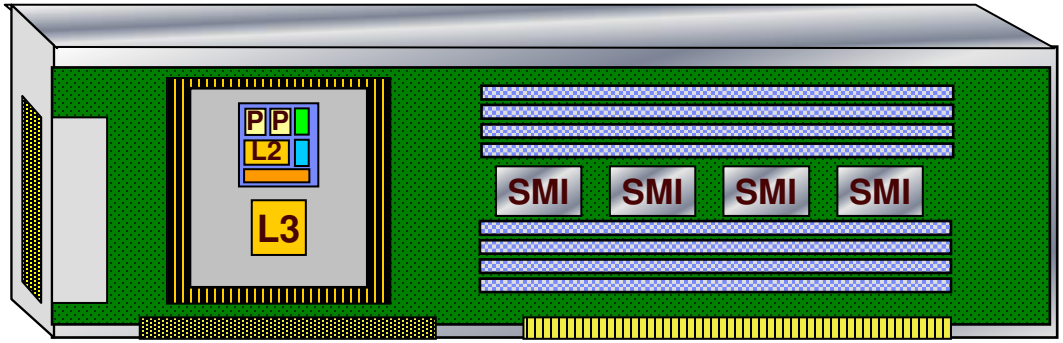
Base system	2- or 4-core systems @ 3.5 / 4.2 / 4.7GHz POWER6 ▸ Expandable to 16-core system 4U rack-mount modules
Functions supported	Dynamic LPAR with Shared Dedicated Processor support IBM Advanced POWER Virtualization option ▸ Micro-Partitioning support (1/10th processor granularity) ✓Maximum 160 partitions ▸ Virtual networking and storage support Integrated Virtual Ethernet Capacity on Demand for processors and memory
Features per Module	Up to 192GB DDR2 memory ▸ Max 768GB 16-core system Four PCIe& Two PCI-X slots Dual Service processor support Integrated Virtual Ethernet USB: 2; System: 2, RIO: 2 One media bay (Optional) Two GX Bus slots Up to six SAS disk drives Redundant cooling and power I/O drawers: ▸ 7311-D11, 7311-D20, or 7314-G30 ▸ Maximum of 32 drawers / 16-core system
Software support	AIX V5.2 and AIX V5.3 Red Hat Enterprise Linux 4.5 for POWER / SoD RHEL 5 SUSE Linux Enterprise Server 9 or 10 for POWER

POWER6 / 5+ Midrange Processor / Memory Packaging

SCM @ 3.5 – 4.7 GHz
Up to 96 DDR2+ memory
Two cores / book

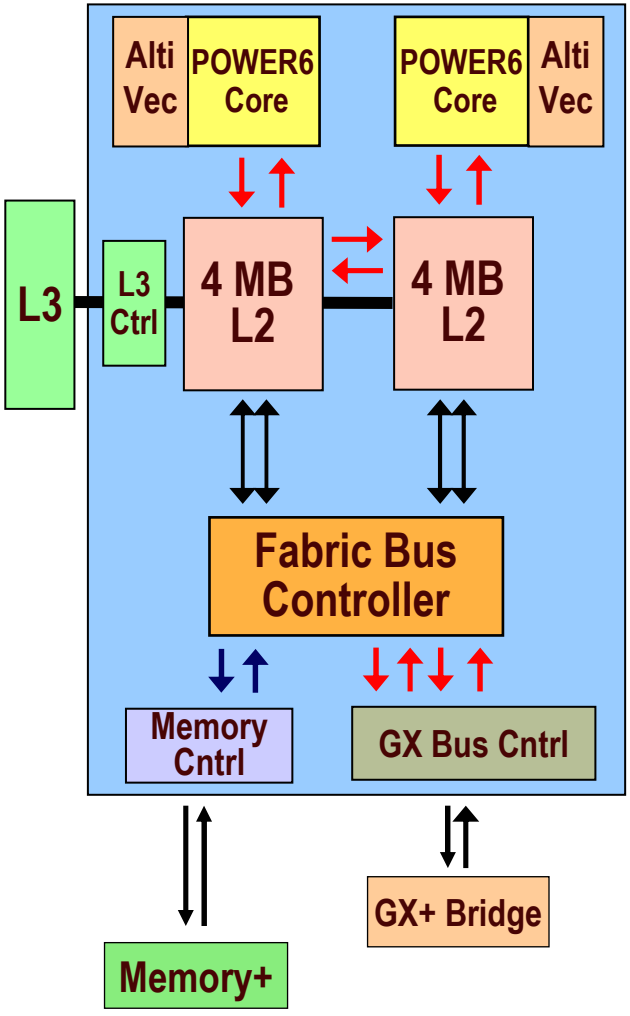


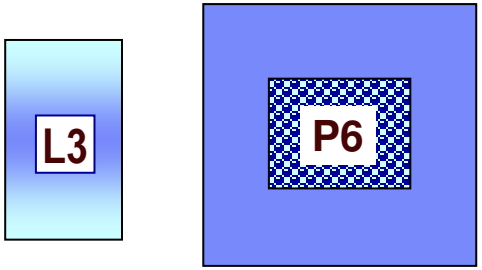
p5-570+ DCM @ 2.2 GHz
Up to 64 GB DDR2 memory
Two cores / book



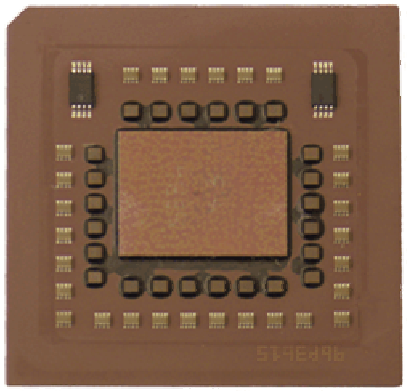
50% More DIMM Slots
Greater Memory Flexibility

System p 570 POWER6 Packaging



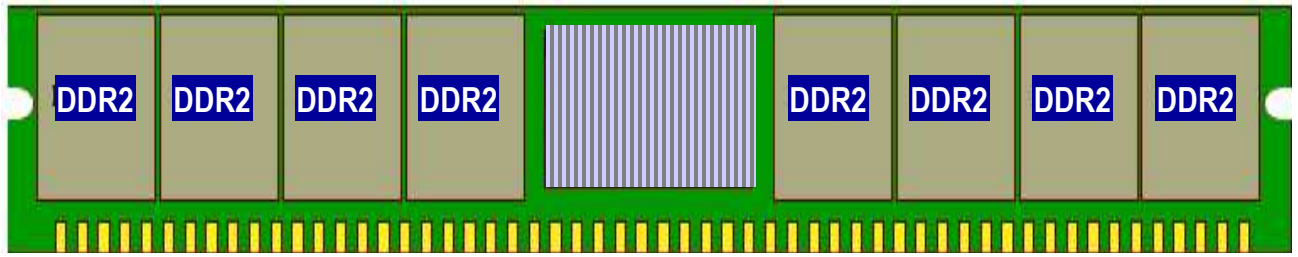


Single Chip Module POWER6 & L3

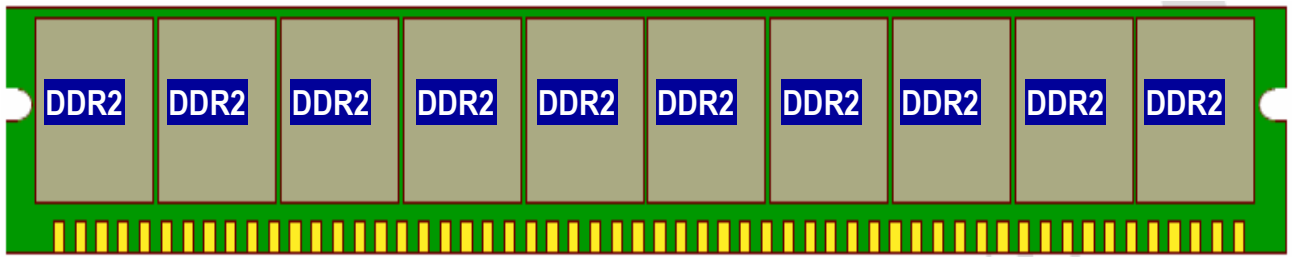


POWER6 Processor Module

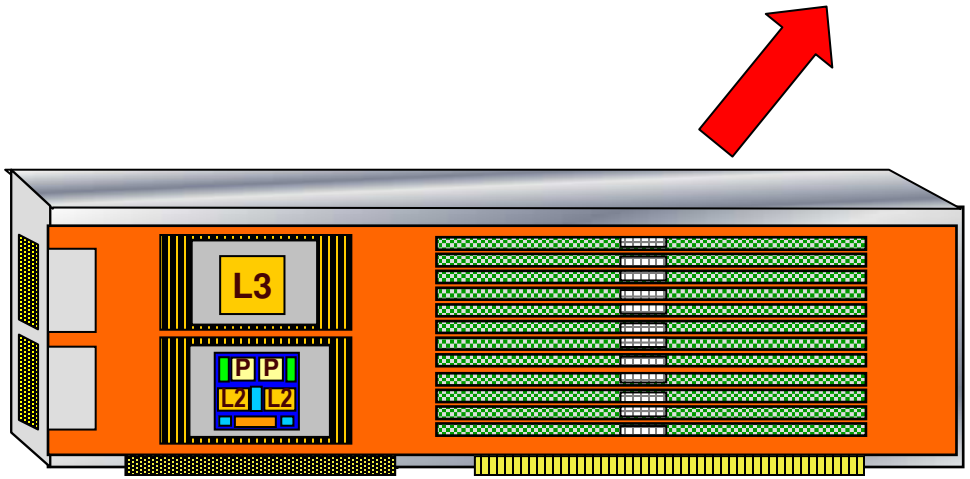
POWER6 DDR2 Memory DIMMs



Front

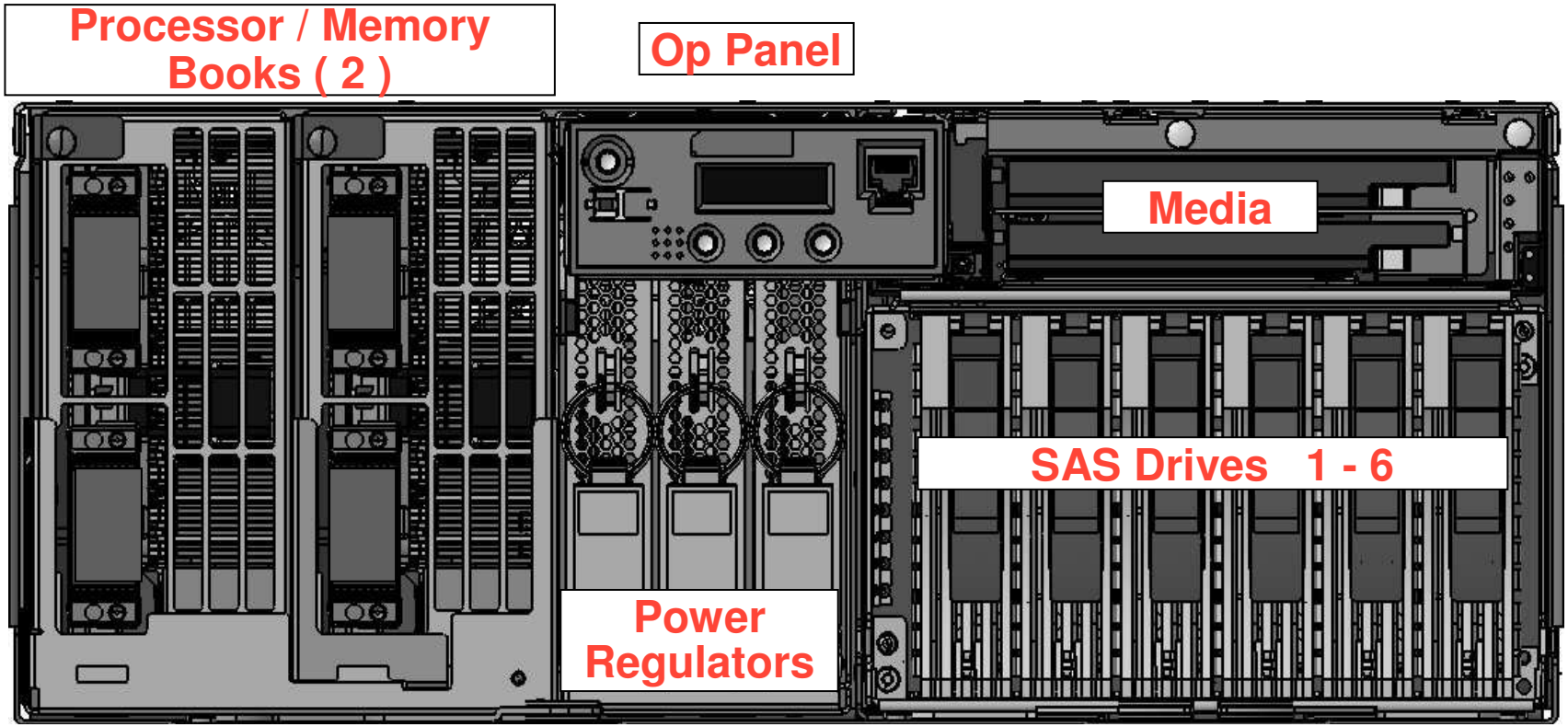


Back



50% More DIMM Slots
Greater Memory Flexibility

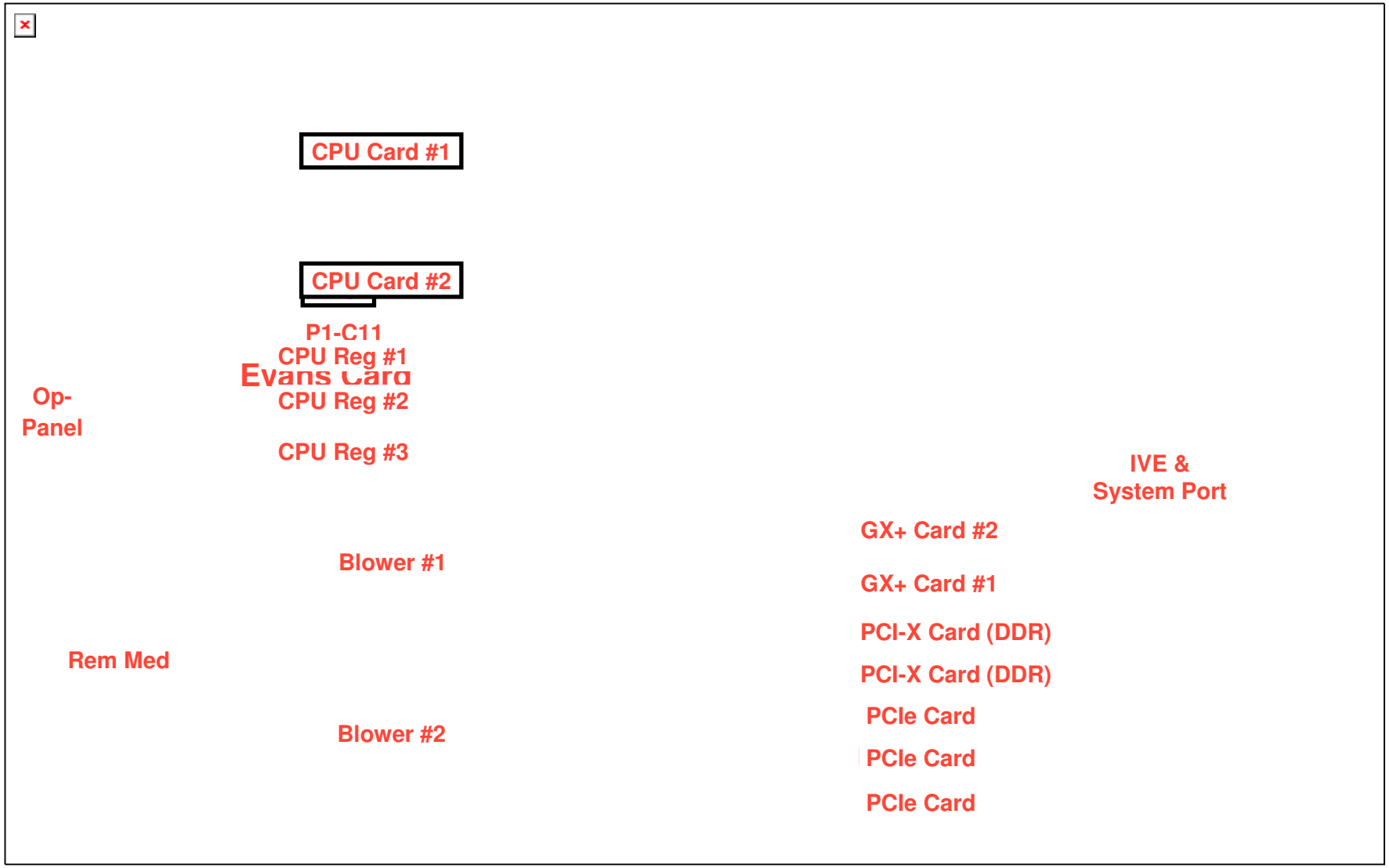
Front View



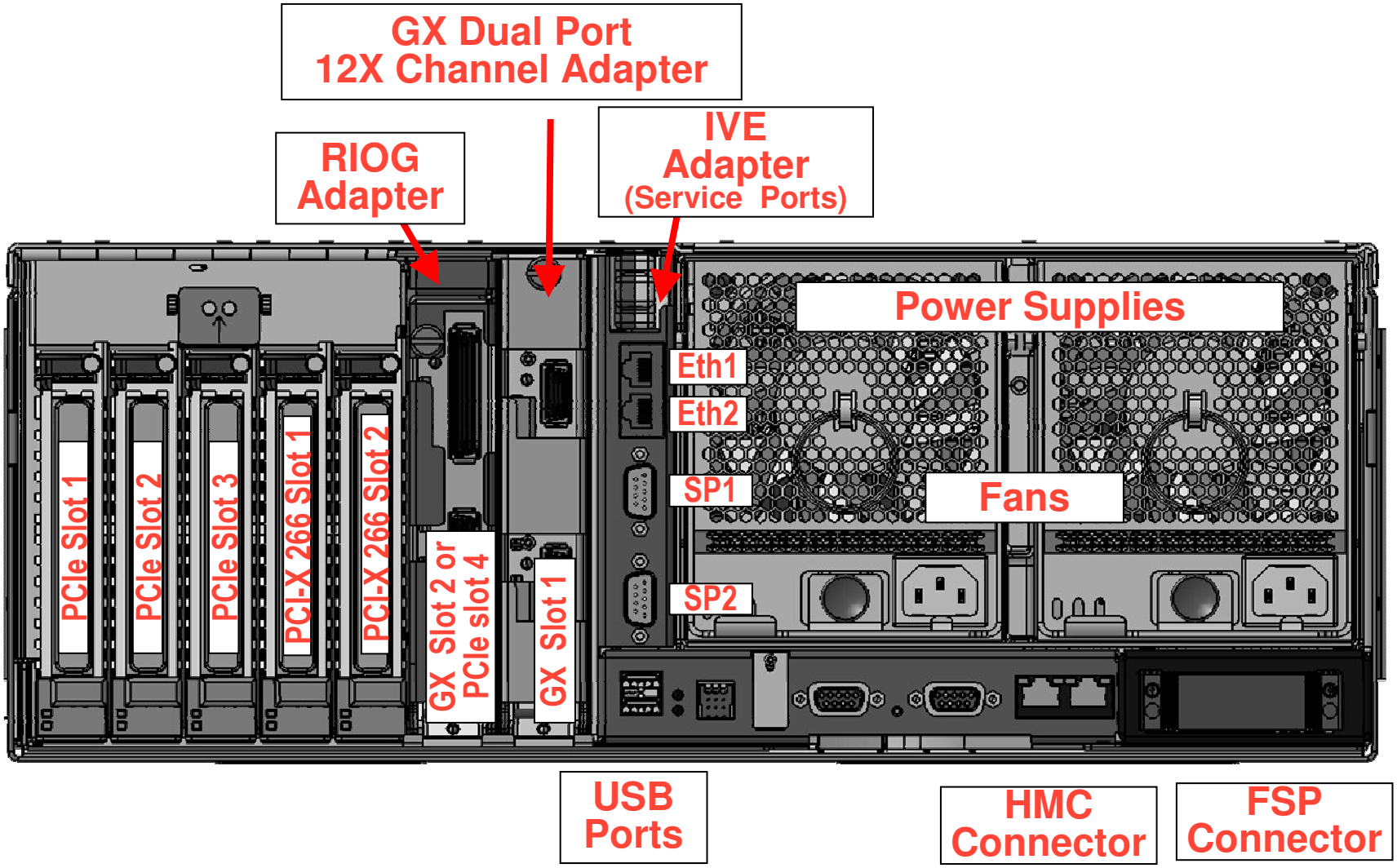
- Six 3.5” SAS disk bays
- One SAS/SATA controller
- SAS hot-swappable disk drives supported:
  - 15K rpm: 73.4, 146.8 and 300GB
- Maximum internal capacity of 1.8 TB

* 79.2 TB with optional I/O drawers in a 16-core system

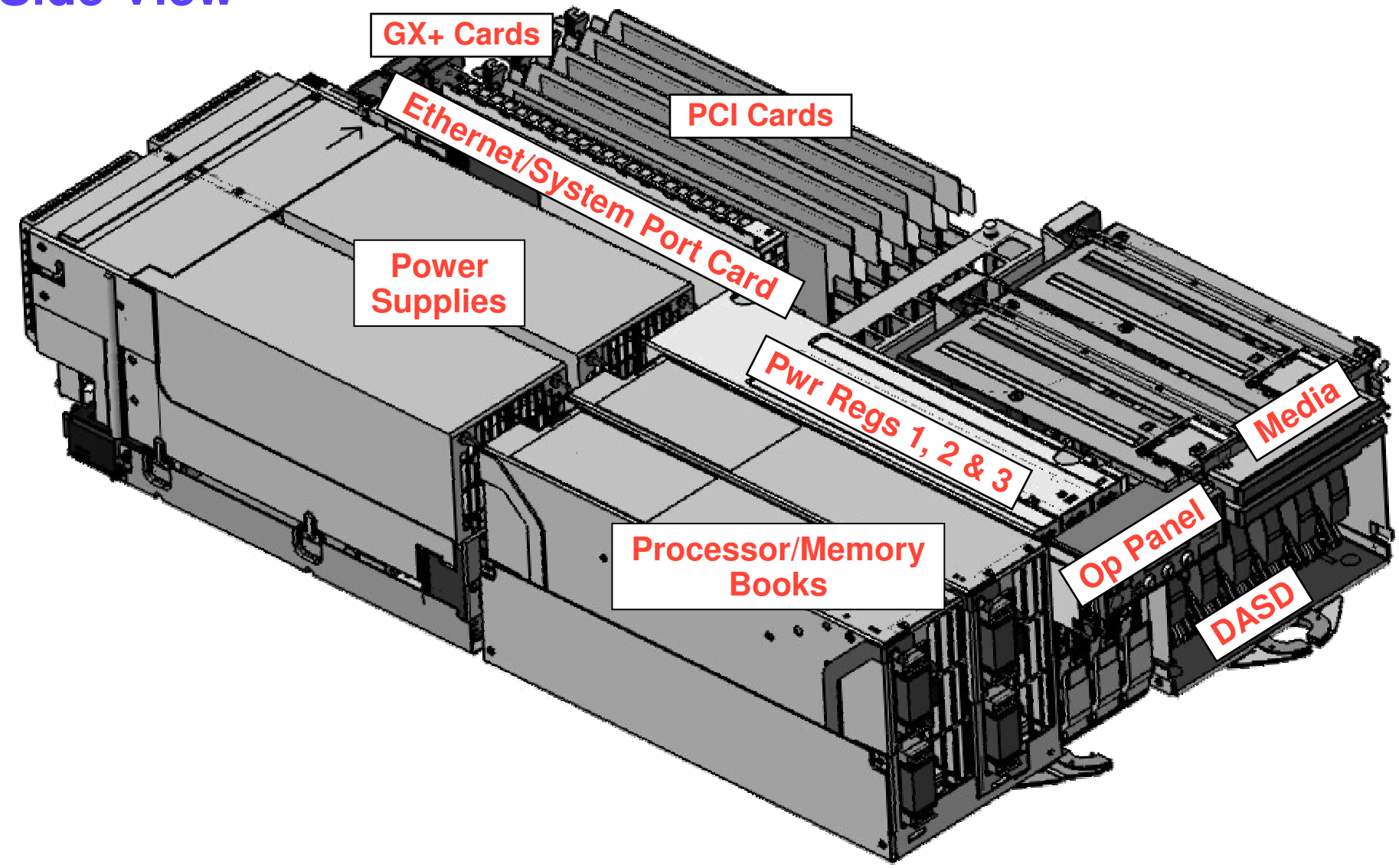
Top View



Back View

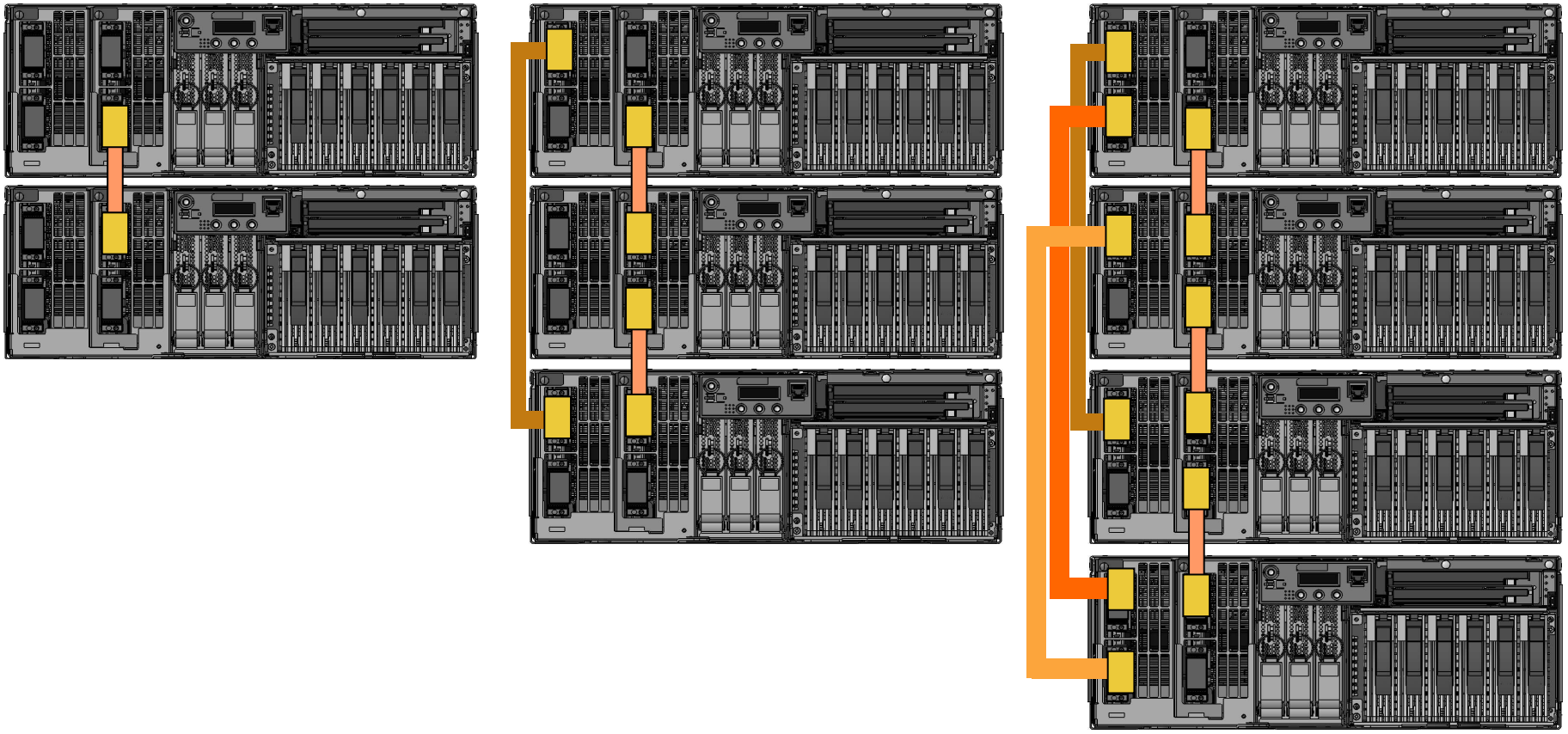


Side View



Building Block Modules: SMP Mid-range Server

Interconnect configurations of 8 / 12 / 16-core servers
Point-to-point connections



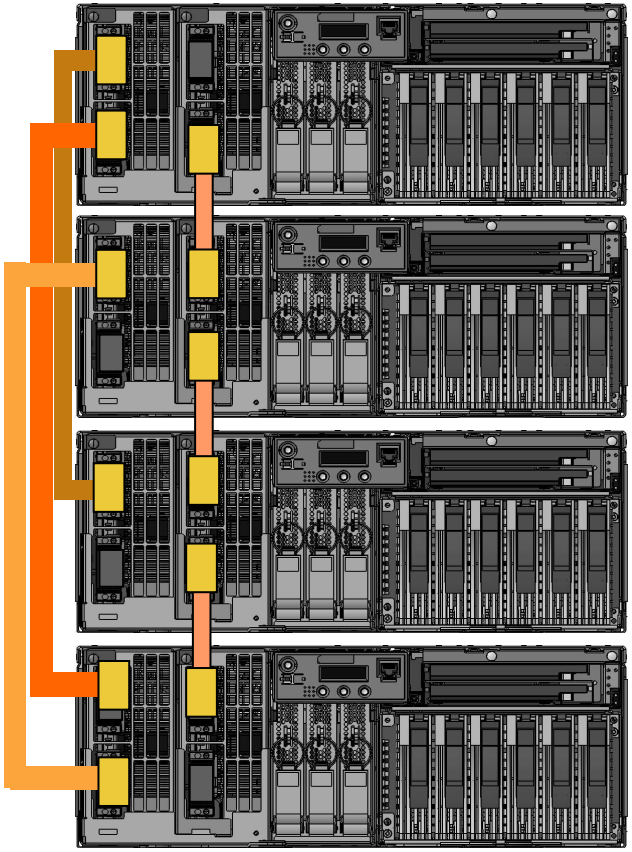
System p 570 Bandwidth

Memory	Bandwidth
L1 (Data)	**75.2** GB/sec
L2	**300.8** GB/sec
L3	**37.6** GB/sec
Memory	**32** GB/sec
Inter-Node Buses (16w)	**75.2** GB/sec
Intra-Node Buses (16w)	**100.26** GB/sec
Internal I/O Bus GX Bus Slot 1 GX Bus Slot 2 Total I/O Bandwidth	**4.7** GB/sec / node **4.7** GB/sec / node **6.266** GB/sec / node **62.6** GB/sec (16w)

Calculations for 4.7 GHz processors and 667 MHz memory

Building Block Modules Create SMP Servers

Configuration considerations of 16-core, 4-module server



Operator panel and service processor* required on first module.
If required, one or two HMCs attached to first module only.
Media required on first module only.
One disk drive required on first module only.
Attaches up to eight I/O drawers.

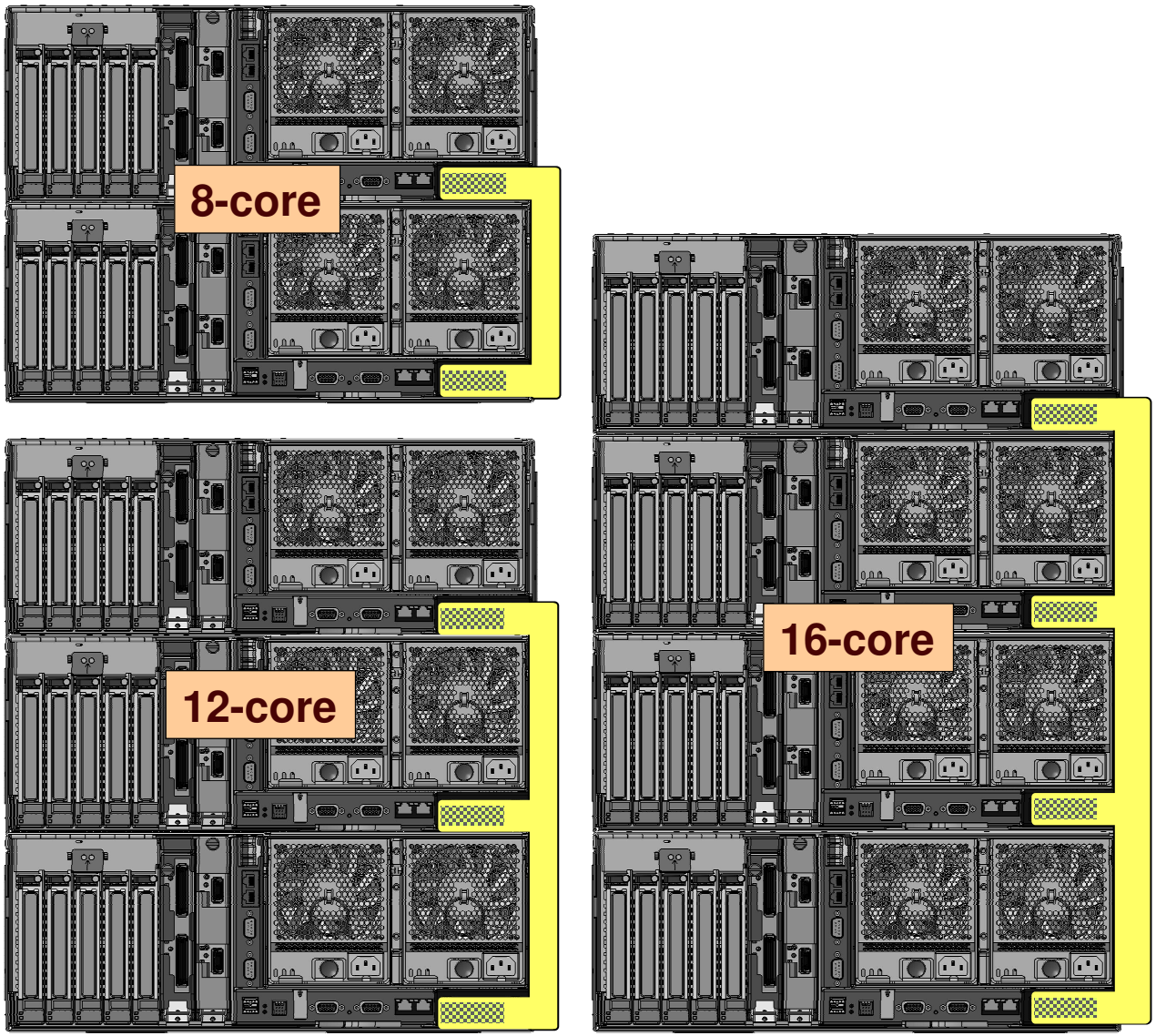
Plus eight more I/O drawers for 16

Plus eight more I/O drawers for 24

Plus eight more I/O drawers for a maximum of 32 I/O drawers

***Note: The service processor in the first or primary module controls the two serial ports on the rear of that module. If a HMC is chosen as an option, the two serial ports will not be available for use. A PCI-X slot will be required.**

Service Processor Cabling Layouts



Service processor and clock use flat flex cabling to integrate individual 4-core servers into a single SMP server (rear view)

SAS (Serial Attached SCSI) DASD

Parallel SCSI vs. Serial Attached SCSI (SAS)		
	Parallel SCSI	**SAS**
Architecture	Parallel, all devices connected to shared bus	Serial, point-to-point, discrete signal paths. Often requires switches for fanout
Performance	**320 Mbytes/sec** (Ultra320 SCSI); performance degrades as devices added to shared bus	**3.0 Gbits/sec full duplex, roadmap to 12.0 Gbits/sec**; performance maintained as more drives added
Scalability	**15 drives**	**Over 16,000 drives**
Compatibility	Incompatible with all other drive interfaces	Compatible with Serial ATA (SATA)
Max. Cable Length	12 meters total (must sum lengths of all cables used on bus)	Eight meters per discrete connection; total domain cabling thousands of feet
Cable Form Factor	Multitude of conductors adds bulk, cost	Compact connectors and cabling save space, cost
Hot-plug Ability	Yes (not inherent in architecture)	Yes
Device Identification	Manually set, user must ensure no ID number conflicts on bus	Worldwide unique ID set at time of manufacture; no user action required
Termination	Manually set, user must ensure proper installation and functionality of terminators	Discrete signal paths enable devices to include termination by default; no user action required

System p 570 SoD

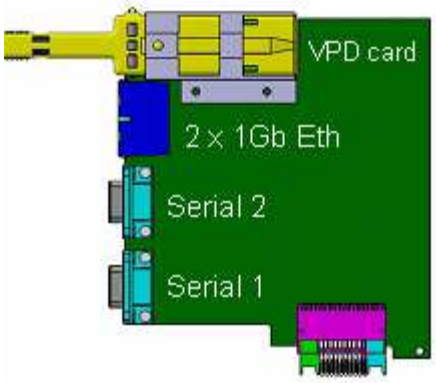
Redundant Service Processor

For POWER6 processor-based p570 systems with at least two CEC enclosures to have redundant service processor function no later than the end of 2007. This feature will be provided at no additional charge to existing POWER6 processor-based p570 users via a system firmware update.

