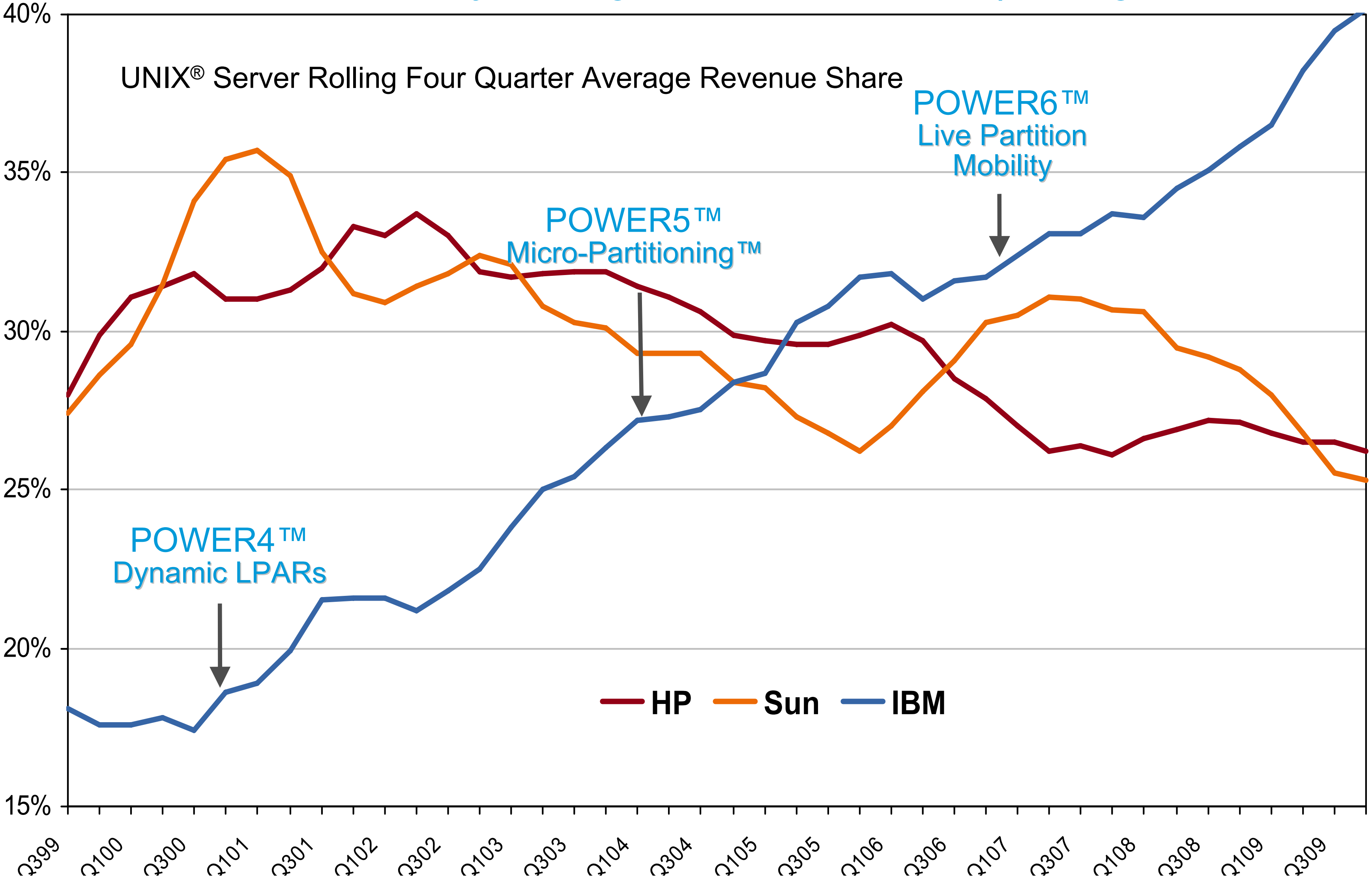
Power your planet.
Smarter Systems for a Smarter Planet

June 2010

Customers are moving to higher value

…as shown by the largest shift of customer spending in UNIX History



Source: IDC Quarterly Server Tracker Q409 release, February 2010

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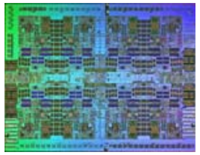
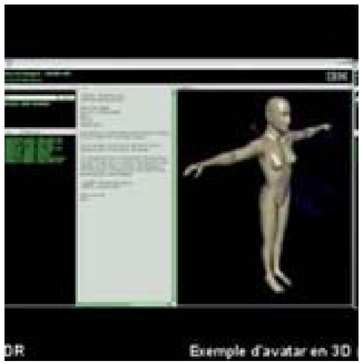
IBM's 2009 Patent Total: 17 yrs of Leadership

- **IBM** **4,914**
- Samsung 3,611
- Microsoft 2,906
- Canon 2,206
- Matsushita 1,829
- Toshiba 1,696
- Sony 1,680
- Intel 1,537
- Seiko Epson 1,330
- HP 1,273
- SUN 562
- Apple 289
- EMC 250
- Oracle 208
- ***Source: IFI Patent Intelligence***



IBM Austin: 880 Patents
#1 IBM location for 7th year



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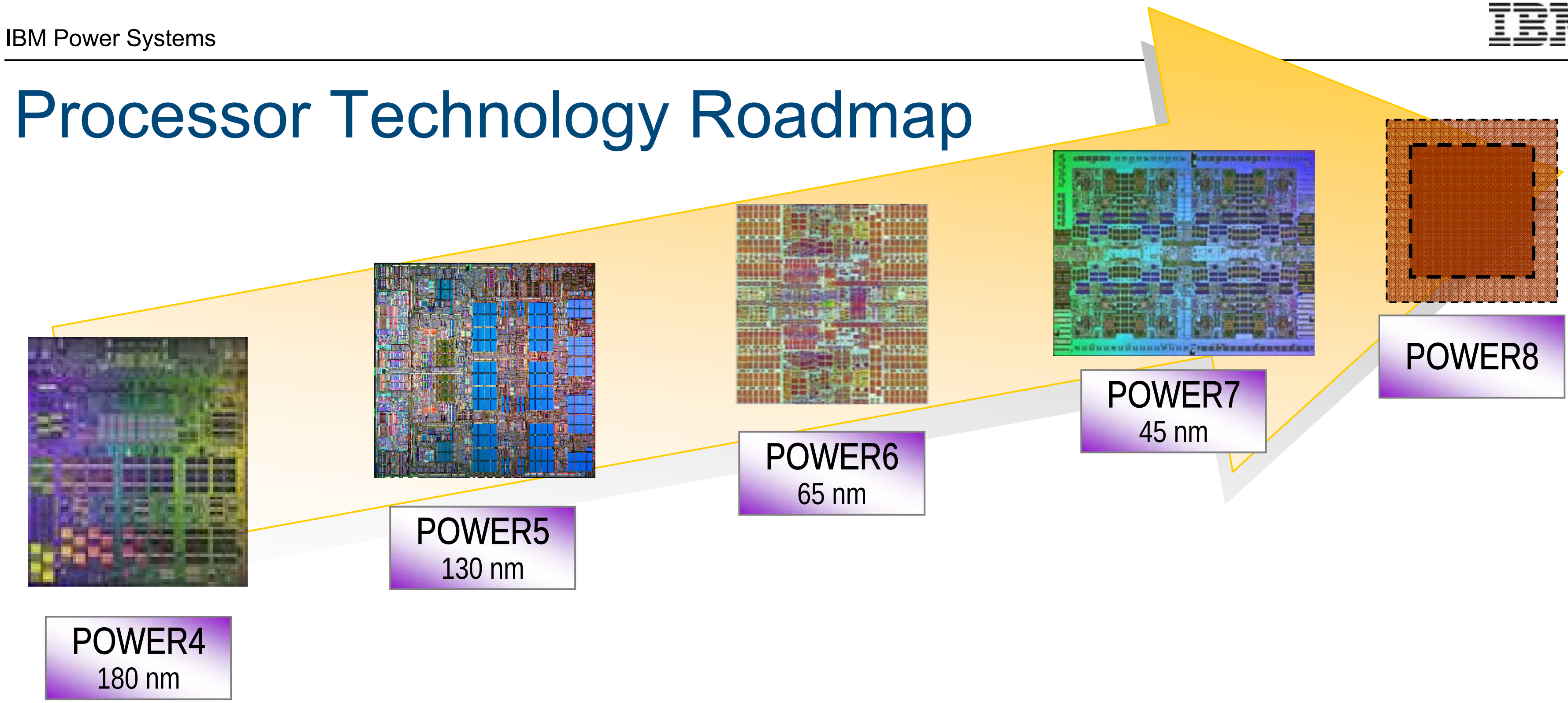
IBM POWER Architecture™
From consumer electronics to supercomputers

- A common architecture . . . A variety of implementations

Processor Technology Roadmap



▪ Dual Core ▪ Chip Multi Processing ▪ Distributed Switch ▪ Shared L2 ▪ Dynamic LPARs (32)	▪ Dual Core ▪ Enhanced Scaling ▪ SMT ▪ Distributed Switch + ▪ Core Parallelism + ▪ FP Performance + ▪ Memory bandwidth + ▪ Virtualization	▪ Dual Core ▪ High Frequencies ▪ Virtualization + ▪ Memory Subsystem + ▪ Altivec ▪ Instruction Retry ▪ Dyn Energy Mgmt ▪ SMT + ▪ Protection Keys	▪ Multi Core ▪ On-Chip eDRAM ▪ Power Optimized Cores ▪ Mem Subsystem ++ ▪ SMT++ ▪ Reliability + ▪ VSM & VSX (AltiVec) ▪ Protection Keys+	▪ Concept Phase
2001	2004	2007	2010	

Power your planet.

Compared to POWER6 systems - the industry leader, POWER7 systems have...

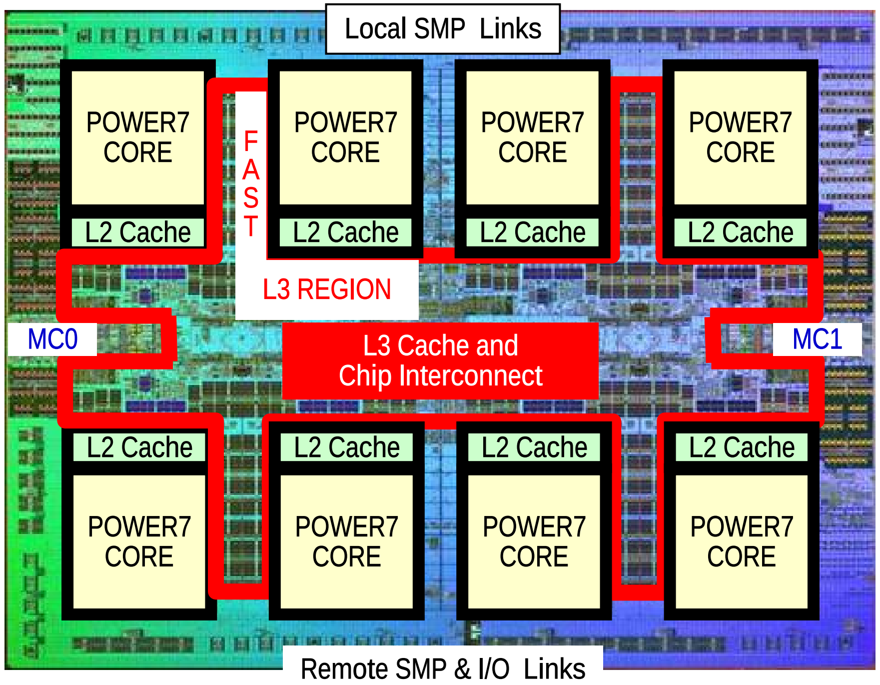
4x
the energy efficiency.

