# Building a Better Infrastructure With IBM Middleware on System p

POWER Hardware Improves Utilization and Reduces Costs

At the Heart of IBM Power™ Systems is the POWER Processor

2001	2003	2004	2006	2007	Future*	
POWER4™	POWER4+™	POWER5™	POWER5+™	POWER6™	POWER7*	*General Purpose Processors*

| | PowerPC 405 | | PowerPC 440 | Cell | Cell | Cell +* | *Specialty Engines* |

Sony PlayStation 3

Microsoft Xbox 360

Nintendo Wii

BladeCenter® JS22 Express

System p520

System p570

System p5-595

Blue Gene P

| Game Systems | Blades | Entry Level to High-end Servers | High Performance Computers |

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

The POWER Processor Is Everywhere

The POWER processor is used in everything from game systems to special purpose high performance computers.

- ▶ Largest UNIX systems market share
- ▶ 50% of automobiles worldwide
- ▶ All of the top three game consoles
  - − Playstation 3, Xbox 360, Wii
- ▶ 47% of world's fastest computers (Top500)

## Quiz: What Does the Acronym POWER, Represent?

A. Packets **O**f **W**ebSphere **E**ngineered **R**equests

B. Performance **O**ptimized **W**orkloads **E**ngineered **R**esilient

C. Processor **O**ptimized **W**ith **E**nergy **R**eduction

D. Performance **O**ptimized **W**ith **E**nhanced **R**ISC

E. Programmatic **O**ctal **W**avelengths **E**lectromagnetically **R**efined

POWER Architectural Concepts – Multi-core

- Why multi-core?
  - ▶ Laws of physics catching up with single core processors, it is no longer a matter of simply increasing speed to increase performance
  - ▶ Chip manufacturing density enables more than one central processing unit (CPU) to be placed on a single chip or socket
- Each central processing unit is referred to as a "core"*
- Each core presents itself as an independent physical processing unit
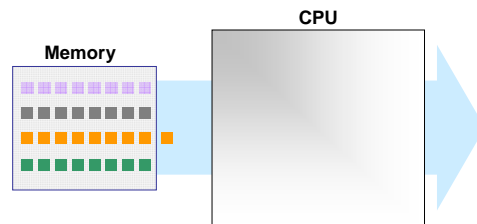
Dual core POWER6 processor
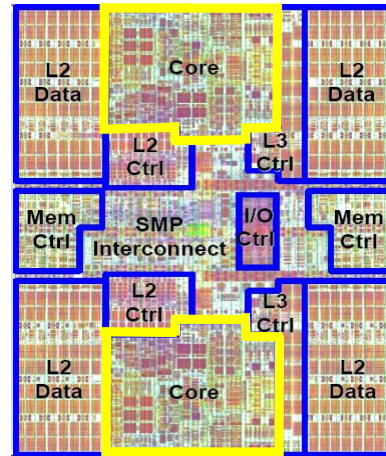
Processor Concepts - Single Thread Execution

Four instruction threads in memory, waiting to be executed

The processor fetches instructions from a single thread and continues to execute instructions from that thread until a decision is made to execute another thread

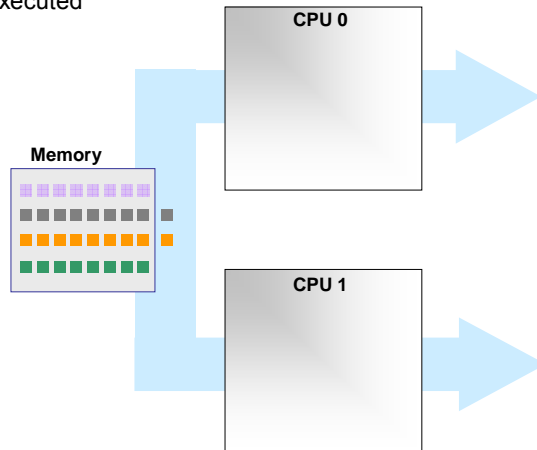Popular design, but branches and data fetches cause idle CPU cycles

CPU

Memory

Processor Concepts – Symmetric Multi-processing (SMP)