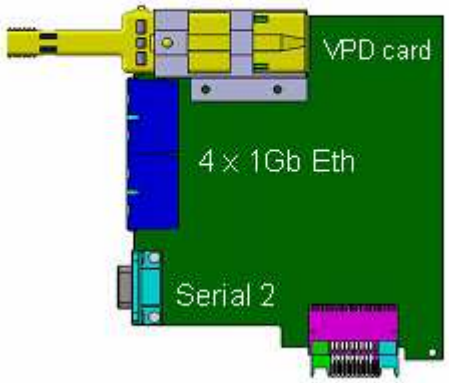
Planned availability: No later than the end of 2007

Integrated Virtual Ethernet

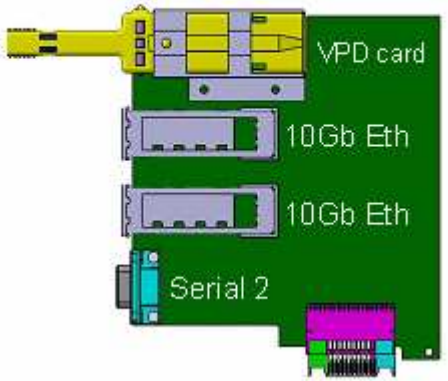
Base Offering: #5636
2 Serial, 2 1Gb Eth



4 x 1Gb Upgrade Offering: #5639
1 Serial, 4 1Gb Eth



10Gb Upgrade Offering: #5637
1 Serial, 2 10Gb Eth



Address Sharing:

- **Dual 1GB: 16 MAC Addresses / pair Total: 16**
- **Quad 1GB 16 MAC Addresses / pair Total: 32**
- **Dual 10GB: 16 MAC Addresses/ port Total: 32**

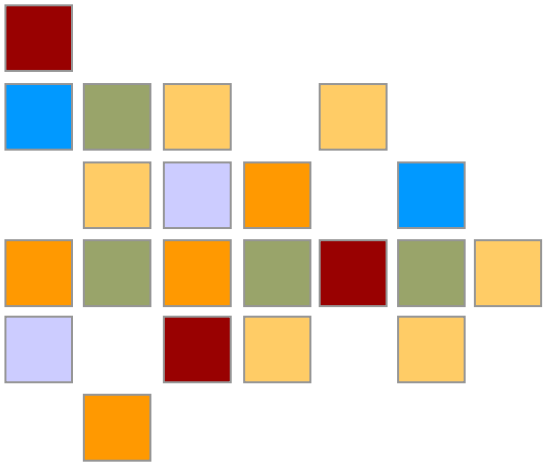
Non VIOS Partition: Address Sharing (MAC Addresses)

- **Time Slicing "Physical" Ethernet adapter resources**

VIOS Partitions: IVE ports dedicated

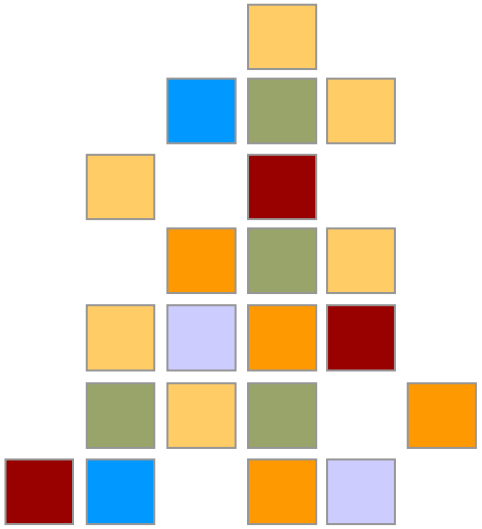
- **Each Physical port uses 102MB of memory**

A 4 port card uses 408MB of memory



Reliability, Availability and Serviceability

Primary POWER RAS Features

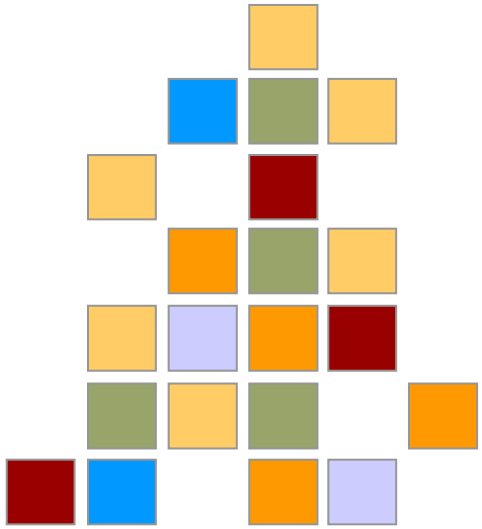


- ✓ Processor Instruction Retry
- ✓ Alternate Processor Recovery
- ✓ First Failure Data Capture
- ✓ DDR Chipkill™ memory
- ✓ Bit-steering/redundant memory
- ✓ Service Processor Failover*
- ✓ Dynamic Firmware Maintenance*
- ✓ Hot I/O Drawer Add*
- ✓ I/O error handling extended beyond base PCI adapter
- ✓ ECC extended to inter-chip connections for the fabric/processor buses
- ✓ Memory and L3 Cache soft scrubbing
  - ✓ Hardware Assisted
- ✓ L2 & L3 Cache Line Delete
- ✓ Hardware Assisted Memory Scrubbing
- ✓ Live Partition Migration
- ✓ P570 Concurrent Add & Cold Repair (SoD)

HMC required to enable these functions..

Primary POWER RAS Features con't

- ✓Redundant power, fans
- ✓Dynamic Processor Deallocation
- ✓Dynamic processor sparing
- ✓ECC memory
- ✓Persistent memory deallocation
- ✓Hot-plug PCI slots, fans, power
- ✓Internal light path diagnostics
- ✓Hot-swappable disk bays



HMC required to enable these functions..

World-class Hardware RAS

Summary of key System p RAS features

Core System Design

- *High quality parts*
- *Fewer parts = Fewer failures*
- *Designed for low power consumption (less heat = fewer failures)*
- *Manufacturing methods, packaging, cooling*
- *Continuous System and Commodity Quality Actions*
- *Integrated RAS features*
- *Failure Avoidance Methodology*
- *Designed for Ease of Service*

Fault Resilience

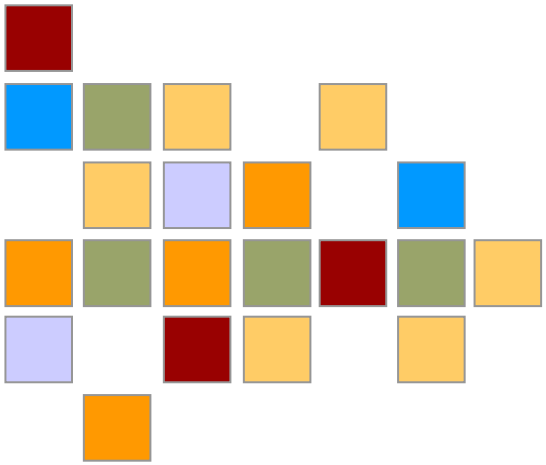
- *N+1 Power Supplies, regulators, power cords*
- *Dual redundant fans*
- *Dynamic Processor Deallocation and sparing*
- *"Chipkill" Technology*
- *Predictive Failure Analysis*
- *Auto Path Reassignment - data paths, power*
- *Processor Instruction Retry*

System Restore

- *Deferred Repair*
- *Concurrent Repair*
- *LED Service Identification*
- *Service Consoles*
- *Migration to Guided Maintenance*

Fault Isolation & Diagnosis

- *First Failure Data Capture*
- *Run Time Self Diagnostics*
- *Service Processor*
- *Rifle-shot repairs (no "plug and pray" parts replacement approach)*



Virtualization

IBM's 40-year History of Leadership in Virtualization

1967 — IBM develops **hypervisor** that would become VM on the mainframe

1973 — IBM announces first machines to do **physical partitioning**

1987 — IBM announces **LPAR on the mainframe**

1997 — **POWER LPAR design** begins

2001 — IBM introduces **LPAR in POWER4™ with AIX**

2004 — **Advanced POWER Virtualization** ships

2007 — IBM announces POWER6, **the first UNIX® servers with Live Partition Mobility**

"In our opinion, they [System p servers] bring mainframe-quality virtualization capabilities to the world of AIX."

- Ulrich Klenke, CIO, rku.it
January 2006

Advanced POWER Virtualization on IBM System p servers

AIX

Linux® on POWER

client quote source: rku.it case study published at http://www.ibm.com/software/success/cssdb.nsf/CS/JSTS-6KXPPG?OpenDocument&Site=eserverpseries

System p5™ Servers Running APV

Royal Bank of Canada
BRED Banque
HSBC
AES/PHEAA
Fifth Third YeePay
Raiffeisen Bank

Acquedotto
Alstom
ISAGEN
TransAlta

Metlife

Franklin Covey
Dundee University
Central Michigan U

Whirlpool
Miele

Sinopec
Bangchak Petroleum

Campbell Soup

Plansee
Wuerth Group
Teleflex
Pilz CmbH & Co

UPMC
Byram Healthcare
Mayo Clinic
St Michael's Hospital

Audi
DaimlerChrysler

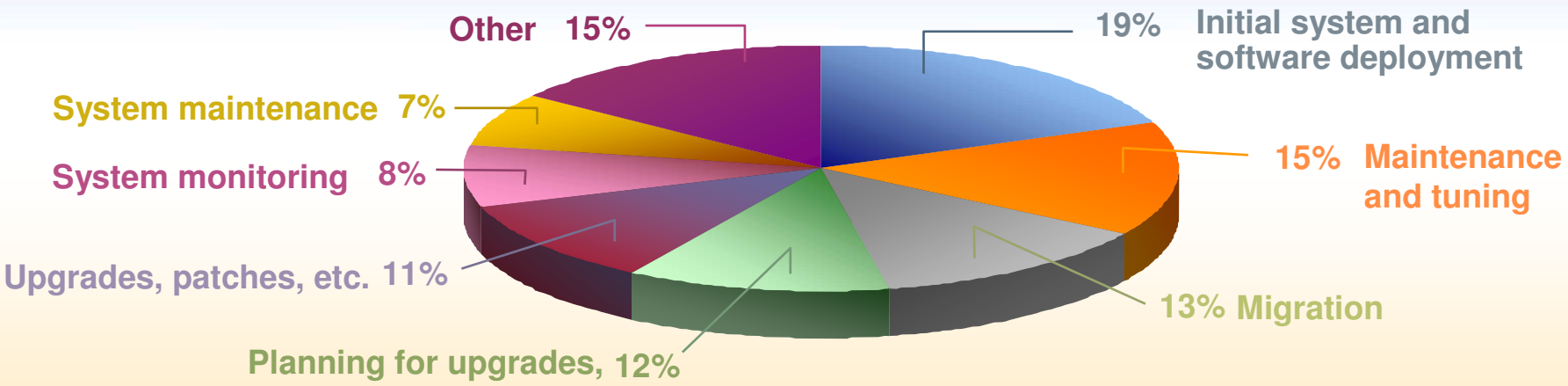
Service Canada
PWGSC
DND
Industry Canada
Health Canada
IBM

Source: IBM Finance data. Full case studies for each named client are available at http://www.ibm.com/software/success/cssdb.nsf/advancedsearchVW?SearchView&Query=(Virtualization)+AND+[WebSiteProfileListTX]=eserverpseries&site=eserverpseries&frompage=ts&Start=1&Count=30&cty=en_us

Virtualization Changes Everything

- Deployment, maintenance, and migration of IT resources are top contributors to cost today
- With the right tools, virtualized resources can be easier to create, adjust, move, clone, checkpoint
- New complexities can emerge
  - Rapid growth of virtualized resources across multiple environments
  - Relationship of virtualized resources to underlying physical infrastructure
  - Health monitoring and problem determination across a physical and virtualized infrastructure

Server Management and Administration Costs

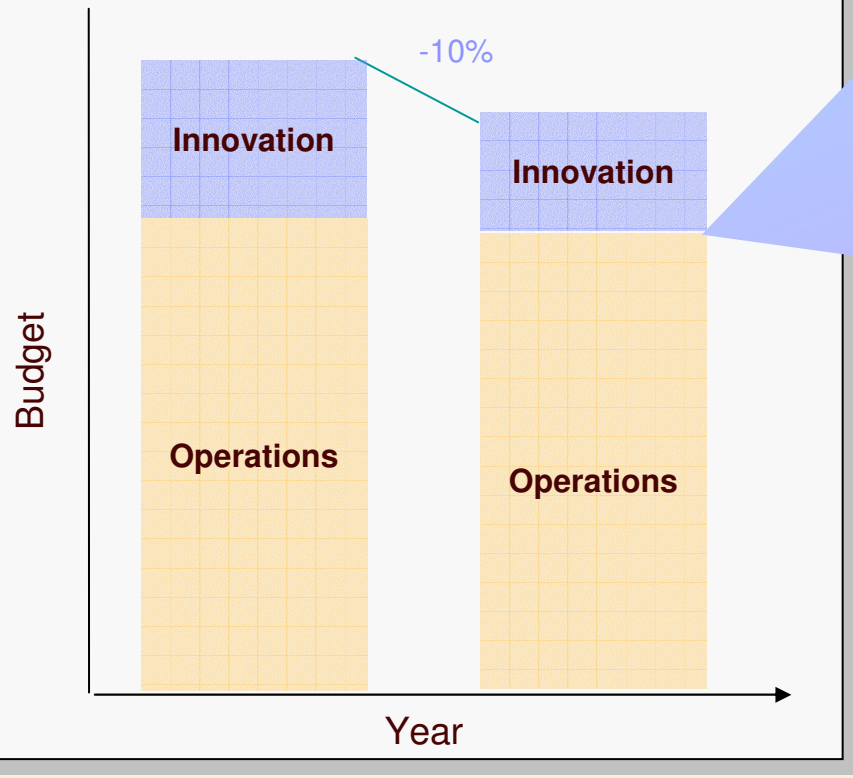


IDC Survey Data, 2002-2004

How Server Consolidation can Fuel Business Innovation

Paradigm Shift for Datacenters:
Pure cost center with 10% cut year over year ➔ Business Unit with strategic growth investments

Datacenter Example
- Pure cost center
- Management cuts costs 10% YOY
- IT cuts innovation and directs to operations

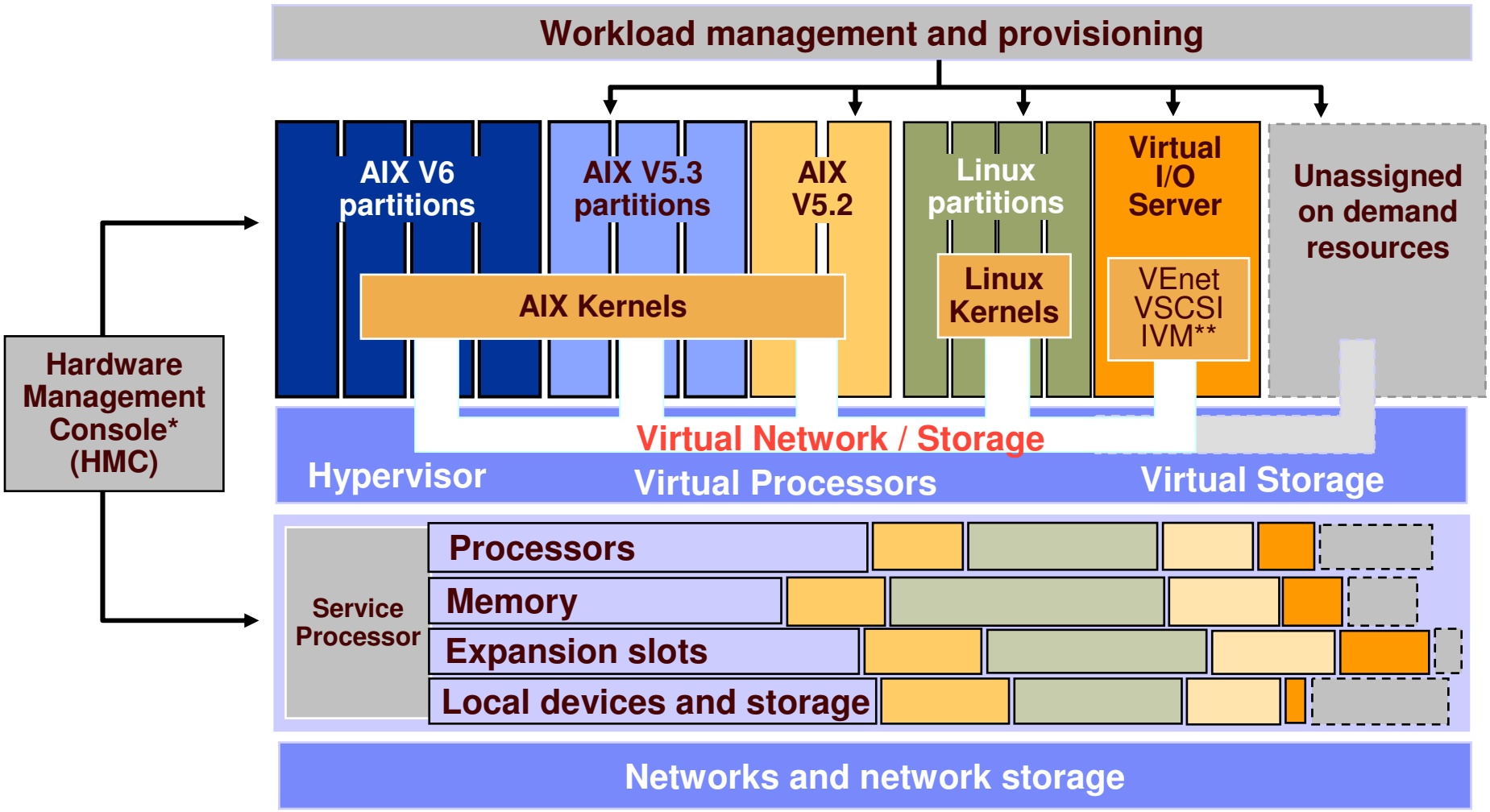


Self-Funding Model

Optimizing IT

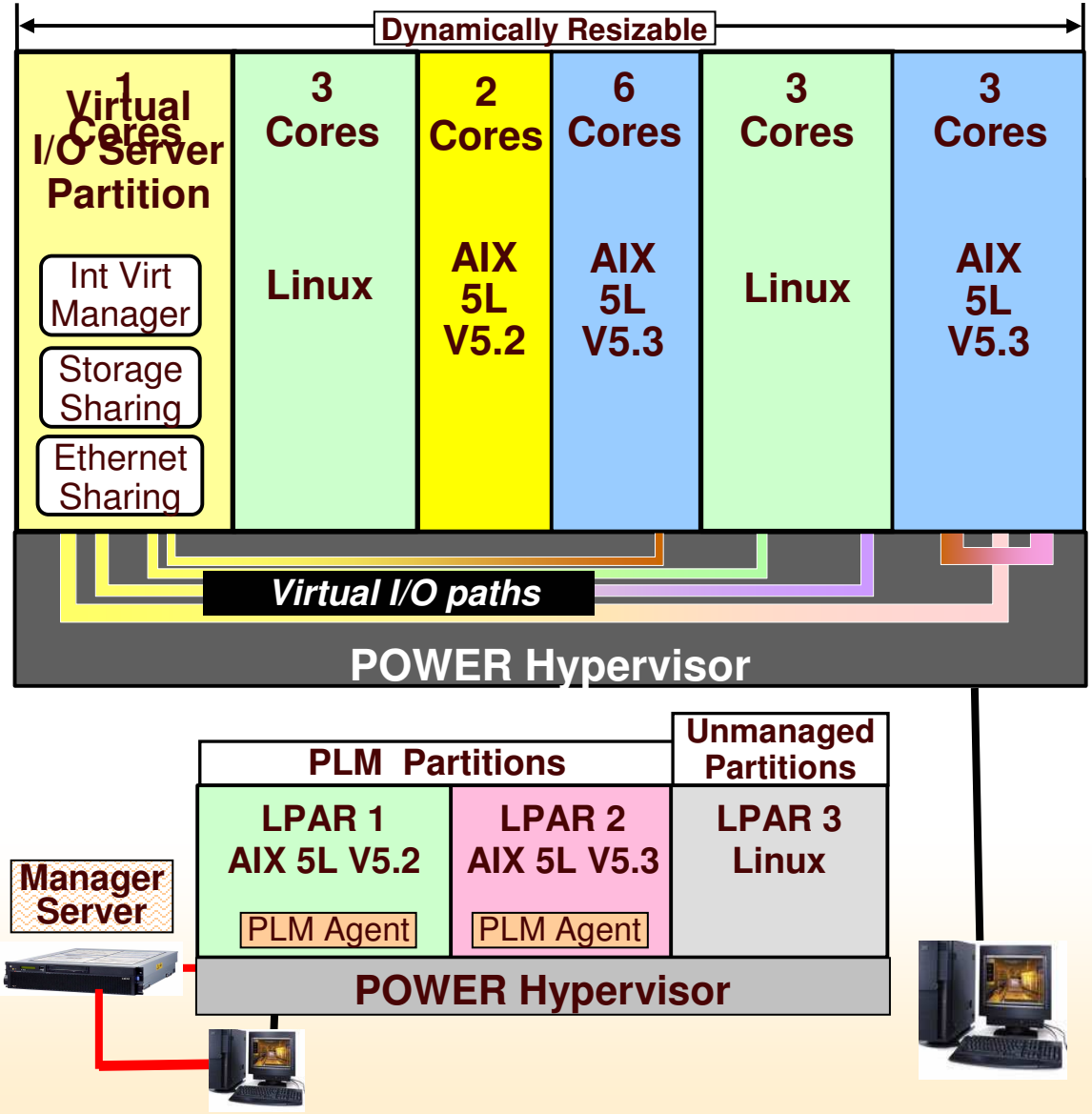
- Energy Efficiency
- Server Consolidation and Virtualization
- Dynamic Infrastructure

POWER Virtualization Architecture



*Integrated Virtualization Manager (IVM) is disabled if HMC attached
**Available on System p5 560Q and below as well as the BladeCenter® JS21

POWER5 Advanced Power Virtualization Option

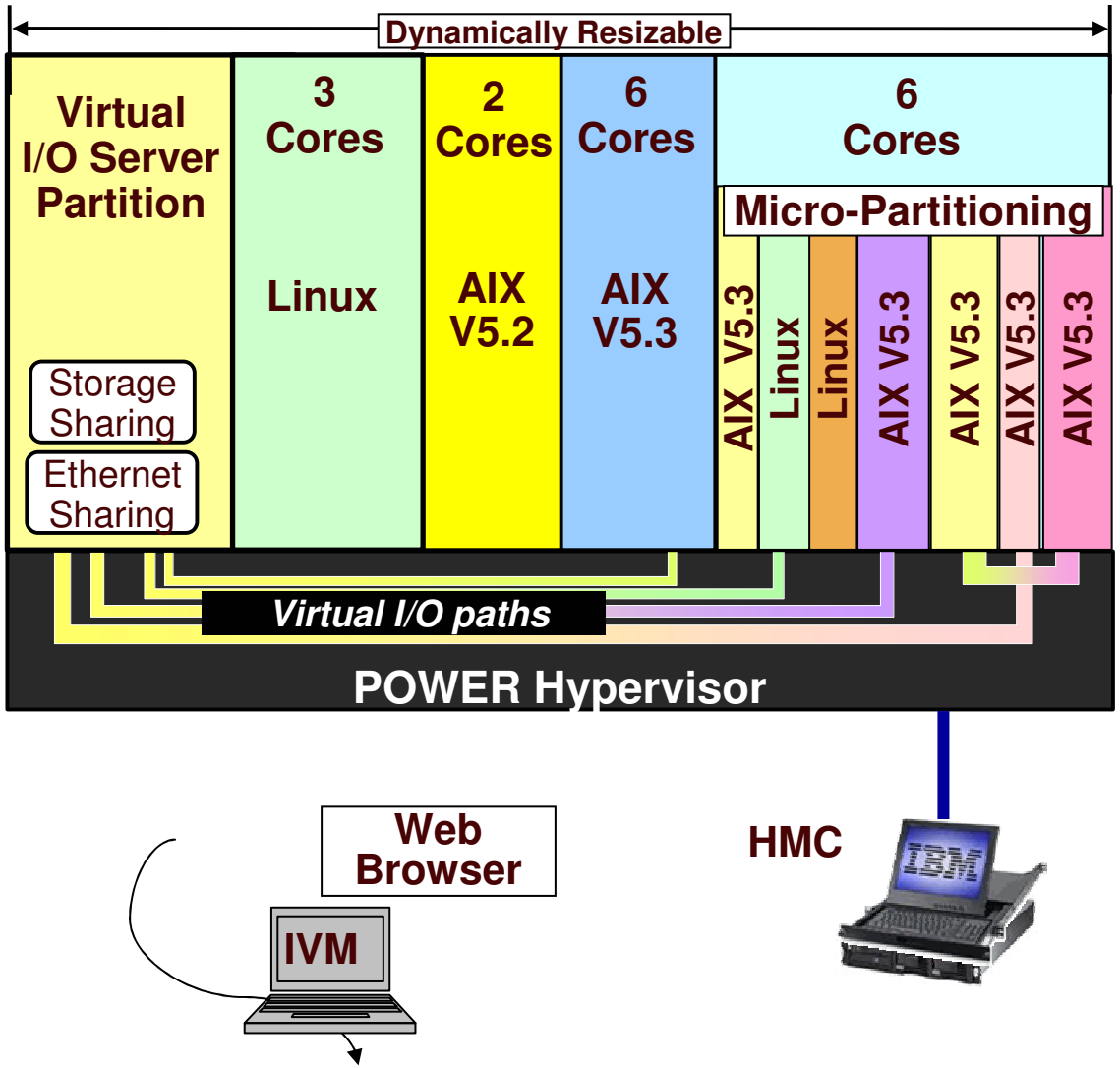


Features

- Micro-partitioning
  - Share processors across multiple partitions
  - Minimum Partition: 1/10 processor
  - AIX 5L V5.3 or Linux*
- Virtual I/O Server
  - Shared Ethernet
  - Shared SCSI & Fiber Channel
  - Int Virtualization Manager
  - AIX 5L V5.3 & Linux partitions
  - From 1 to 10 per server
- Partition LoadManager
  - AIX 5L V5.2 & V5.3 supported
  - Balances Processor & memory request
- Managed via HMC

*** = SLES 9 or RedHat v3 with update 3**

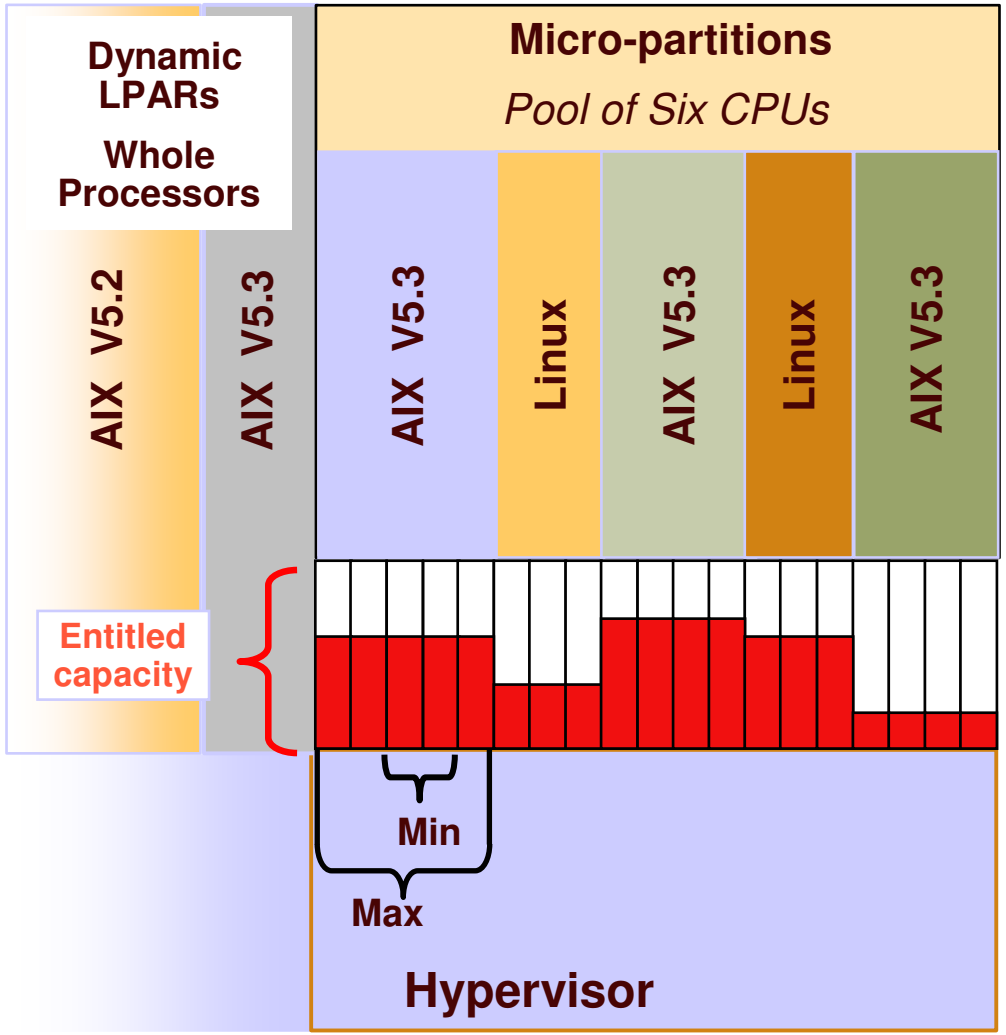
Advanced POWER Virtualization Option for POWER6



- **New Offering for POWER6**
- **Micro-Partitioning™**
  - Share processors across multiple partitions
  - Minimum Partition: 1/10 processor
  - AIX V5.3 / V6
  - Linux
- **Virtual I/O Server**
  - Shared Ethernet
  - Shared SCSI & Fiber Channel
  - Integrated Virtualization Manager
- **Live Partition Mobility (SoD)**

Micro-Partitioning Technology

Micro-Partitioning technology allows each processor to be subdivided into as many as 10 "virtual servers", helping to consolidate UNIX® and Linux applications.



Note: Micro-partitions are available via optional Advanced POWER Virtualization or POWER Hypervisor and VIOS features.