2x
the performance.

1x
the price.

Pricing may vary in different countries.

POWER7 Processor Chip



Binary Compatibility with POWER6

- Cores : 8 (4 / 6 core options)
- 567mm^2 Technology:
  - 45nm lithography, Cu, SOI, eDRAM
- Transistors: 1.2 B
  - Equivalent function of 2.7B
  - eDRAM efficiency
- Eight processor cores
  - 12 execution units per core
  - 4 Way SMT per core
  - 32 Threads per chip
  - L1: 32 KB I Cache / 32 KB D Cache
  - L2: 256 KB per core
  - L3: Shared 32MB on chip eDRAM
- Dual DDR3 Memory Controllers
  - 100 GB/s Memory bandwidth per chip
- Scalability up to 32 Sockets
  - 360 GB/s SMP bandwidth/chip
  - 20,000 coherent operations in flight

Power is Workload Optimization

Power Systems offers balanced systems designs that automatically optimize workload performance and capacity at either a system or VM level

- ✓ **TurboCore™** for max per core performance for databases
- ✓ **MaxCore** for incredible parallelization and high capacity
- ✓ **Intelligent Threads** utilize more threads when workloads benefit
- ✓ **Intelligent Cache** technology optimizes cache utilization flowing it from core to core
- ✓ **Intelligent Energy Optimization** maximizes performance when thermal conditions allow
- ✓ **Active Memory™ Expansion** provides more memory for SAP
- ✓ **Solid State Drives** optimize high I/O access applications
- ✓ **Optimization and increased flexibility**, for a more efficient cloud environment

Workload-Optimizing Features make POWER7 #1 in Transaction and Throughput Computing

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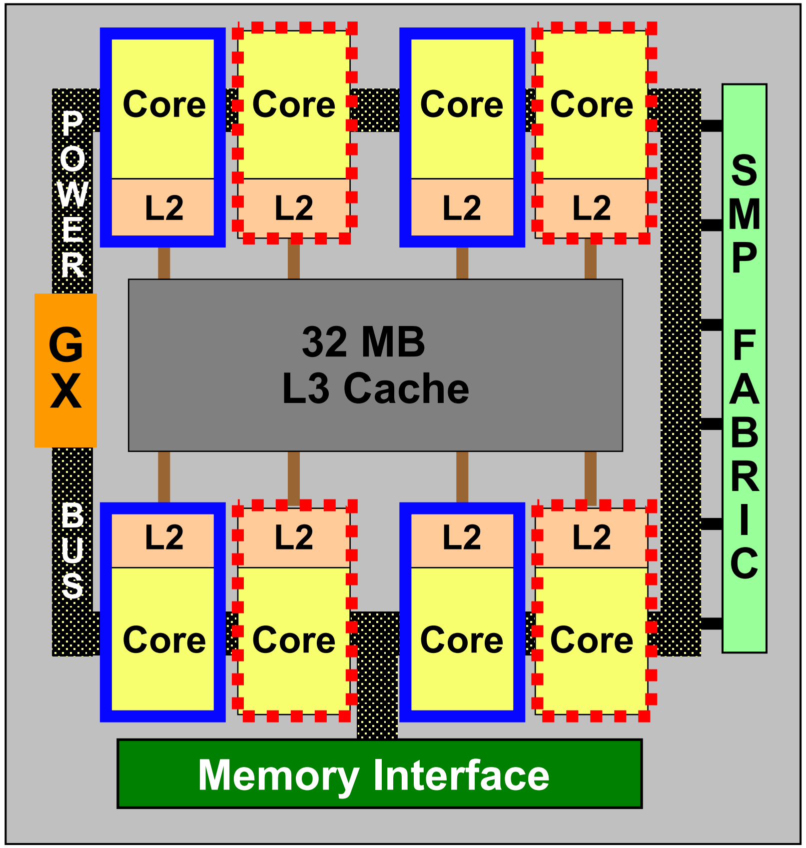
POWER7 TurboCore Mode

POWER7 TurboCore Chip

- TurboCore Chips: 4 available cores
- Aggregation of L3 Caches of unused cores.
- TurboCore chips have a 2X the L3 Cache per Chip available
  - –4 TurboCore Chips **L3 = 32 MB**
- Performance gain over POWER6.
  - –Provides up to 1.5X per core to core
- Chips run at higher frequency:
  - –Power reduction of unused cores.
- With "Reboot", System can be reconfigured to 8 core mode.
  - –ASM Menus



TurboCores **Unused Core**

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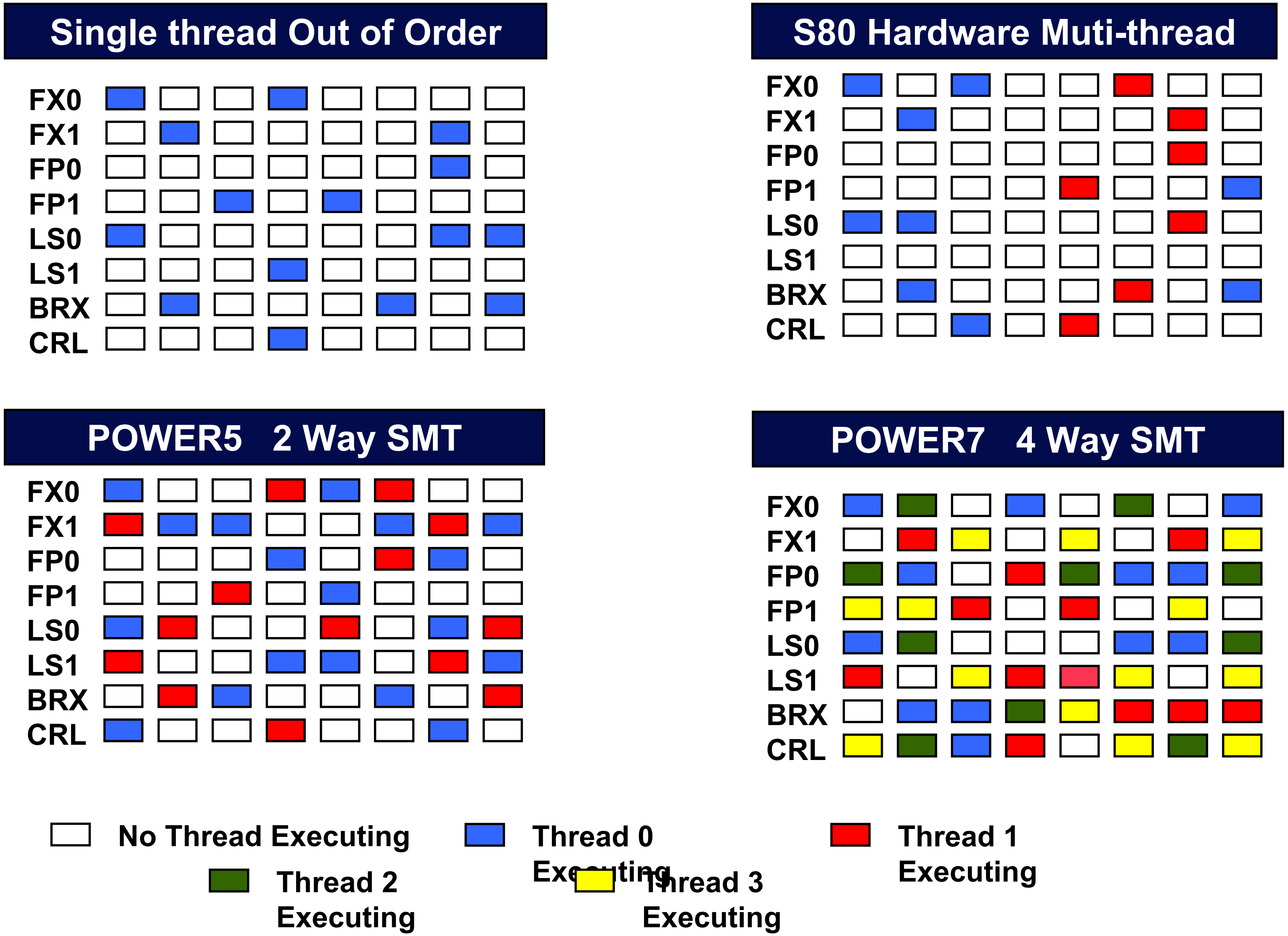
Multi-threading Evolution



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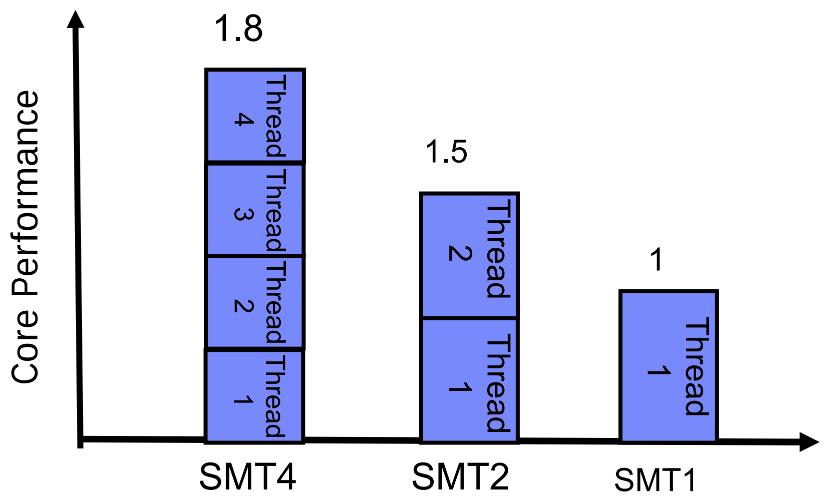
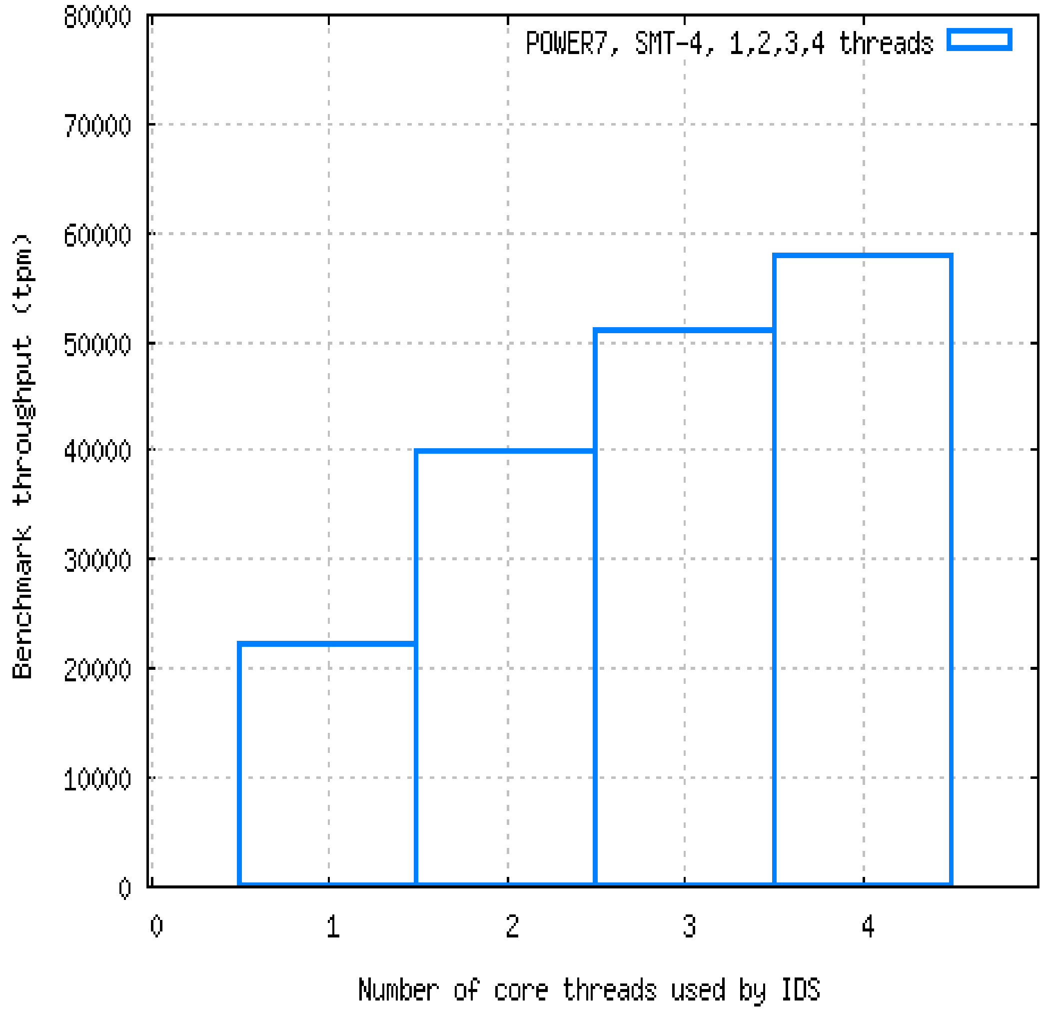
Intelligent Threads