Four instruction threads in memory, waiting to be executed

Each processor fetches instructions from a single thread

CPU 0

Memory

CPU 1

- Achieves higher overall throughput by utilizing all available CPUs
  - ▶ Operating system assigns threads to CPUs
  - ▶ Still single thread execution with idle cycles within each CPU

- System p is architecturally engineered to exploit full SMP function up to the largest number of processors
  - ▶ Hardware
  - ▶ Virtualization

POWER Architectural Concepts – Simultaneous Multi-threading (SMT)

Four instruction threads in memory, waiting to be executed

Each processor presents itself as two virtual processors to the operating system and fetches instructions from two threads.
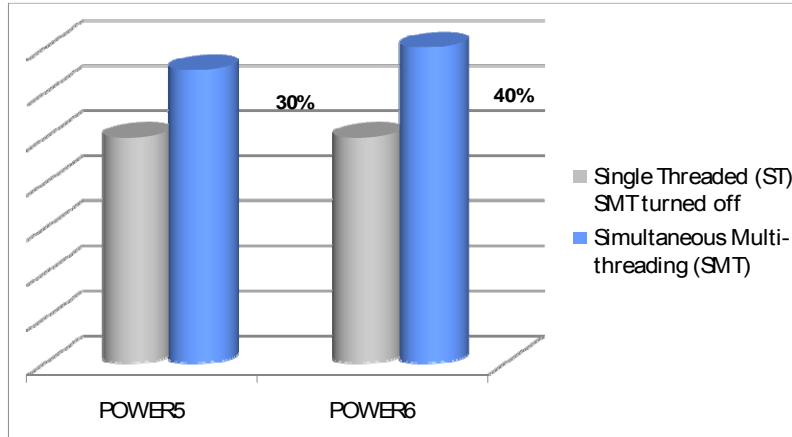
CPU 0

Memory

CPU 1
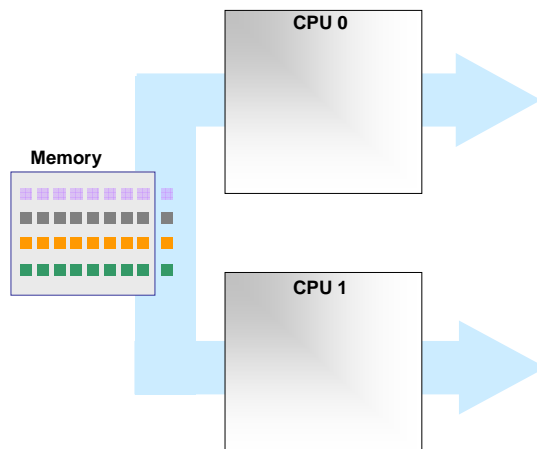
- Instructions from both threads are executed in each processor concurrently

- Utilizes unused CPU cycles

Simultaneous Multi-threading (SMT) Delivers More Processing Power

30%   **40%**

POWER5   POWER6

- Single Threaded (ST) SMT turned off
- Simultaneous Multi-threading (SMT)

- Net result
  - ▶ Better performance and processor utilization increases throughput and response time, depending on workload

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System p Architectural Concepts – Server Virtualization

- Run multiple operating system images on a single platform
  - ▶ Like having several separate servers running simultaneously
- Each image runs in a logical partition
- The POWER Hypervisor™ shares the underlying physical resources dynamically among the partitions

VIOS	AIX 5.3	SUSE Linux	AIX 6.1	Red Hat Linux	AIX 5.3

POWER Hypervisor ™
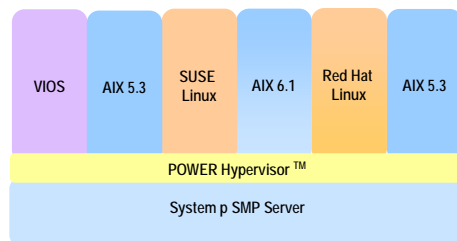
System p SMP Server

Dynamically shared physical resources in a single platform

We will discuss virtualization and consolidation in more detail later today.