Partitioning options

– Micro-partitions: Up to 254*

Configured via the HMC

Number of logical processors

– Minimum / Maximum

Entitled capacity

– In units of 1/100 of a CPU
– Minimum 1/10 of a CPU

Variable weight

– % share (priority) of surplus capacity

Capped or uncapped partitions

*on p5-590 and p5-595

Integrated Virtual Ethernet Overview

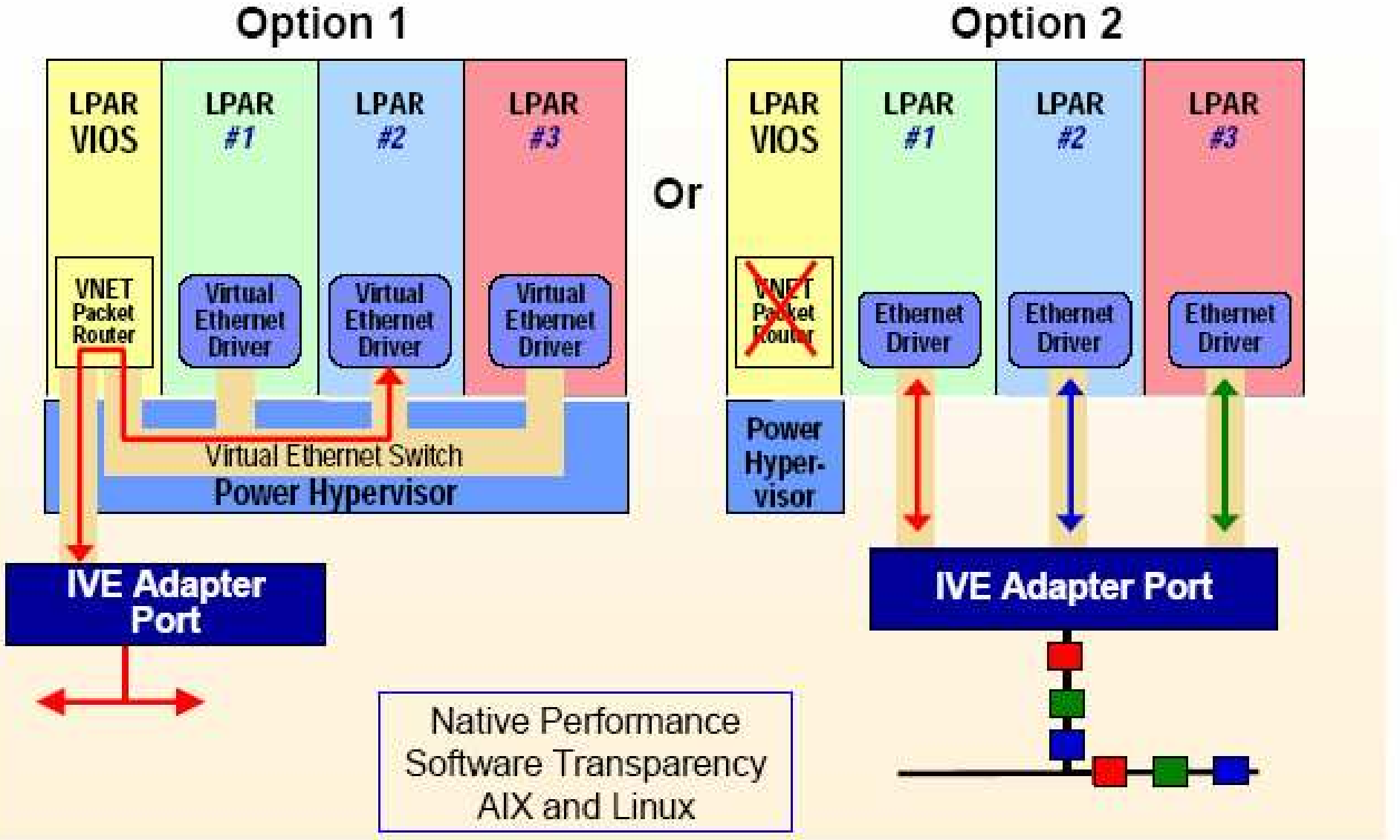
Naming

- **Integrated Virtual Ethernet** – External name in marketing and other documentation
- **Host Ethernet Adapter (HEA)** – Name used on user interfaces

New hardware capability

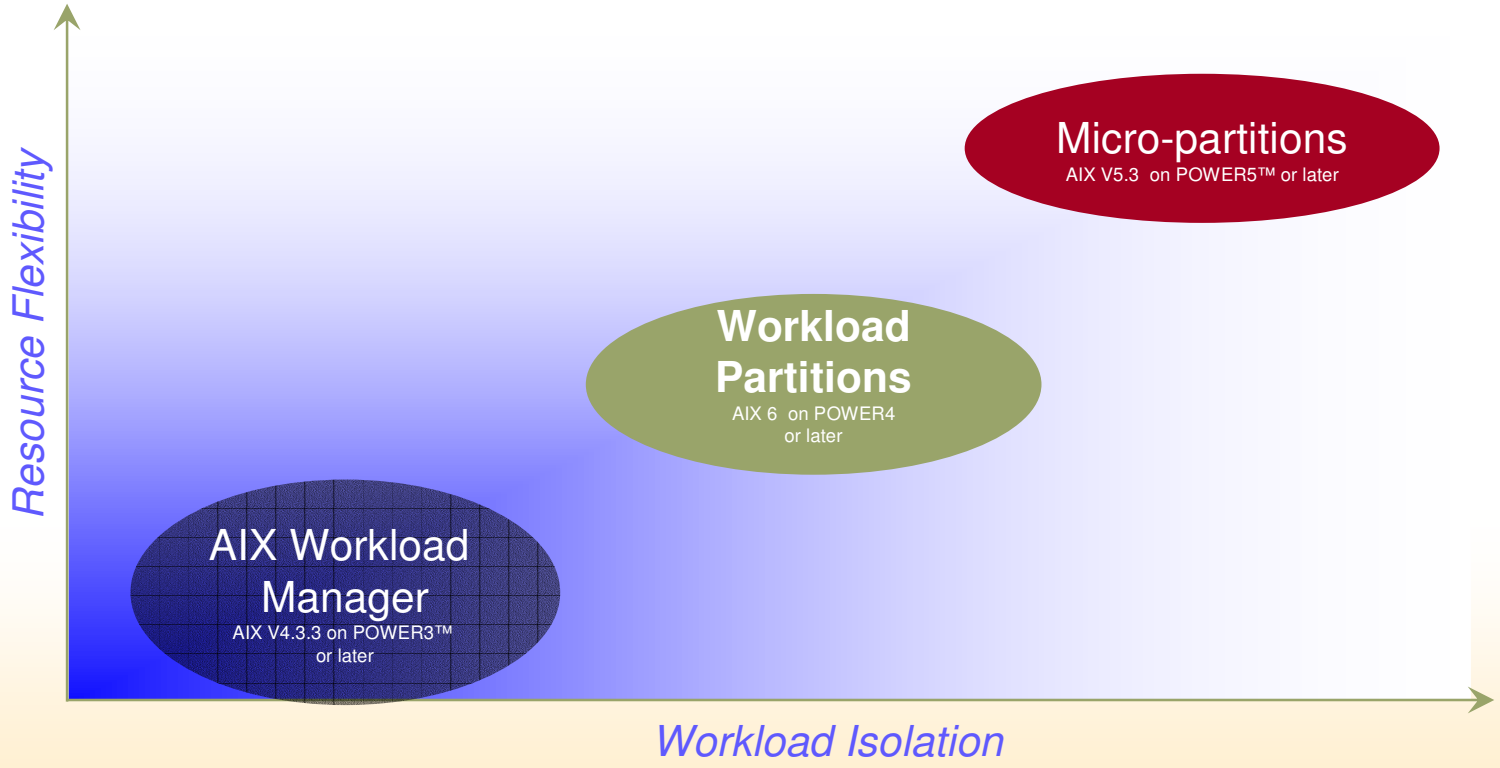
- **Provides enhanced Ethernet connectivity**
  - **No TCEs, PCI protocol, etc**
  - Several integrated Ethernet adapters, called **Logical Ports**.
  - Can be assigned to one or more partitions and/or VIOS partitions.
- **Available on most POWER6 systems**
- **Multiple options of physical, external ports**
  - Dual 1 Gbit copper: 10BASE-T, 100BASE-T, 1000BASE-T
  - Quad 1 Gbit copper: 10BASE-T, 100BASE-T, 1000BASE-T
  - Dual 10 Gbit fibre: 10GBASE-SR or 10GBASE-LR
- **Logical Ports**
  - Up to 32 logical ports, but can also be configured as 1, 2, 4, 8, 16 logical ports
  - Logical port / physical dedicated when assign to VIOS partition
- **Several configuration parameters**
  - All based on tuning performance to match client configuration and environment
  - e.g.: Speed, frame size, duplex

Integrated Virtual Ethernet - How it Works……



IBM System p Flexible Resource Management

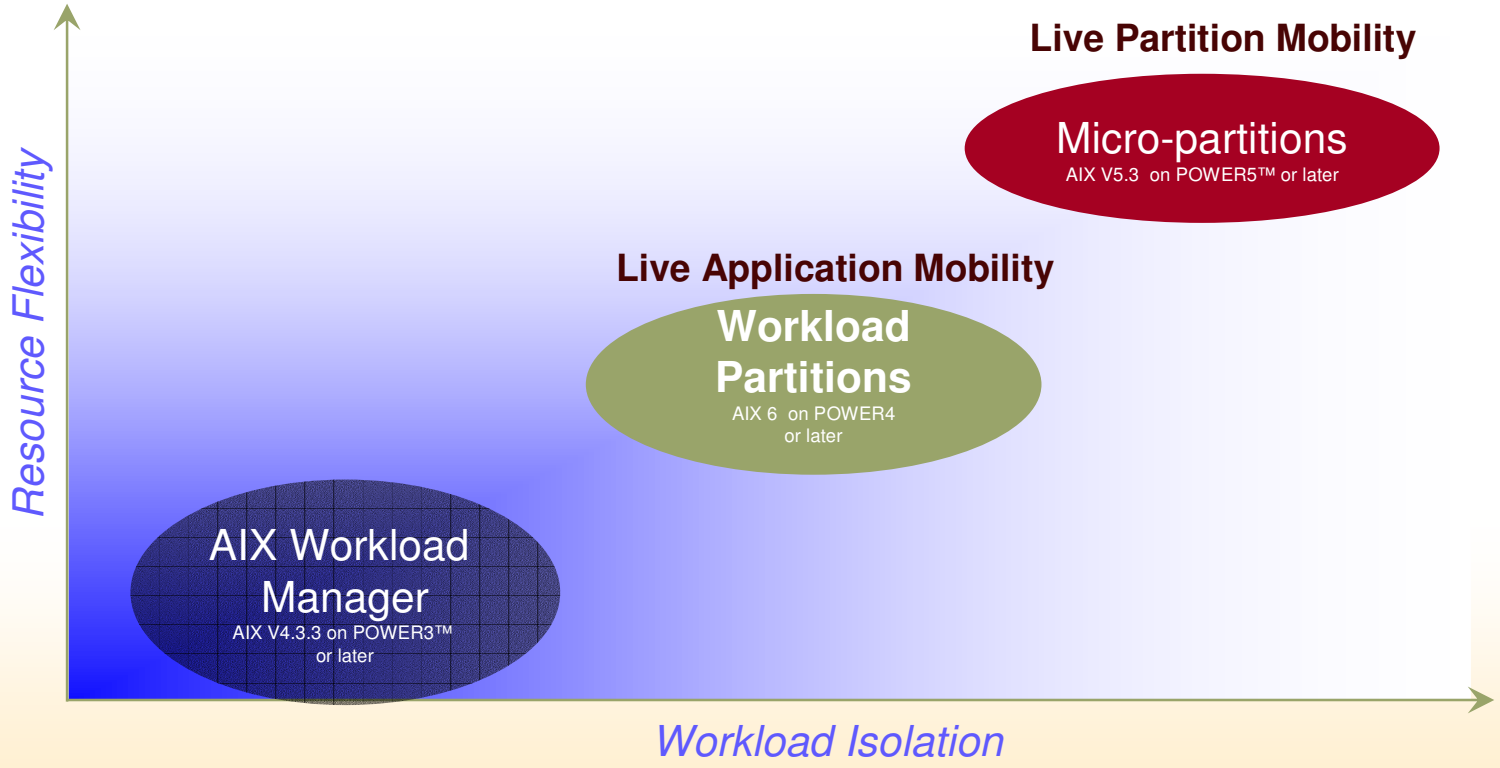
A new method of virtualization on IBM System p: AIX Workload Partitions



* All statements regarding IBM future directions and intent are subject to change or withdrawal without notice and represent goals and objectives only. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

IBM System p Announces Two Methods of Mobility

Live Partition Mobility – move a running POWER6 partition …
Live Application Mobility – move a running AIX 6 application …
… From one server to another



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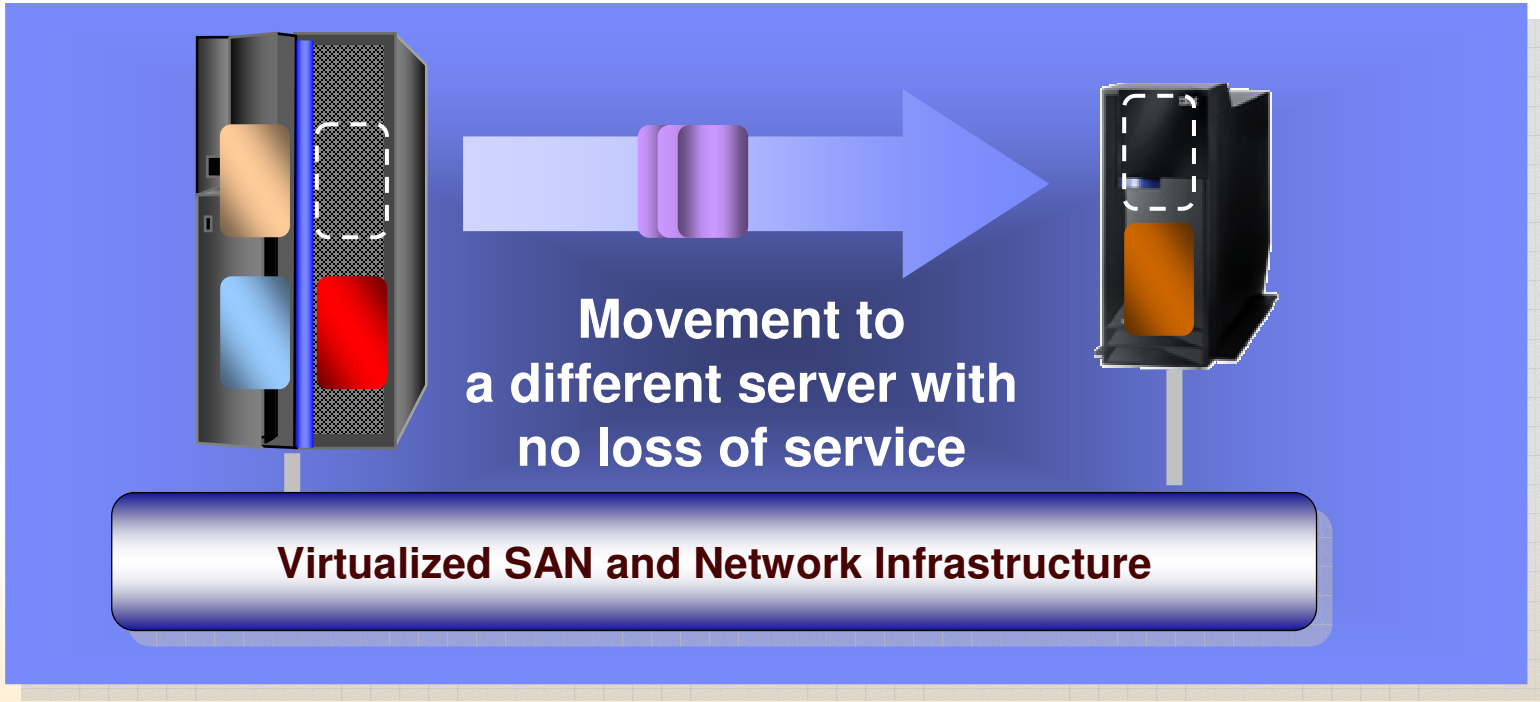
Live Partition Mobility with POWER6*

Allows migration of a running LPAR to another physical server

- ✓ Reduce impact of planned outages
- ✓ Relocate workloads to enable growth
- ✓ Provision new technology with no disruption to service
- ✓ Save energy by moving workloads off underutilized servers



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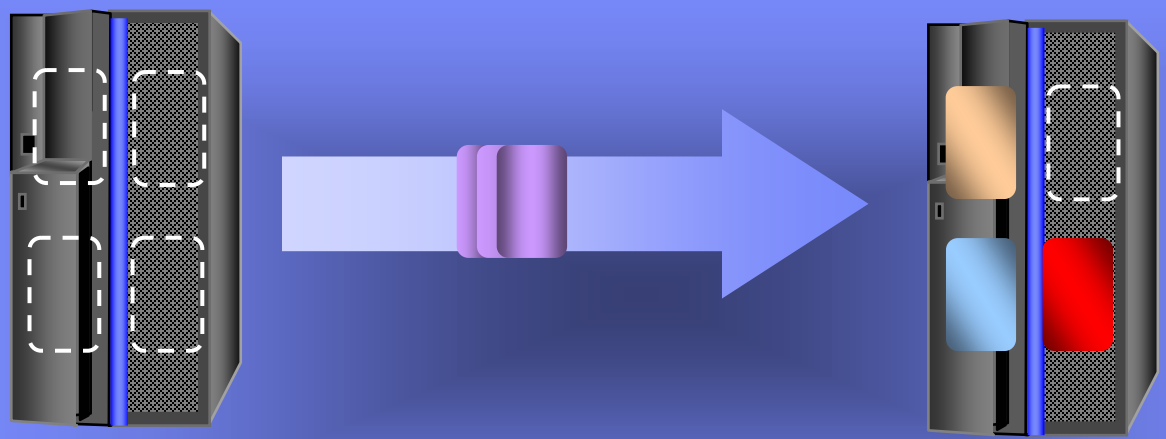
Continuous Application Availability

With Live Partition Mobility and Live Application Mobility, planned outages for hardware and firmware maintenance and upgrades can be a thing of the past



Relocate all partitions from one server to another when performing maintenance. Move the partitions back when maintenance is complete

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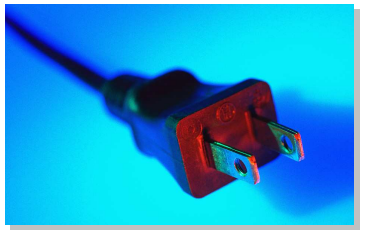
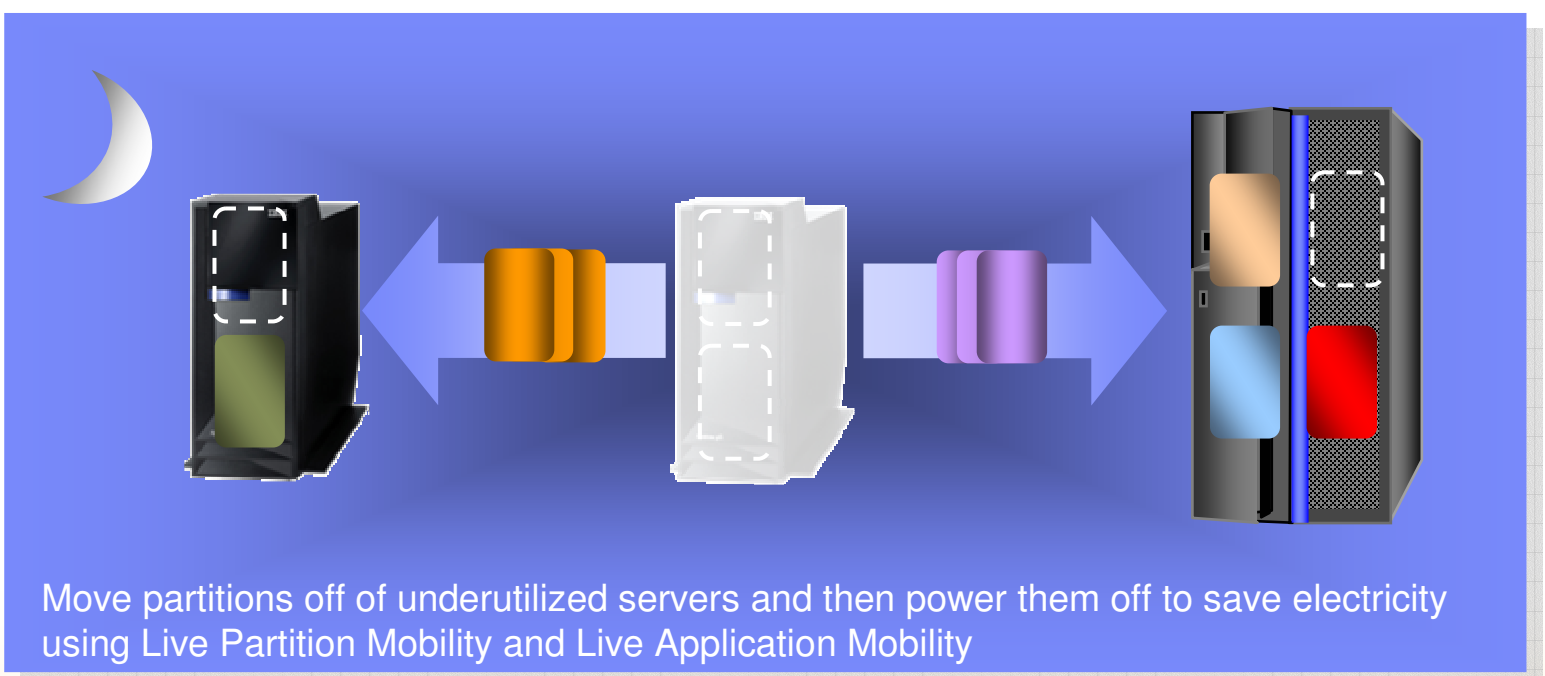
Energy Savings

During non-peak hours, consolidate workloads and power off excess servers





Move partitions off of underutilized servers and then power them off to save electricity using Live Partition Mobility and Live Application Mobility

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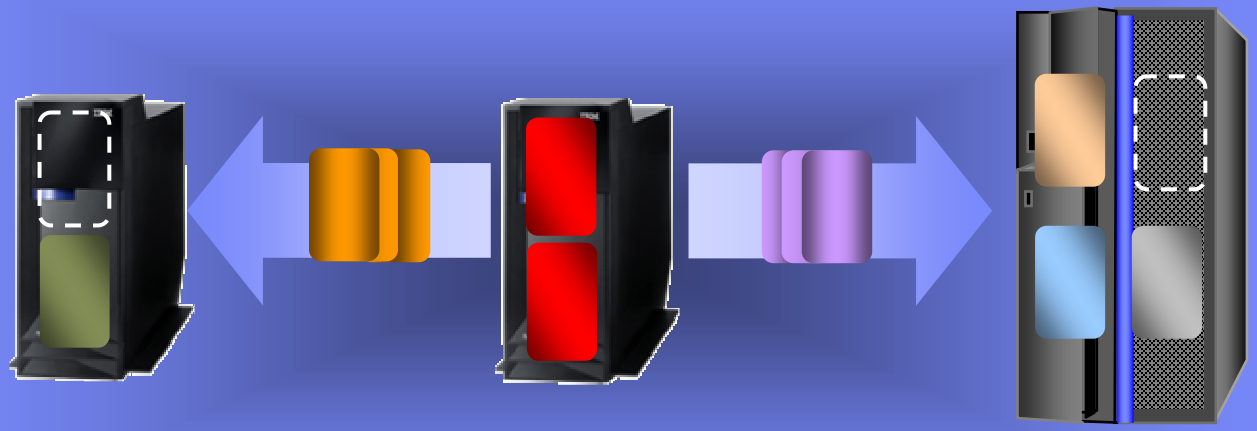
Workload Balancing with Live Partition Mobility*

As computing needs spike, redistribute workloads onto multiple physical servers without service interruption



As one server gets overtaxed from a spike in demand, relocate partitions to other servers

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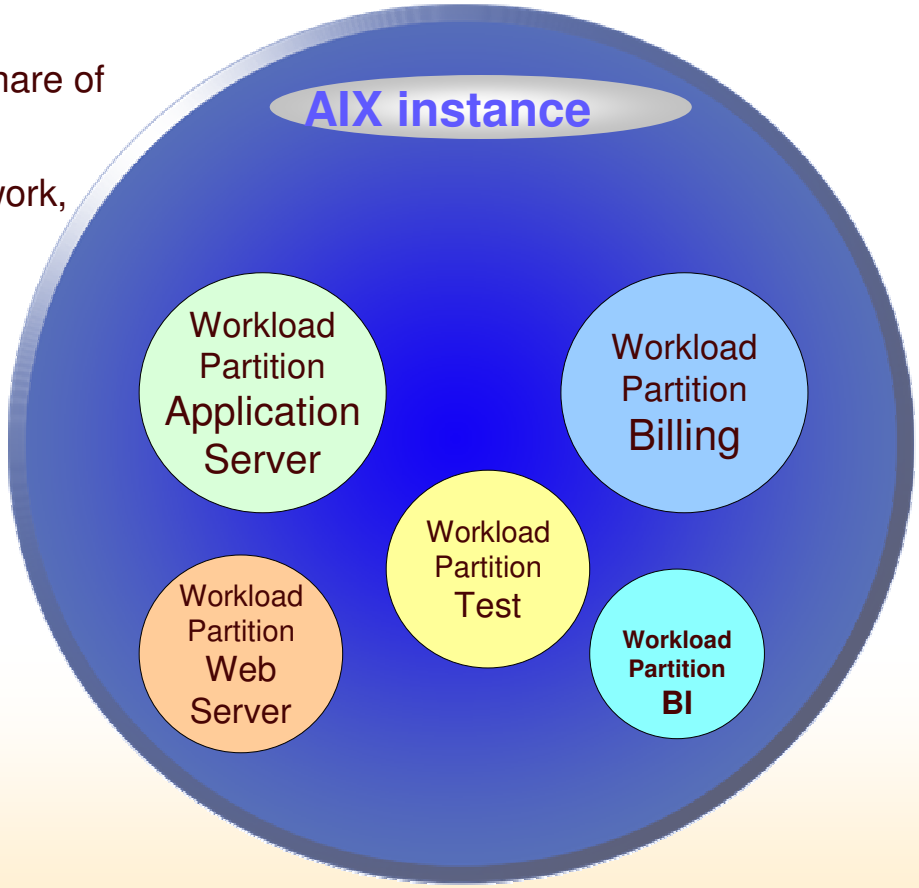
AIX 6 Workload Partitions

Improved administrative efficiency by reducing the number of AIX images to maintain

- **Software partitioned system capacity**
  - Each Workload Partition obtains a regulated share of system resources
  - Each Workload Partition can have unique network, filesystems and security
- **Two types of Workload Partitions**
  - System Partitions
  - Application Partitions
- **Separate administrative control**
  - Each Workload Partition is a separate administrative and security domain
- **Shared system resources**
  - Operating system, I/O, processor, memory



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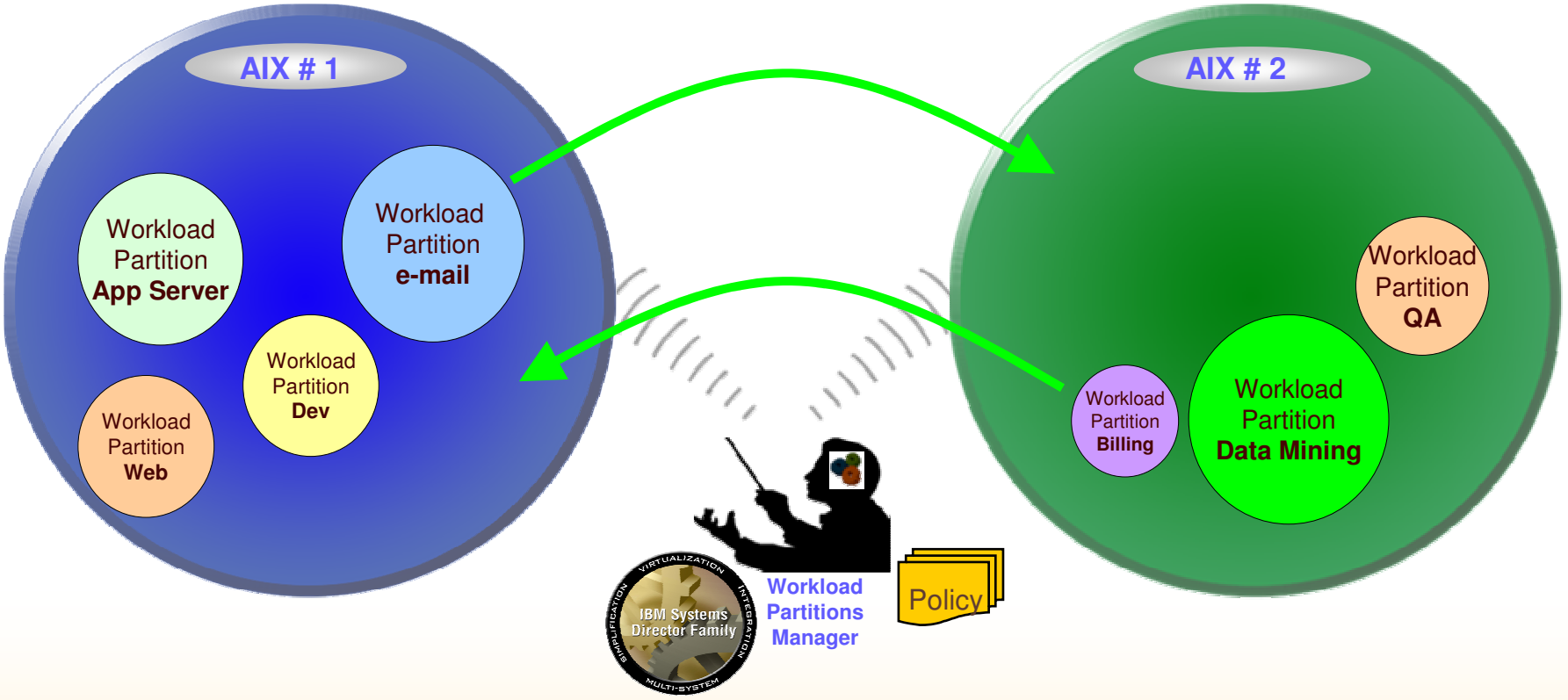
AIX 6 Live Application Mobility

Move a running Workload Partition from one server to another for outage avoidance and multi-system workload balancing



Works on any hardware supported by AIX 6 including POWER5

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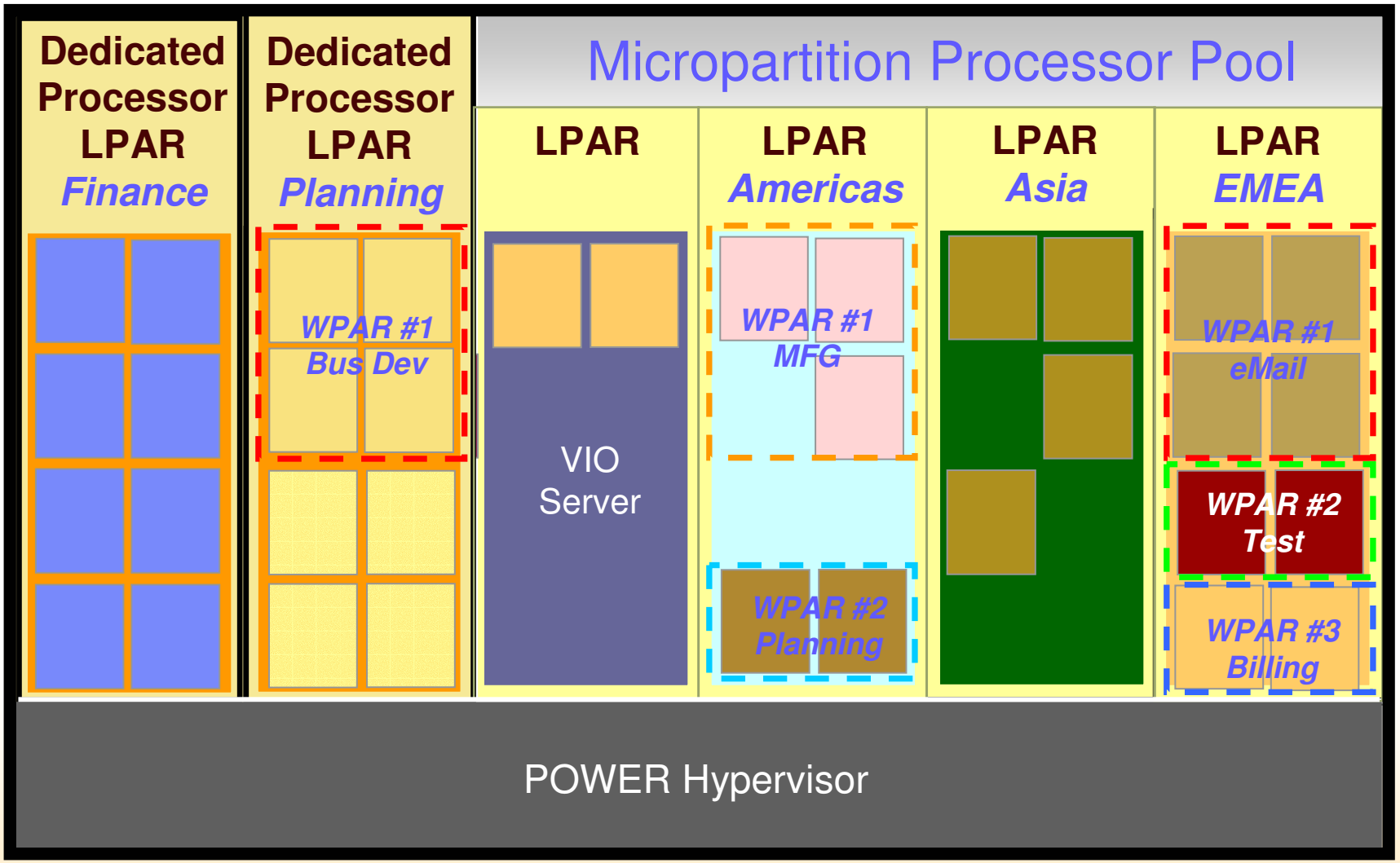
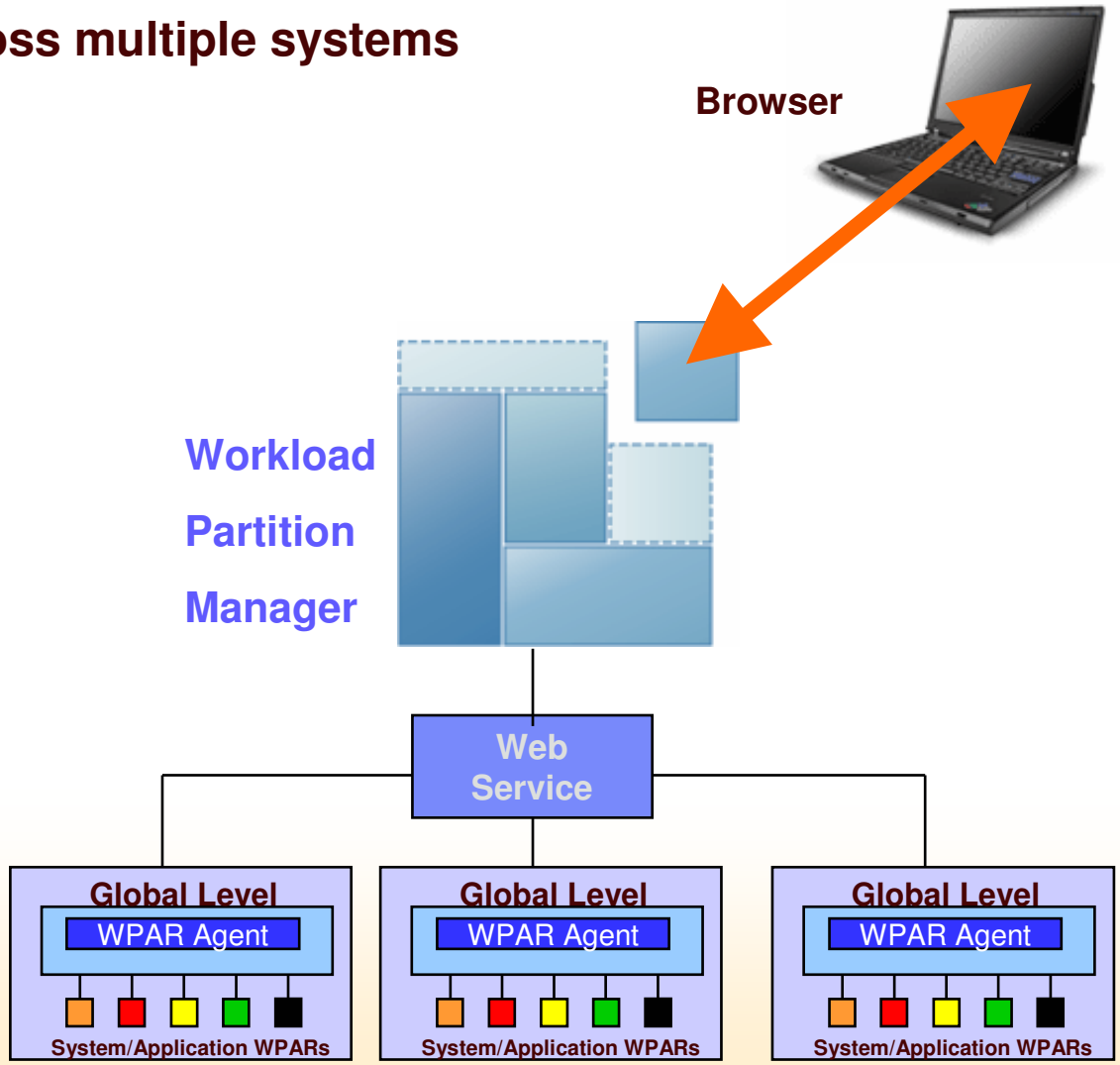
AIX Workload Partitions can be Used in LPARs