- Historically, applications have used homogeneous systems
- In reality, different pieces of code have different needs of performance
  - Applications which do not run in parallel
  - Insufficiently parallelized or legacy applications (e.g. serial transactions within a parallel OLTP system)
  - Parallel applications with load imbalance (e.g. dispatcher thread, shared memory bottlenecks)
  - Serial code segments of parallel applications (e.g. startup, checkpoints, garbage collection)
- POWER7 processor offers multiple modes to optimize workloads
  - Power System Software stack optimizes these modes for different workloads
  - In many cases the optimization is automated; in other cases admin can set manually



Exploitation of threads with Informix

- Single core in SMT-4 mode
- IDS using 1,2,3,4 CPU VPs
  - internal OLTP workload
  - ~2.55x throughput factor between 1 and 4 threads.



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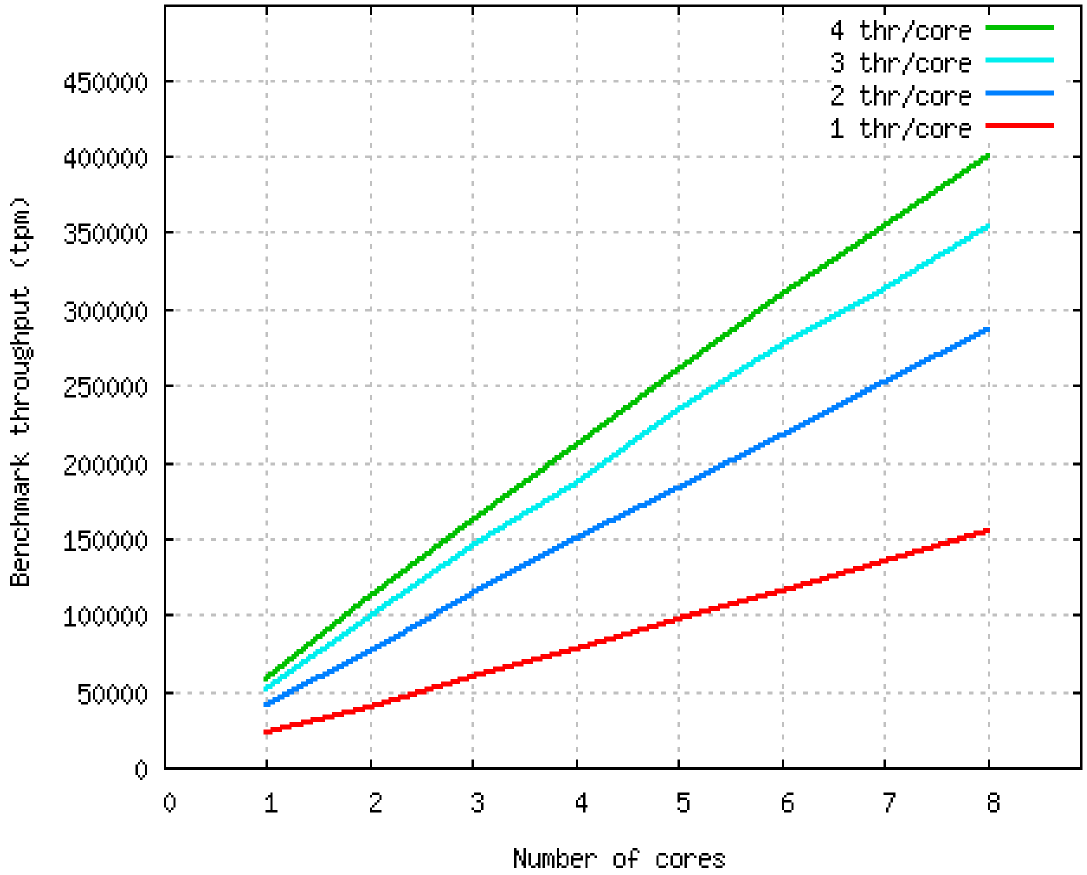
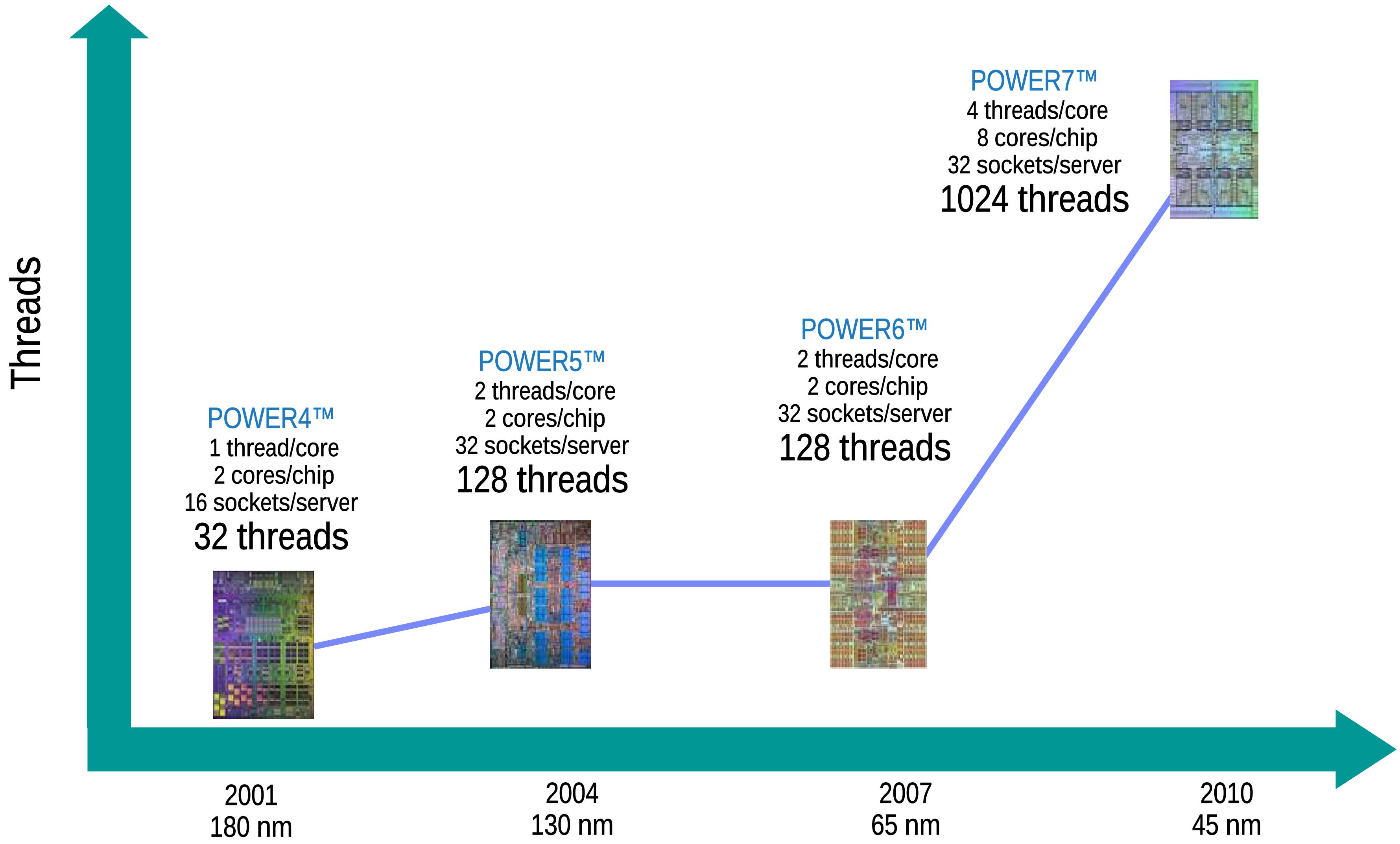
Exploitation of multiple Cores

- Single 8-core socket
- Throughput using 1-8 cores
- Using 1,2,3,4 Threads per Core



In 2010 Power Systems Brings Massive Parallelism Mainstream



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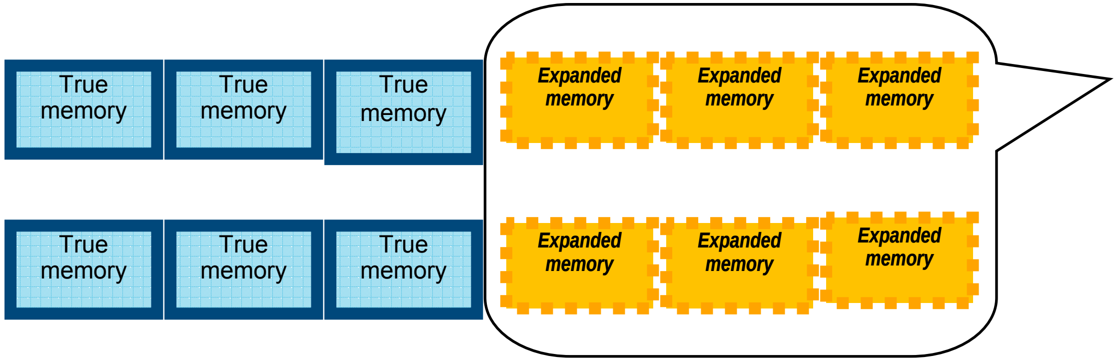
Active Memory Expansion



Effectively up to 100% more memory

- POWER7 advantage
- Expand memory beyond physical limits
- More effective server consolidation
  - Run more application workload / users per partition
  - Run more partitions and more workload per server

IBM POWER7 EnergyScale Functions

Power / Thermal Trending

- Collect and report power consumption, inlet and exhaust temp

Power Capping

- Static (hard) Power Save: Enforces via Dynamic Frequency & Voltage Slewing
- Soft Power Cap: Attempted lower cap, but not guaranteed.