IBM

IBM Power™ Systems Has a Complete Line of System p Servers for Your Data Center *

Express Entry

p5-550Q (4 to 8 cores)
p550 (2 to 8 cores) ← New! POWER6

p5-520Q (4 cores)
p520 (1 to 4 cores) ← New! POWER6

p5-510 (1 to 2 cores)
p5-510Q (4 cores)

p5-505 (1 to 2 cores)
p5-505Q (4 cores)

Express Mid-Range

p5-560Q (4 to 16 cores)
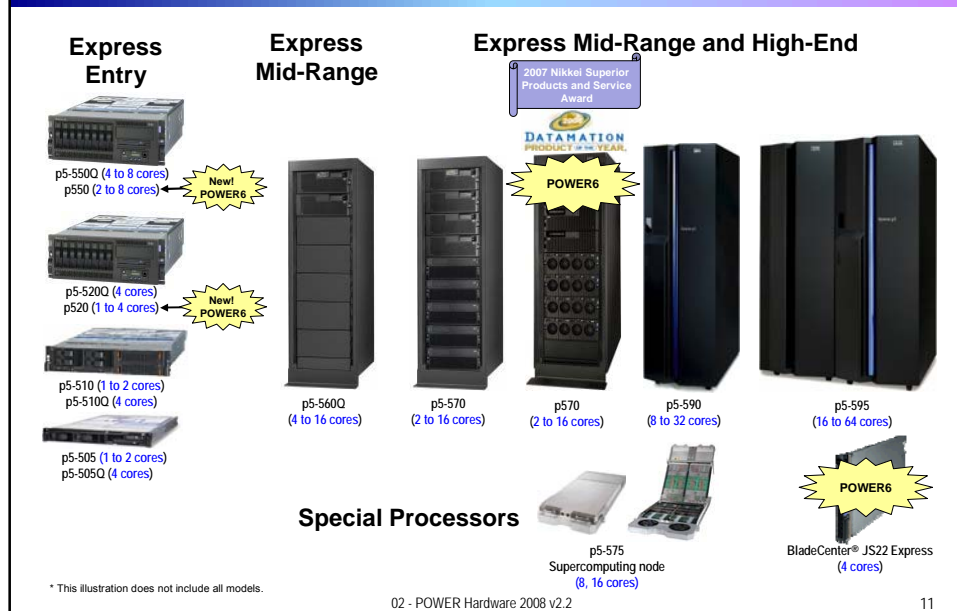
p5-570 (2 to 16 cores)

Express Mid-Range and High-End

2007 Nikkei Superior Products and Service Award

DATAMATION PRODUCT OF THE YEAR

POWER6

p570 (2 to 16 cores)

p5-590 (8 to 32 cores)

p5-595 (16 to 64 cores)

Special Processors

p5-575 Supercomputing node (8, 16 cores)

POWER6

BladeCenter® JS22 Express (4 cores)

* This illustration does not include all models.

Quiz: What Is a Grand Slam?

A. In tennis, a singles player or doubles team that wins all four Grand Slam event titles in the same year.

B. In baseball, a Grand Slam is a home run with all of the bases occupied.

C. In computing, a Grand Slam is being the performance leader in four major benchmarks at the same time.

D. A breakfast item on the menu at Denny's restaurant.

E. All of the above

IBM System p with POWER6 "*Grand Slam*" for Major Workloads

tpmC per core
3X Transaction Performance
TPC-C Benchmark**
Systems with 16 or more cores

POWER6 — IBM p570
XEON — Unisys ES7000
Itanium — HP Superdome
XEON — HP DL380G5
Itanium — Fujitsu PQ480

bops per JVM
2X Java Performance
SPECjbb Benchmark*
Systems with 16 or more cores

POWER6 — IBM p570
XEON — Fujitsu RX600
Itanium — Fujitsu PQ480
SPARC64 — Sun M8000
Opteron — Fabrio7 C60

SPECint rate 2006 per core
2.3X Integer Performance
SPECint_rate2006*
Systems with 8 or more cores

POWER6 — IBM p570
POWER6 — IBM p550
Itanium — HP rx6600
Opteron — HP DL585
SPARC64 — Sun M8000