Workload Partitions Manager

- **Management of WPARS across multiple systems**
- **Lifecycle operations**
- **Single Console for:**
  - Graphical Interface
  - Create & Remove
  - Start & stop
  - Checkpoint & Restart
  - Monitoring & Reporting
  - Manual Relocation
  - Automated Relocation
  - Policy driven change
- **Infrastructure Optimization**
- **Load Balancing**



Advanced POWER Virtualization for POWER6

IBM APV Benefits

- ☑ ***Can help lower the cost** of existing infrastructure **by up to 72%**[4]*
- ☑ *Can increase **business flexibility** and **reduce** the **complexity to grow your infrastructure***
- ☑ *Deployed in production by a significant number of System p clients[5]*

Advanced POWER Virtualization[1]

Virtual I/O Server
- Share Ethernet, SCSI and Fibre Channel disks

Integrated Virtualization Manager[3]
- Manage a single system without an HMC

Live Partition Mobility 2007[3]
- Move a running partition from one POWER6 processor-based server to another with no downtime

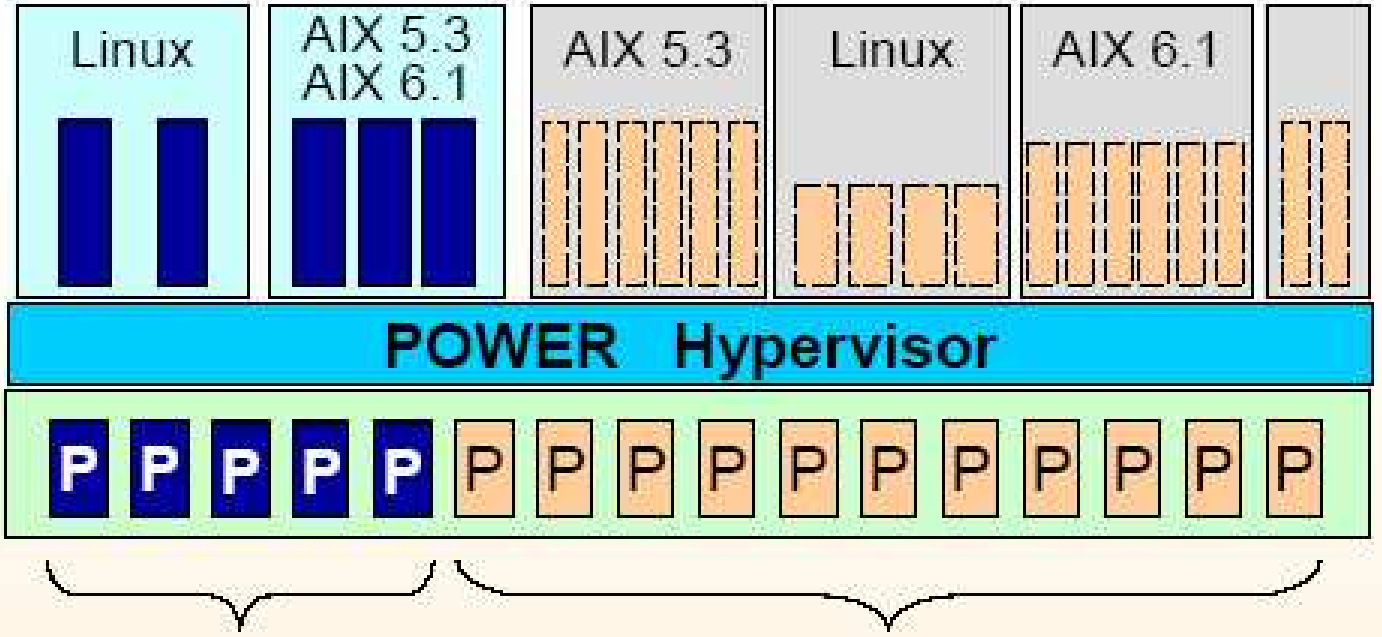
Micro-Partitioning™
- Create up to 10 micro-partitions for each System p5 processor
- Resize without rebooting your system

AIX 6 Live Application Mobility 2007[3]
- Move a running partition from one POWER6 processor-based server to another with no downtime

Linux on POWER

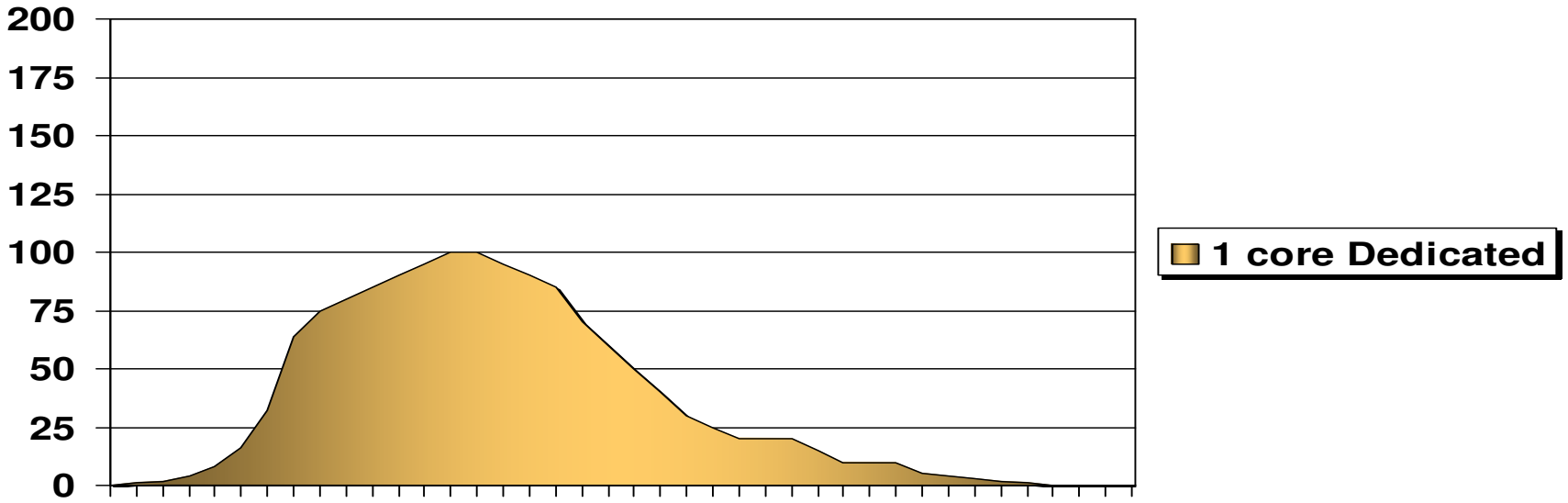
1) Advanced POWER Virtualization (APV) is an optionally orderable feature on IBM System p. 3) All statements regarding IBM future directions and intent are subject to change or withdrawal without notice and represent goals and objectives only. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM. 4) "Impact of IBM System p Server Virtualization," Transforming the IT Value Equation with POWER6 Architecture. International Technology Group, 05/2007. Study methodology: Companies in financial services, manufacturing and retail with $15 Billion+ revenues focusing on UNIX large enterprise environments with multiple, broad-ranging applications. Study compared the cost of the company's workloads running on multiple vendor servers and employing minimal virtualization to the cost of the company's workloads running on p570 (POWER6 processor-based) as well as POWER5+ processor-based servers – all using Advanced POWER Virtualization [APV]. APV is standard on System p5 590 and 595. Other System p servers have the option to add APV except the System p5 185. This cost analysis was performed for financial services, manufacturing and retail example environments with an overall average savings of up to 72% in TCO savings by virtualizing and consolidating on the System p servers. Total Cost of Ownership may not be reduced in each consolidation case. TCO depends on the specific client environment, the existing environments and staff, and the consolidation potential. 5) IBM sales Statistics

Dedicated Shared Processors



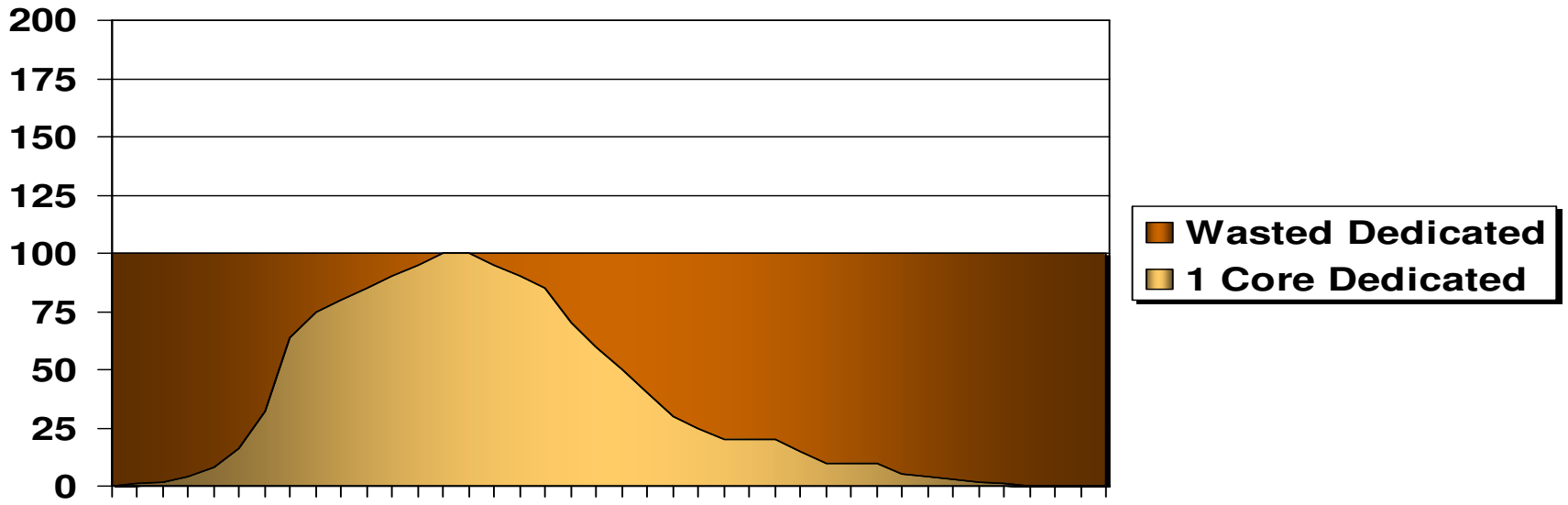
Excess Dedicated Capacity Utilization	• Unused capacity in dedicated processor partitions can be "Donated" to shared processor pool • Excess cycles will only be utilized by uncapped partitions that have consumed all of their entitled capacity. • POWER6 Servers

Shared Dedicated Capacity In Action



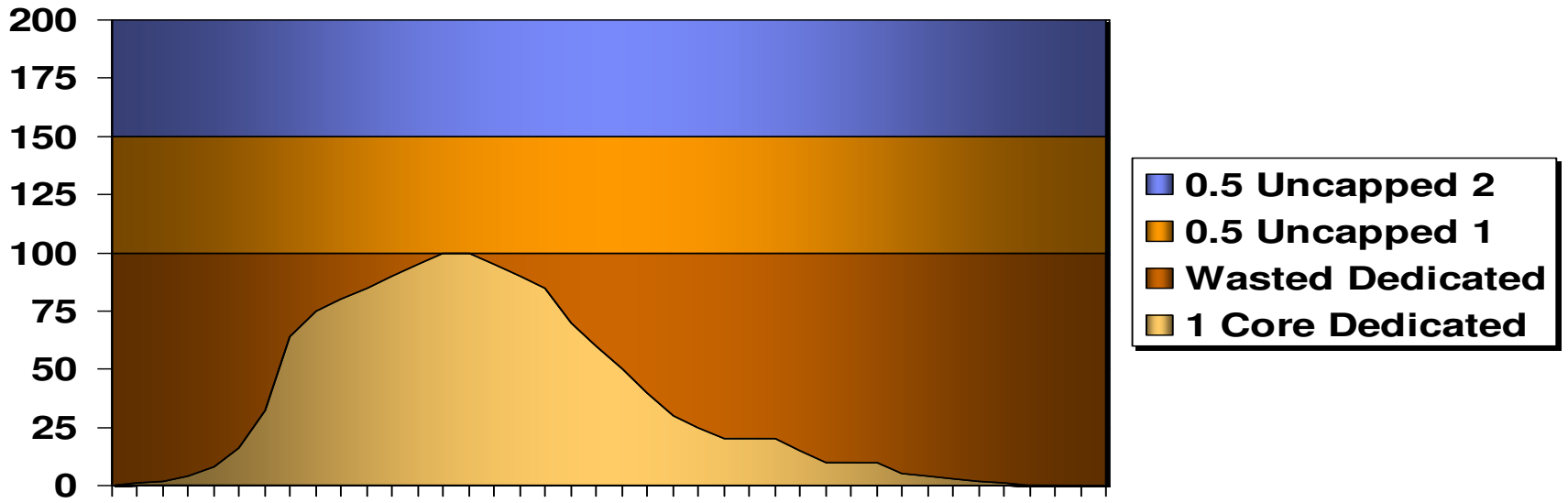
– Consider a 2-core server with 1-core dedicated partition with variable workload (between 0% and 100%)

Shared Dedicated Capacity In Action



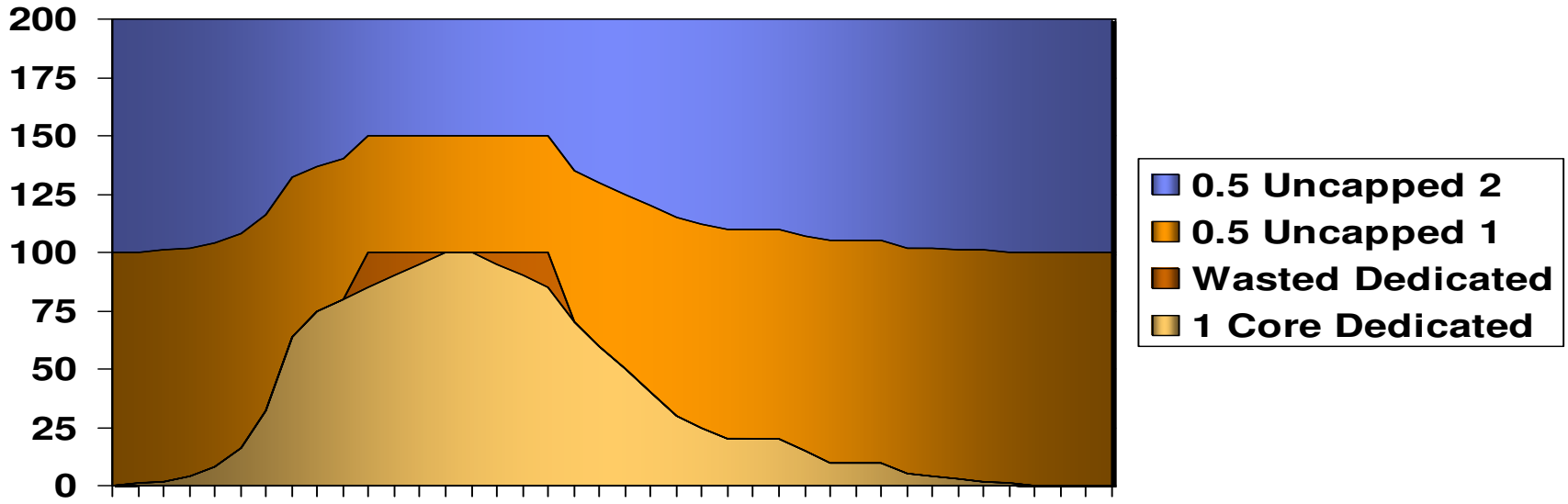
- Consider a 2-core server with 1-core dedicated partition with variable workload (between 0% and 100%)
- The excess capacity on the dedicated processor is wasted

Shared Dedicated Capacity In Action



- Add two evenly weighted 1-core uncapped partitions that are CPU bound
- Each uncapped partition will share the remaining physical processor even though each can consume an entire processor

Shared Dedicated Capacity In Action



- With the new support, a dedicated partition will donate its excess cycles to the uncapped partitions
- Each uncapped partition will consume an entire processor if available (when dedicated at 0%) and will split a processor when dedicated fully utilized (when dedicated at 100%)
- The total processor capacity in the system is better utilized while the dedicated processor partition maintains the performance characteristics and predictability of the dedicated environment when under load

Planned CoD Offering Evolution for POWER6

Today	2007 / 2008 POWER6
Permanent	**Permanent**
CoD Processors: One processor increment Memory: 1 GB increment	**CoD** Processors: One processor increment Memory: 1 GB increment
Temporary	**Temporary**
On/Off CoD Activations: Manual Utilization Reporting Required (Contract) Post-pay Integrated into Capacity BackUp offering	**On/Off CoD** Activations: Manual Utilization Reporting Required (Contract) Post-pay Integrated into Capacity BackUp offering
Capacity BackUp (CBU) CBU offering for p5-590 / p5-595	**Capacity BackUp (CBU)** CBU offering for POWER6 High End
Reserve CoD Pre-pay usage for blocks of time Charges based on measured workload Operates within the shared pool	**Utility CoD** * Post pay or pre-pay (One Processor Minute) Charges based on measured workload Operates within the shared pool
Trial CoD Standard Exception Web-based distribution	**Trial CoD** Standard Exception Web-based distribution

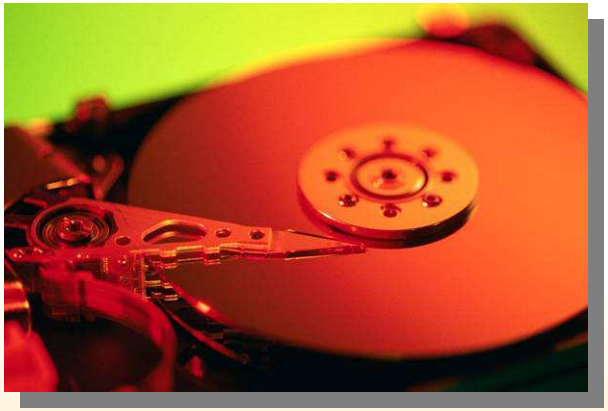
* Utility CoD billing is 100 minutes

APV Enhancements – VIOS 1.4

Virtual I/O Server
- Share Ethernet, SCSI and Fibre Channel disks

Expanded support for industry standard protocols

– Centralized user management support through LDAP
– Support for monitoring and management through SNMP
– Automatic registration of VLANs to external switches through GVRP support

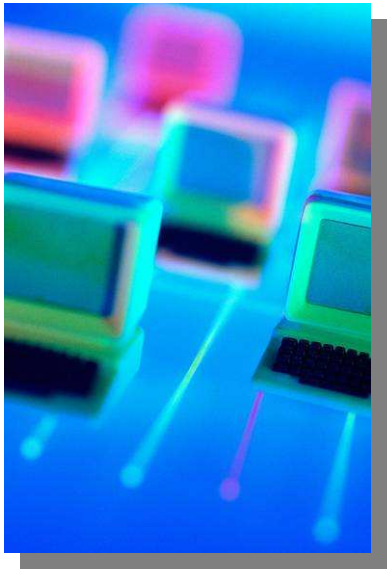


Expanded storage and subsystem support

–Support for nSeries and NetApp subsystems
–iSCSI and fibre channel attach
–Interconnect support for SAS (for disk attach), SATA (optical controller)

APV Enhancements – VIOS 1.4

Virtual I/O Server
- Share Ethernet, SCSI and Fibre Channel disks



Systems management enhancements

– System Planning and Deployment tool upgrades to simplify the process of planning and deploying System p, the Virtual I/O Server and virtual I/O devices.

– CLI enhancements for usability, security, maintenance, user management

Tivoli agent support

Tivoli

–Support for automatic backup and restore of VIOS partitions through IBM Tivoli Storage Manager

–Support for accounting and usage metric collection and analysis through IBM Tivoli Usage and Accounting Manager

–Support for VIOS and System p resource discovery through IBM Tivoli Application Dependency Discovery Manager

System p Advanced POWER Virtualization (APV) offers **business advantages** compared to VMware for clients doing server consolidation

ONE VENDOR, IBM

Intel, vmware, microsoft, server vendor, storage vendor, etc

Virtualization capability	*APV on System p**	*VMware Infrastructure 3 Enterprise on x86*	*Business Benefit of APV*
Partition scalability **System scalability**	**64 CPUs, 2 TB RAM** **64 CPUs, 2 TB RAM**	**4 CPUs,16 GB RAM**[1] **32 CPUs, 64 GB RAM**	Helps improve TCO from consolidating more workloads
Dynamic Logical Partitioning	**Yes**	**VM reboot**[2]	Adapt to changes without downtime
Security/fault isolation	**CAPP/EAL 4+**	**CAPP/EAL 2**[3]	Secured environment for mission critical applications
Support for dedicated I/O	**Yes**	**No**[4]	Superior performance for I/O intensive workloads
Capacity on Demand integration	**Reserve CoD**	**No**[1]	Add capacity when/where needed, turn it off when not required
Partitions per CPU	**10**	**8**[1]	Management flexibility
Price	**Standard on JS21, p5-590, p5-595** **$590/CPU: p5-505 - p5-550** **$990/CPU: p5-560Q** **$1130/CPU: p5-570 & p570**	**$5,750 + support: 2 sockets**[5]	Helps lower acquisition cost

*Advanced POWER virtualization is standard on the System p5 590 and 595. It is an optional feature on all other System p5 servers, except the System p5 185. Also available on the BladeCenter JS21 (1) IBM conclusion based on analysis of www.vmware.com (2) Source: http://pubs.vmware.com/vi301/wwhelp/wwhimpl/js/html/wwhelp.htm (3) Sources: VMware test at http://www.commoncriteriaportal.org/public/files/epfiles/ST_VID10056-VR.pdfIBM certification info at http://www-03.ibm.com/servers/aix/products/aixos/certifications/index.html, picture from http://www.cesg.gov.uk/site/iacs/index.cfm?menuSelected=1&displayPage=13 (4) Source: http://h20331.www2.hp.com/ActiveAnswers/downloads/vmwareESXserver_virtualize_ProLiant_1005.pdf (5) http://www.vmware.com/pdf/vi_pricing.pdf

System p Advanced POWER Virtualization (APV) offers **business advantages** compared to HP Integrity Virtual Machine (IVM) for clients doing server consolidation

Virtualization

Virtualization capability	*APV on System p**	*HP Integrity Virtual Machines 2.0*	*Business Benefit of APV*
Partition scalability	**64 CPUs 2TB RAM**	**4 CPUs (max) [1] 1 CPU (recommended) [2] 64GB RAM[1]**	Helps improve TCO from consolidating more workloads
Dynamic Logical Partitioning	**Yes**	**VM reboot[3]**	Adapt to changes without downtime
Security/fault isolation	**CAPP/EAL 4+[4]**	**No Certification**	Secured environment for mission critical applications
Support for dedicated I/O	**Yes**	**No[5]**	Superior performance for I/O intensive workloads
Dynamic Processor Sharing	**Yes**	**No[6]**	Highly flexible configuration, with automatic deployment of machine resources where and when they're needed
Externally Published References	**94[7]**	**1[8]**	Rest assured knowing that APV is client proven and running on 40% of all System p5 CPUs

*Advanced POWER virtualization is standard on the System p5 590 and 595. It is an optional feature on all other System p5 servers, except the System p5 185. Also available on the BladeCenter JS21 (1) Source: http://h18004.www1.hp.com/products/quickspecs/12715_div/12715_div.HTML (2) From Best Practices for Using Integrity Virtual Machines: "Scheduling, memory access, and resource contention issues are all easier if only one processor is involved ... The CPU resources of a VM Host may be prematurely exhausted by the definition of a virtual SMP." http://docs.hp.com/en/9983/BestPractices2.2.pdf p6 (3) Sources: HP states "All attributes and resources can be changed statically, so that changes take effect when the virtual machine is next restarted. Some attributes and resources can also be changed dynamically." http://docs.hp.com/en/T2767-90024/T2767-90024.pdf p 155. Although they do not provide a full listing of those resources which can be changed dynamically, they do state that change of virtual CPU cannot happen without VM Reboot http://forums1.itrc.hp.com/service/forums/questionanswer.do?threadId=1028522 (4) IBM certification info at http://www-03.ibm.com/servers/aix/products/aixos/certifications/index.html (5) Source http://h18004.www1.hp.com/products/quickspecs/12715_div/12715_div.HTML (6) "Each of virtual processor from a virtual SMP must be allocated resources from separate physical processors – two virtual processors from the same virtual machine cannot be scheduled on the same physical processor." http://docs.hp.com/en/9983/BestPractices2.2.pdf p6 (7) Complete list of IBM System p Virtualization References at http://www-306.ibm.com/software/success/cssdb.nsf/advancedsearchVW?SearchView&Query=(Virtualization)+AND+[WebSiteProfileListTX]=eserverpseries&site=eserverpseries&frompage=ts&Start=1&Count=30&cty=en_us (8) HP's single case study for Integrity Virtual Machines published at http://h71028.www7.hp.com/erc/library/GetPage.aspx?pageid=387810&audienceid=0&statusid=0&ccid=0&langid=121&ERL=true&pageTitle=Enterprise%20library:%20Royal%20London

Advanced POWER Virtualization Web Site

http://www.ibm.com/systems/p/apv/index.html

Your one-stop shop for System p virtualization info:

-Discussion Forums
-Certifications
-Case Studies
-Whitepapers
-Education

"The logical partition [LPAR] capability of the System p5 server was the key factor in our decision, enabling us to run multiple independent systems on the same physical machine. In our opinion, IBM leads the market in this area." [1]

- Wolfgang Franz, IT Manager, Bionorica AG. December 2005

1) Bionorica case study published at http://www-306.ibm.com/software/success/cssdb.nsf/CS/DNSD-6KBFWW?OpenDocument&Site=eserverpseries

Advanced POWER Virtualization enhancements

*Leverage System p Virtualization and reduce server TCO by up to 60%**

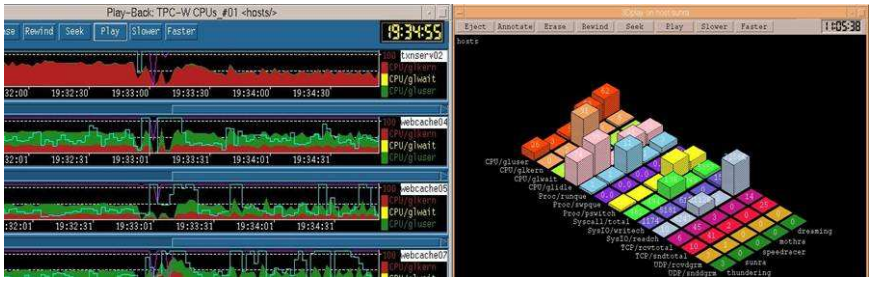
Virtual I/O Server (VIOS) V1.4

VIOS Monitoring **through PTX and Topas**

Topas (part of AIX V5.3)

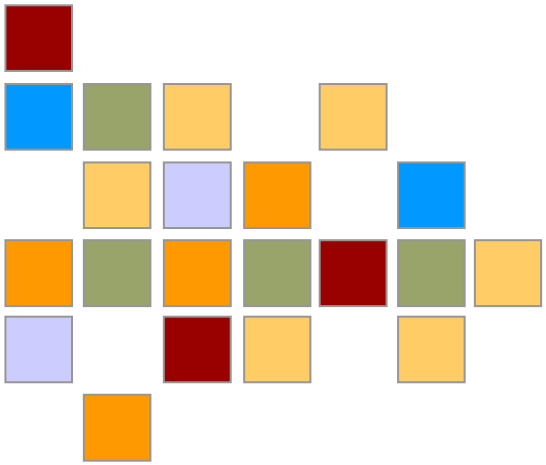
```
Topas CEC Monitor            Interval:  10
Partitions      Memory (GB)                Proce
Shr:  3         Mon:24.6  InUse: 2.7       Shr:1
Ded:  3         Avl:   -                   Ded:

Host          OS  M Mem InU Lp  Us Sy Wa Id  Ph
-------------------------------------shared---
ptools13      A53 c 4.1 0.4  2  20 13  5 62   0
```

PTX (AIX® LPP)



Performance Enhancements **for Virtual SCSI and Virtual Ethernet**

* "Business Case for IBM System p5 Virtualization," *Economic Benefits of IT Simplification*. International Technology Group, February 10, 2006



Performance

Today, we are announcing…THE POWER OF SIX

IBM System p 570. . .with POWER6™ technology!

More than twice the performance* and modular flexibility

System p Virtualization. . .with Live Partition Mobility*!

Extending the most complete virtualization offering for UNIX and Linux

IBM AIX 6 . . . with full binary compatibility!

The next evolution of UNIX with new workload partitions, manageability and security

** All statements regarding IBM future directions and intent are subject to change or withdrawal without notice and represent goals and objectives only.
Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

Ten years ago…

Deep Blue changed the world's perception of what a computer can do

May 11, 1997

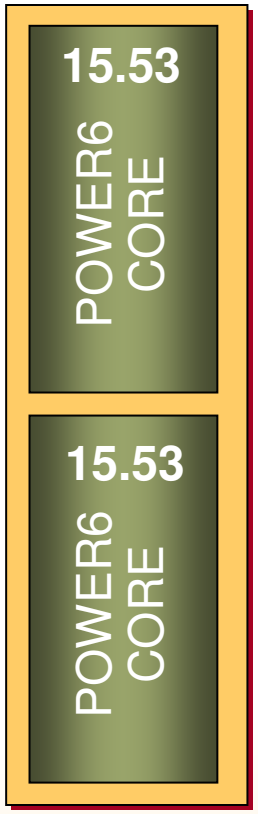
Equitable Center
New York City

IBM POWER technology: 10 years of innovation

Each core of IBM POWER6 exceeds the performance of Deep Blue

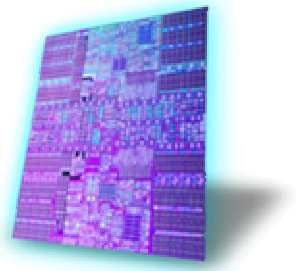
Deep Blue

1.4 tons / 1,270 kg



POWER6 System p 570

341mm²



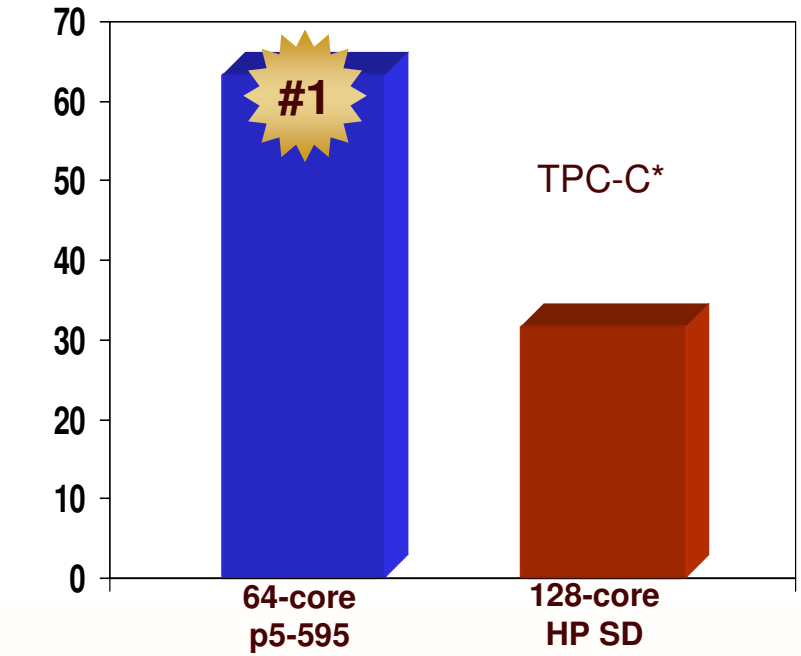
GFLOPS

Source: http://www.top500.org/list/1997/11/100 IBM DEEP BLUE(R) 1.2 GHz, 32 NODE SP2 P2SC, Rpeak: 15 GFLOPS, Rmax: 11.38 GFLOPS: IBM POWER6 CHIP, 4.7 GHZ 2 CORE, Rpeak – 37.6 GFLOPS, Rmax: 30.5 GFLOPS; to be submitted 5/21/07

POWER5+ -- nearly 2X transaction performance and scalability per core and 50% more Java™ performance per core

Today's workloads

p5-595 and DB2®

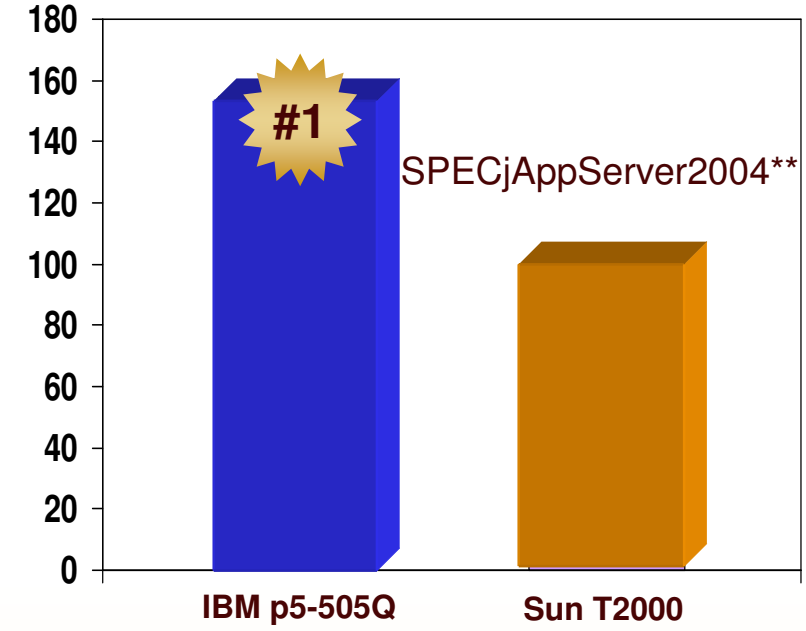


*Source: www.tpc.org/ All results as of 03/02/07

System (Processor, Chip/Core/Thread)	tpmC	Avail.	$/tpmC
IBM p5-595 (2.3 GHz POWER5+, 32/64/128)	**4,033,378**	**01/22/07**	**$2.97**
HP Superdome (1.6 GHz Itanium® 2, 64/128/256)	**4,092,799**	**8/23/07**	**$2.93**