Power States

- Static Power Save (SPS): Save via a fixed voltage and frequency drop – 14% freq
- Dynamic Power Save (DPS): Optimize power vs. performance
- Dynamic Power Save - Favor Performance (DPS-FP):

Enhanced Energy Management (POWER7 new)

- Processor Sleep, Larger V/F drop
- Intelligent VCPU folding, Higher Turbo Frequency
- Smart Fan Control based on Thermals
- Performance Aware Memory Throttling and Control

Common Functions on all systems (POWER7 new)

- TPMD Hardware on all P7 systems

Power Systems Leadership Portfolio

POWER7 Servers
- ✓POWER7 Blades
- ✓Power® 750 Express
- ✓Power 755 for HPC
- ✓Power 770 modular
- ✓Power 780 modular high-end

Entire POWER6 line continues to be available

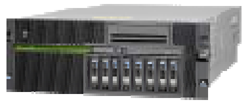
Power 595

Power 780

Power 770
Power 570

Power 560

Power 750
Power 550



Power 520

PS Blades
JS Blades

PowerHA
PowerVM
IBM Systems Director

Power Systems Software

AIX
i for Business
Linux

High Performance Computing

Power 755

Power 575

Power your planet.

Power 750 System

4U
Depth: 28.8”

ENERGY STAR

8233-E8B	
POWER7 Architecture	6 Cores @ 3.3 GHz 8 Cores @ 3. 0, 3.3, 3.55 GHz Max: 4 Sockets
DDR3 Memory	Up to 512 GB
System Unit SAS SFF Bays	Up to 8 Drives (HDD or SSD) 73 / 146 / 300GB @ 15k (2.4 TB) (Opt: cache & RAID-5/6)
System Unit IO Expansion Slots	PCIe x8: 3 Slots (2 shared) PCI-X DDR: 2 Slots 1 GX+ & Opt 1 GX++ 12X cards
Integrated SAS / SATA	Yes
System Unit Integrated Ports	3 USB, 2 Serial, 2 HMC
Integrated Virtual Ethernet	Quad 10/100/1000 Optional: Dual 10 Gb
System Unit Media Bays	1 Slim-line DVD & 1 Half Height
IO Drawers w/ PCI slots	PCIe = 4 Max: PCI-X = 8 MAX
Cluster	12X SDR / DDR (IB technology)
Redundant Power and Cooling	Yes (AC or DC Power) Single phase 240 VAC or -48 VDC
EnergyScale	Active Thermal Power Management Dynamic Energy Save & Capping

Power your planet.

Power 770

4U x 32 inches Depth

Maint Coverage: 9 x 5

Power 770		
Processor Technology	6 Cores @ 3.55 GHz 8 Cores @ 3.1 GHz	
L3 Cache	On Chip	
Redundant Power & Cooling	Yes	
Redundant Server Processor	Yes / Two Enclosure minimum	
Redundant Clock	Yes / Two Enclosure minimum	
Concurrent Add Support	Yes	
Concurrent Service	Yes	
System Unit	**Single Enclosure**	**4 Enclosures**
Processors	Up to 2 Sockets	8 Sockets
DDR3 Memory (Buffered)	Up to 512 GB	Up to 2 TB
SAS/SSD SFF Bays	6	24
DVD-RAM Media Bays	1 Slim-line	4 Slim-line
SAS / SATA Controller	2 / 1	8 / 4
PCIe bays	6 PCIe	24 PCIe
GX++ Slots (12X DDR)	2	8
Integrated Ethernet	Std: Quad 1Gb Opt: Dual 10Gb + Dual 1 Gb	Std: Four Quad 1Gb Opt: Four x Dual 10Gb + Dual 1 Gb
USB	3	12
12X I/O Drawers w/ PCI slots	Max: 4 PCIe, 8 PCI-X	Max: 16 PCIe, 32 PCI-X

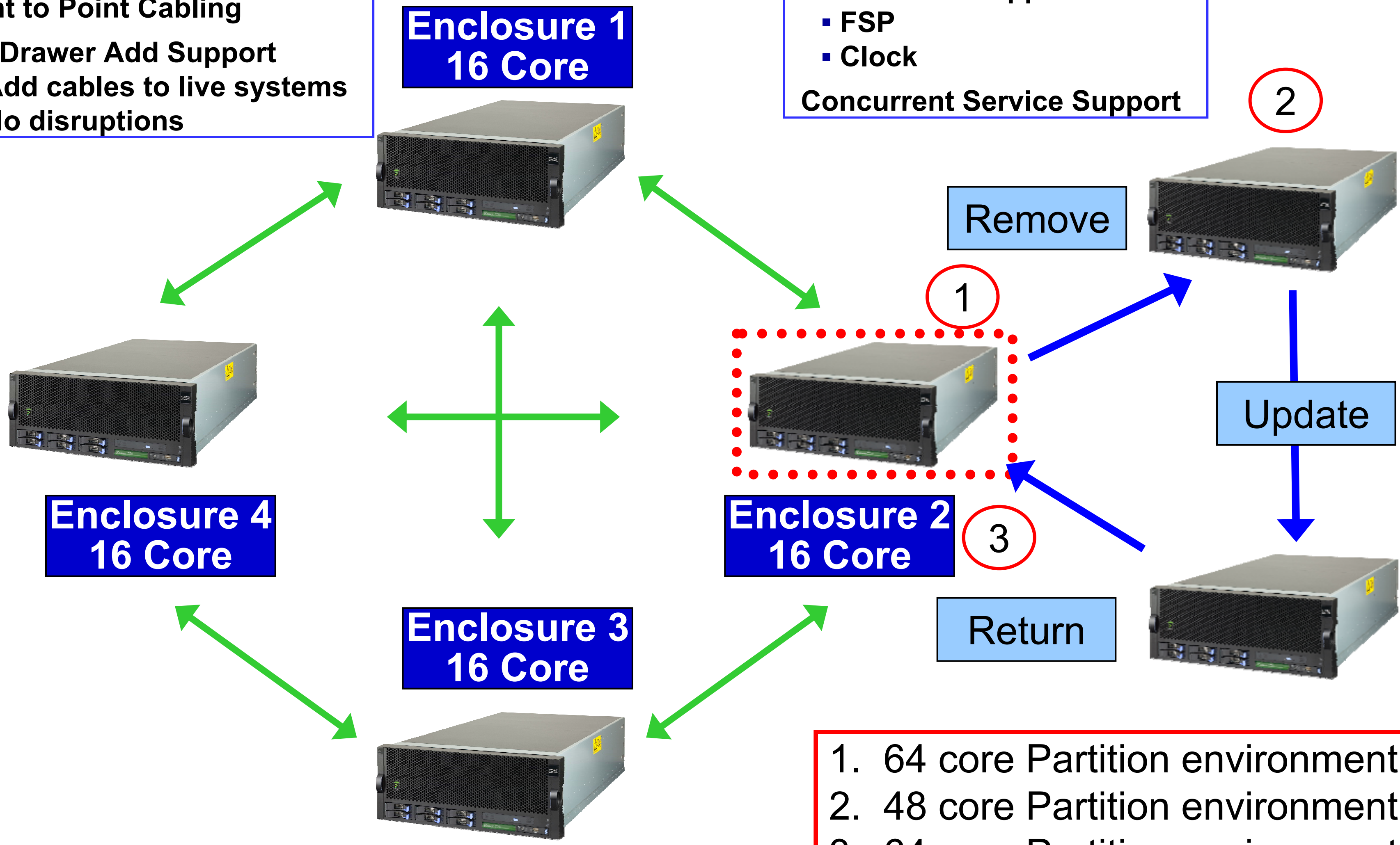
POWER7 Modular Concurrent Maintenance…

Point to Point Cabling

Hot Drawer Add Support
- **Add cables to live systems**
- **No disruptions**

Hot Failover support
- **FSP**
- **Clock**

Concurrent Service Support



1. 64 core Partition environment
2. 48 core Partition environment
3. 64 core Partition environment

Additional support 2H / 2010

Move up to enterprise class RAS

● Standard
○ Optional
– Not available

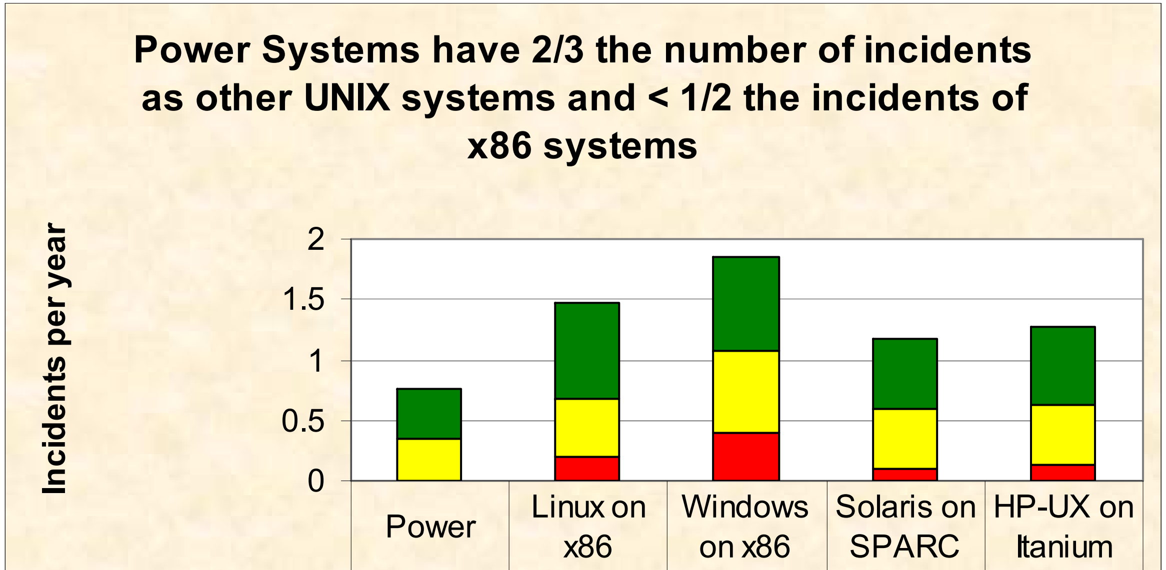
RAS Item	Power 750	Power 770	Power 780
Redundant / Hot Swap Fans & Blowers	●	●	●
Hot Swap DASD / Media / PCI Adapters	●	●	●
Concurrent Firmware Update	●	●	●
Redundant / Hot Swap Power Supplies	○	●	●
Dual disk controllers (split backplane)	○	●	●
Processor Instruction Retry	●	●	●
Alternate Processor Recovery	●	●	●
Storage Keys	●	●	●
PowerVM™/Live Partition Mobility/Live Application Mobility	○	○	○
Redundant Service Processors	–	● *	● *
Redundant System Clocks	–	● * New!	● *
Redundant / Hot Swap Power Regulators	–	●	●
Dynamic Processor Sparing	–	○	○
Memory Sparing	–	○	○
Hot GX Adapter Add and Cold Repair	–	●	●
Hot-node Add / Cold-node Repair	–	● *	● *
Hot-node Repair / Hot-memory Add	–	● *	● *
POWER7 Enhanced Memory	–	●	●
Dynamic Service Processor and System Clock Failover	–	● * New!	● *
Hot-node Repair / Hot-memory Add for all nodes**	–	● * New!	● *
Hot GX Adapter Repair	–	● New!	●

* Requires two or more nodes
** Planned for 4Q 2010

Power your planet.