SPECfp rate2006 per core
2.3X Floating Point Performance
SPECfp_rate2006*
Systems with 8 or more cores

POWER6 — IBM p570
POWER6 — IBM p550
Itanium — HP rx7640
SPARC64 — Sun M8000
Xeon — Fujitsu RX300

* Source: www.spec.org/
** Source: www.tpc.org/

Not Just a Grand Slam, It Is a "Slam Dunk," System p Versus The Best Competitive Result

Grand Slam Results

- TPC-C 16-core
- SPECjbb2005 16-core
- SPECint_rate2006 8-core
- SPECfp_rate2006 8-core
- TPC-C 64-core
- TPC-C 32-core
- TPC-C 8-core
- TPC-C 4-core
- SAP SD 3-tier Overall
- SAP SD 2-tier 16-core
- SAP SD 2-tier 8-core
- SAP SD 2-tier 4-core
- SAP SD 2-tier 2-core
- Siebel 7.7 Industry Applications
- Oracle Apps. Std. Batch 11.5.9
- SPECint_rate2000 4-core
- SPECfp_rate2000 4-core
- SPECint_rate2000 8-core
- SPECfp_rate2000 8-core
- SPECint_rate2000 16-core
- SPECfp_rate2000 16-core
- SPECint_rate2000 32-core
- SPECfp_rate2000 32-core
- SPECint_rate2000 64-core
- SPECfp_rate2000 64-core
- SPECint2006
- SPECfp2006
- SPECsfs R1.v3
- Lotus NotesBench R6Mail
- Lotus NotesBench D7 R6iNotes
- SPEC OMPM2001 (peak) 2-core
- SPEC OMPM2001 (peak) 4-core
- SPEC OMPM2001 (peak) 8-core
- SPEC OMPM2001 (peak) 16-core
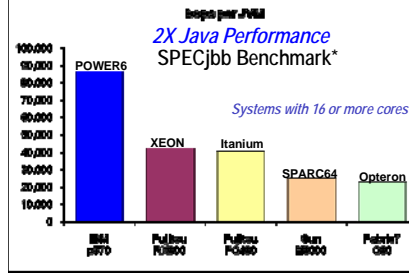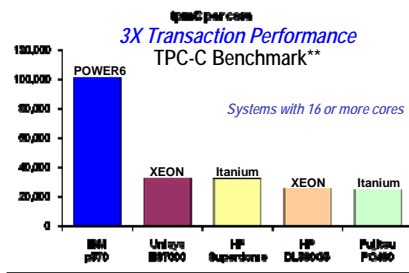- SPEC OMPM2001 (peak) Overall
- SPEC OMPL2001 base (64-core)
- LINPACK HPC 2-core
- LINPACK HPC 4-core
- LINPACK HPC 8-core
- LINPACK HPC 16-core
- LINPACK HPC 32-core
- LINPACK HPC 64-core

□ **Best Competitive Result**
■ **IBM**

Relative Performance

Source:
http://www.spec.org
http://www.tpc.org
http://www.sap.com/benchmark/
http://performance.netlib.org/performance/html/PDSreports.htm
For a complete list of all #1 POWER results, go to http://ibm.com/systems/p/benchmarks/

All results are as of 02/01/08.

System p with POWER6 Delivers More Than Just Lightning Fast Processor Speed

- Breaks the 4 GHz milestone within the same energy envelope as POWER5™

- On-chip energy efficiency intelligence for dynamic energy savings

- Balanced design with highest system bandwidth

- Integrated hardware accelerators for specialized performance

- Designed for continuous availability

System p Supports Standard Programming Interfaces In a Flexible Ecosystem

Partitions

IBM and 3rd Party Compilers
(C, C++, COBOL, Fortran, Java, Perl, Scripts, …)

IBM and 3rd Party Middleware
(IBM, SAP, Oracle, Apache, Sybase, BMC, …)

IBM and 3rd Party Operating Systems
(AIX, SUSE Linux, RedHat Linux)

