

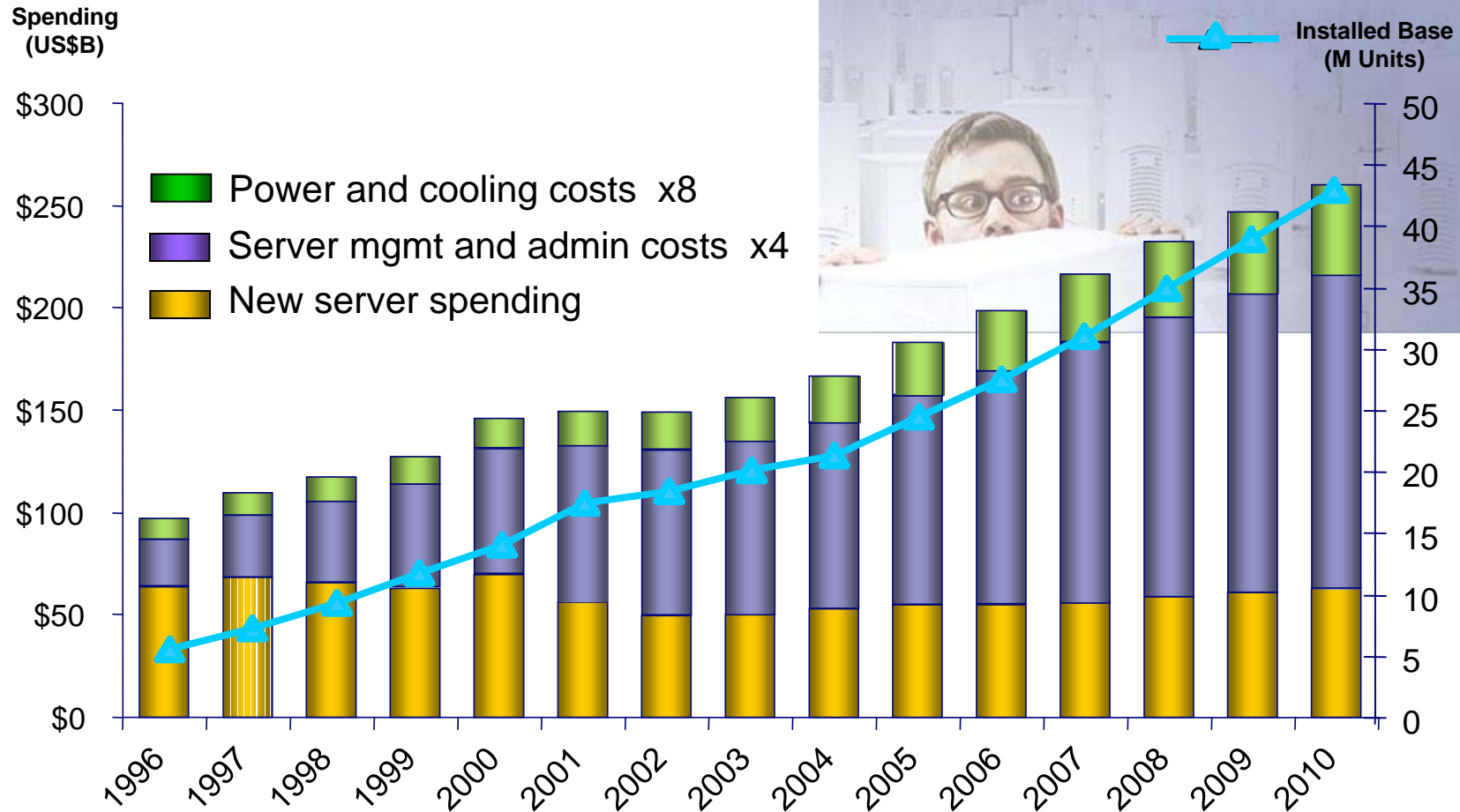


Competitive Takeout: Why PowerVM is Better Than the Competition

Agenda

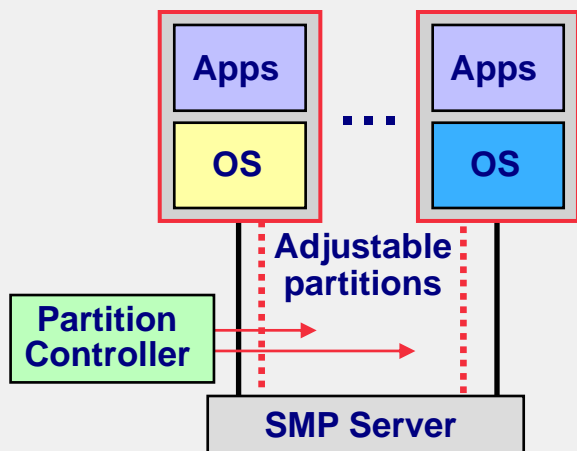
- Virtualization Overview and Competitive Positioning
- Competitive Positioning:
 - PowerVM™ vs. Sun
 - PowerVM vs. HP
 - PowerVM vs. VMware