Power Systems are more reliable

No severe incidents on Power systems



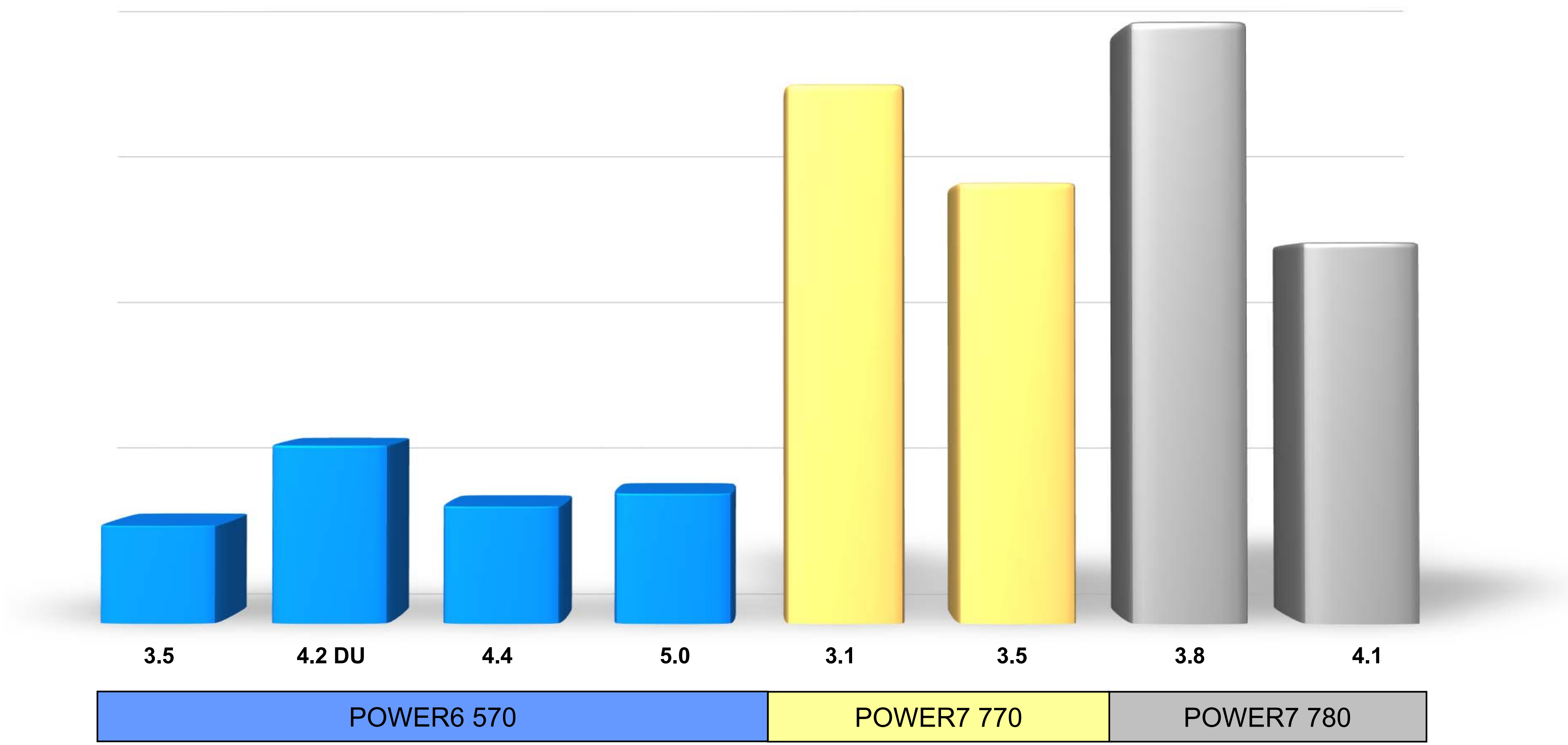
	Power	Linux on x86	Windows on x86	Solaris on SPARC	HP-UX on Itanium
Tier 1 Incidents	0.42	0.8	0.78	0.59	0.65
Tier 2 Incidents	0.34	0.475	0.68	0.49	0.48
Tier 3 incidents	0	0.195	0.395	0.1	0.14

- Tier 1 incidents are minor problems that can usually be solved in 30 minutes by an administrator
- Tier 2 incidents usually cause the server to be out of service for up to ½ day. They can be handled by a single administrator
- Tier 3 incidents are severe problems that require a team of administrators to resolve and typically cause downtime of > ½ day. A real threat of tier 3 incidents is loss of business and /or loss of reputation.

Source: ITIC 2009 Global Server Hardware & Server OS Reliability Survey Results, July 7, 2009

System Capacity Moves Up with POWER7

…expands performance traits of POWER6+

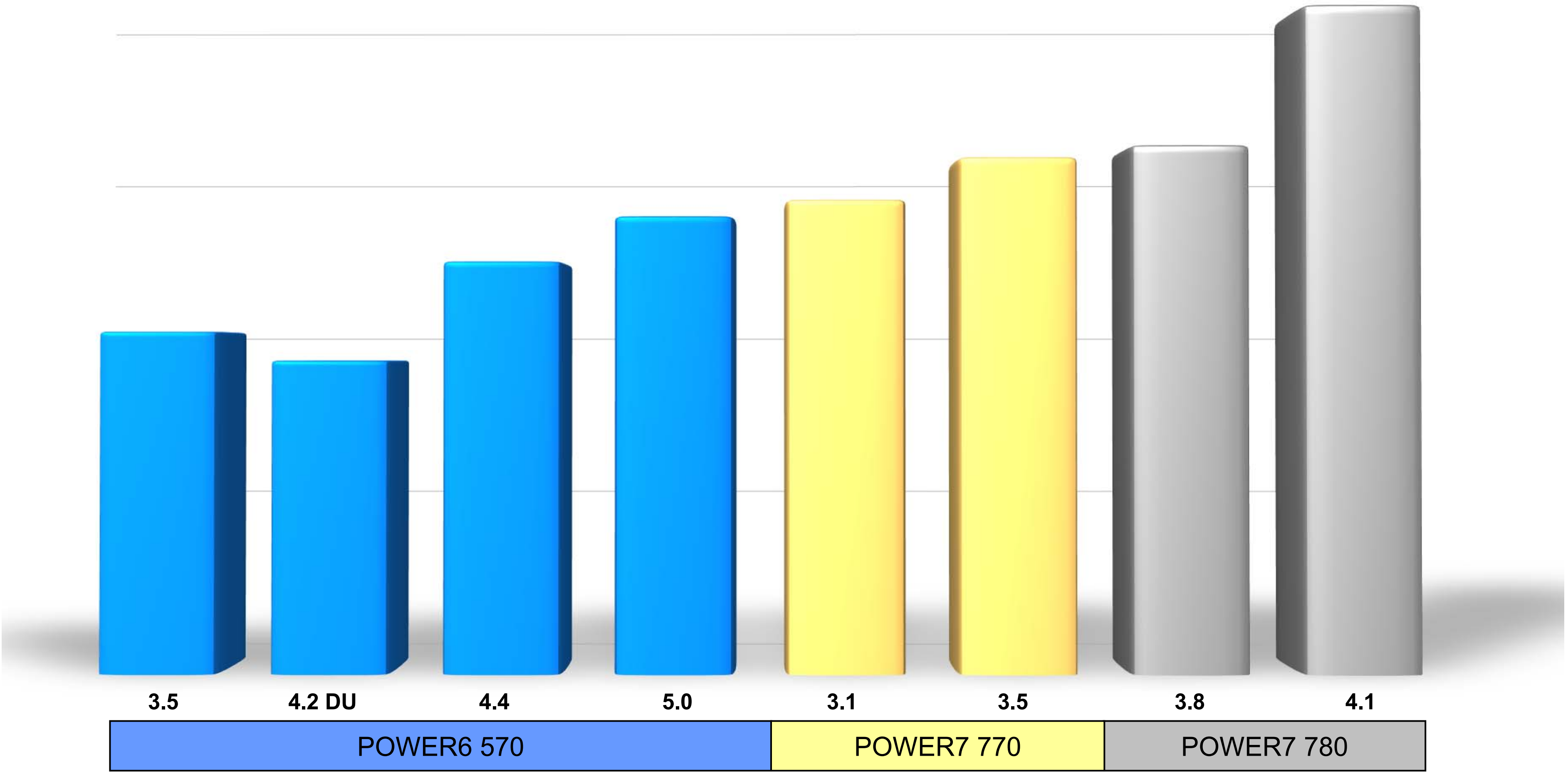


OLTP capacity as estimated in maximum projected rPerf performance
All POWER7 estimates are preliminary, pending further performance testing

Power your planet.

Performance per Core Moves Up with POWER7

…expands performance traits of POWER6+



OLTP performance per core as estimated in projected maximum system rPerf performance
All POWER7 estimates are preliminary, pending further performance testing

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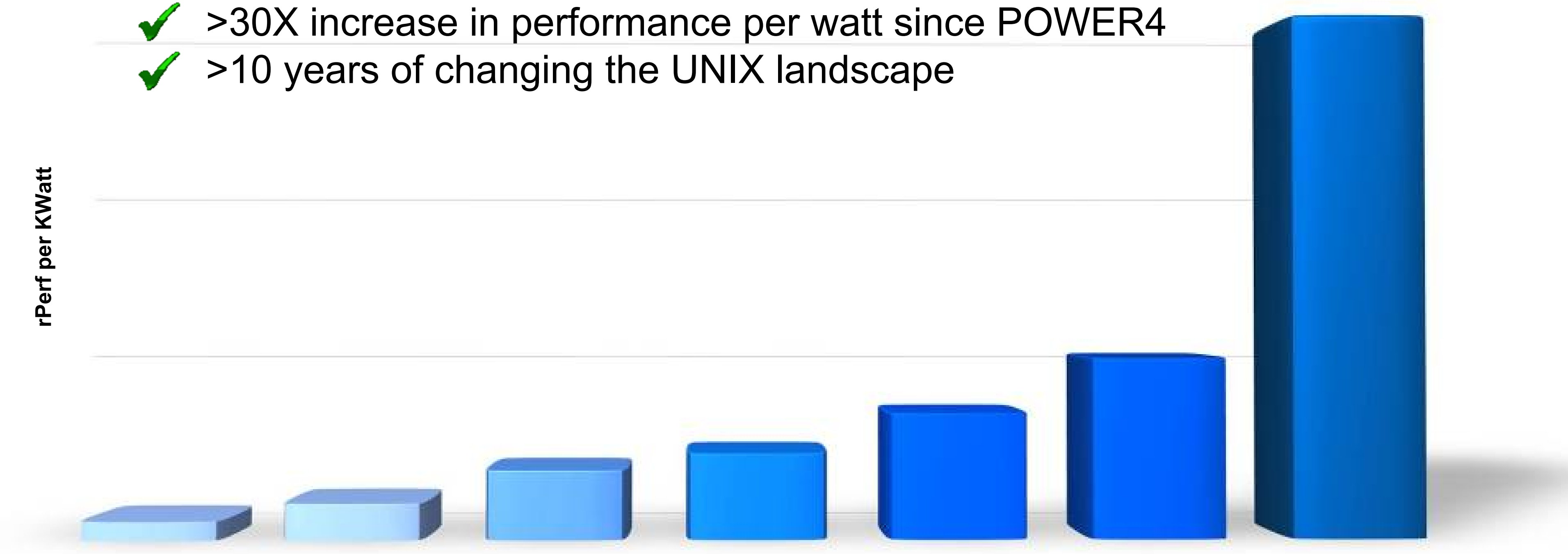
POWER7 continues to deliver more