Virtual I/O Server	C++	Java	C++	Java	Fortran	COBOL	x86 Linux apps — PowerVM Lx86		
							C	Java
	Middleware		Middleware		Middleware		Middleware	
	AIX		Linux		AIX		Linux	

POWER Hypervisor ™

System p SMP Server

Survey of 277 Enterprise Customers Rank AIX the Best

- **AIX has a better history of binary compatibility**
  Compatibility guarantee: http://www-03.ibm.com/systems/p/os/aix/compatibility/

Operating System Features

4Q06 VPI	IBM	HP	Sun
	103.75	92.41	80.25
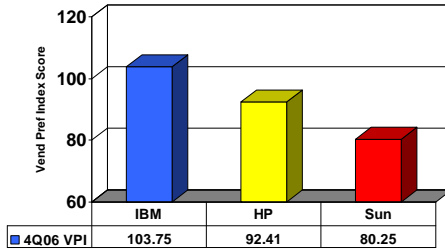
Operating System Quality

4Q06 VPI	IBM	HP	Sun
	105.00	89.87	87.65
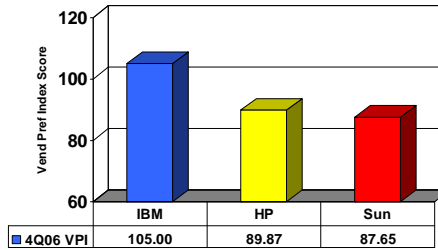
Source: Unix Vendor Preference Survey, December 2006, Gabriel Consulting Group

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System p User Interfaces

Command Interface on ASCII Terminal

Command Interface on ASCII Emulator

X Windows Server with System p

ASCII Terminal

ASCII Emulator
Desktop OS

X Windows Server
Desktop OS

Server Application

p570

DEMO: Demonstrations in Partitions on One System p

POWER5 p505

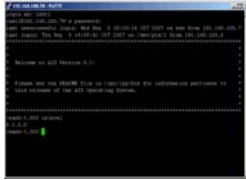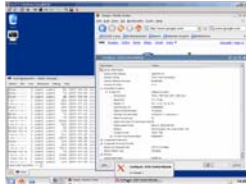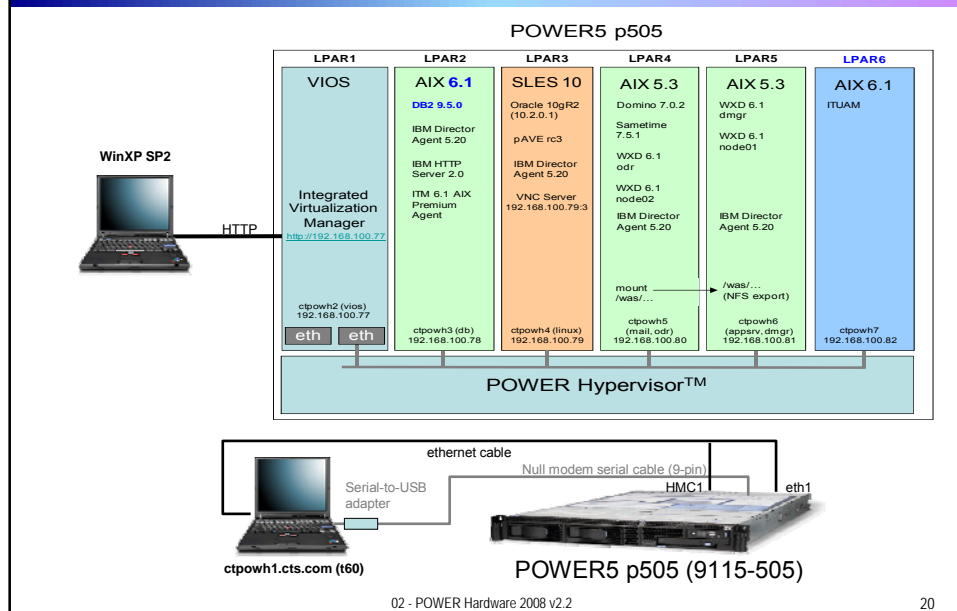| LPAR1	LPAR2	LPAR3	LPAR4	LPAR5	LPAR6
VIOS	AIX 6.1	SLES 10	AIX 5.3	AIX 5.3	AIX 6.1