SOA and emerging applications

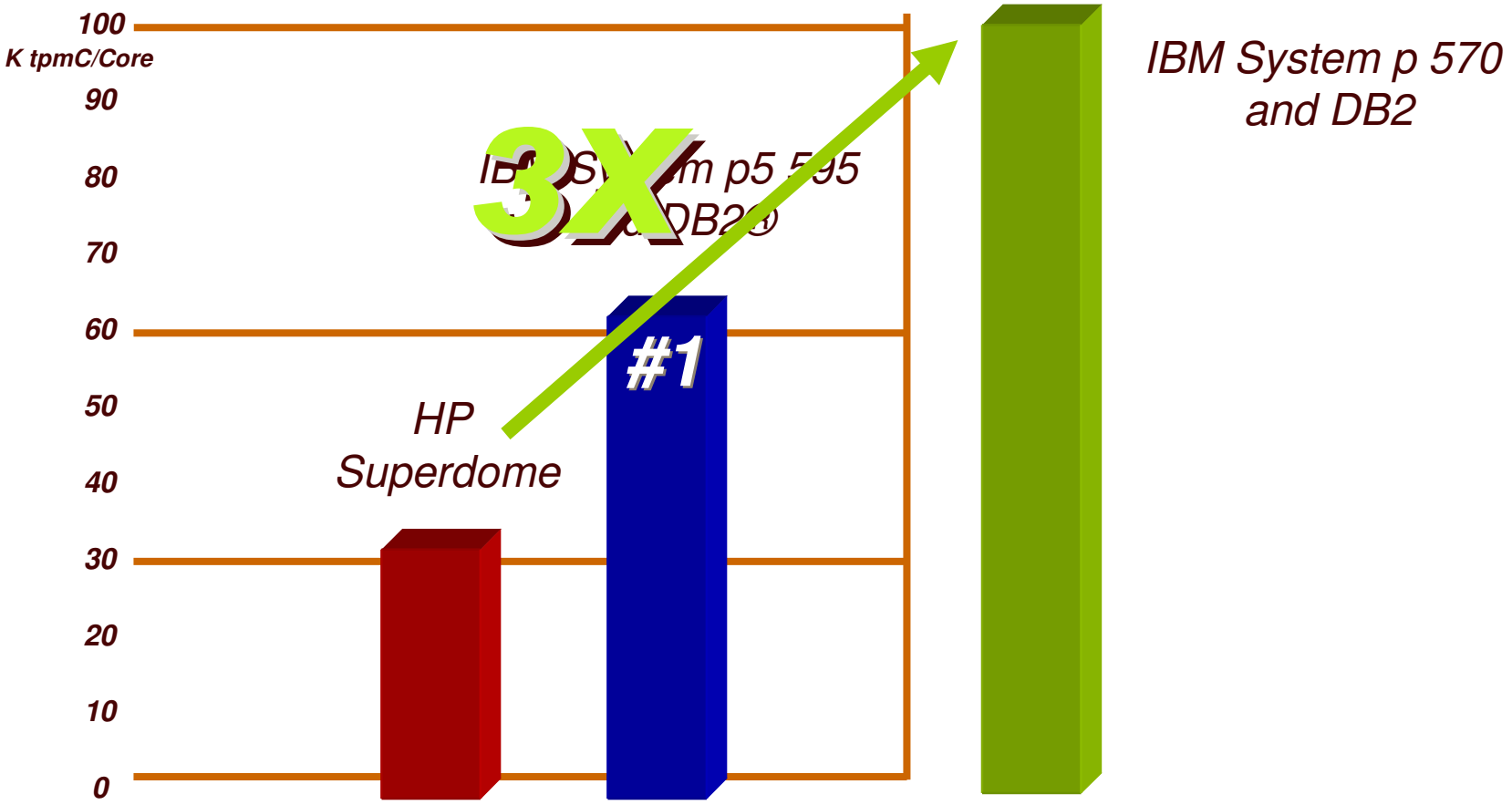
p5-505Q and WebSphere®



**Source: www.spec.org/ All results as of 02/15/06

System (Processor, Memory)	JOPs	Cores	Space
IBM p5-505Q (1.6GHz, 16 GB)	**618**	**4**	**1U**
Sun T2000 (1.2 GHz, 32 GB)	**733**	**8**	**2U**

System p with POWER6+

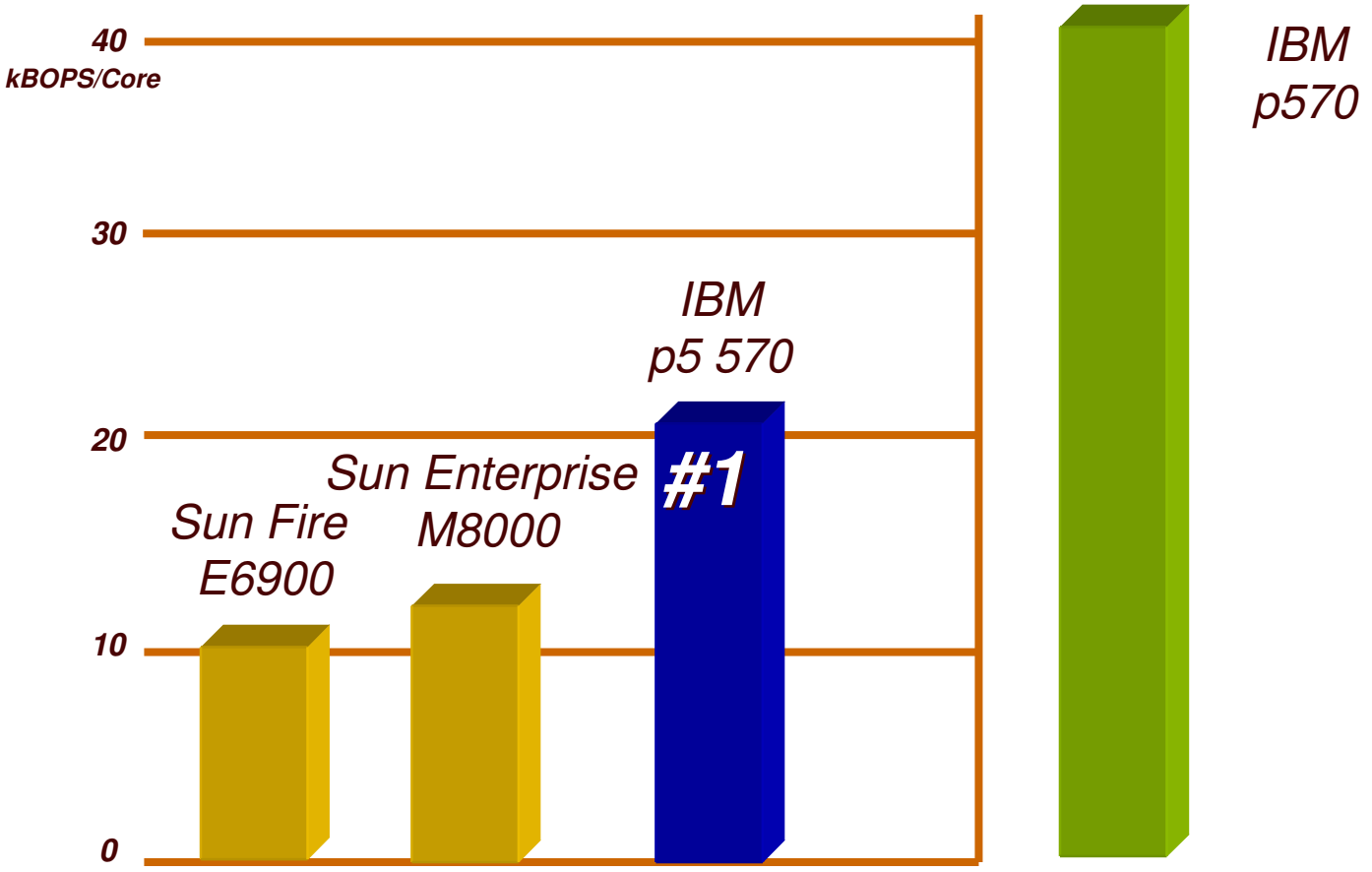


TPC-C*

System (Processor, Chip/Core/Thread)	tpmC	Avail.	$/tpmC
IBM p570 (4.7 GHz POWER6 , 8/16/32)	1,616,162	11/21/07	$3.54
IBM p5-595 (2.3 GHz POWER5+, 32/64/128)	4,033,378	01/22/07	$2.97
HP Superdome (1.6 GHz Itanium 2, 64/128/256)	4,092,799	8/23/07	$2.93

*Source: www.tpc.org/ All results as of 05.21.07

System p with POWER6+

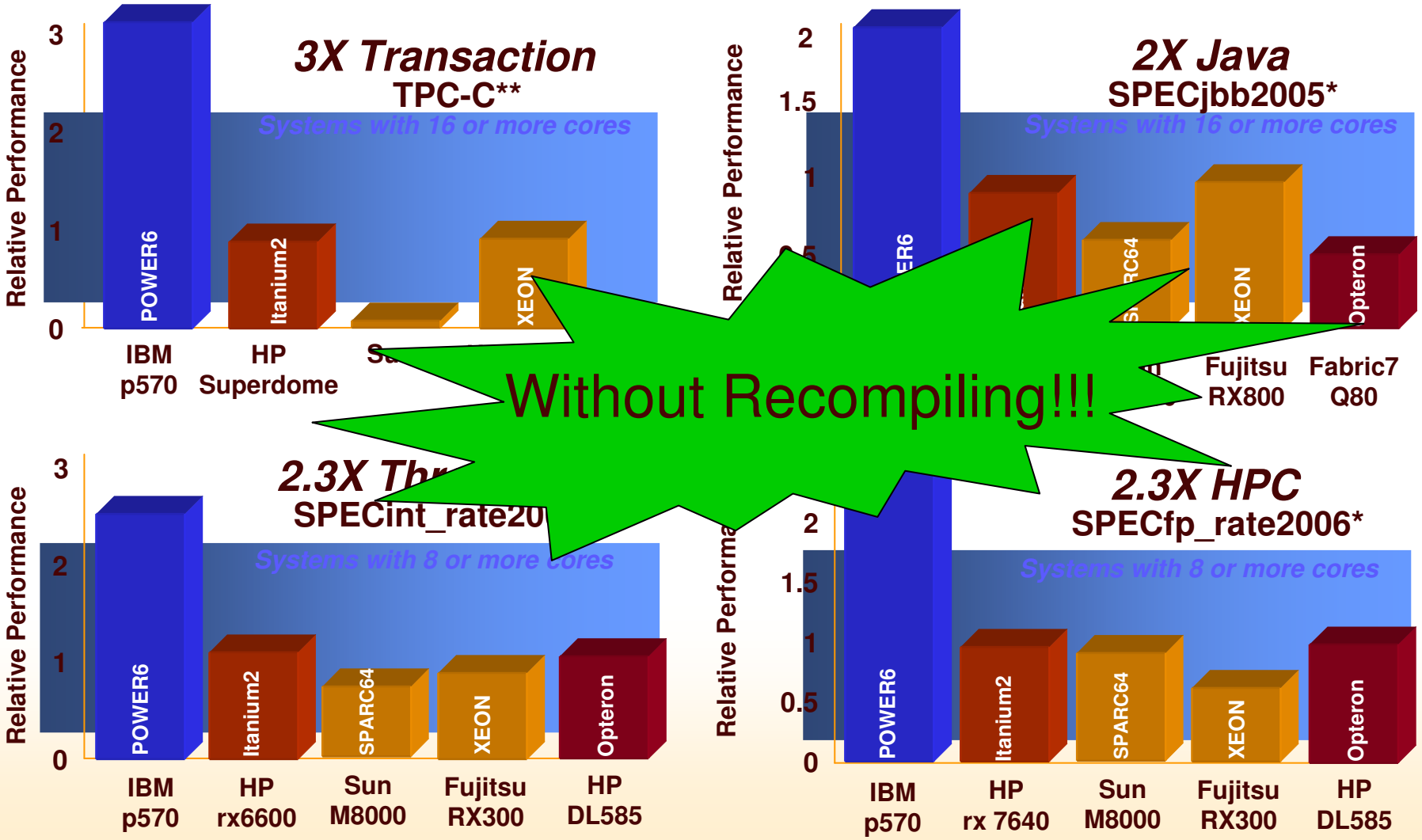


SPECjbb2005**

System (Processor, Cores)	BOPS	Date.	BOPs/JVM
IBM p570 (4.7 GHz POWER6 , 16-core)	691,975	May - 2007	86,497
IBM p5-570 (2.2 GHz POWER5+, 16-core)	326,651	March - 2006	40,831
Sun Fire E6900 (1.95 GHz UltraSPARC VI+, 48-core)	354,733	April - 2007	22,171
Sun Enterprise M8000 (2.4 GHz SPARC64 VI, 32-core)	440,207	May - 2007	27,513

**Source: www.spec.org All results as of 05/21/07

The IBM POWER6 *"Grand Slam"* for major workloads



* Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted on 5/21/07: All other results as of 04/27/07;
** Source: www.tpc.org/ IBM p570 POWER6 result to be submitted on5/21/07; All other results as of 04/27/07
See next page for full detail

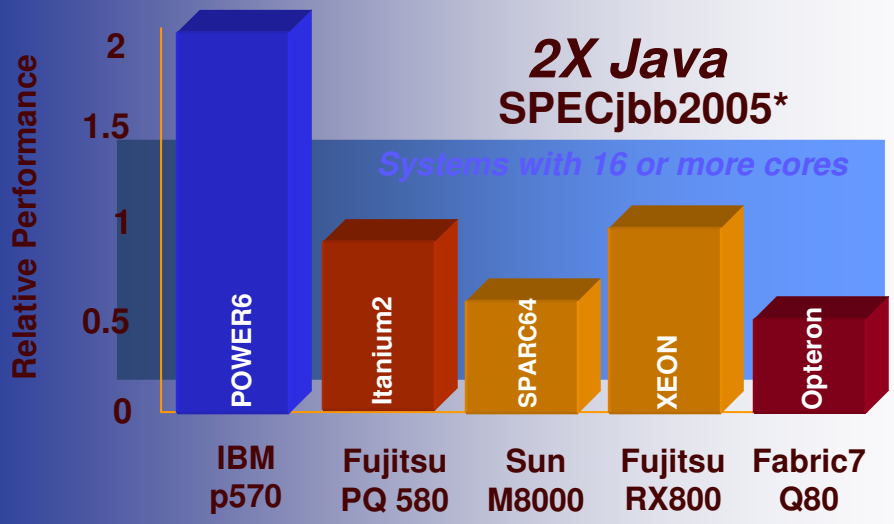
The IBM POWER6 *"Grand Slam"* for major workloads

- SPECjbb2005 comparisons (Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted on 5/21/07: All other results as of 04/27/07)
  - **IBM POWER6 p570 (8 chips, 16 cores) @ 4.7 GHz with 691,975 bops (86,497 bops/JVM) and 43,125 bops per core**
  - **Fujitsu PRIMEQUEST 580 (32 chips, 64 cores) @ 1.6 GHz with 1,214,251 bops (75897 bops/JVM) and 18,974 bops per core**
  - **Sun Fire M8000 (16 chips, 32 cores) @ 2.4 GHz with 440,207 bops (27,513 bops/JVM) and 13,756 bops per core**
  - **Fujitsu RX800 (8 chips, 16 cores) @ 3.5 GHz with 336,653 bops (42,082 bops/JVM) and 21,041 bops per core**
  - **Fabric7 Q80 (8 chips, 16 cores) @ 2.6 GHz with 180,418 bops (22,552 bops/JVM) and 11,276 bops per core**
- TPC-C comparisons (Source: www.tpc.org/ IBM p570 POWER6 result to be submitted on 5/21/07; All other results as of 04/27/07)
  - **IBM POWER6 p570 (8 chips, 16 cores, 32 threads) @ 4.7 GHz with tpmC of 1,616,162 @ $3.54 $/tpmC with availability of 11/20/07 and 101,010 tpmC per core**
  - **HP Integrity Superdome (64 chips, 128 cores, 256 threads) @ 1.6 GHz with tpmC of 4,092,799 @ $2.93 $/tpmC with availability of 8/23/07 and 31,953 tpmC per core**
  - **Unisys ES7000 (8 chips, 16 cores, 32 threads) @ 3.4 GHz with tpmC of 520,467 @ $2.73 $/tpmC with availability of 5/1/07 and 32,529 tpmC per core**
- SPECint_rate2006 (Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted on 5/21/07: All other results as of 04/27/07)
  - **IBM POWER6 p570 (4 chips, 8 cores) @ 4.7 GHz with 242 and 30.25 per core**
  - **HP rx6600 (4 chips, 8 cores) @ 1.6 GHz with 102 and 12.75 per core**
  - **Sun Fire M8000 (16 chips, 32 cores) @ 2.4 GHz with 298 and 9.3125 per core**
  - **Fujitsu RX300 (4 chips, 8 cores) @ 2.66 GHz with 91.2 and 11.4 per core**
  - **HP ProLiant DL585 (4 chips, 8 cores) with 98.3 and 12.29 per core**
- SPECfp_rate2006 (Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted on 5/21/07: All other results as of 04/27/07)
  - **IBM POWER6 p570 (4 chips, 8 cores) @ 4.7 GHz with 224 and 28 per core**
  - **HP rx7640 (4 chips, 8 cores) with 90.8 and 11.35 per core**
  - **Sun Fire M8000 (16 chips, 32 cores) @ 2.4 GHz with 313 and 9.7813 per core**
  - **Fujitsu RX300 (4 chips, 8 cores) @ 2.66 GHz with 60.9 and 7.61 per core**
  - **HP ProLiant DL585 (4 chips, 8 cores) with 91.3 and 11.41 per core**

* Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted on 5/21/07: All other results as of 04/27/07;
** Source: www.tpc.org/ IBM p570 POWER6 result to be submitted on5/21/07; All other results as of 04/27/07

IBM WebSphere® optimized for System p

Performance Leadership



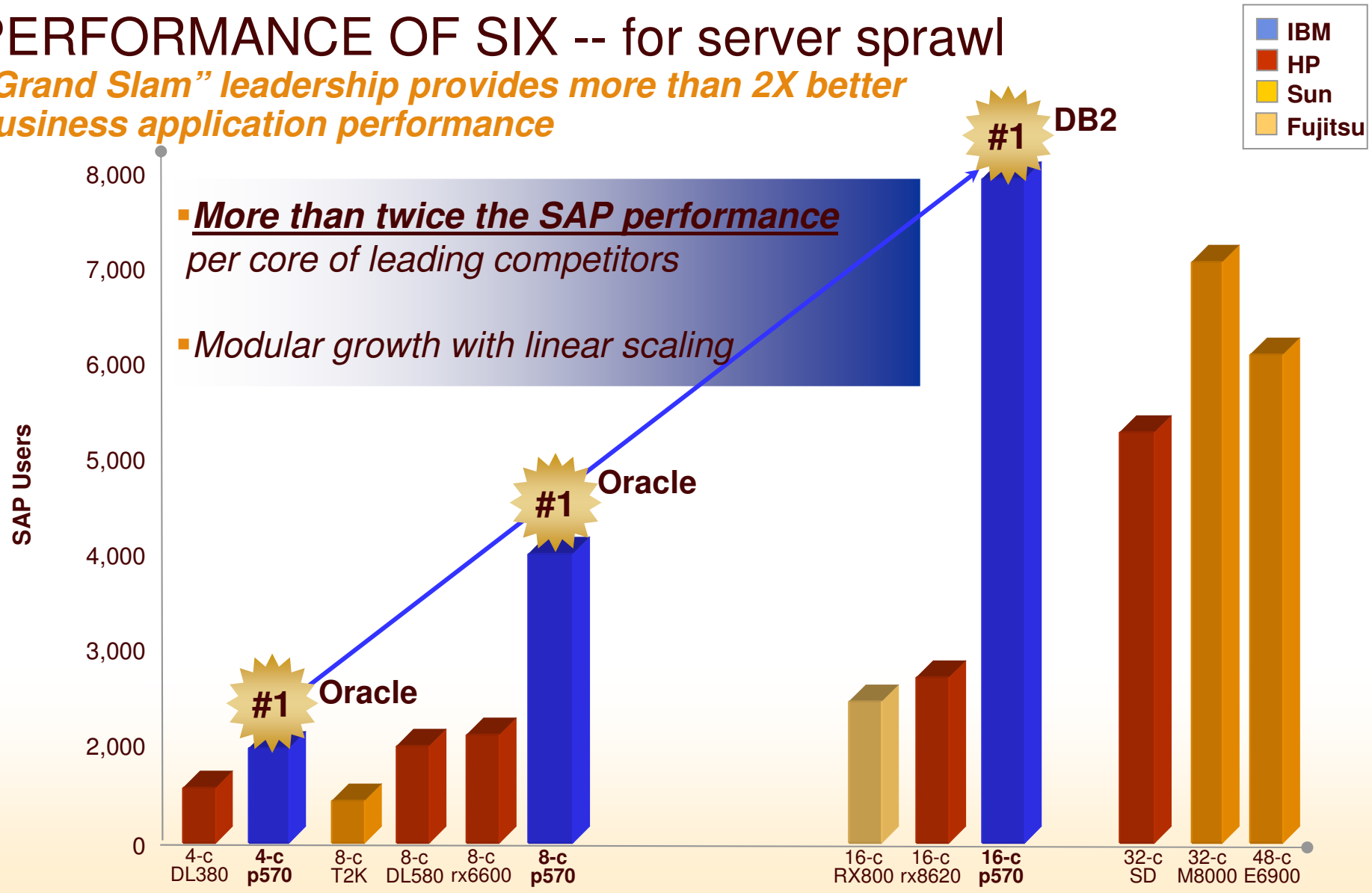
SOA Affinity

IBM System p Configurations for SOA Entry Points

*Source: http://www.spec.org/ IBM p570 POWER6 results to be submitted by 5/21/07: All other results as of 04/27/07.

PERFORMANCE OF SIX -- for server sprawl

"Grand Slam" leadership provides more than 2X better business application performance



Source: www.sap.com/benchmark/ IBM results submitted on 5/21/07; All other results as of 04/27/2007; see accompanying table for additional detail

SAP SD 2-tier detailed results

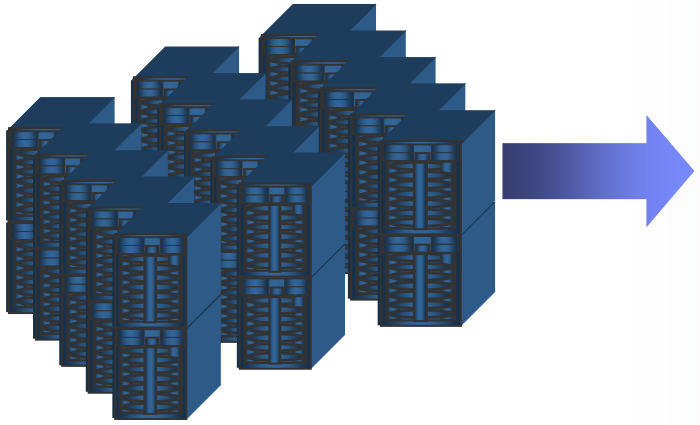
Configuration	Chips, Cores, Threads	Software	Certification #	Benchmark users	Response Time
IBM p570 4.7 GHz POWER6	8, 16, 32	SAP ECC 6.0 AIX 5L V5.3, DB2 9.1	New *	8,000	1.98 sec
Sun Microsystems M8000 2.4 GHz SPARC64 VI	16, 32, 64	SAP ECC 6.0 Solaris 10, Oracle 10g	2007026	7,300	1.98 sec
Sun Microsystems E6900 1.95 GHz USIV+	24, 48, 48	SAP ECC 6.0 Solaris 10, Oracle 10g	2007023	6,160	1.98 sec
HP Integrity Superdome 1.6 GHz Itanium2	16, 32, 64	SAP ECC 6.0, Windows Server 2003 DE, SQL Server 2005	2006090	5,600	1.91 sec
IBM p570 4.7 GHz POWER6	4, 8, 16	SAP ECC 6.0 AIX 5L V5.3, Oracle 10g	New *	4,010	1.96 sec
HP Integrity rx8620 1.5 GHz Itanium2	8, 16, 32	SAP R/3 4.70 HP-UX 11i, Oracle 9i	2003062	2,880	1.95 sec
Fujitsu Siemens PRIMERGY RX800 3.0 GHx Xeon	8, 16, 32	SAP ECC 5.0, Windows Server 2003 EE, SQL Server 2005	2006022	2,600	1.94 sec
HP Integrity rx6600 1.6 GHz Itanium2	4, 8, 16	SAP ECC 6.0, HP-UX11/V3, Oracle 10g	2006082	2,150	1.97 sec
HP Proliant DL580 G4 3.4 GHz XEON	4, 8, 16	SAP ECC 5.0, Windows Server 2003 EE, SQL Server 2005	2006060	2,127	1.99 sec
IBM p570 4.7 GHz POWER6	2, 4, 8	SAP ECC 6.0 AIX 5L V5.3, Oracle 10g	New *	2,035	1.99 sec
HP Proliant DL380 G5 3.0 GHz XEON	2, 4, 4	SAP ECC 5.0, Windows Server 2003 EE, SQL Server 2005	2006039	1,216	1.99 sec
Sun T2000 1.2 GHz US T1	1, 8, 32	SAP ECC 5.0 Solaris 10, MaxDB 7.5	2005047	950	1.91 sec

* The SAP certification number was not available at press time and can be found at the following web page: http://www50.sap.com/benchmarkdata/sd2tier.asp
Source: www.sap.com/benchmark/
New IBM results submitted on 5/21/07
All other results as of 04/27/07

Save more than $100K per year on energy and space costs!

Based on new IBM p570 performance and efficiency*

30 Sun Fire V890 systems at 20% utilization



- 480 total cores @ 1.5 GHz
- $5,625 annual space costs @ $62.50 sq ft
- $113,607 annual energy costs @ $0.09 / kWhr

Two IBM System p 570 systems at 60% utilization

- *Save up to 90% cost of floor space*
- *Save up to 90% cost of energy*
- *Save up to 90% on per core SW costs*

- 32 total cores @ 4.7 GHz
- $375 annual space costs @ $62.50 sq ft
- $13,667 annual energy costs @ $0.09 / kWhr

*Datacenter floor space cost was estimated as of 5/3/2007 based on Alinean, Inc.'s ROI Analyst software. Energy cost of $.0928 per kWh is based on 2007 YTD US Average Retail price to commercial customers at $.0928 per US DOE at http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.htm as of 05/18/2007
The reduction, if any, in floor space, power, cooling and software costs depends on the specific customer, environment, application requirements, and the consolidation potential. Sun system power requirements based on http://www.sun.com/products-n-solutions/hardware/docs/html/817-3956-12/system_specs.html#pgfId-1001301
Air conditioning power requirement estimated at 50% of system power requirement. SPEC® results source: www.spec.org as of 05/22/2007: System p 570 (16-core, 8 chips, 2 chips per core, 4.7 GHz): SPECjbb2005 691,975 bops 86497 bops/JVM; Sun Fire v890 (16-core, 8 chips, 2 chips per core) 1.5 GHz SPECjbb2005 117,986 bops, 29,497 bops/JVM

Why buy fifteen HP systems when you can get better performance AND reduce costs with only two IBM p570s?

FIFTEEN 16-core HP Integrity rx7640 systems

- 240 total cores @ 1.6 GHz
- $38,538 annual energy costs @ $0.09 / kWhr
- $1,500 annual space costs @ $62.50 sq ft

TWO 16-core IBM p570 systems

- *Gain up to 14% performance advantage, and*
- *Save up to 85% cost per core in software fees*
- *Save up to 75% cost of floor space*
- *Save up to 65% cost of energy costs*

- **32 total cores @ 4.7 GHz**
- **$13,254 annual energy costs @ $0.09 / kWhr**
- **$375 annual space costs @ $62.50 sq ft**

*Datacenter floor space cost was estimated as of 5/3/2007 based on Alinean, Inc.'s ROI Analyst software. The reduction, if any, in floor space, power, cooling and software costs depends on the specific customer, environment, application requirements, and the consolidation potential. SPEC® results source: www.spec.org as of 05/22/2007: System p 570 (16-core, 4.7 GHz): SPECint_rate2006: 478, HP Integrity rx7640 16-core, 1.6 GHz SPECint_rate2006: 167 Energy cost of $.0928 per kWh is based on 2007 YTD US Average Retail price to commercial customers at $.0928 per US DOE at http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.htm as of 05/18/2007

Now you may be able to save even more!

The German company Voith consolidated on System p5 570s saving*:

- *70-80% on energy costs*
- *30% on SW costs*

Twice the performance at almost the same energy

30 HP systems
Capacity = 50,000 SAPs

Four IBM System p5 570 servers
Capacity = 80,000 SAPs

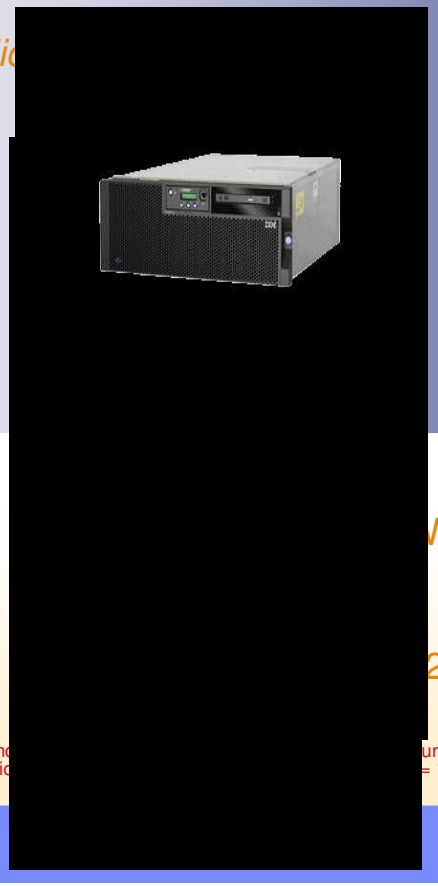
Two POWER6 System p 570s
Capacity =80,000 SAPs

http://www-306.ibm.com/software/success/cssdb.nsf/CS/STRD-72NM7N?OpenDocument&Site=corp&cty=en_us

Get 39% more Java application performance by migrating from a 32-core Sun Fire E6900 to an 8-core System p 570

And potentially save. . .

- *87% cost of floor space*
- *50% cost of energy*
- *75% cost per core SW li*



Sun Fire E6900

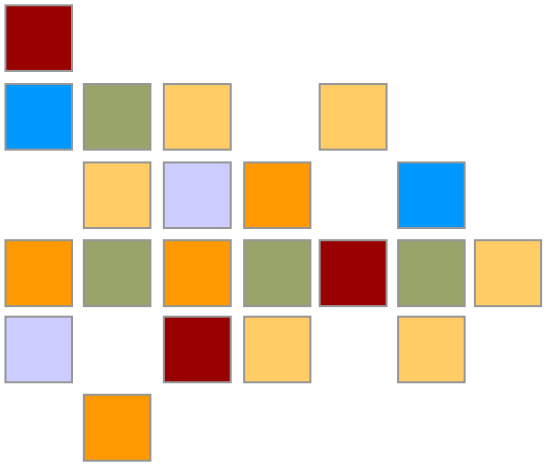
- 32-core, 1.5 GHz (UltraSPARC IV+)
- 28 Rack Units
- 5,945 Volt-Amps
- SPECjbb2005: 248,075 bops (bops/JVM: 31,009)

VER6)

2 bops (bops/JVM: 86,686)

*The reduction, if any, in floor space, power, cooling, and software costs depends on the specific customer, environment, and
power requirements based on VA ratings at http://www.powerware.com/UPS/selector/BuildByDevice.asp used with permissio

urce: www.spec.org as of 05/22/2007 **System
= 1.0

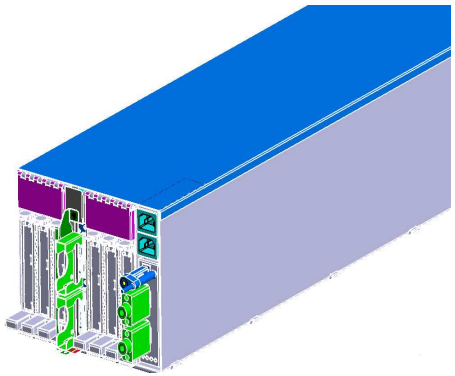


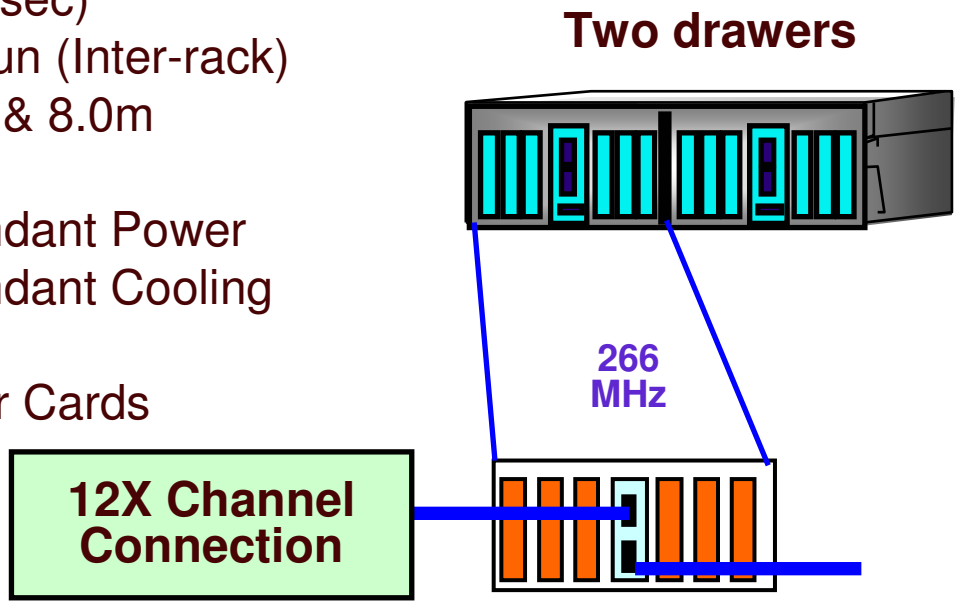
Additional Hardware

POWER6 Remote I/O Drawer 19” Rack

7314-G30

- ½ x 19” 4U Rack Mount
  - Optional enclosure for two individual drawers
- Six PCI Adapter Slots
  - PCI-X 2.0 (DDR)
  - 64-bit @ 266 MHz (2 GB/s)
- “InfiniBand” Host Interface (Loop Architecture)
  - 12 x 2.5Gb/s Full Duplex (30 Gb/sec)
  - Short Run (Intra-rack) or Long Run (Inter-rack)
  - Four cable lengths: 0.6, 1.5, 3.0, & 8.0m
- Customer Setup
- Concurrently Maintainable Redundant Power
- Concurrently Maintainable Redundant Cooling
- Hot Drawer Add
- Blind Swap Cassettes for Adapter Cards
  - Hot-pluggable





New POWER6 I/O Adapters

Adapter	Fibre Channel	Ethernet	Host Enet Adap. Integ. Virt. Enet	2D Graphics
Host Bus	PCIe x4 1 GB/s FDX	PCIe x4 1 GB/s FDX	GX+ (P5IOC2) ~2-3 GB/s FDX	PCIe x1 250 MB/s FDX
Technology	4 Gb/s	1 Gb/s TX/SX	1 Gb/s TX 10 Gb/s SR	Analog & Digital
Ports	1 & 2	2	2 & 4 (1 Gb/s) 2 (10 Gb/s)	2
Feature Codes	5773 / 5774	5767 / 5768	5636 / 5639 / 5637	5748
AIX	5.3..6	5.2.10, 5.3.6	5.2.10, 5.3.6	5.2.10, 5.3.6
Linux	SLES 10 SP1 RHEL 4.5	SLES 10 SP1 RHEL 4.5	SLES 10 SP1 RHEL 4.5	SLES 10 SP1 RHEL 4.5
Virtualization	VIOS	VIOS	Stand-alone	NA

PCI Express Overview

PCI Express is available in several sizes

- x1, x2, x4, x8 & x16
- x4 is what most adapters are being designed to

PCI Express uses less pins then does PCIx

- PCIx = 188 pins, PCIe = 64 pins

(x4) theoretical bandwidth is 10 Gb in each direction (20 Gb aggregate bandwidth), where as PCI-X 1.0 (133 MHz) aggregate bandwidth is 8 Gb.