Performance per Watt

- ✓ >3X increase in performance per watt over POWER6+
- ✓ >30X increase in performance per watt since POWER4
- ✓ >10 years of changing the UNIX landscape

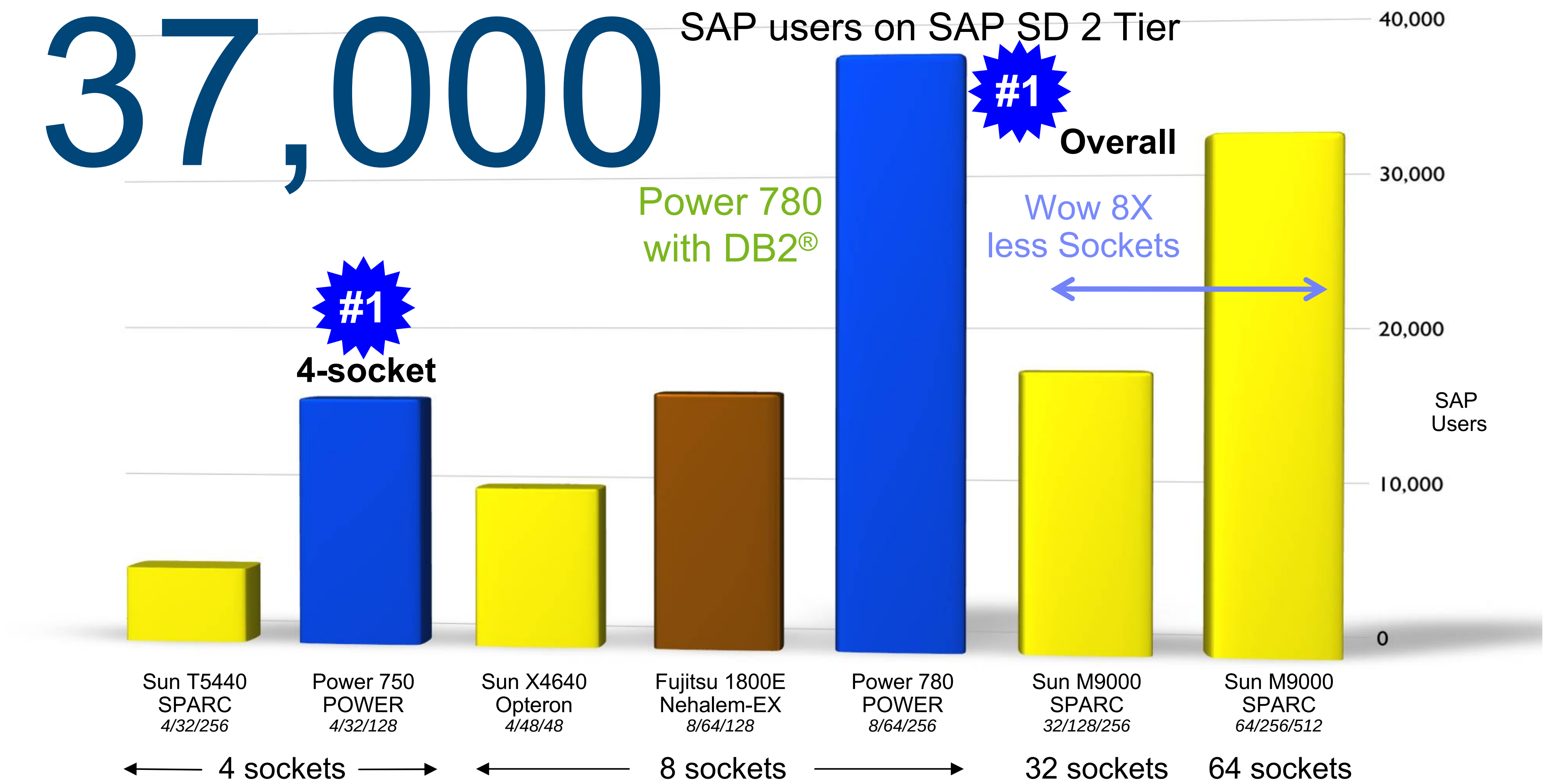


POWER4™ **p670** **1.1 GHz** **rPerf: 24.46** **KWatts: 6.71**	POWER4+™ **p670** **1.5 GHz** **rPerf: 46.79** **KWatts: 6.71**	POWER5™ **p5-570** **1.65 GHz** **rPerf: 68.4** **KWatts: 5.2**	POWER5+™ **p570** **1.9 GHz** **rPerf: 85.20** **KWatts: 5.2**	POWER6™ **Power 570** **4.7 GHz** **rPerf: 134.35** **KWatts: 5.6**	POWER6™ **Power 570** **4.2 GHz** **rPerf: 193.25** **KWatts: 5.6**	POWER7™ **Power 780** **3.8 GHz** **rPerf: 685.09** **KWatts: 6.4**

Power your planet.

More SAP performance than any system in the industry

20% more performance … one-fourth the number of cores vs. Sun M9000

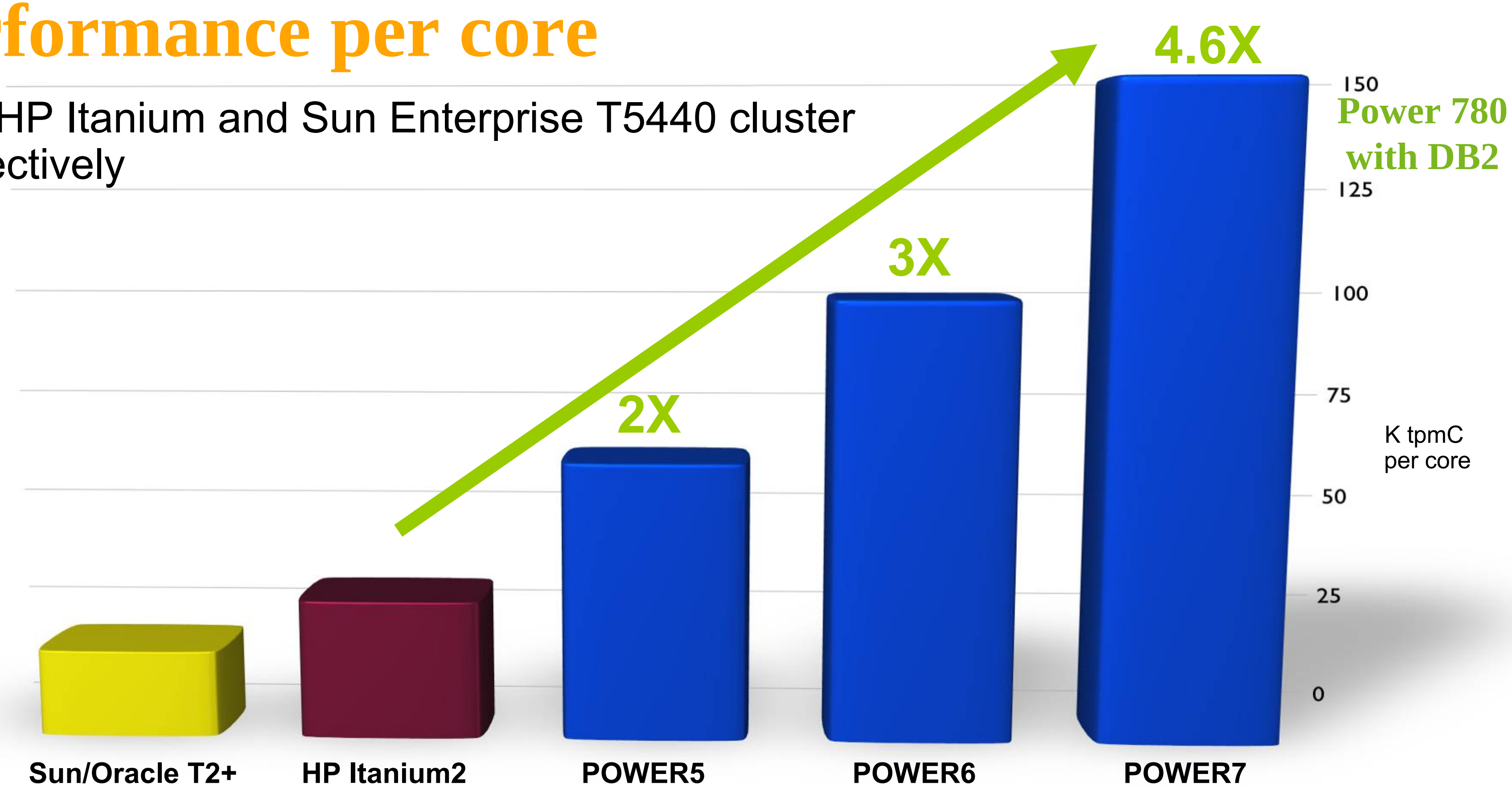


Systems are listed with processor chips/core/threads under system name; IBM Power System 780, 8p / 64–c / 256–t, POWER7, 3.8 GHz, 1024 GB memory, 37,000 SD users, dialog resp.: 0.98s, line items/hour: 4,043,670, Dialog steps/hour: 12,131,000, SAPS: 202,180, DB time (dialog/ update):0.013s / 0.031s, CPU utilization: 99%, OS: AIX 6.1, DB2 9.7, cert# 2010013; SUN M9000, 64p / 256-c / 512–t, 1156 GB memory, 32,000 SD users, SPARC64 VII, 2.88 GHz, Solaris 10, Oracle 10g , cert# 2009046; All results are 2-tier, SAP EHP 4 for SAP ERP 6.0 (Unicode) and valid as of 4/1/2010; Source: http://www.sap.com/solutions/benchmark/sd2tier.epx - See Power 780 benchmark details for more information

More TPC-C performance per core than any system in the industry

4.6 to 7.5 times more performance per core

than HP Itanium and Sun Enterprise T5440 cluster respectively



Best results listed for IBM POWER, HP, and Sun/Oracle systems over 1M tpmC.
Source: http://www.tpc.org as of 4/1/08. See Power 780 benchmark details for specific results.

83%

savings on energy costs with 28% more performance at a fraction of the price using a single **IBM Power 750** instead of a 64-core HP Integrity Superdome.

Superdome or Super Power?

Shown to actual scale

HP Integrity Superdome 64c

- 1.6GHz dual-core Itanium2 in a 30”x77.2”x48” frame
- Maximum energy requirement of **11,586 Watts**
- **SPECint_rate2006: 824**

IBM Power 750 Express

- 4 socket, 32 Core 4Ux19” wide
- POWER7 Processors
- Maximum energy requirement of **1,950 Watts**
- **SPECint_rate2006: 1060**

Power your planet.

See Power 750 Express vs 64-core HP Integrity Superdome for more details.
Source: SPECiint_rate2006. For the latest SPEC benchmark results, visit http://www.spec.org.