WinXP SP2

HTTP

LPAR1 — VIOS
Integrated Virtualization Manager
http://192.168.100.77
ctpowh2 (vios) 192.168.100.77
eth eth

LPAR2 — AIX 6.1
DB2 9.5.0
IBM Director Agent 5.20
IBM HTTP Server 2.0
ITM 6.1 AIX Premium Agent
ctpowh3 (db) 192.168.100.78

LPAR3 — SLES 10
Oracle 10gR2 (10.2.0.1)
pAVE rc3
IBM Director Agent 5.20
VNC Server 192.168.100.79:3
ctpowh4 (linux) 192.168.100.79

LPAR4 — AIX 5.3
Domino 7.0.2
Sametime 7.5.1
WXD 6.1 odr
WXD 6.1 node02
IBM Director Agent 5.20
mount /was/…
ctpowh5 (mail, odr) 192.168.100.80

LPAR5 — AIX 5.3
WXD 6.1 dmgr
WXD 6.1 node01
IBM Director Agent 5.20
/was/… (NFS export)
ctpowh6 (appsrv, dmgr) 192.168.100.81

LPAR6 — AIX 6.1
ITUAM
ctpowh7 192.168.100.82

POWER Hypervisor™

ethernet cable
Null modem serial cable (9-pin)
Serial-to-USB adapter
HMC1
eth1

ctpowh1.cts.com (t60)
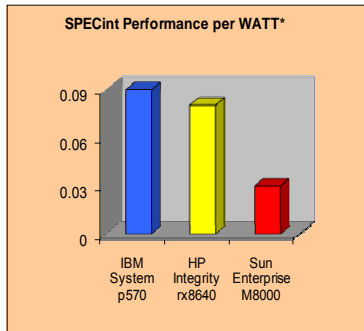
POWER5 p505 (9115-505)

Cool Blue System p is Environmentally Friendly

- Energy efficiency management functions for POWER6 chips
  - ▶ Power reduction
  - ▶ Nap mode
  - ▶ Thermal tuning

- Energy efficiency management and control functions in the new System p
  - ▶ Enhanced design and implementation
  - ▶ Variable fan speed
  - ▶ Power off PCI slots when not in use
  - ▶ Rear door heat exchanger
  - ▶ System energy efficiency management software

- Consolidation and virtualization inherently reduce energy requirements

IBM Energy Efficiency Self Assessment Tool: http://www.ibm.com/itsolutions/optimizeit/cost_efficiency/energy_efficiency/services.html

Cool Blue System p Is Green

- IBM Project Green - The IBM Energy Efficiency Initiative
    1. Best practices and services
    2. Technology and management innovations
    3. Environmental responsibility
- System p570's innovative "green" design saves energy

SPECint Performance per WATT*

0.09
0.06
0.03
0

IBM System p570 | HP Integrity rx8640 | Sun Enterprise M8000

The top 26 most energy efficient computers are Power processor based systems (Green500).**

* Performance per WATT based on dividing SPECint_rate2006 performance by vendor recommended maximum power requirement.
Source: www.spec.org
** Only systems where measured power is available .
Source: http://www.green500.org/

What Is System p Capacity Upgrade on Demand?

p570
2-16 cores
2-768 Gb RAM

Customer orders p570* with maximum cores and memory, but with only half activated

Only pay in full for active resources and get 65% discount to cover the cost of unactivated processors

Active | Inactive | Active | Inactive

4 dual cores | 4 dual cores | 384 Gb RAM | 384 Gb RAM
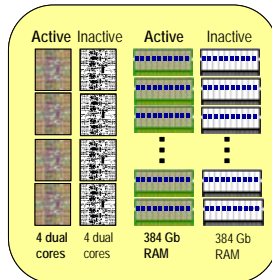
Customer determines they need additional capacity for their workload and activates remaining processors and memory**

Additional payment required for newly activated resources, total cost is the same as if all hardware was activated at the time of the original purchase