Overall, we recommend all the new installations to take advantage of PCI Express slots, due to the inherent advantages of PCI Express technology (e.g. less I/O pins, lower power, lower latency etc.) and protect their investment for foreseeable future.

iSCSI (SCSI over IP)

	iSCSI TOE	iSCSI TOE
Models	Copper	Fibre
I/O slot	PCI-X 1.0	PCI-X 1.0
Wire speed	1 Gbps	1 Gbps
Transfer rate (full duplex)	200 MBps	200 MBps
Ports	1	1
Storage	Tape and Disk	Tape and Disk
Operating systems	AIX, Linux	AIX, Linux

4 Gbps Fibre Channel

	4 Gbps	Dual 4 Gbps
Models	Fibre	Fibre
I/O slot	PCI-X 1.0	PCI-X 1.0
Wire speed	1 Gb/sec	1 Gb/sec
Transfer rate (full duplex)	4000 MB/sec	4000 MB/sec per port
Ports	1	2
Primary use	Storage Area Network	Storage Area Network
Operating systems	AIX, Linux	AIX, Linux

SCSI Offerings

	SCSI	SCSI RAID	SCSI RAID
Interface	Ultra320	Ultra320	Ultra320
I/O slot	PCI-X 2.0 DDR	PCI-X 2.0 DDR	Daughter Card [1]
Transfer rate	2 GBps	2 GBps	1 GBps
Ports	2	2	Imbed Dependant
Connections	External and Internal	External and Internal	Internal and External
Storage [2]	Tape and Disk	Tape and Disk	Tape and Disk
RAID support	na	0, 5, 6, 10	0, 5, 10
Write cache size	na	90 MB	40 MB
Operating systems [3]	AIX, Linux	AIX, Linux	AIX, Linux

Internal tape drives

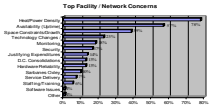
	DAT72	VXA-2	VXA-320	LTO-2
Form factor	HH, Autodock	Half-high	Half-high	Half-high
Interface	SCSI-2 LVD	SCSI-2 LVD	SCSI-3 LVD	SCSI-3 LVD
Media type	DDS Gen-5	VXA	VXA	Ultrium
Native capacity	36 GB	80 GB	160 GB	200 GB
Compressed capacity	72 GB	160 GB	320 GB	400 GB
Native data rate	3 MBps	6 MBps	12 MBps	24 MBps
Compressed data rate	6 MBps	12 MBps	24 MBps	48 MBps
Reads and writes	DDS 3,4,5	VXA 2	VXA 2, 3	Ultrium 1, 2
Operating systems [1]	AIX, Linux	AIX, Linux	AIX, Linux	AIX, Linux

Ethernet connectivity

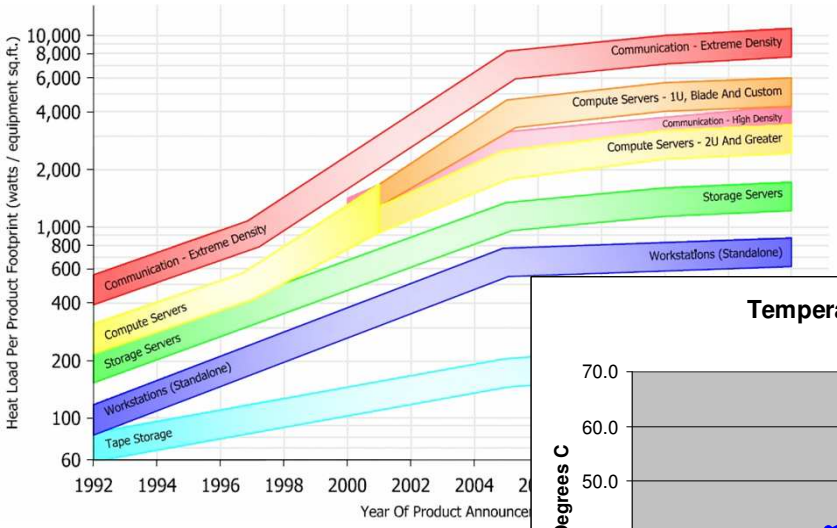
	10 Gb SR	10 Gb LR	1 Gb	1 Gb
I/O slot	PCI-X	PCI-X	PCI-X	PCI-X
Ports	1	1	1 / 2	4 [1]
Wire speed	10 Gbps [2]	10 Gbps [2]	1 Gbps	1 Gbps
Copper / fibre	Fibre	Fibre	Copper / Fibre	Copper
Distance	300m	10Km		
Operating systems [3]	AIX , Linux	AIX , Linux	AIX , Linux	AIX , Linux

Rear Door Heat Exchanger (RDHx) for Power Architecture systems

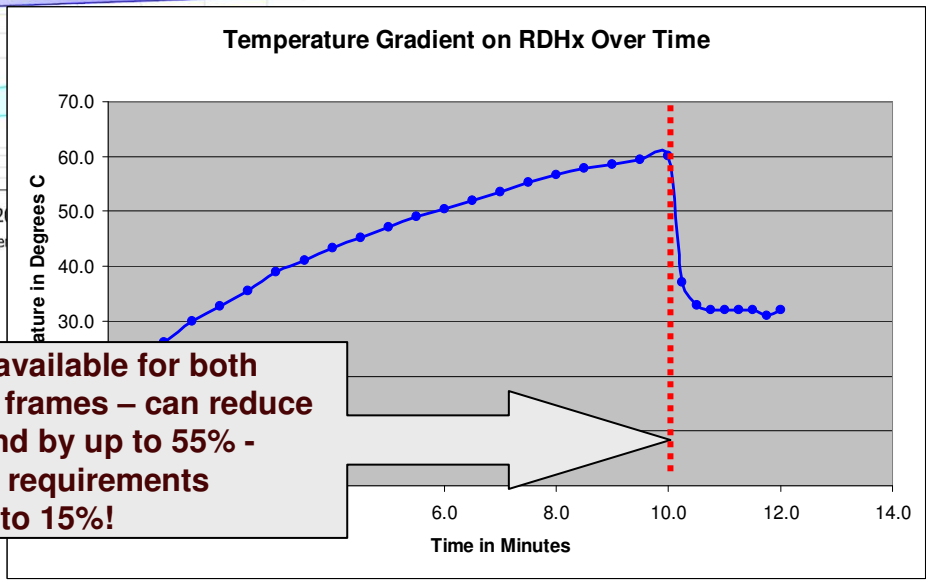
INSTALLATION HEAT AND POWER LEVELS ARE MAJOR ISSUES…



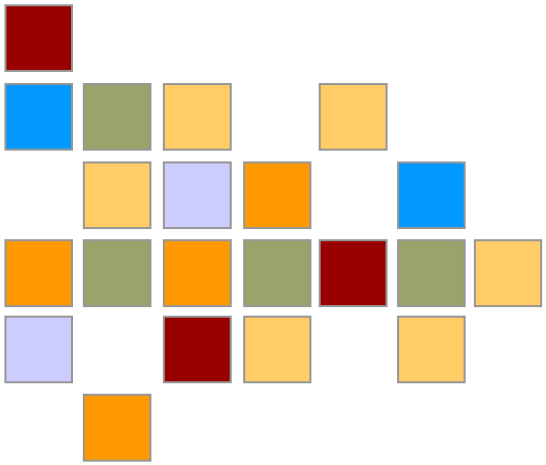
DEMANDS ARE GROWING…



RDHx OFFERS RELIEF!…



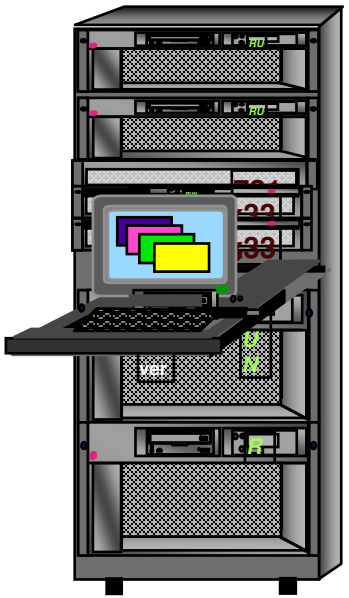
RDHx is now available for both 19" racks and 24" frames – can reduce cooling demand by up to 55% - and power requirements by up to 15%!



Hardware Management Console & Tools

Hardware Management Console (HMC)

Models available:	7310/7042-C06 (desktop) 7310/7042-CR4 (rack-mount)
Ethernet support:	POWER6 and POWER5 Systems
Requirements:	Required for: ▸ Partition Management ▸ CoD ▸ Virtualization activities Optional for APV on standalone servers
Licensed Machine Code Version 7:	Supports POWER6 and POWER5/5+ processor-based servers only



POWER6 HMC Enhancements

Support for POWER5 and POWER6 on same HMC

Updated HMC hardware (Intel® technology refresh)

No change: Hardware scaling support

- 7342-CR4 & 7342-C06
- 32 physical systems
- Up to 254 LPARS

Native browser access; WebSM no longer required

- Firefox 1.5.0.6 or later.
- Microsoft® Internet Explorer 6.0 or later

Support for modified CSM on HMC

Upgrade support for POWER5 HMC to POWER6

- 7310 will support POWER6 environment
- New model type for POWER6: 7042

Internal modem support for rack models

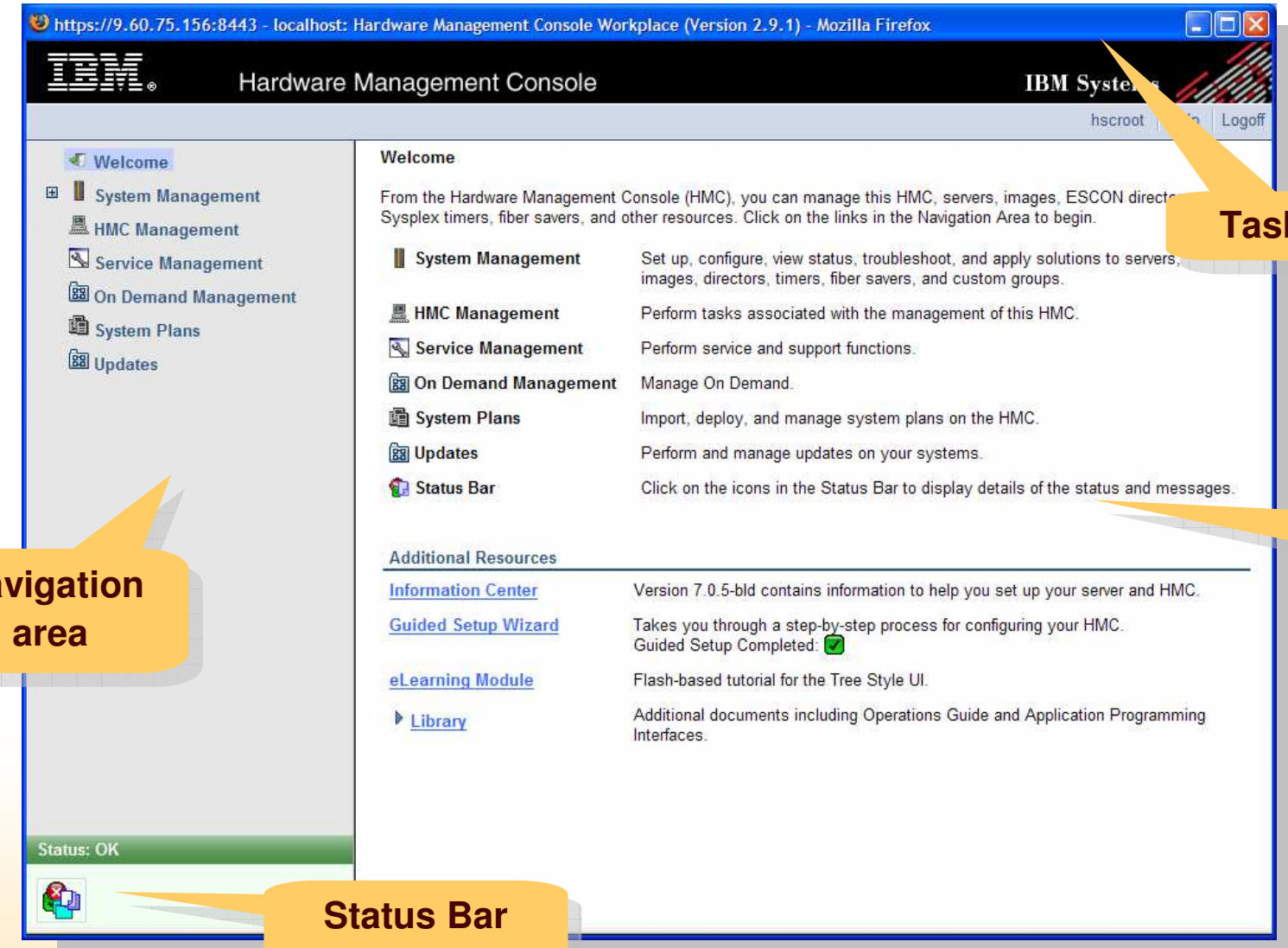
- Available with CR5 models
- Support will vary by geography

MES on Existing p5 HMC to get HMC v7

HMC Enhancements

- New Web-based User Interface
  - Improved task discovery – improve visibility of important tasks
  - Reduced task depth - reduce number of clicks and views to find a task
  - Consistent navigation and categorization
  - No special remote client installation required, supports both Firefox and Internet Explorer
  - Unifies user experience across HMC, IVM and IBM Web UI family
- Enhanced Management and Deployment Wizards

New HMC Layout



Simplify Virtualized Systems Planning

With the free IBM Systems Planning and Deployment Tool

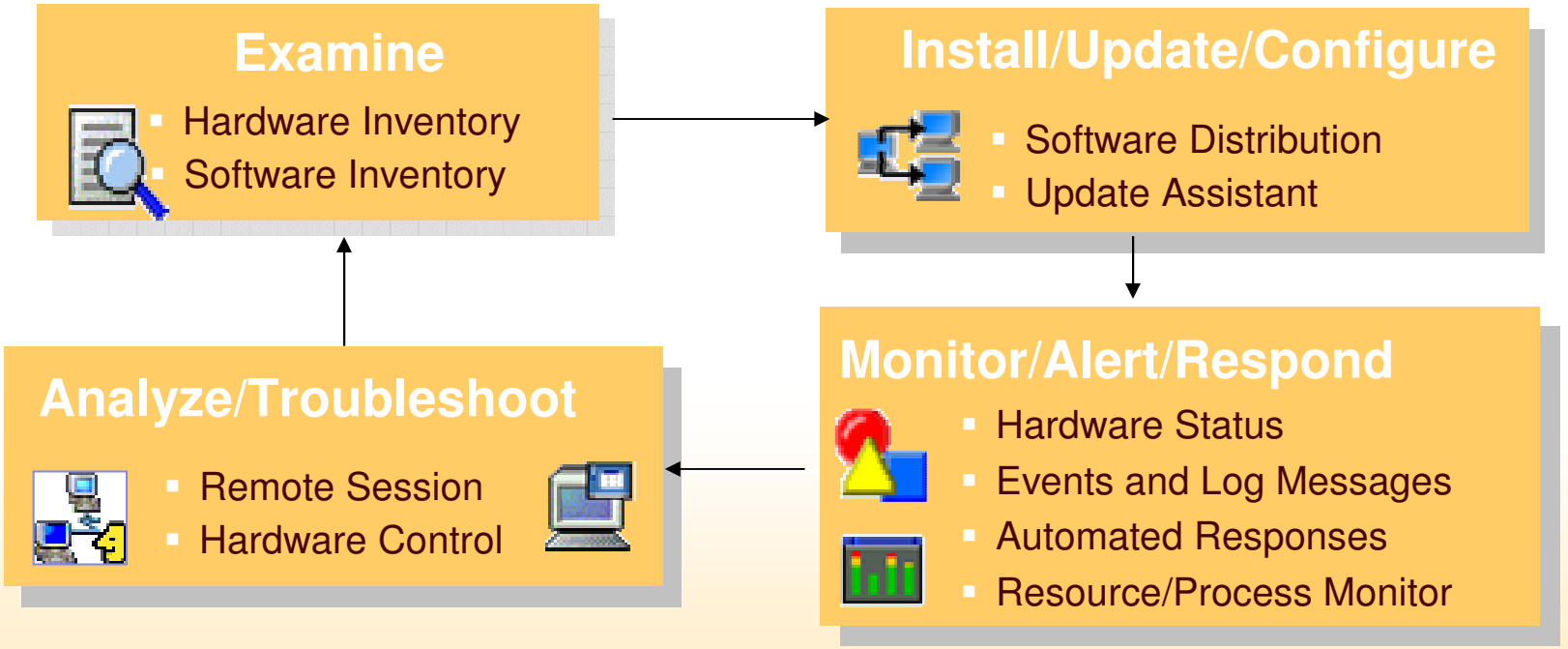
- **Seamlessly plan, order, and deploy your system using this free tool**

- **Enhancements include**
  - Virtual I/O Server Partition Planning and Deployment Support
    - Support for primary and backup VIOS instances
    - Redundancy, Shared Ethernet, SAN connections and internal storage
    - MPIO attachments
    - VIOS configuration recovery support
    - Configuration validation
  - Integrated Virtualization Manager Support
    - For automated configuration of partitions and deployment through IVM
  - Enhanced Reporting
    - HTML reporting for partition hardware inventory and system attributes

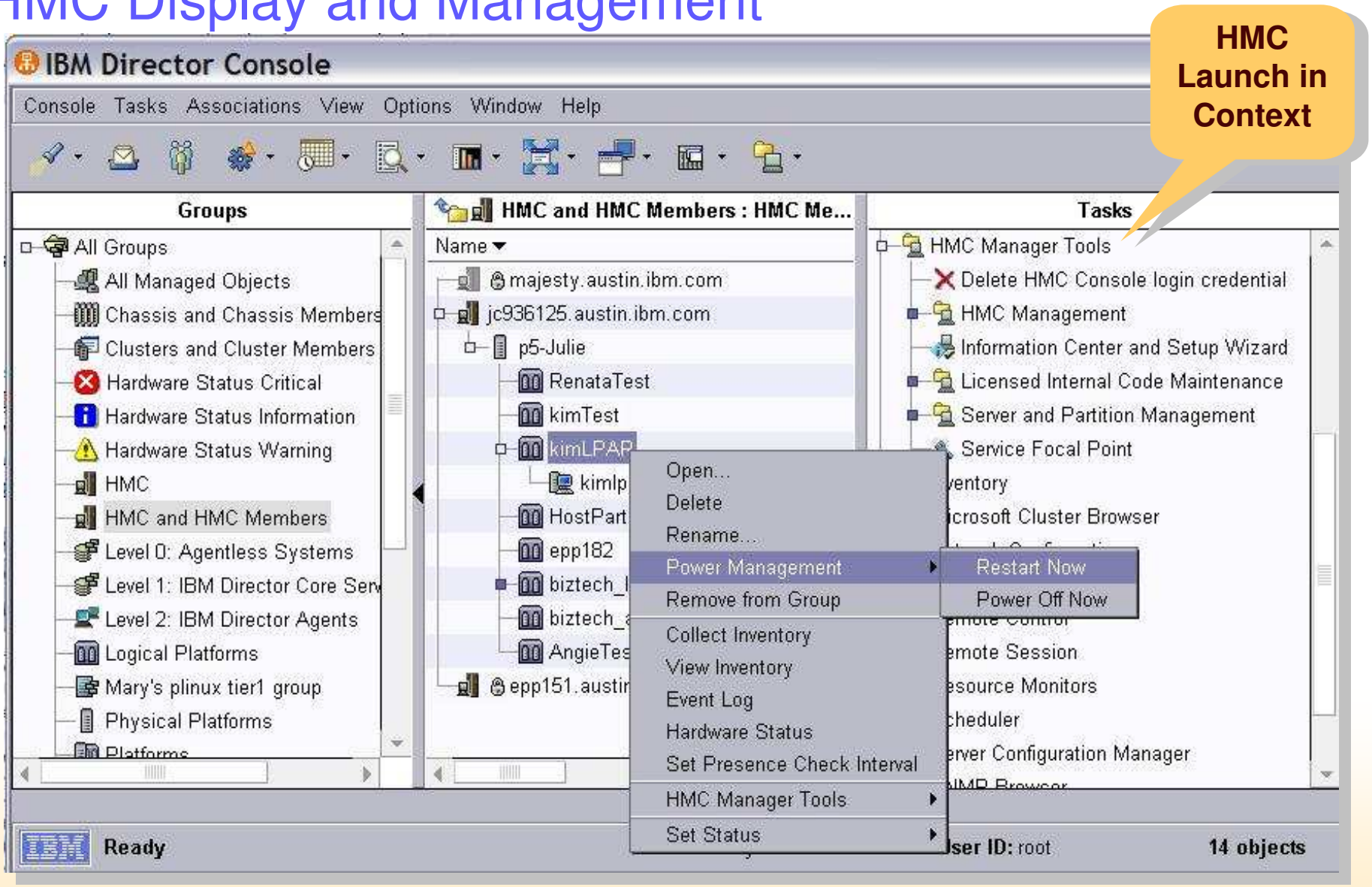
Free download from http://www.ibm.com/systems/support/tools/systemplanningtool/

IBM Systems Director Value Propositions for System p

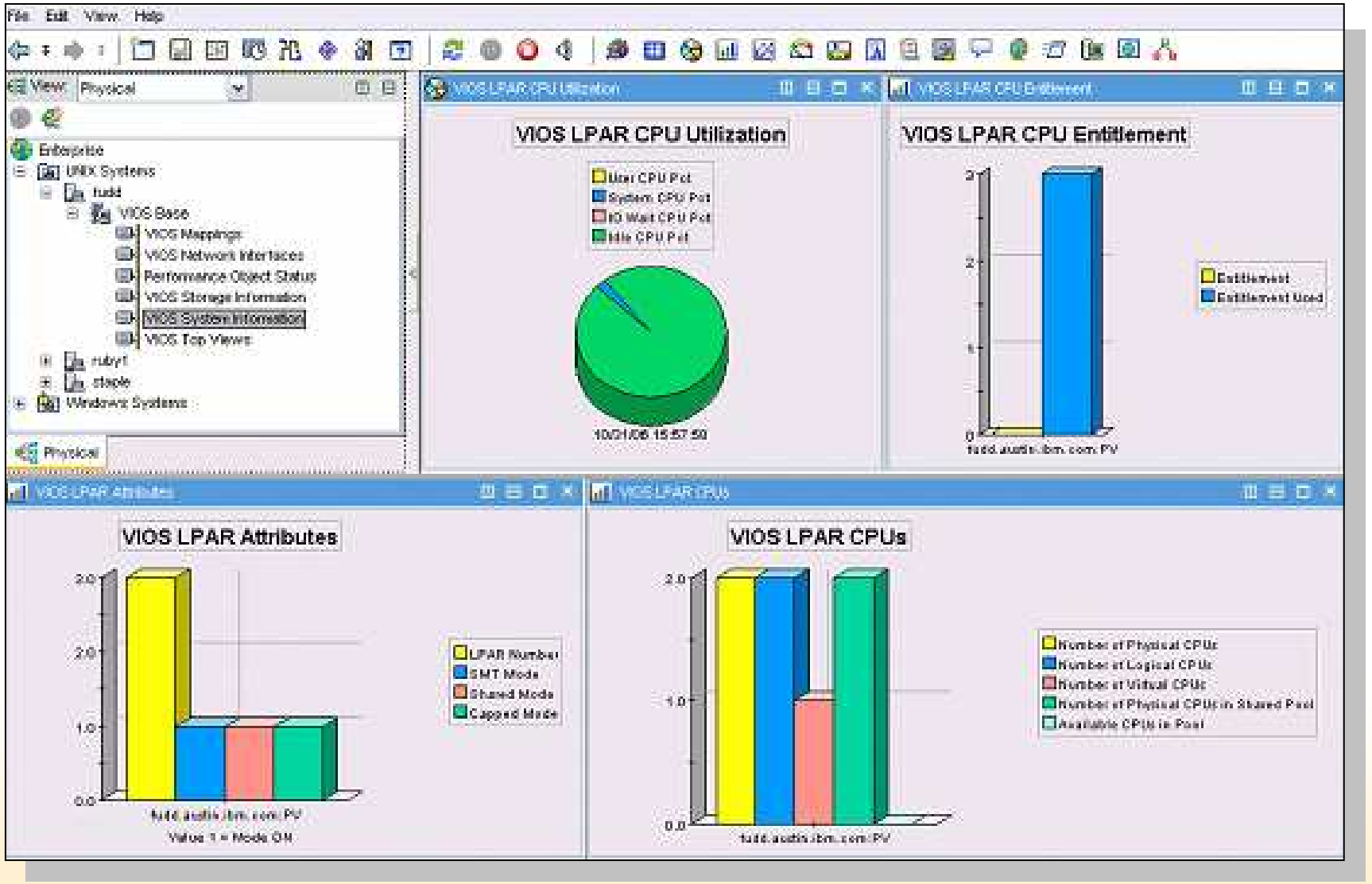
- Consistent platform management of both **physical** and **virtual** System p resources (AIX, Linux, HMC, IVM, VIOS)
- IBM Director on System p provided at no charge for core management capabilities
- SWMA available for $120 / CPU



HMC Display and Management

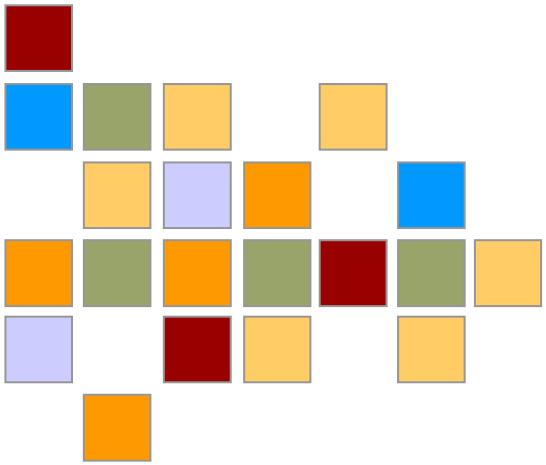


IBM Tivoli Monitoring System Edition for System p



IBM Tivoli Monitoring Free vs. Fee Products

	Free	Fee
Topology and Navigation ▪ HMC, IVM, VIOS, CEC, LPARs, VIOS Server and Client, WPARs	X	X+
Availability Monitoring ▪ HMC, IVM, VIOS, LPAR, WPAR Status ▪ AIX and VIOS System Level CEC, LPAR, CPU, Memory Metrics	X	X+
Health ▪ AIX and VIOS Checks, Alert Messages, Expert Advise, Actions ▪ CPU, Memory, Disk, and Network Thresholds, File System Status, Paging Space, Status of Daemons and Services (i.e. NFS, http), Top Resource Consumers, etc.	X	X+
Client Customizable Workspaces, Navigators, Eventing, Situations	X	X+
Performance and Throughput ▪ AIX and VIOS ▪ Existing ITM Metrics (i.e. CPU, Memory, I/O, Network, File System) ▪ AIX PTX Metrics (i.e. CPU, Memory, LAN, TCP, UDP, IP , WLM, Process, LPAR, Disk, I/O, LVM, Paging Space, IPC, NFS, CEC) ▪ Customized VIOS and WPAR Metrics		X
Data Warehouse ▪ Historic Performance Data		X
Workflows ▪ Client Configurable		X



Operating System

AIX Features Roadmap

AIX V5.3– TL4
- Multiple page size
- Support: 4K, 64K, 16M, & 16GB

AIX V5.3– TL6
- POWER6 Enablement
- **Decimal Floating Point**

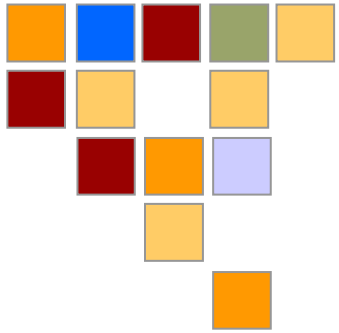
AIX V5.3– TL5
- LPARs: Common OS Image
- AIX Login (Using LDAP Client)
  - Microsoft Active Directory
- CAPP/EAL4+ Security

AIX 6 (Availability 2H / 2007)
- POWER 6 systems & I/O
- Reliability / Availability / Serviceability
- Workload Partitions
  - Live Application Mobility
- LPARs
  - Live Partition Mobility

All statements regarding IBM future directions and intent are subject to change or withdrawal without notice

AIX Version 5.3 Features

Flexible resource management	IBM Advanced POWER Virtualization ▸ Micro-Partitioning ▸ Virtual I/O : Networking and Storage ▸ Partition Load Manager ▸ Integrated Virtualization Manager Advanced accounting JFS2 file system shrink Cross partition performance monitoring
Enterprise scalability	POWER5+ support Simultaneous multithreading processor 1,024 disk volume group NFSv4
Entreprise reliability	AIX First Failure Data Capture instrumentation Component level tracing Parallel dump, Minidump
Data center management	AIX Security Expert Shared Boot Image management SUMA integration with NIM Network Data Administration Facility (NDAF) Virtualization management Tivoli® integration



AIX V5.3 August 2006 Update Highlights

AIX Security Expert

- Template-based security wizard
- Security templates can be distributed throughout an enterprise

AIX LDAP client support for Microsoft Active Directory

- AIX systems can use Active Directory for user and group repository

Shared Boot Disk Management

- Boot multiple LPARs/systems from a single boot disk

LPAR Historical Performance Reports

Enterprise Reliability

- Parallel system dump processing
- Component level system trace
- AIX First Failure Data Capture

Tivoli Integration

- Tivoli Usage and Accounting Mgr
- Tivoli Access Manager (U.S.)

NFS Proxy Caching system

Ideal for WAN environments

NDAF – NFSv4 management

Network Data Administration Facility

Manage large, replicated filesystems

NIM and installation enhancements

New command *geninv* & *niminv*

Installation support for >1TB LUN

AIX 6: The Next Step in the Evolution of UNIX®

Introducing AIX 6

AIX 6 is **binary compatible*** with AIX 5L™
It is *named* to reflect it's unity with POWER6™

The POWER of SIX – AIX 6 and POWER6

- **Workload Partitions**
- **Live Application Mobility**

} **AIX 6**

- Live Partition Mobility
- Storage Keys
- Hardware Decimal Floating-Point
- Dynamic Variable Page Size

} **POWER 6**

IBM System p Innovation and
Advanced POWER™ Virtualization
Provide Unique Features for ISV and Customer Exploitation

*Complete details on AIX binary compatibility can be found at http://www.ibm.com/servers/aix/os/compatibility/

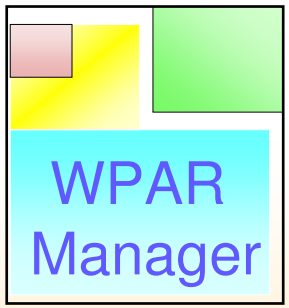
Planned Smooth Upgrade to AIX 6

- **AIX 6 is binary compatible with AIX 5L**
  - Current applications will continue to run
  - Runs on POWER4™, POWER5™, POWER6 systems
  - Open beta will provide early access to AIX 6
  - Other activities planned to assure ISVs
- **No charge upgrade for current AIX 5L clients with SWMA**
  - No additional out of pocket expense for clients
- **Upgrade process**
  - Tools like alt disk installation and multi-bos minimize client risk

Two Planned WPAR AIX Offerings in 2007

- AIX 6
  - Workload Partitions (WPAR) included in base AIX 6
  - Element (single system) WPAR Management

- Workload Partitions Manager
  - Enablement for Live Application Mobility
  - Cross System Management for Workload Partitions
  - Automated, Policy-based Application Mobility
  - Part of the IBM System Director Family



*All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

Workload Partitions provide Simplified System Management

One button install and configuration

- *Installs in minutes*
- *Highly configurable and flexible*
- *Command line, SMIT interface, or template*

One button startup/boot

- *Workload Partition boots in seconds*

One button stop/shutdown

Planned Role Based Access Control

- **Improved Administrative Security**
  - Improved security by reducing the need for many root users
  - Reduced administration cost thought delegation

aix

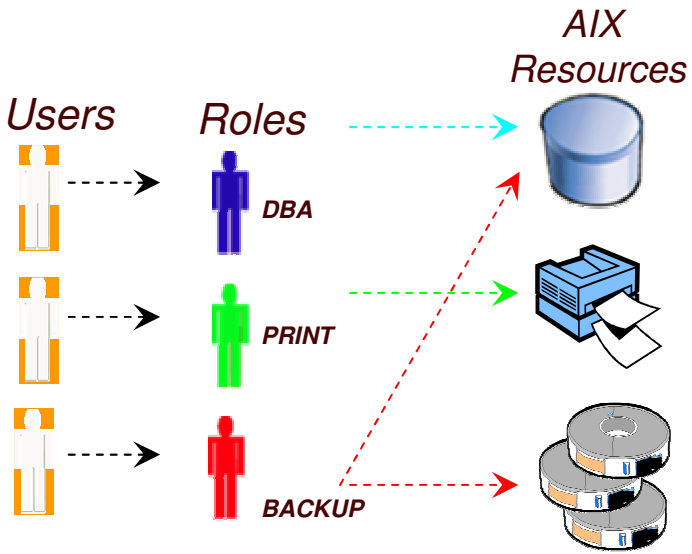
- device
- fs
- network
- proc
- ras
- security
- **system**
- wpar

boot

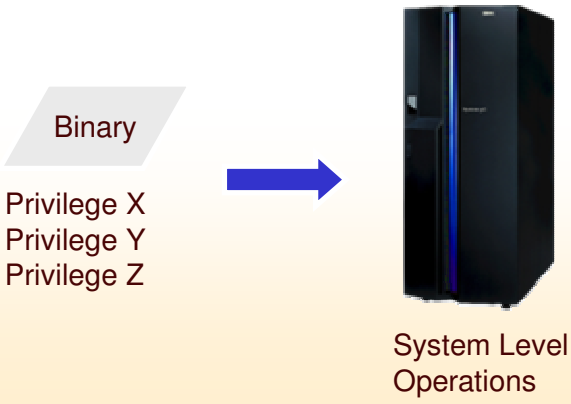
- config
- install
- stat

create	“create boot image”
Halt	“halt the system”
Info	“display boot information
Reboot	“reboot the system”
Shutdown	“shutdown the system”

auth = aix.system.boot.create

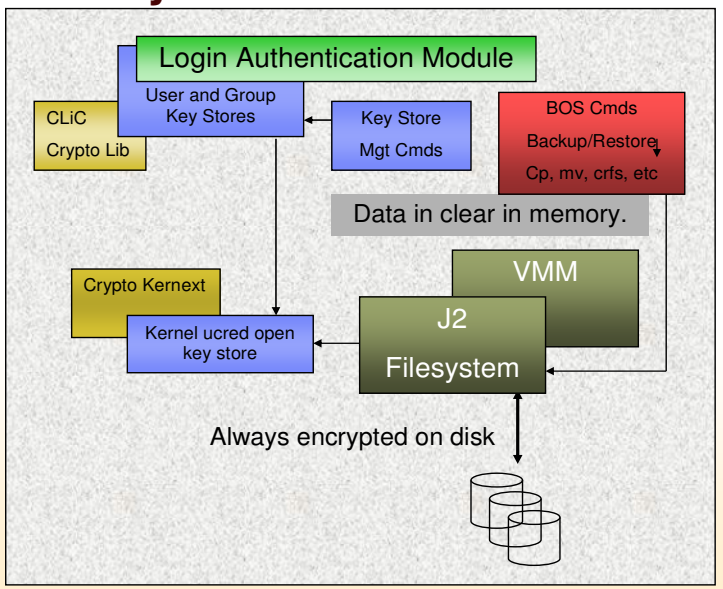


- **Improved Program Security**
  - Allows programs to do system level operations without running as root or having setuid root capability
  - Only allow program to perform restricted set of needed operations