Rising Costs and Complexity Threaten Profits and Competitiveness



Server Virtualization Approaches

Hardware Partitioning

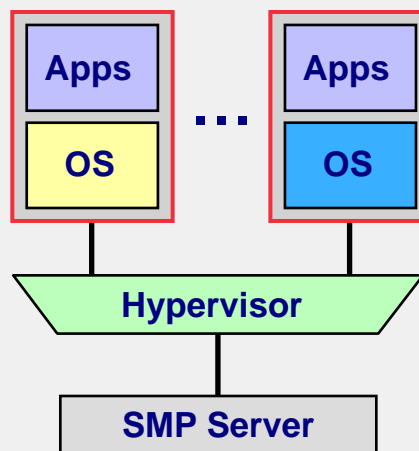


Server is subdivided into fractions each of which can run an OS

Board-level partitioning
 S/370 SI->PP & PP->SI,
 Sun Domains, HP nPartitions

Core/thread-level partitioning
 Original POWER4 LPAR
 HP vPartitions
 Sun Logical Domains

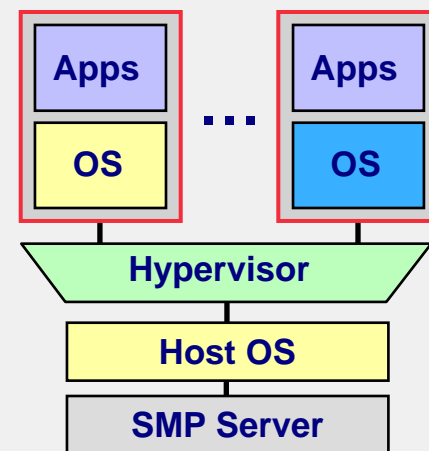
Bare Metal Hypervisor



Hypervisor provides fine-grained timesharing of all resources

Hypervisor software/firmware runs directly on server
 System z PR/SM and z/VM
 PowerVM hypervisor
 VMware ESX Server
 Xen Hypervisor
 Microsoft Hyper-V

Hosted Hypervisor



Hypervisor uses OS services to do timesharing of all resources

Hypervisor software runs on a host operating system
 VMware GSX
 Microsoft Virtual Server
 HP Integrity VM
 User Mode Linux
 Linux KVM

IBM's History of Virtualization Leadership

A 40 year tradition culminates with PowerVM



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**

1999

IBM announces **LPAR on POWER™**

2004

IBM announces POWER Hypervisor™ for System p™ and System i™

2007

IBM announces POWER6™, the first UNIX® servers with Live Partition Mobility

2008

IBM announces **PowerVM**

“In our opinion, the System p platform offers exceptionally high performance and availability in a very flexible package. We can quickly adapt to changing business conditions by activating additional processors or moving system resources from one partition to another – all without the delay and complexity of installing new hardware.”

— Clive Taylor, Head of Operations, Metavante Technologies Ltd March 2008

PowerVM Technologies



The leading virtualization platform for UNIX, i and Linux enables a more agile and responsive infrastructure

- **Hypervisor**
Support for multiple operating environments
- **Dynamic Logical Partitioning**
Micro-partitioning, resource movement
- **Multiple Shared Processor Pools**
Cap processor resources for a group of partitions
- **Virtual I/O Server**
Virtualizes resources for client partitions
- **Integrated Virtualization Manager**
Simplifies partition management for entry systems
- **Lx86**
Supports x86 Linux applications
- **Live Partition Mobility**
Move running AIX and Linux partitions
- **System Planning Tool**
Simplifies the planning for and installation of Power servers with PowerVM



What's new in PowerVM Technologies



Improved server utilization and shared I/O resources to help reduce TCO and make better use of IT assets

➤ N_Port ID Virtualization (NPIV)

- Simplifies the management of Fibre Channel SAN environments
- Enables access to SAN devices including tape libraries

➤ Virtual Tape

- Simplifies backup and restore operations
- Enables resource sharing between partitions

➤ Dynamic Heterogeneous Multi-Path I/O

- Delivers flexibility for Live Partition Mobility environments
- Provides efficient path redundancy to SAN resources

➤ Live Partition Mobility support for multiple HMCs

- Improves flexibility for moving partitions between systems

➤ Active Memory Sharing – Statement of Direction

- Improves memory utilization, reducing costs

➤ IVM Support for i on 520(8203) and 550(8204)