Active | Active

8 dual cores | 768 Gb RAM
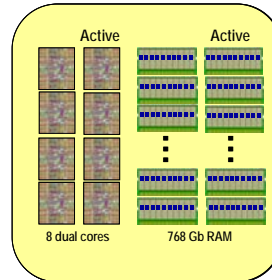
* System optional capacity options do not require purchase of a new system. Assumes appropriate storage, IO drawers, software licensing, etc. for the configuration. Only processors and memory are shown here as an illustration.
** Activation occurs via one of the optional capacity options available for System p. Not all processors or memory need to be activated at one time. This was done as an illustration

Also Four Other Capacity on Demand Options

- Capacity Upgrade on Demand (processors, memory)
  - ▶ Activate capacity permanently for non-disruptive growth

- On/Off Capacity on Demand (processors, memory)
  - ▶ Temporary capacity for fluctuating workloads

- Trial Capacity on Demand (processors)
  - ▶ Temporary capacity for workload testing or any one time need

- Utility Capacity on Demand (processor minutes)
  - ▶ Autonomic, charges based on measured workload

- Capacity Backup (processors, memory)
  - ▶ Only pay for installed disaster recovery capacity when used
  - ▶ Can be used with IBM HACMP™ V5 and HACMP/XD software (5765-F62) in failover scenarios

System p Reliability

- Error detection
  - ▶ Predictive failure analysis on processors, caches, memory, I/O and DASD

- Built-in redundancy
  - ▶ Redundant power supplies, fans, service processor

- Processor instruction retry
  - ▶ Transparent retry of soft errors on application fault

- Storage protection keys
  - ▶ POWER6 storage keys will isolate data and protect against memory overlay that can cause subtle, intermittent problems

- First Failure Data Capture (FFDC)
  - ▶ Automatic capture of diagnostic information

System p Serviceability

- AIX supports concurrent maintenance
  - ▶ Non-disruptive fixes to AIX
  - ▶ No downtime (reboot) required to apply fix and make it active

- Hot swappable parts replacement

- Electronic Service Agent (ESA)
 - ▶ Automatically contact IBM if problem

p570

ESA runs automatically in the background!

IBM
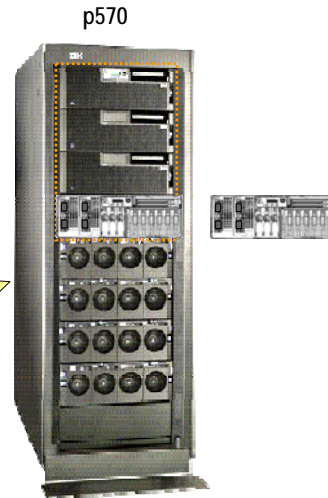
System p High Availability Cluster Multi-Processing (HACMP) Increases Availability

- HACMP manages Resource Groups

- Resource Groups move from one node to the other when an event happens

- Resources in a group could be one of the following
  - ▶ Applications, Disk Drives, Volume Groups, File Systems, NFS File Systems, Tape Drives, IP Addresses, Replicated Resources

- AIX and Linux support

- Ease of use enhancements in HACMP 5.4
  - ▶ Configure or upgrade an HACMP cluster on a node without disrupting the target application
  - ▶ Resource dependency graphs