PowerVM Builds on IBM's History of Virtualization Leadership

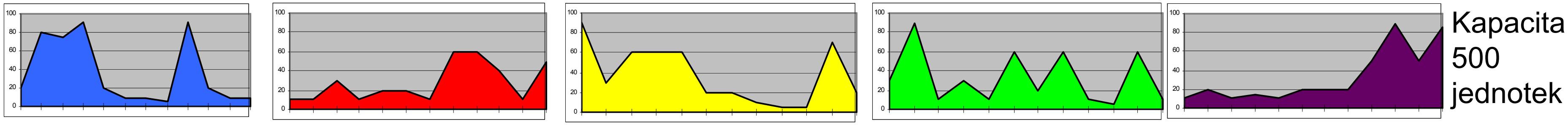
A 40-year track record in virtualization innovation continues with PowerVM™

1967	1973	1987	1999	2004	2007	2008
IBM develops **hypervisor** that would become VM on the mainframe	IBM announces first machines to do **physical partitioning**	IBM announces **LPAR on the mainframe**	IBM announces **LPAR** on POWER™	IBM intro's POWER Hypervisor™ for System p™ and System i™	IBM announces POWER6™, **the first UNIX® servers with Live Partition Mobility**	**IBM announces PowerVM**

Power your planet.

Kdy virtualizovat?

Přístup v minulosti: Server je dimenzován na špičky požadovaného výkonu



Server 1
Kapacita = 100 jednotek

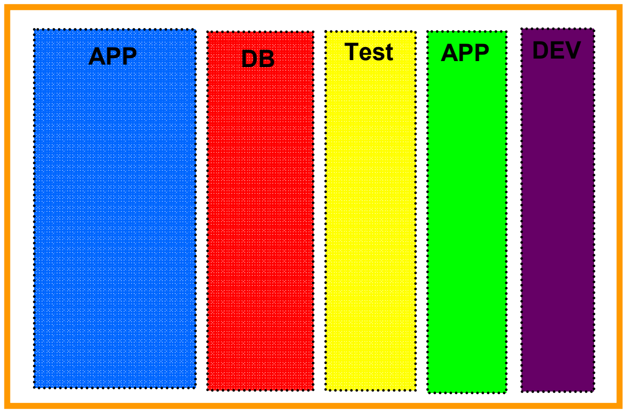
Server 2
Kapacita = 100 jednotek

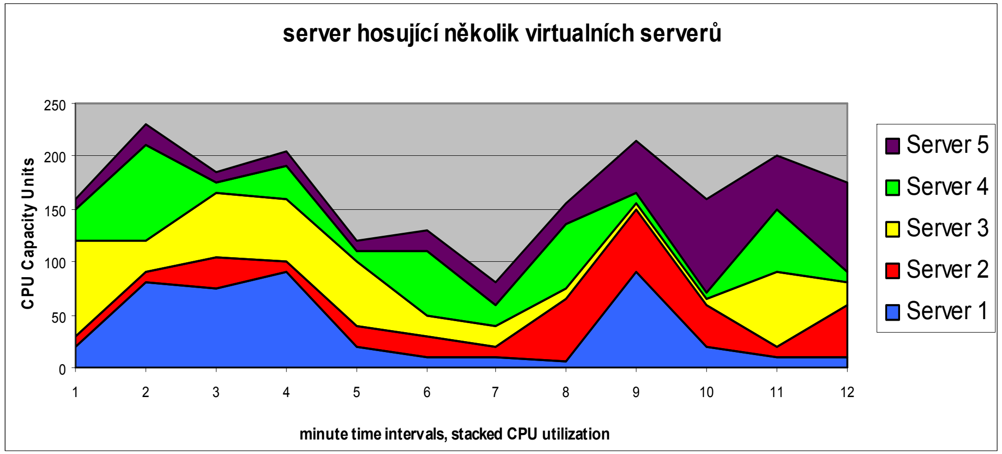
Server 3
Kapacita = 100 jednotek

Server 4
Kapacita = 100 jednotek

Server 5
Kapacita = 100 jednotek

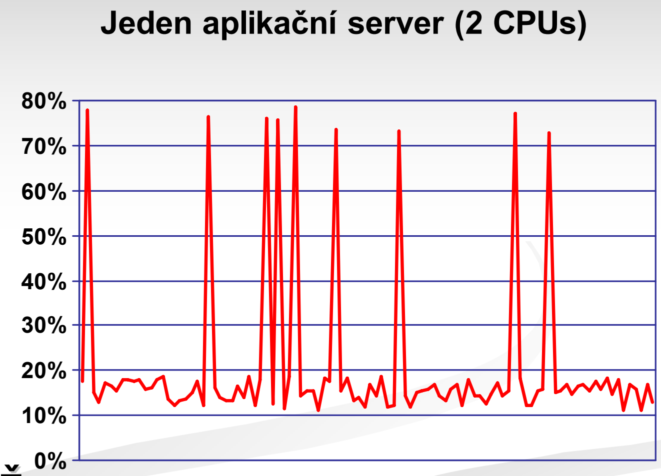
Přístup dnes: Server s dynamickými virtuálními servery, které umožní automatické přerozdělení procesorů a dalších zdrojů. Návrh serveru odpovídá maximálnímu současnému zatížení.

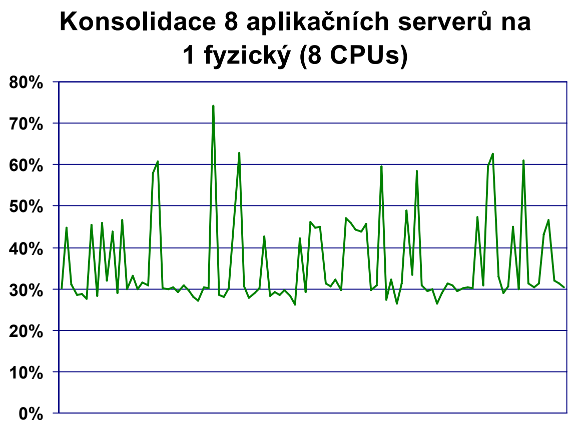


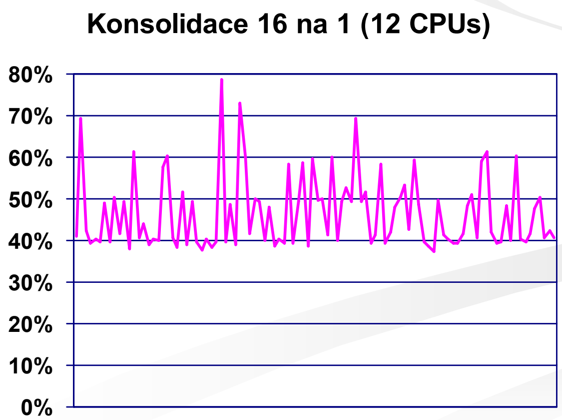


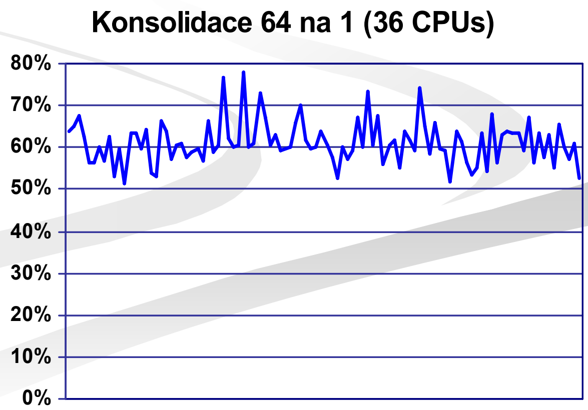
Vliv virtualizace na procesory

- Jeden virtuální server:
  - Průměrné vytížení: 20,7%
  - Špičkové vytížení: 79%
- Více virtualních serverů zvyšuje průměrné vytížení, ale špičkové se příliš nemění:
  - 8:1 průměrné: 39%, špičkové 76%
  - 16:1 průměrné: 48%, špičkové 78%
  - 64:1 průměrné: 61%, špičkové 78%
- Počet potřebných procesorů roste pomaleji než počet přidávaných serverů.



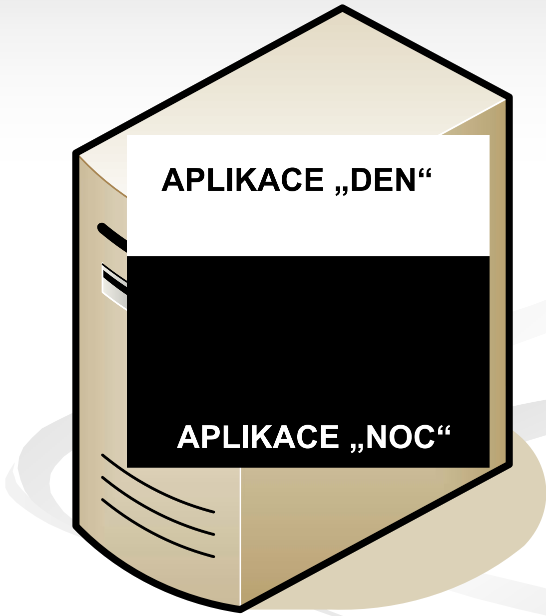




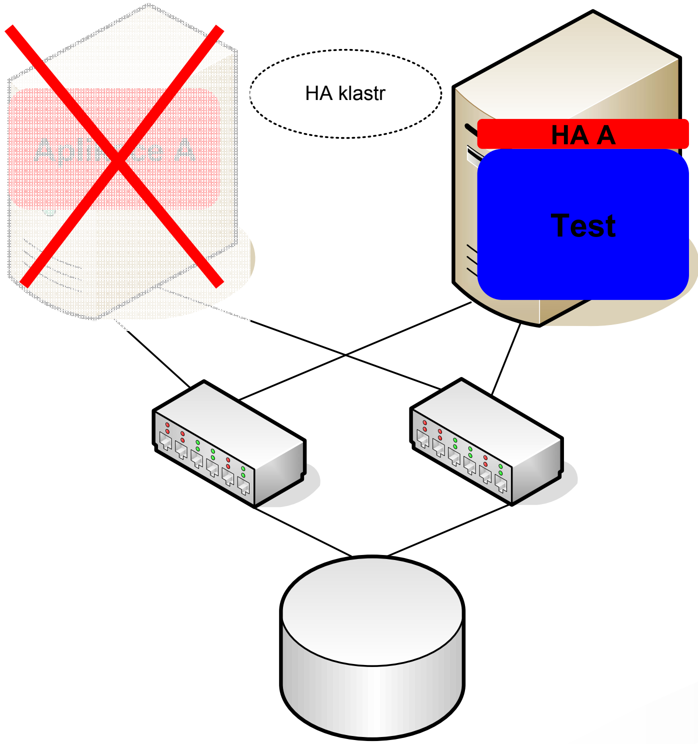


Příklad: Virtualizace serveru „den“ a „noc“

- Provoz aplikací s výkonnostními špičkami v různém čase,
- automatické nebo operátorem vyvolané změny parametrů virtuálních serverů,
- procesory přerozděleny obvykle v řádu sekund,
- operační paměť reaguje obvykle v řádu desítek sekund,
- až stovky virtuálních serverů na jednom fyzickém.