Encrypted File System

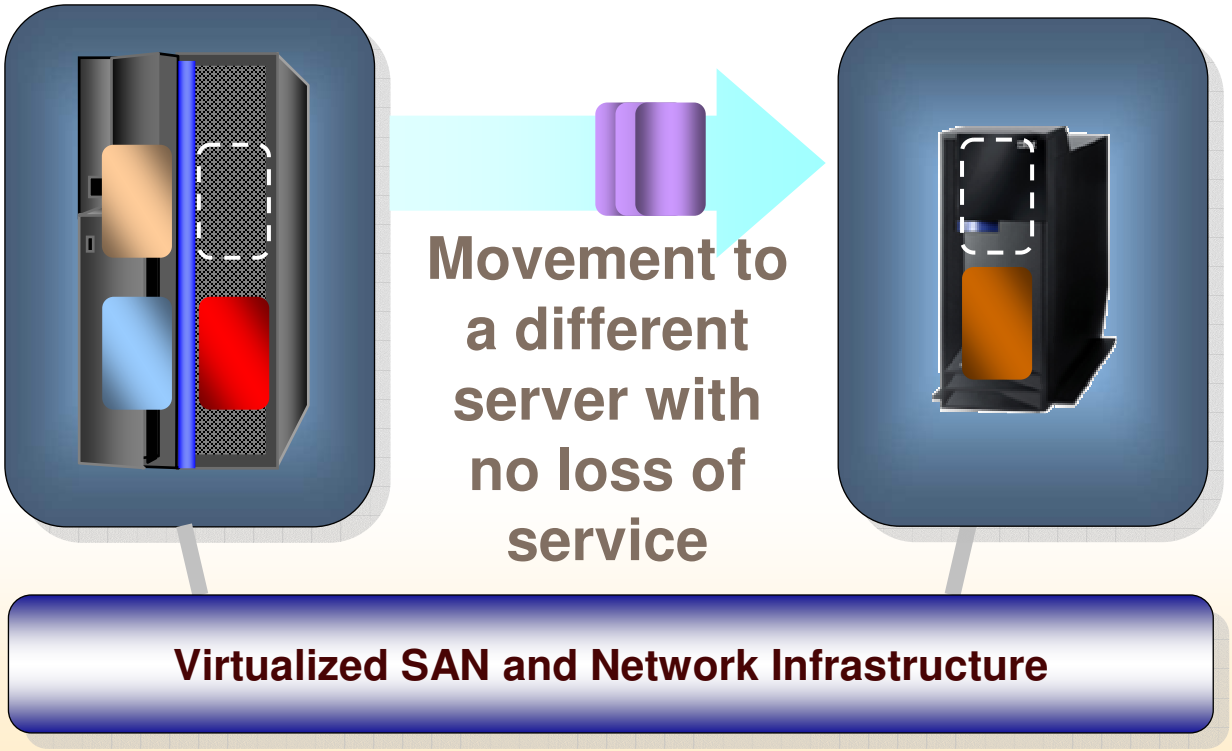
- **Backup in encrypted or clear formats**
- **Can be protected from root access to encrypted data**
- **Integrated into user and group administration**
- **Automatic key store creation on user creation**
- **Key store open on login, integrated into AIX security Loadable Authentication Module**
- **Each file encrypted with unique key**
- **No keys stored in clear in kernel memory**
- **Key stores in PKCS12 format.**
- **AES, and RSA Cryptography**



Planned Live Partition Mobility with POWER6

Allows migration of a running LPAR to another physical server

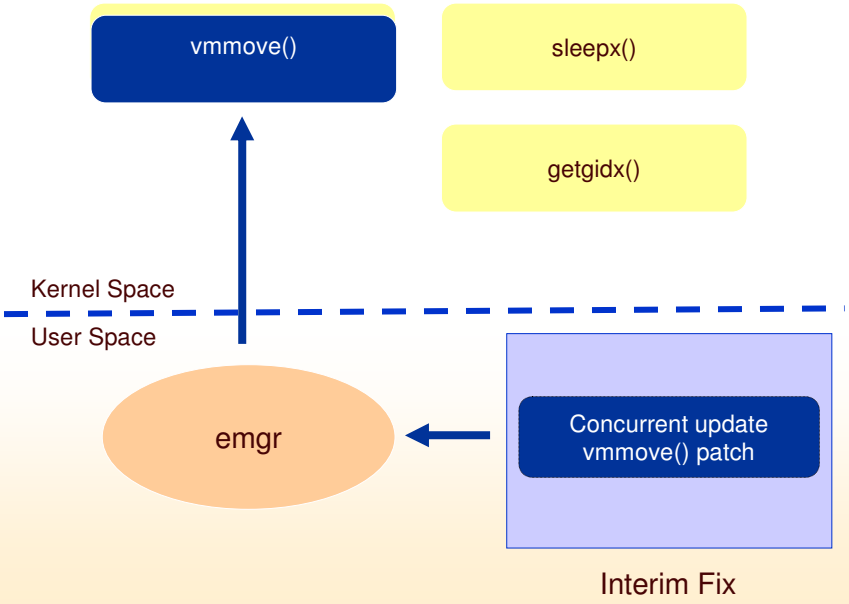
- ✓ Reduce impact of planned outages
- ✓ Relocate workloads to enable growth
- ✓ Provision new technology with no disruption to service
- ✓ Save energy by moving workloads off underutilized servers



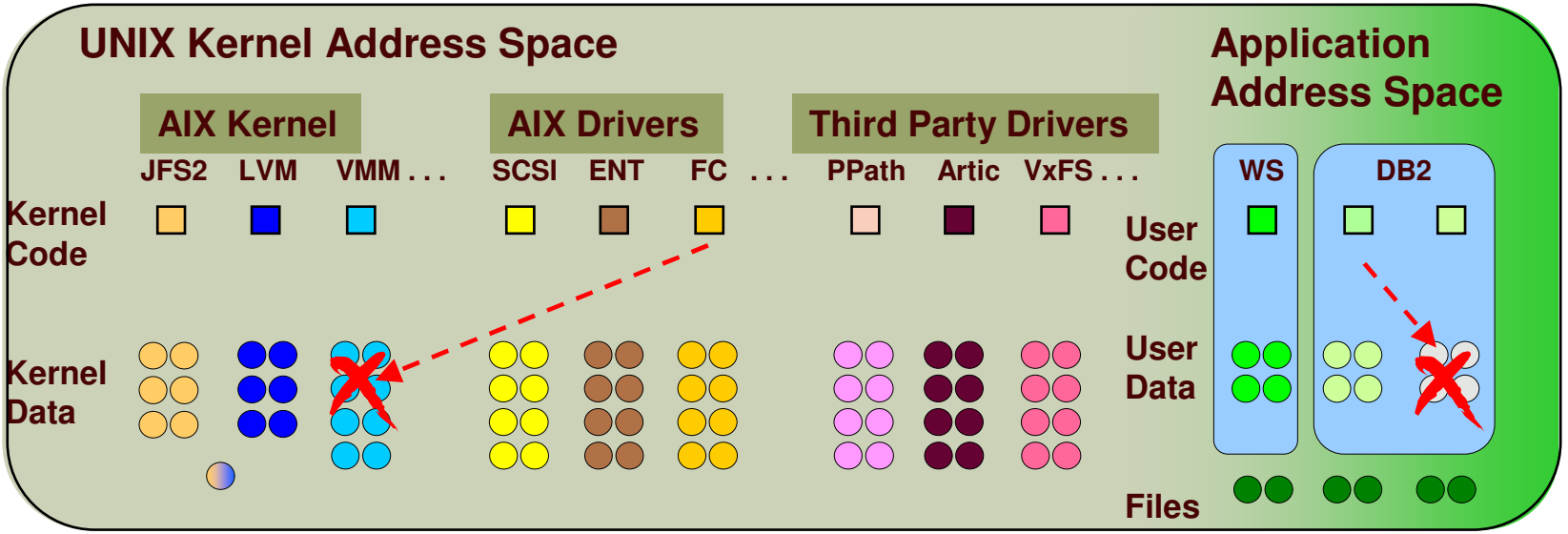
AIX Planned Concurrent Maintenance

Fix selected AIX kernel problems without a service outage

- **Non-disruptive fixes to executable code in a running AIX kernel**
  - Base AIX Kernel (/unix), kernel extension, or device driver
- **No downtime (reboot) required to apply fix and make it active**
- **Concurrent updates will be packaged as Interim Fixes**

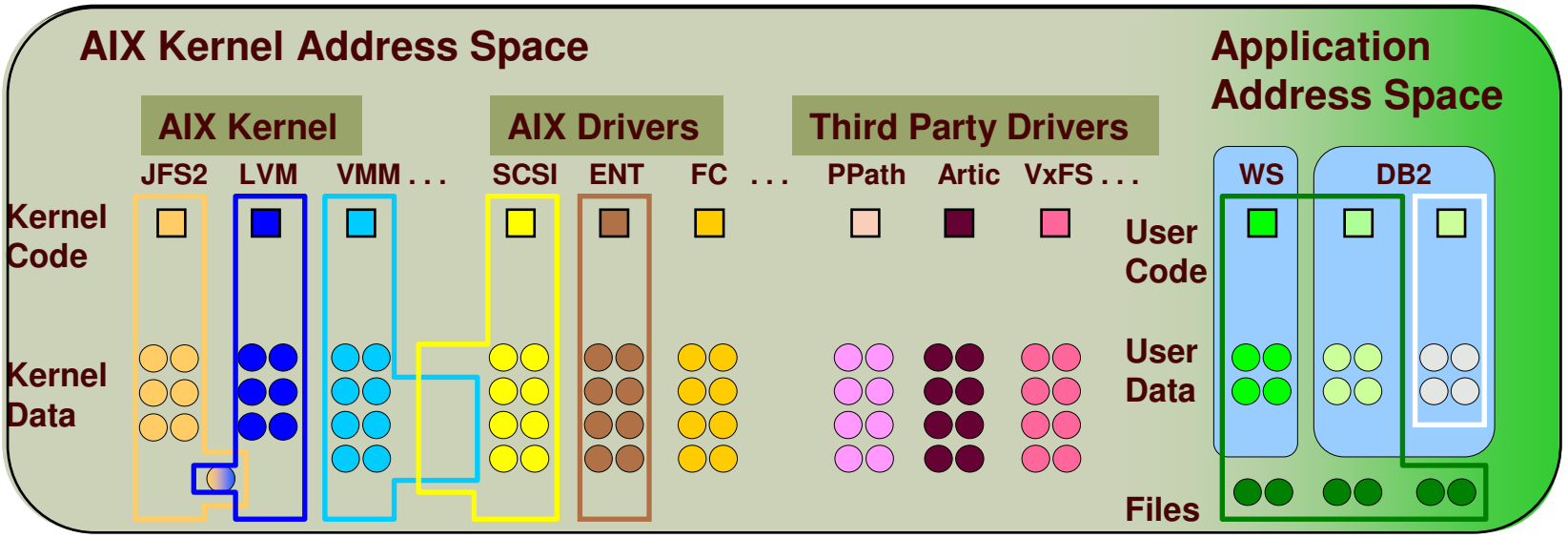


AIX Planned Storage Keys



- **In current UNIX implementations, any kernel routine can overwrite any kernel memory**
  - **Memory overlay can cause subtle, intermittent problems**

AIX Planned Storage Keys



- **In current UNIX implementations, any kernel routine can overwrite any kernel memory**
  - Memory overlay can cause subtle, intermittent problems
- **POWER6 Storage Keys will isolate data and protect against corruption**
  - Enabled through POWER6 H/W & provides isolation between subsystems or subsystems classes
- **Initially provide eight keys w/POWER6**
  - More keys brings finer-grain isolation and better protection
- **Extensible to applications to protect against corruption within the application**
  - AIX will provide enablement to allow applications to exploit keys
- **Application keys with AIX V5.3 - Kernel key exploitation with AIX 6**

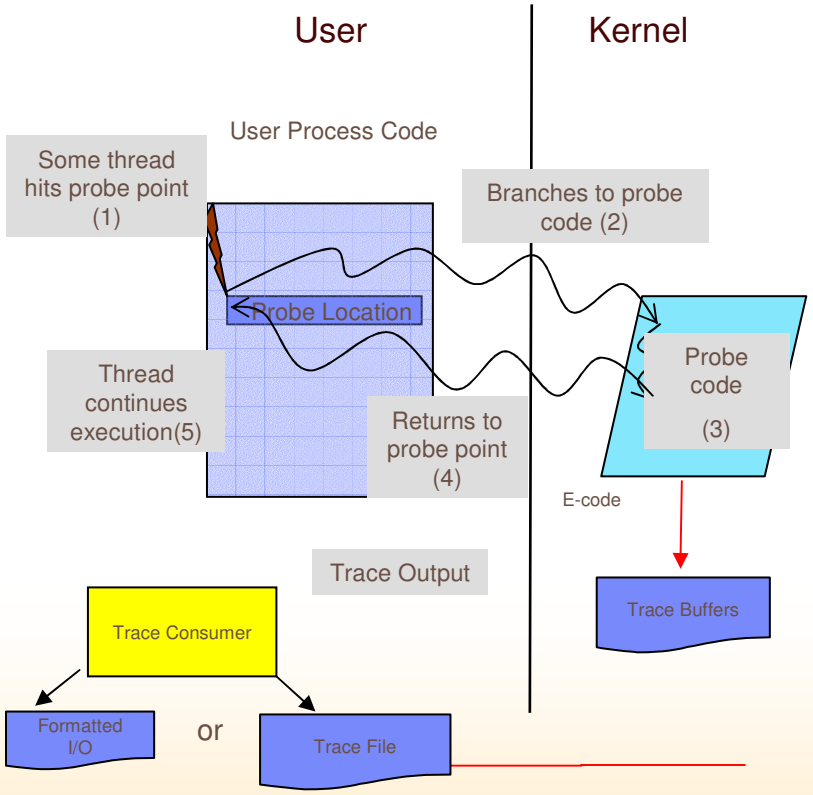
Planned Dynamic Tracing With *probevue*

- **Trace existing programs without recompiling**
- **Dynamic placement of trace probes**
- **For debugging and performance analysis**
- **AIX system calls, application functions, and application calls to library functions traceable**
- **Dynamic tracing language called Vue**
- **Initial support for "C" programs**

"Vue" probe code example

```
#!/usr/bin/probevue
/* countreads.v */

@@syscall.$1.read.entry
{
  count++;
}
@@interval.*.clock.100
{
  printf("Number of reads = %d\n", count);
  count = 0;
}
```

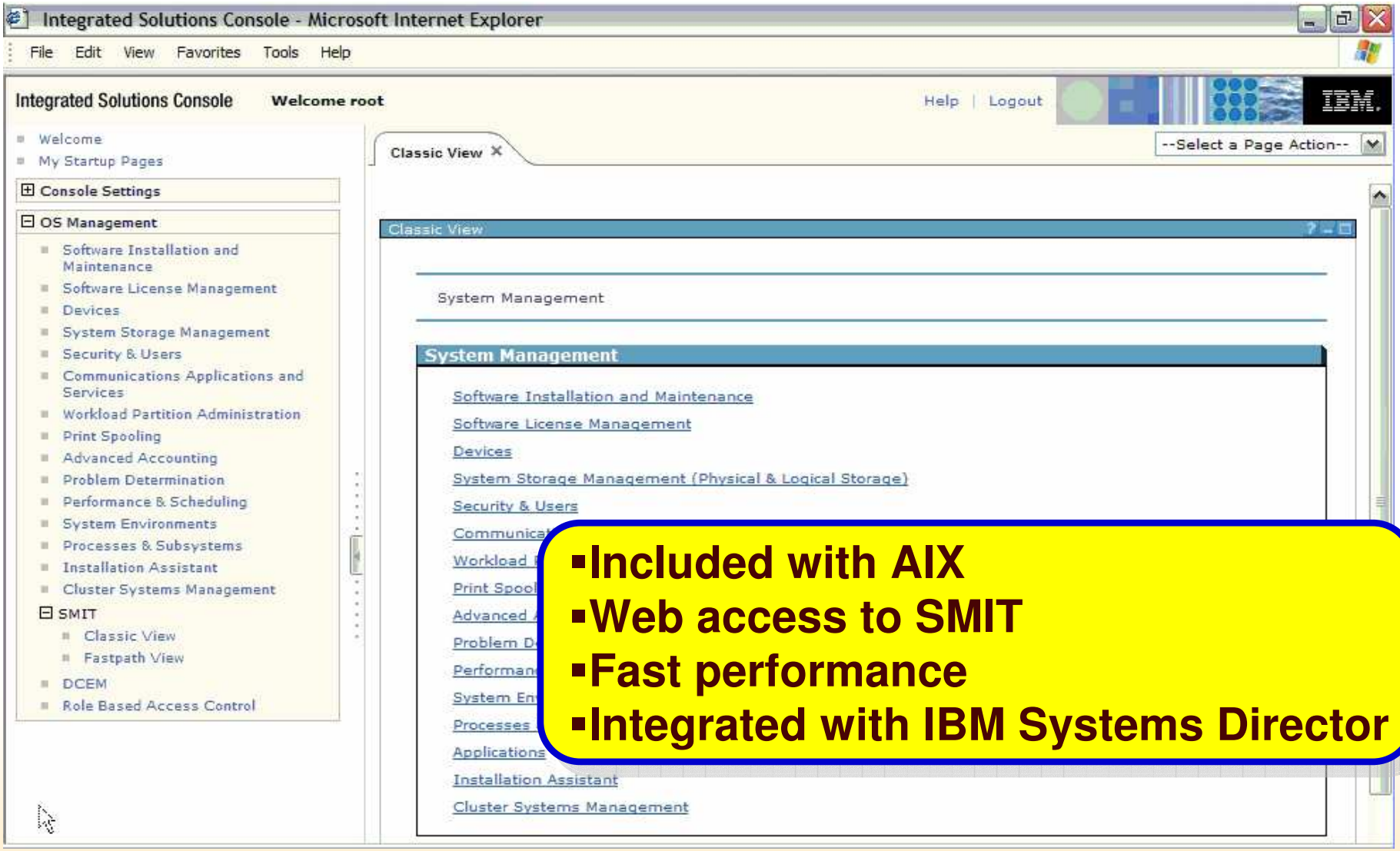
```
# countreads.v 404
Number of reads = 22
Number of reads = 0
Number of reads = 1
Number of reads = 17
.....
```



Planned AIX Enhanced Manageability

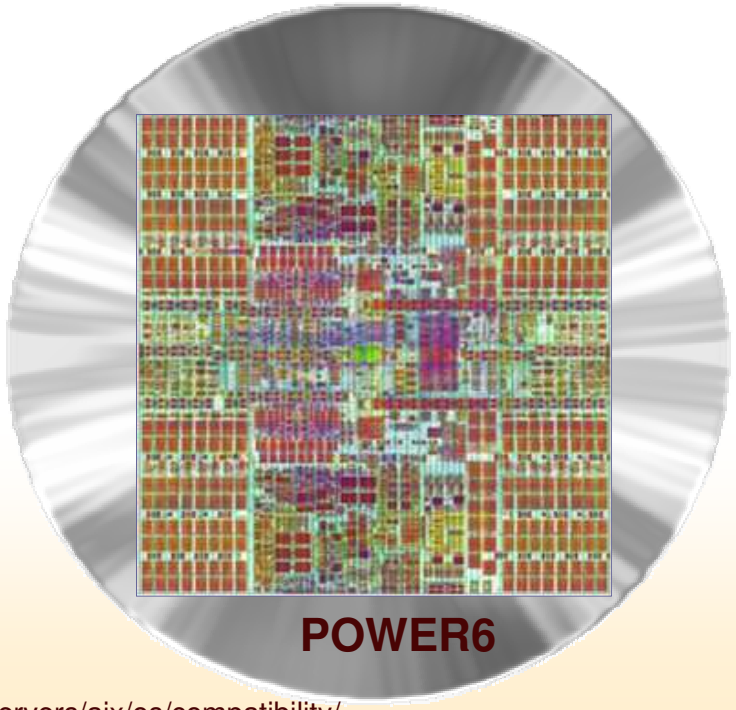
- **Systems Director Console for AIX**
- **WPAR Management**
- **Integrated Filesystem Snapshot**
- **IBM Director enablement**
- **Tivoli Integration**

Planned Systems Director Console for AIX



AIX - Planned POWER6 Support

- **2Q07 support POWER6 by AIX 5L V5.2 and V5.3**
  - Technology Level 6 for AIX 5L V5.3
  - Technology Level 10 for AIX 5L V5.2 **(this is the last planned update for AIX V5.2)**
- **POWER6 is Binary Compatible* with previous POWER processors**
- **Exploitation of some features of POWER6 will require AIX 6**
  - **Kernel Storage Keys**
  - **Dynamic, variable page size**
- **But many features of POWER6 will be supported by AIX 5L V5.3**
  - **Live Partition Mobility**
  - **Shared Dedicated processor**
  - **Hardware Decimal Floating-Point**
  - **Application Storage Keys**



*Complete details on AIX binary compatibility can be found at http://www.ibm.com/servers/aix/os/compatibility/

AIX 6 Hardware Support

- **Systems based on POWER4, PPC970, POWER5 and POWER6 processors will be supported**
- **32- and 64-bit applications will continue to run unchanged on AIX 6**
- **64-bit Kernel only**

*Complete details on AIX binary compatibility can be found at http://www.ibm.com/servers/aix/os/compatibility/

Planned AIX Beta Programs

First ever 'Open Beta' for an AIX release

AIX Beta "Traditional"		AIX "Open Beta"
		
Select customers & ISVs	*Participants*	Open to all
Tens	*Number of participants*	Thousands
Physical Media	*Distribution method*	Web download only
Feedback on functionality	*Goal*	Mind share
Beta Support team	*Support*	Self help via forum
Questionnaire, Support interaction	*Feedback*	Web feedback only

AIX Planned Open Beta Program

Focus Areas

- Workload Partitions
- WPAR Manager
- Application Mobility
- Role Based Access Control
- AIX Security Expert
- *probevue* dynamic trace
- Director for AIX management
- Host Name Caching

Open Beta Overview

- Open to everyone
- Planned availability – Early 3rd quarter 2007
- Simple "Click to accept" license
- Not for production use
- Limited support – Q&A and Self Help via forum
- AIX Developers will monitor forum
- Web download only – no physical media distribution
- Image will be delivered as multiple ISO CD images
- Documentation: "Quick Start Guide" and early pubs
- No translation – English only

AIX

- Innovative features for virtualization, security, continuous availability, and systems management
- Mainframe-inspired technologies
- Strong future roadmap and IBM commitment

AIX 6

5.1 5.2 5.3 6.1

The next step in the evolution of UNIX®

ibm.com/aix

Performance Proof Points for Linux on POWER

Linux on POWER holds 24 leadership benchmark results across a range of commercial and HPC workloads – with three #1 overall results and twenty-one #1 Linux results

Current Linux Leadership Results Last updated 10/11/06								Results submitted to SPEC on 10/11/06					
Benchmark	p5 570	p5 570	OP 720	OP 710	p5 575	p5 595	p5 595	p5 505	p5 510	p5 550	p5 575	p5 575	
	1.9GHz	1.9GHz	1.65GHz	1.65GHz	1.9GHz	1.9GHz	1.9GHz	2.1GHz	2.1GHz	2.1GHz	2.2GHz	1.9GHz	
SPECfp 2000											8w SLES		
SPECint_rate 2000											8w SLES	16w SLES	
SPECfp_rate 2000					8w RHEL	32w SLES		2w SLES	2w SLES	4w SLES	8w SLES	16w SLES	
SPECompM 2001	4w SLES				8w RHEL								
Linpack HPC					8w RHEL	32w SLES	64w SLES						
Stream Triad Tuned			4w SLES	2w RHEL									
SPECjbb2000	16w SLES					32w SLES							
SPECweb99	4w RHEL	8w RHEL (Overall											
SPECsfs97_R1.v3		4w SLES	4w SLES										
TPC-C	4w RHEL												Totals
Subtotal	4	2	2	1	3	3	1	1	1	1	3	2	24
#1 Leadership n-way	1	1	0	0	0	1	0	0	0	0	0	0	3
Best of Linux n-way	3	1	2	1	3	2	1	1	1	1	3	2	21

Source: spec.org, November 2006

Turbocharge Linux with POWER6 platform

Performance
Flexibility
Availability

Performance Of Six

- Breaking the 4 GHz barrier: up to 2X the performance of POWER5
- Decimal Floating-point
- Altivec support in GCC toolchain with autovectoring

Availability of Six

- New reliability features: processor instruction retry & storage keys
- Processor recovery
- Live Partition mobility SoD [11/07]*
- Concurrent maintenance SoD [11/07]*

Efficiency Of Six

- More performance than POWER5 in same energy envelope
- Lower energy at same performance as POWER5
- Reduce energy costs through leadership virtualization
- Energy monitoring and savings capabilities

* All statements regarding IBM future directions and intent are subject to change or withdrawal without notice and represent goals and objectives only. Any reliance on these Statements of General Direction is at the relying party's sole risk and will not create liability or obligation for IBM.

System p Application Virtual Environment for x86 Linux

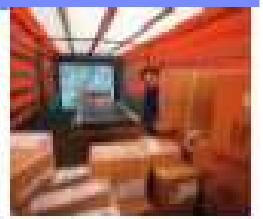
- **What is System p Application Virtual Environment for x86 Linux (System p AVE - x86)**
  - Supports installation and running of existing 32-bit x86 Linux applications[1,2]
  - Creates an x86 Linux application environment running on Linux on System p
  - Extends value of IBM System p and BladeCenter JS21 to x86 Linux apps

- **How does it work?**
  - Dynamically translates and maps x86 Linux instructions to POWER
  - Mapping and caching techniques are used to enhance application performance within the System p AVE-x86 environment

(1) No direct hardware access and no kernel access
(2) IA-32 instruction set architecture (x86) *
* As defined by the 1997 Intel Architecture Software Developer's Manual consisting of Basic Architecture (Order Number 243190), Instruction Set Reference Manual (Order Number 243191) and the System Programming Guide (Order Number 243192) all dated 1997.

System p Advanced POWER Virtualization

Setting a New Bar for Linux OS-Based Virtualization



Optimize your IT infrastructure and respond to rapidly changing business needs

- *By balancing workloads across multiple servers*

Eliminate planned downtime

- *By dynamically moving resources between servers without application disruption*

Improve power efficiency

- *By consolidating workloads as business demands change and powering down/off underutilized servers*

Securely share systems resources

- *Through industry-standard certified security capabilities*

	SUSE	Red Hat
Shared Dedicated Capacity*	✓	✓
Integrated Virtual Ethernet	✓	✓
New Management Tools	✓	✓
Live Partition Mobility (11/07)*	✓	✓
Workload Partitions (11/07)**		
Live Application Mobility (11/07)**	✓	✓

* Available on Novell SLES 10 SP1 and Red Hat Enterprise Linux (RHEL) 5.1. Not available on RHEL 4.5

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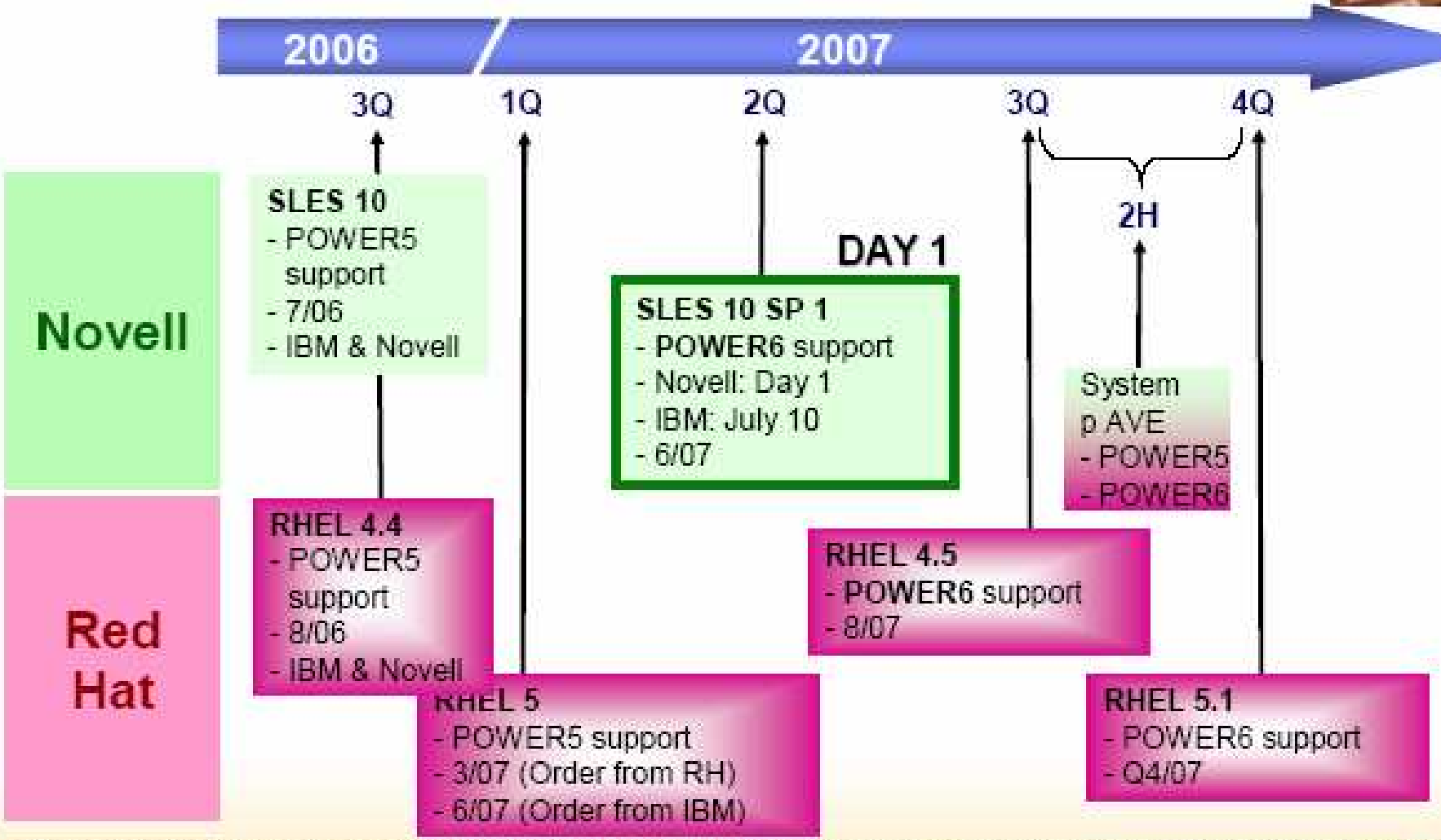
Linux Distribution Support of POWER6™ platform*



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Linux on POWER benefits

Virtualization
Exceptional Virtualization for Linux
Partitions 1/10 with .01 Increments
Low Overhead Hypervisor
Shared Dedicated Capacity* *(NEW)*
Integrated Virtual Ethernet *(NEW)*

Security
Native Linux Security
Hardware Virtualization
Virtual Storage Protection Keys
(NEW!)

Manageability
Installation Tool Kit for POWER
HMC Partition Management
IBM Director/Tivoli®
New Management Tools (NEW!)