System p HACMP with Failover

LAN

Production System p570

Applications

Workload failover

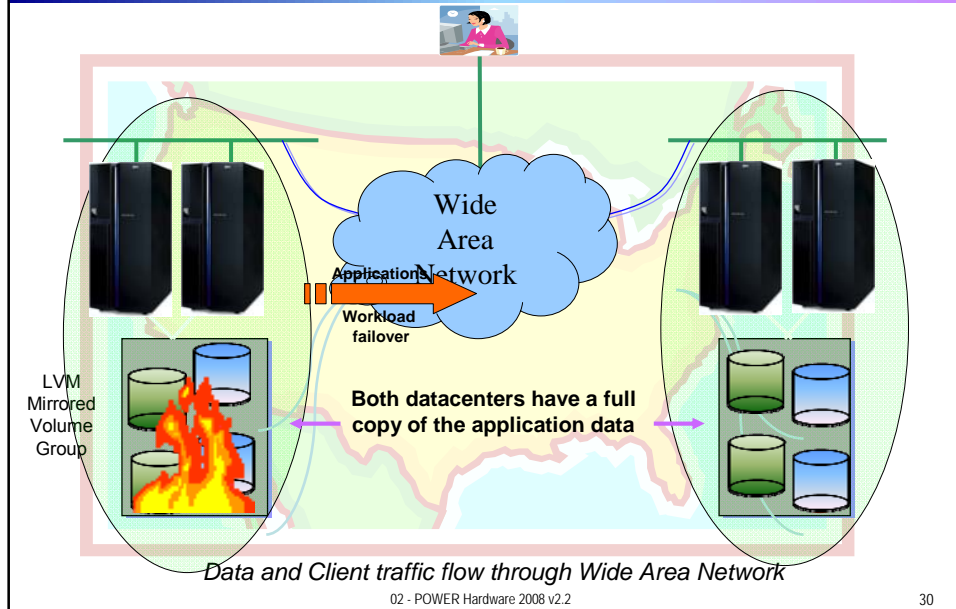**Standby System p570**

Shared Disk
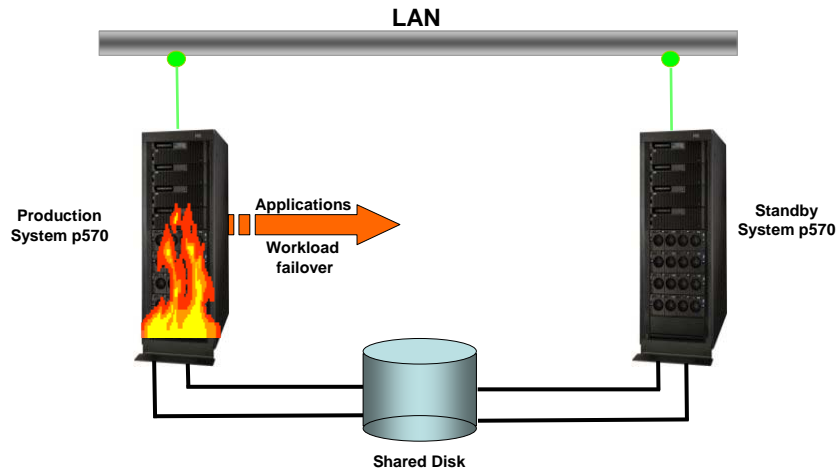
System p HACMP Extended Distance (XD) Provides Disaster Recovery

- Provides high availability and disaster recovery solutions
  - ▶ Recovers locally or moves entire application to backup site
- Integrates HACMP with unique data replication code to provide a fully automated solution
- Resources automatically failover to surviving node, no manual steps required
- Clusters
  - ▶ Campus wide – resources in multiple buildings, customer owns network
  - ▶ Metro wide – separate datacenters within same metro area, local network provider
  - ▶ Unlimited – datacenters in different states or countries, leased line networks
- Setup typically requires IBM services

System p HACMP XD Can Provide Data Center Level Disaster Recovery

Wide Area Network

Application

Workload failover

LVM Mirrored Volume Group

Both datacenters have a full copy of the application data

Data and Client traffic flow through Wide Area Network

Compare the Competition

	IBM ☆ System p	Sun Families	HP Families
Processor speed within an energy envelope	✔	Slower	Slower
Integrated energy efficiency functions	✔	Future	Future
Overall, price/performance	✔	Higher Cost	Higher Cost
Integrated hardware decimal floating point	✔	No	No
Integrated RAS functions	✔	Partial	Partial
Single unified processor architecture	✔	No (SPARC, UltraSPARC, SPARC64)	No (Itanium, PA-RISC)
Integrated virtualization assists	✔	Only UltraSPARC T1,T2	Only With Itanium (Limited Capability)
Has gone to Mars	✔	No	No

POWER Processor Has Gone To Mars!

NASA's New Phoenix Lander

The Phoenix Lander is powered by a processor based on IBM's POWER Architecture, similar to the one used in Sony's PlayStation 3.