Příklad: Virtualizace a vysoká dostupnost

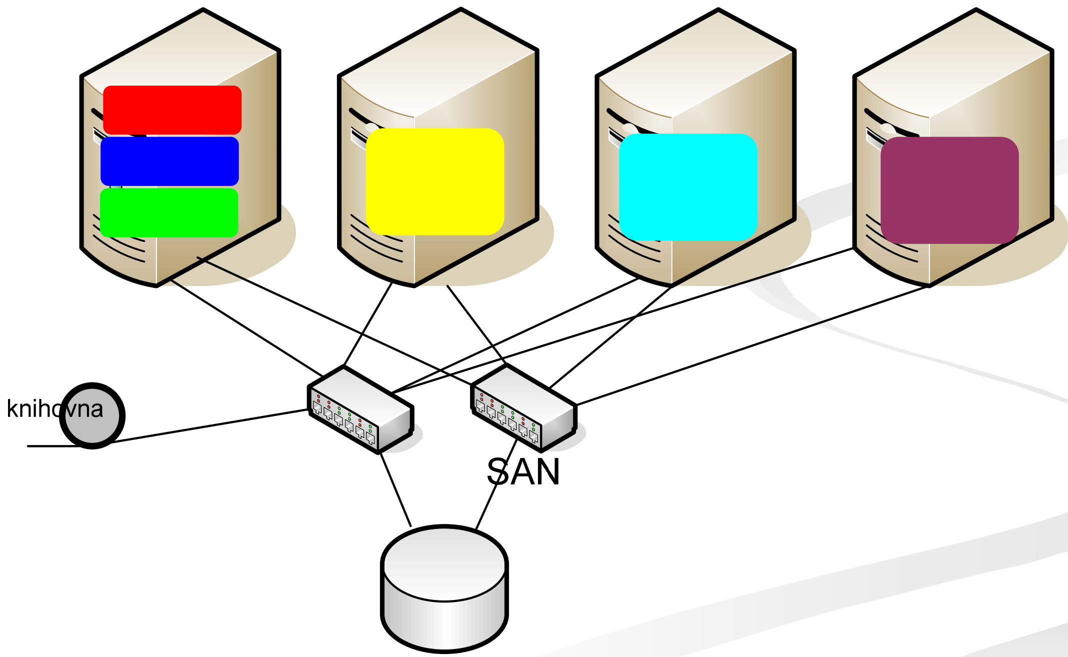


- Automatická modifikace záložního virtuálního serveru,
- v případě selhání primárního serveru, záložní server si přebírá zdroje od prostředí ‚Test',
- test prostředí je výkonnostně utlumeno (případně zastraveno),
- změny mohou byt provedeny automaticky nebo poloautoamticky (iniciovány eventy klusterového řešení)

Příklad: virtualizace a mobilita

Požadavek provozovatele:

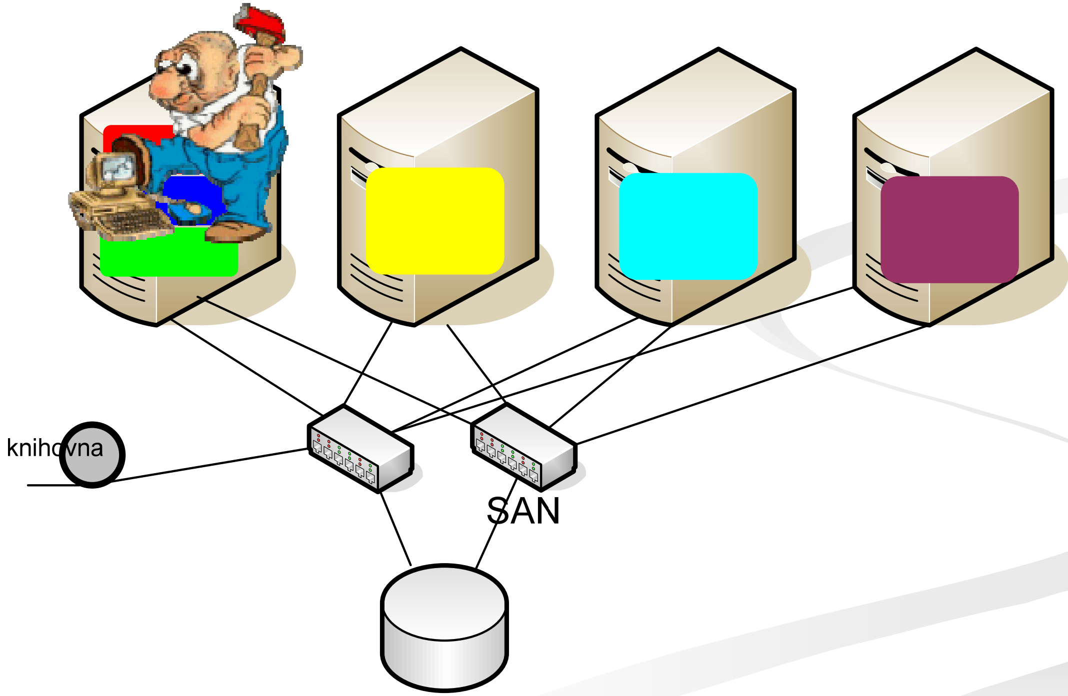
- Více výkonu pro ‚modrou' databázi
- Zachovat zdroje ‚červené' a ‚zelené' databáze
- Zachovat běh ostatních databází (možné snížit výkon)



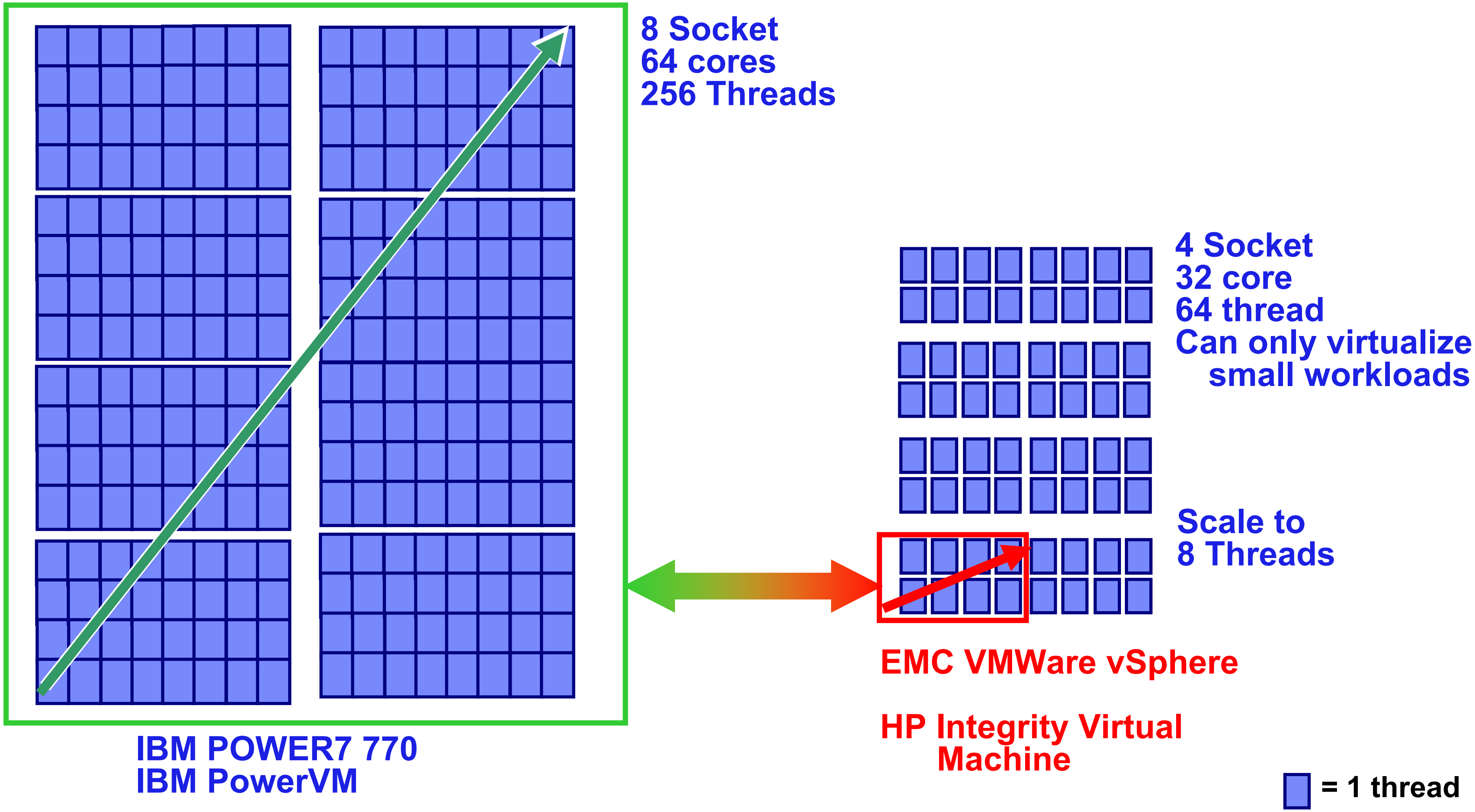
Příklad: virtualizace a mobilita

Požadavek provozovatele:

- Uvolnit server A pro plánovanou údržbu
- Zachovat běh všech databází
- Možno omezit výkon



Virtual Machine scalability



IBM POWER Virtual Machines scale to all threads
VMWare and HP IVM only scale to 8 threads

How much performance can you get from VMWare?

- Bare metal Nehalem-EP outperforms VMWare by >60%
  - Even though the virtualized environment had twice the memory

SAP SD Benchmark results (SAPS/core)	Native	VM
Fujitsu PRIMERGY Model TX300 S5 / RX300 S5	2,271	1,404

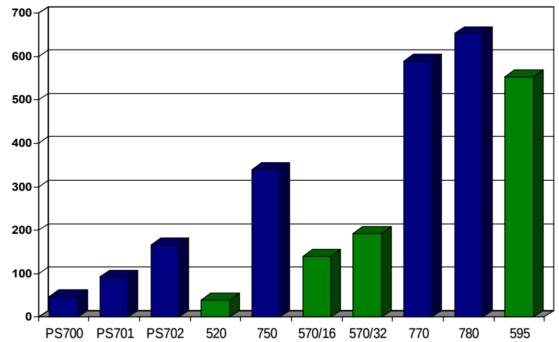
Power Systems enables you to enjoy the advantages of virtualization for all your applications

For more information, see "A Comparison of PowerVM and x86-Based Virtualization Performance, available at http://www-03.ibm.com/systems/power/software/virtualization/whitepapers/powervm_x86.html

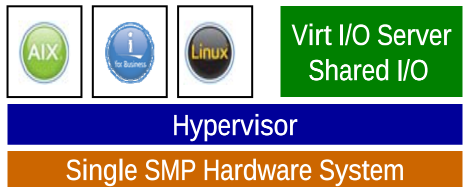
The Fujitsu benchmarks were run on the SAP benchmark kit with Unicode.
See chart SAP Benchmark Results for benchmark detail.

POWER7 Systems Technology Value…

- **Technology**
  - Roadmap
  - Processor Instruction Retry
  - Green Technology built in
  - Common architecture from Blades to High-end



- **Performance**
  - Power Systems scalability from blades to high end systems
  - Performance leadership in a variety of workloads
  - Best Performance per core
  - Memory and IO bandwidth



- **Virtualization**
  - Consolidate to higher levels
  - Virtualize Processors, Memory, and I/O
  - Dynamic movement of Partitions and Applications
  - Reduce infrastructure costs

- **RAS**
  - Power Systems mainframe inspired RAS features
  - Hot Add support / Concurrent Maintenance
  - Alternate Process Recovery
  - Operating Systems Availability Leadership

Power your planet.

Power your planet.

Workload-Optimizing Systems

+

AIX® - the future of UNIX

Total integration with i

Scalable Linux® ready for x86 consolidation

Virtualization without Limits

- ✓ Drive over 90% utilization
- ✓ Dynamically scale per demand

Dynamic Energy Optimization

- ✓ 70-90% energy cost reduction
- ✓ EnergyScale™ technologies

Resiliency without Downtime

- ✓ Roadmap to continuous availability
- ✓ High availability systems & scaling

Management with Automation

- ✓ VMControl to manage virtualization
- ✓ Automation to reduce task time

Smarter Systems for a Smarter Planet.