Reliability, Availability, Serviceability
Hardware Service Processor
Self Managing/Self Healing
High Availability Solutions
Processor Recovery *(NEW!)*
Live Partition Mobility SoD [11/07]** *(NEW!)*

Scalability

Performance

* Available on Novell SLES 10 SP1 and Red Hat Enterprise Linux (RHEL) 5.1. Not available on RHEL 4.5

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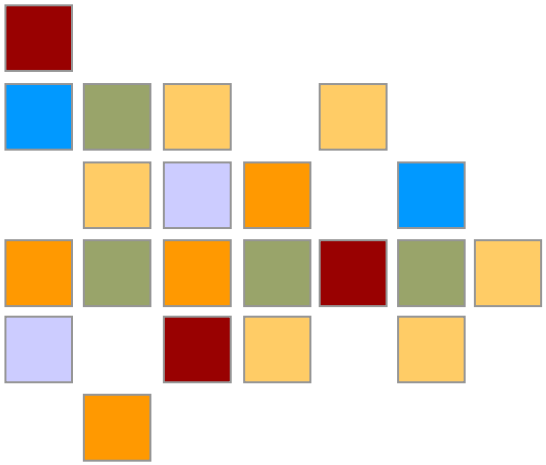
Linux on POWER*

- **Enterprise Class Computing with Linux on POWER (LoP)**
  - **Flexibility with LPAR, dynamic LPAR, and virtualization features**
  - **Reliability with built in self-healing capabilities**
  - **Power Architecture/Servers include POWER5, POWER6 and PowerPC97(**
    JS20, JS21 blades)
- **Linux distributions available for LoP:**
  - SUSE LINUX Enterprise Server 9 or 10 for POWER (SLES 9, SLES 10)
  - Red Hat Enterprise Linux 4 for POWER (RHEL)
- **Technical support available through IBM SupportLine contract.**
  - SUSE LINUX and Red Hat, Inc. also provide support, upgrades and maintenance
- **Orderable from IBM or directly from Linux distributors**
- **For more information about Linux running on IBM System p servers:**
  - **http://www.ibm.com/systems/p/linux/**
  - **http://www.redhat.com/rhel/server/**
  - **http://www.novell.com/products/server/**



Operating System Release / Service Strategy

New AIX Service Strategy

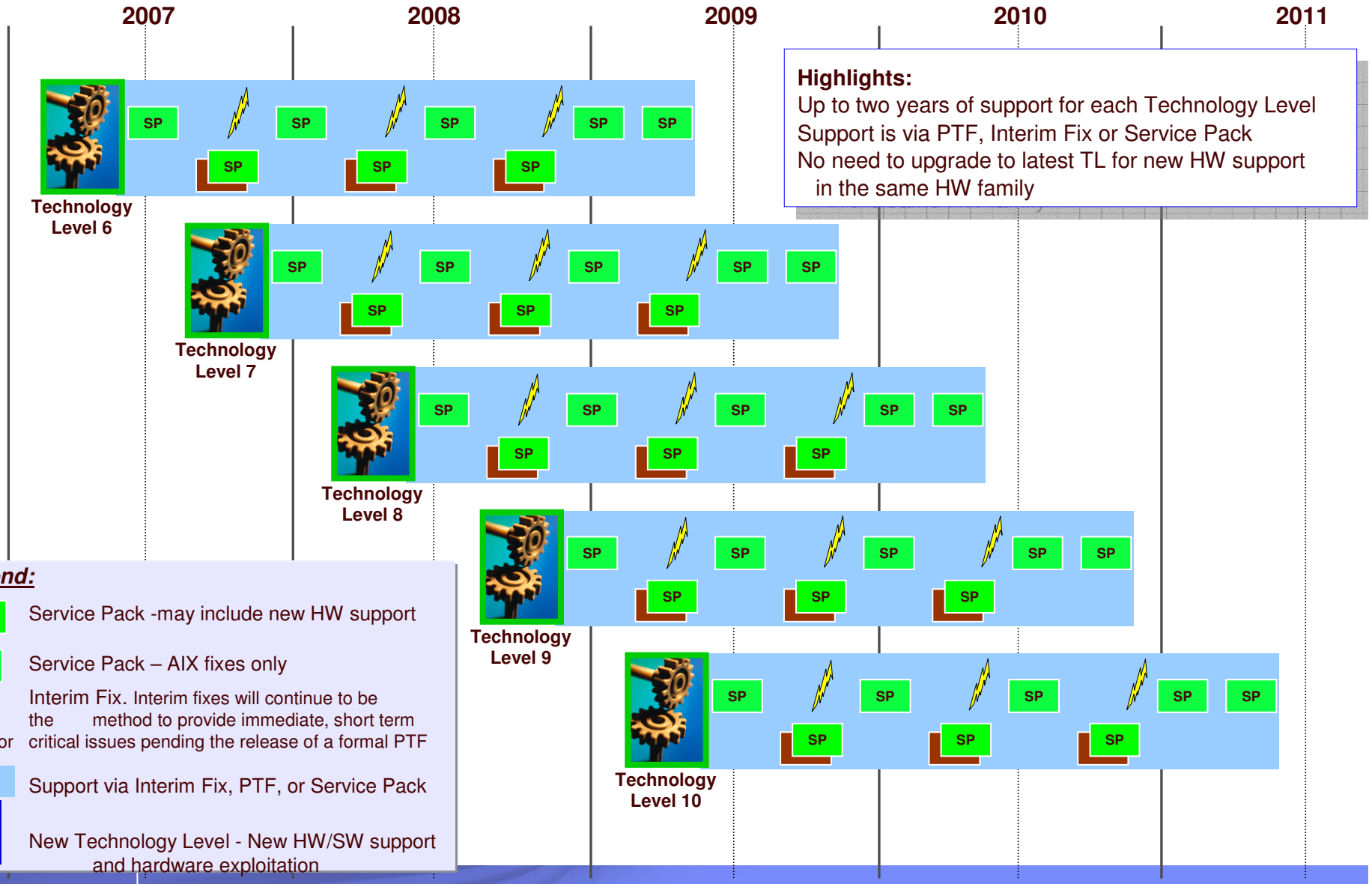
IBM has made significant enhance the AIX Release and Service Delivery strategy in 2007 for AIX V5.3

The principal changes planned are:

- **Twenty four months of support for each Technology Level (TL)****
- **Service for entire period is provided by Service Packs, PTFs and Interim Fixes**
- **New hardware within the same family will be supported on previous Technology Levels for ease of migration.**

****Due to variations in the release dates of Technology Levels from year to year, some Technology Levels will be supported for slightly more that two years and some will be supported for slightly less than two years. A two year service life for each Technology Level is an objective, not an absolute limit.**
The service life of Technology Levels will also be limited by the end of service life for the underlying AIX release

AIX Release Strategy – 2007 * (AIX V5.3 shown)



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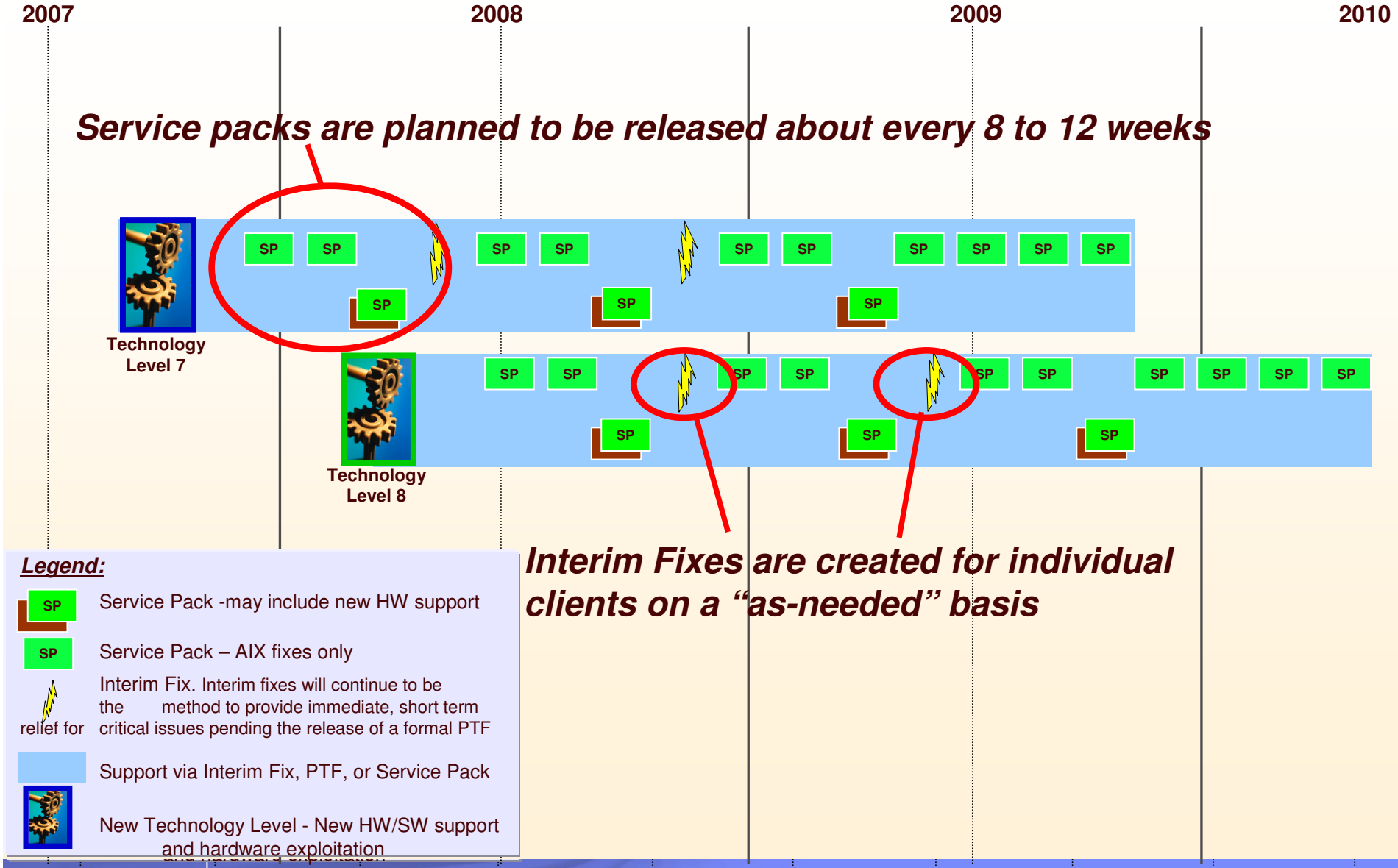
Release Strategy Schedule Detail* (AIX V5.3 shown)



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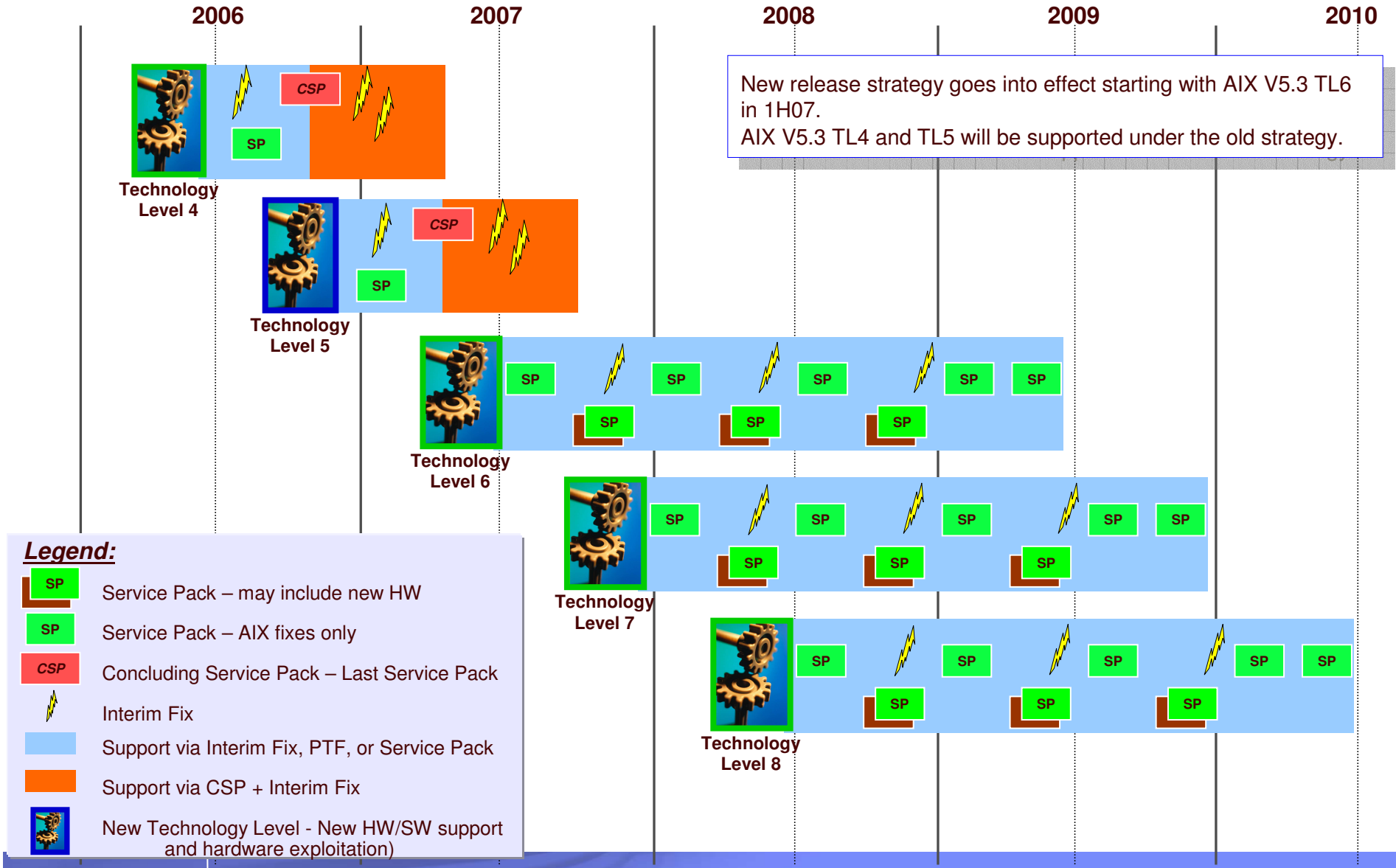
Release Strategy Transition*



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New Hardware Supportability*

Degree of hardware change	On prior TLs plus latest Service Pack	On the latest Technology Level
Processor Speed Increase Only **(No AIX Code Changes)**	**Yes**	Supported
New Processor in Compatibility Mode **(No AIX Code Changes)**	**Yes**	Supported
New Processor in Family **(Recognize New Processor)**	**Yes**	Supported
New I/O **(New Device Drivers)**	**Yes**	Supported
New Technology **(Significant/pervasive)**	**No**	**Yes**

Note: Exploitation of new hardware features will require moving up to the latest TL or in some cases, moving up to the next AIX release

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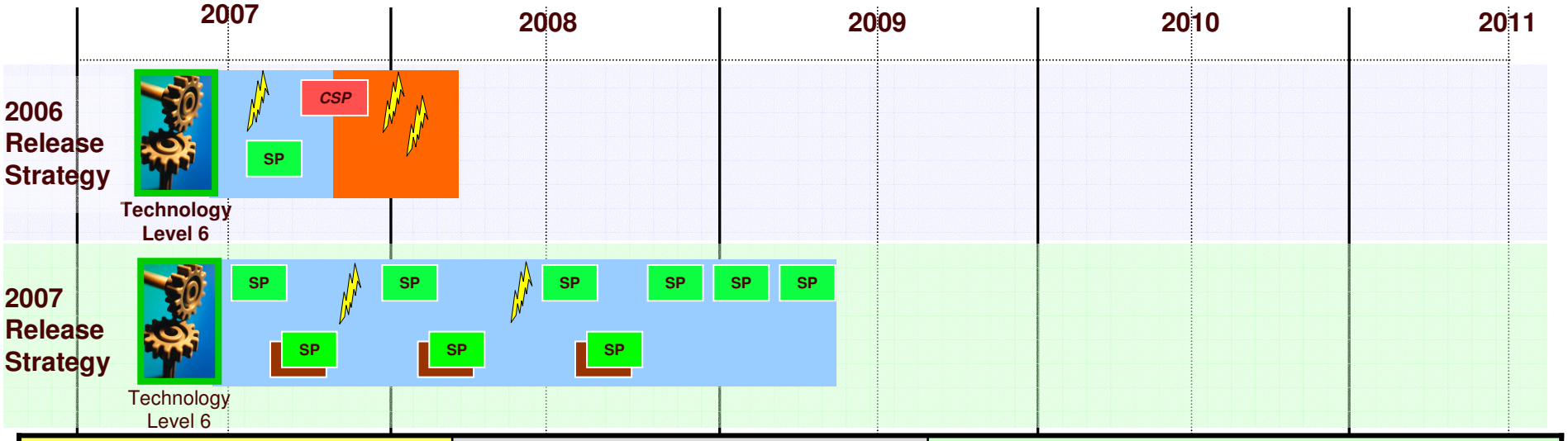
Differences From Previous Release Strategy



Difference	2006	2007*
Length of Service for a TL	12 months	24 months
Extended service via …	CSP + Interim Fix only	PTF, Interim fix or Service Pack
Concluding Service Pack?	Yes, start of extended service	No longer used
Service Packs include…	Only fixes	Fixes + new HW support within same family
Service Packs ship every…	4-6 weeks	8-12 weeks
AIX releases supported…	AIX V5.2 and AIX V5.3	AIX V5.3 and future releases
Policy started with . . .	AIX V5.2 TL8, AIX V5.3 TL4	AIX V5.3 TL6
Hardware support via…	Latest Technology Level only	Exploitation via latest TL. Some hardware support available via prior TLs plus a SP
Version Release Mod. Fix	5.3.0.41	5.3.7.1

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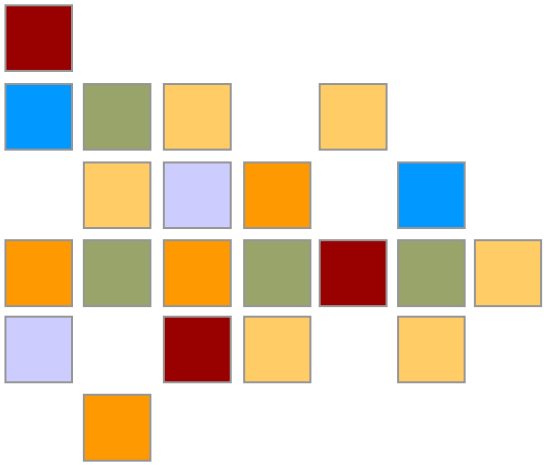


IBM Software

IBM Usage and Accounting Manager

Know what IT costs (in shared and virtualized environments)

Helps businesses to understand the true costs of their IT

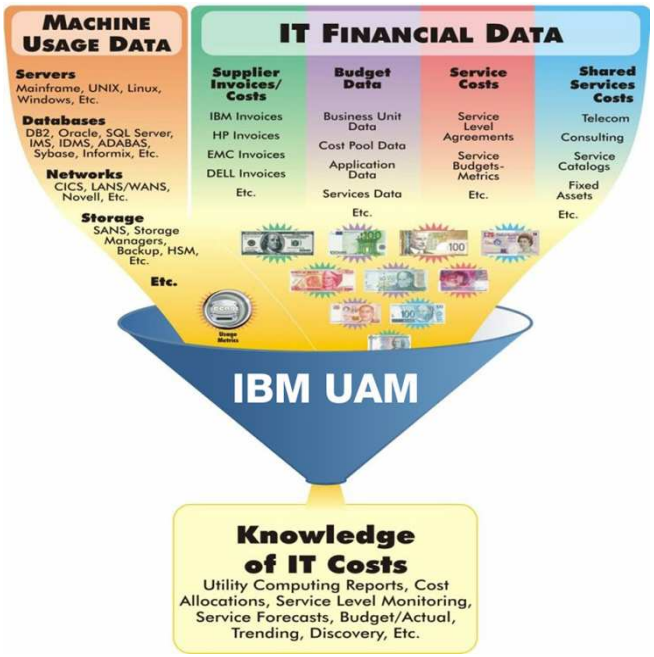
- **Who is consuming which resources?**
- **What are the true costs of these resources?**
- **How should costs be allocated for ROI or chargeback?**

Enables businesses to make informed decisions about IT options and acquisitions

Facilitates chargeback accounting to bill internal or external customers for their actual resource use

Tracks and analyzes resource utilization across the entire enterprise

- **Servers, storage, networks, applications, etc.**



IBM Director:
Cross-platform systems management and automation

Designed to reduce the cost and complexity of systems management

- **Features like a drag-and-drop GUI, wizards and a scheduler enable productivity with minimal training**
- **Heterogeneous support enables cross-platform management with one tool**
  - **System p, System x™, System i™, System z™ and non-IBM; AIX, Linux, i5/OS and Windows®**

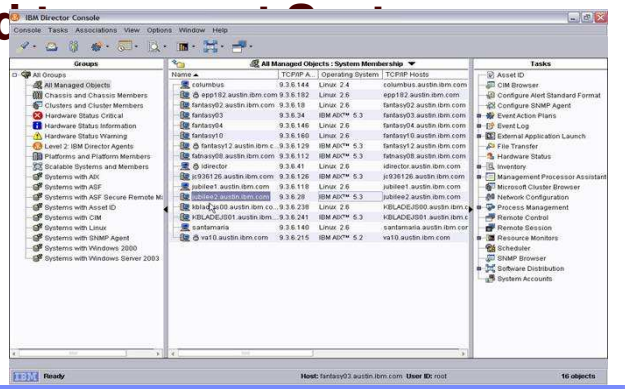
Comprehensive capabilities

- Hardware and software inventory
- Software distribution
- Monitoring and automated response
- Hardware status and control

Proven on other IBM platforms for years, now enhanced

Available to System p clients at no additional charge

- **Downloadable from ibm.com**
- **Media packs orderable (shipping charge applies)**
- **Support available as a priced option**

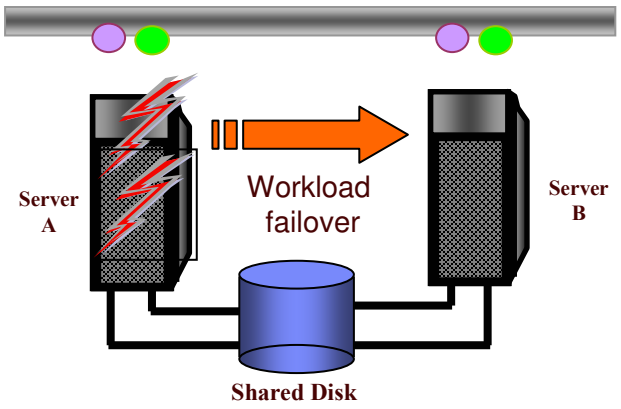


HACMP V5.4 - High Availability Cluster Multiprocessing

Leadership AIX High Availability and Disaster Recovery Product

Available for Linux!

Protect your critical business applications through reliable monitoring, failure detection and automated recovery of business applications



HACMP

New Linux Support

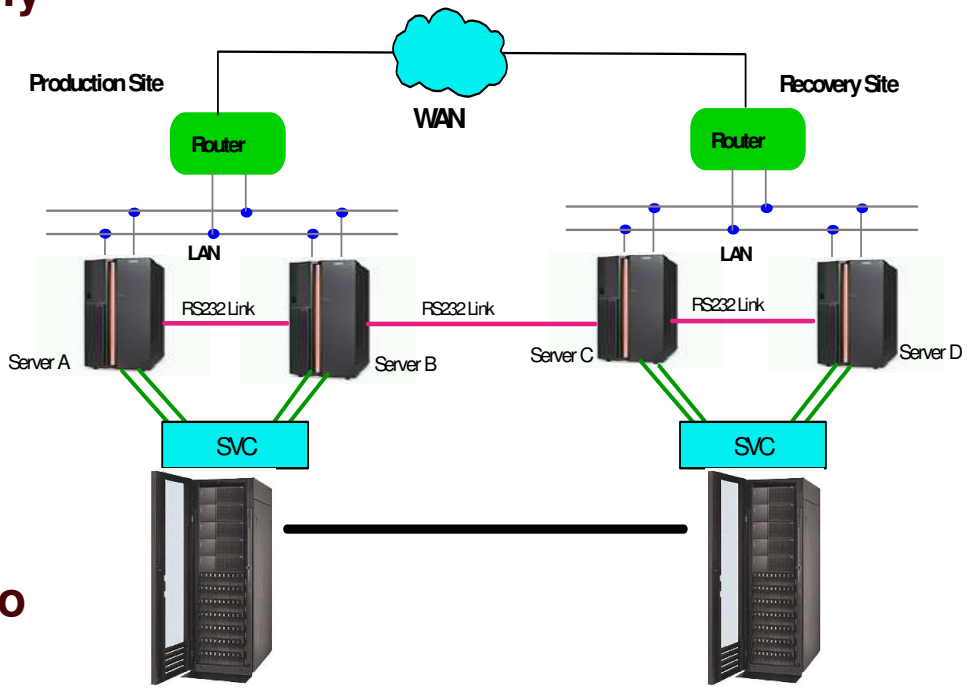
- SLES 9 and RHEL 4 support

Ease of Use Enhancements

- Configure an HACMP cluster or upgrade HACMP on a node without disrupting the target application
- Fast Failover Detection through enhanced AIX integration improves failover time
- Recognize Application and Resource presence
- Resource Dependency Graph
- Adjustable preferences

Business Continuity Solution:
Server Automation Using Continuous Availability for AIX (HACMP/XD)

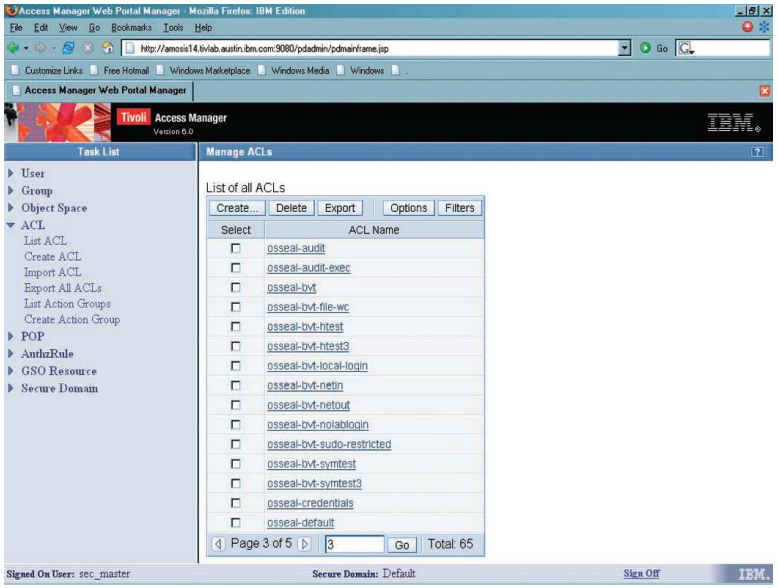
- Offers a High Availability as well as an effective D/R solution for geographically dispersed AIX clusters
- Integrates HACMP with unique data replication code to provide a fully automated disaster tolerant solution
- Resources automatically failover to surviving AIX node – no manual steps required
- Designed for Continuous Business operations, reduced administrative intervention and increased resiliency to planned and unplanned interruptions
- Will support DS4700 thru SVC

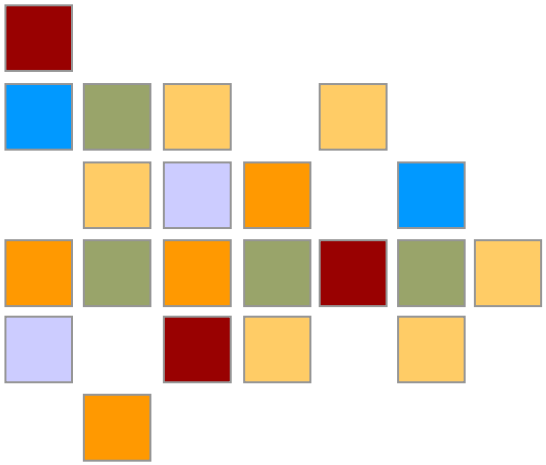


IBM Tivoli Access Manager

Defend against the top security threats

- Protects against misuse by employees and internal users
- Prevents most hacking exposures
- Increased security through fine-grained user authorization
- Secure control of all root user privileges
- Comprehensive audit records of all root user activity
- Document regulation compliance
- Available at no additional charge on System p



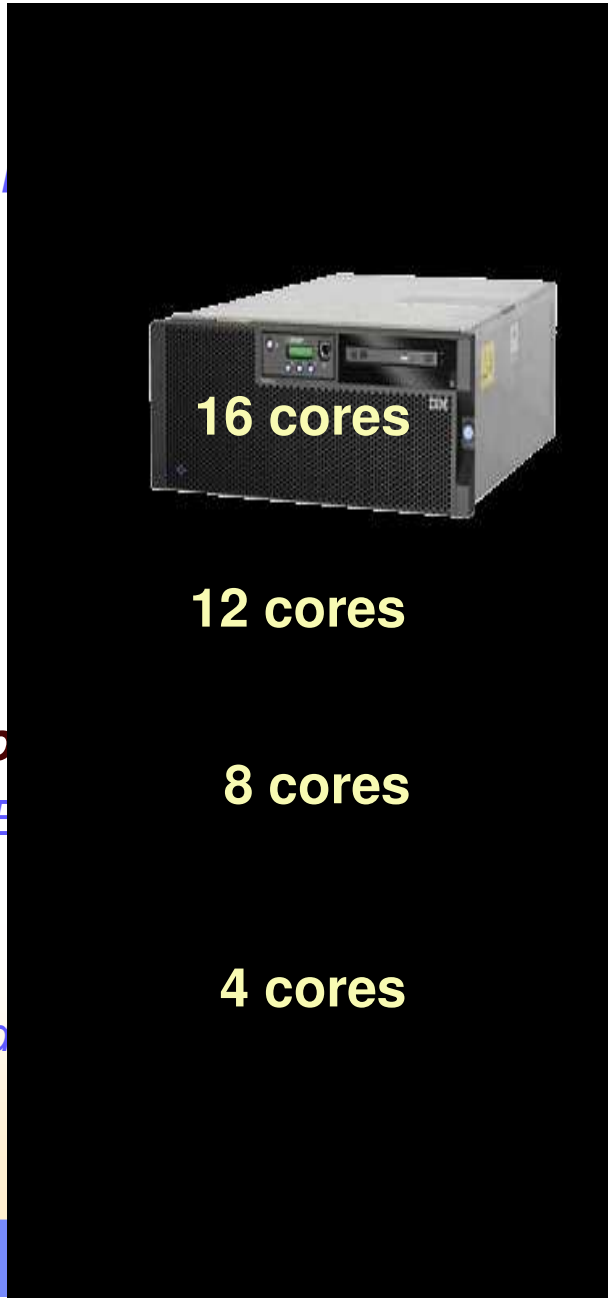


Summary

New IBM System p 570

Modular design for scale-out economics and scale-up

- ***Modular building blocks***
  - *--Start with four cores, grow to 16*
- ***All 3 speeds are faster than competition***
  - *--3.5, 4.2 and 4.7 GHz POWER6*
- ***More memory per core – than anyone***
  - *--Up to 768 GB max, 48GB/core!*
- ***Full binary compatibility for investment protectio***
  - *-- Existing Apps and AIX® 5L V5.2 & V5.3 run on POWE*
- ***Price-reduced POWER5+ 570s for customer flexibility***
  - *--IBM System p5 570 is now 20-25% more affordable*
  - *--Upgrades to POWER6 – buy now, upgrade when read*



System p Virtualization

Advancing the Most Complete Virtualization Offering for UNIX and Linux

Optimize your IT Infrastructure and Respond to Rapidly Changing Business Needs

- *By balancing workloads across multiple servers*

Eliminate Planned Downtime

- *By moving workloads from one server to another without application disruption*

Improve Power Efficiency

- *By consolidating workloads as business demands change and powering down/off underutilized servers*

Securely Share Systems Resources

- *Through industry-standard certified security capabilities*

New Capabilities

- Live Partition Mobility
- Workload Partitions
- Live Application Mobility
- Shared Dedicated Capacity
- Integrated Virtual Ethernet
- New Management Tools
- IBM System p AVE

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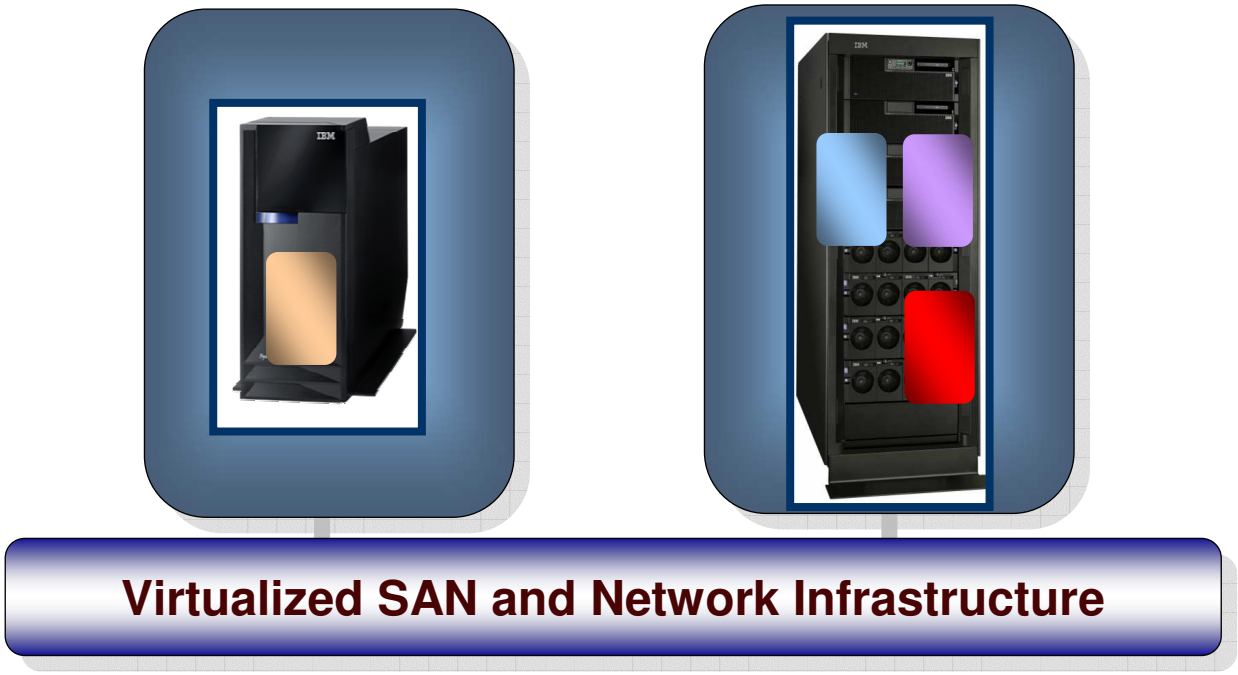
Live Partition Mobility on IBM System p*

Move running UNIX and Linux operating system workloads from one POWER6 processor server to another!



- First to support both UNIX and Linux on the same system
- Designed for high CPU and I/O intensive workloads
  - ***-- Four times the number of CPUs (16 to 4)*****
  - ***-- 12 times the amount of memory/core (48 to 4)******

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Previewing AIX 6

Investing in the future of the #1 UNIX

Just a few examples of dozens of new features:

Virtualization
Workload Partitions
Live Application Mobility between systems

Security
Encrypting Filesystem

Continuous Availability
Concurrent AIX Updates

Manageability
System Director Console for AIX

A first for AIX! Open Beta: Downloadable AIX coming this summer for clients and ISVs

IBM Statements of Direction

IBM is committed to enhancing its clients' investments in IBM System p servers. Based on this commitment, IBM plans to provide future enhancements as identified here.

1. **It is IBM's intention to support a future version of Red Hat Enterprise Linux 5 for POWER starting in the second half of 2007 on POWER6 processor-based servers.**

2. **IBM plans to provide redundant service processor capability to existing POWER6 processor-based p570 systems with two or more CEC enclosures. This capability is planned to be provided via a firmware upgrade at no additional charge by the end of 2007. Once this upgrade is applied, the appropriate HMC connections made and the system rebooted, service processor functions can maintain operational status in the unlikely event that one of the service processors fails.**

3. **In addition, IBM plans to provide the capability for POWER6 processor-based p570 systems that have experienced a failure and rebooted without one of the CEC enclosures active to be able, in certain cases, to have the de-activated enclosure repaired and reintegrated into the active system without powering down the system ("cold-node repair"). The additional resources of the repaired CEC enclosure could then be assigned to existing applications or new applications as required. This capability is planned to be provided at no additional charge to existing POWER6 processor-based p570 users via a system firmware upgrade by the end of 2007.**

4. **IBM plans to provide a new feature, "Live Partition Mobility", as part of IBM System p Advanced POWER Virtualization for POWER6 processor-based servers in late 2007. Live Partition Mobility will allow clients to move a running partition from one physical System p POWER6 processor-based server to another System p POWER6 processor-based server without application downtime helping clients to avoid application interruption for planned system maintenance, provisioning and workload management.**

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POWER6 and AIX 6 New Functionality

Feature	Licensed Via			Supported OS			Supported Hardware			GA Date*
	Firm Ware	APV	AIX V6.1	AIX V5.3	AIX V6.1	Linux	POWER4™	POWER5™	POWER6	
Dedicated processor sharing		✓		✓	✓	✓			✓	6/07
Hardware Decimal FP	✓			✓	✓	✓			✓	6/07
Integrated Virtual Ethernet	✓			✓	✓	✓			✓	6/07
Storage keys - application	✓			✓	✓				✓	6/07
Storage keys – kernel*			✓		✓				✓	4Q07
Live Partition Mobility*		✓		✓	✓	✓			✓	4Q07
WPARs*			✓		✓		✓	✓	✓	4Q07
Live Application Mobility*			✓		✓		✓	✓	✓	4Q07

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“Checkmate!” with the POWER OF SIX

IBM Innovations

- **IBM System p 570 with POWER6 Technology**
- **System p Virtualization**
- **IBM AIX 6**

IBM Dominates the UNIX NMSO
Scale up. Scale out. Scale within.

- *1-core to 64-core solutions*
- *AIX 5L and Linux operating systems*
- *Using IBM POWER: Dual-Core ,Quad-Core, & MCM technologies*