- Provides an easier to use, lower cost of entry virtualization solution



PowerVM Editions

Delivering industrial-strength virtualization for UNIX, i and Linux clients

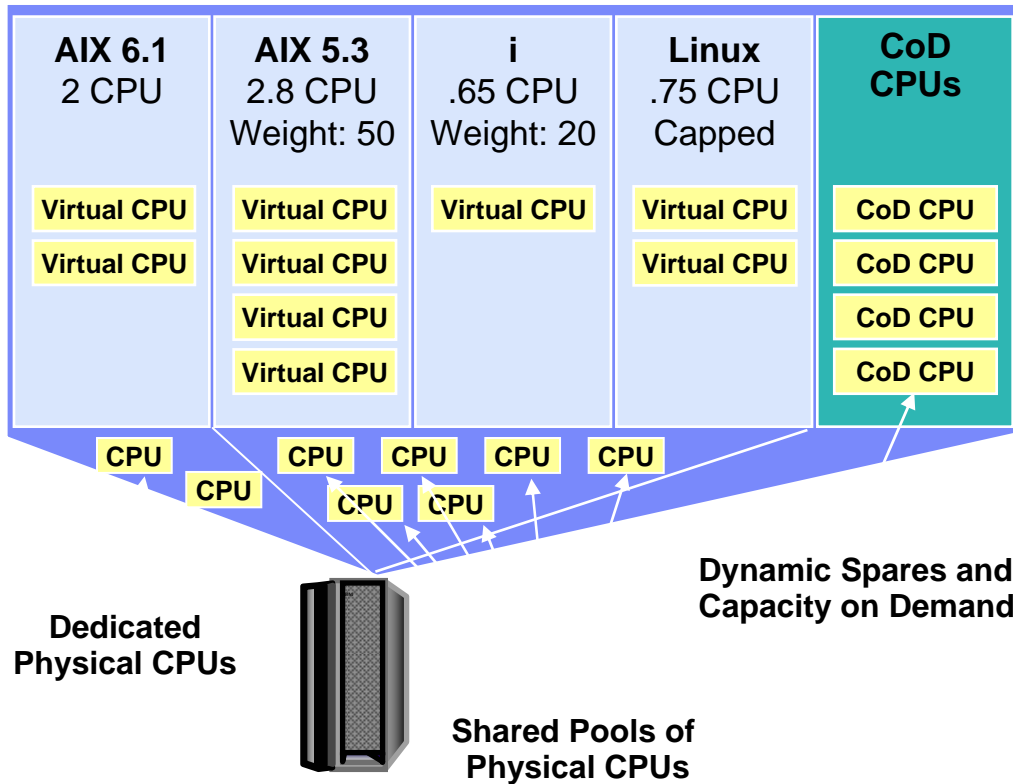
- ✓ Unified virtualization branding & technology for AIX, i and Linux
- ✓ Exploiting 40 years of IBM virtualization leadership
- ✓ One approach for ordering and deployment across Power™ servers

PowerVM Editions

	Express	Standard	Enterprise
Maximum LPARs	1+2 / Server	10 / Core	10 / Core
Management	IVM	IVM, HMC	IVM, HMC
Virtual I/O Server	✓	✓	✓
Lx86	✓	✓	✓
Shared Dedicated Capacity*	✓	✓	✓
Multiple Shared Processor Pools*		✓	✓
Live Partition MobilityP			✓

Selected PowerVM technologies are not available on all models of Power systems

PowerVM Editions



■ Scaling

- Up to 254 partitions
- Partitions up to 64-core SMP

■ Processors

- Dedicated or shared pools of processors
- Fine-grained resource allocation
- Shared processor controls
 - # of virtual processors
 - Entitlements
 - Capped and uncapped
 - Weights
- Adjustable via Dynamic LPAR

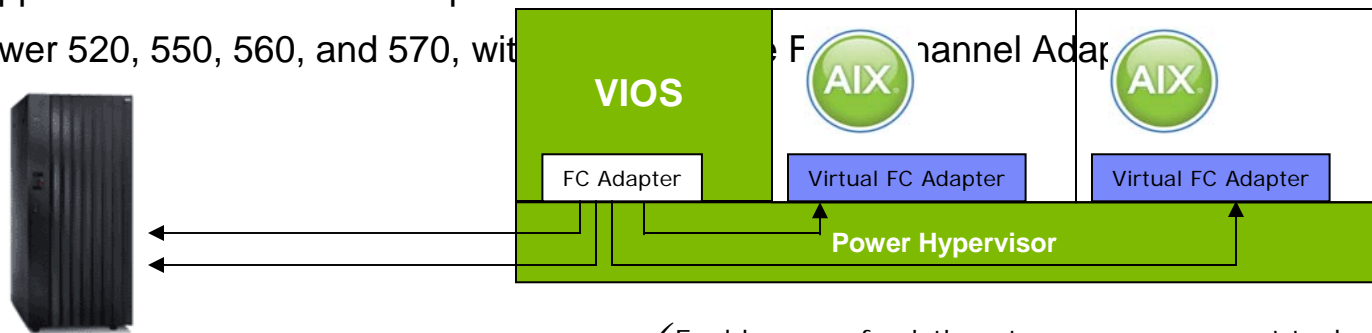
■ Memory

- From 128 MB to all of physical memory (up to 4 TB)
- Dedicated physical memory
- Adjustable via Dynamic LPAR (for AIX and i)

■ Capacity on Demand

N_Port ID Virtualization

- N_Port ID Virtualization (NPIV) provides direct Fibre Channel connections from client partitions to SAN resources , simplifying SAN management
 - Fibre Channel Host Bus Adapter is owned by VIOS partition
 - Each Fibre Channel Host Bus Adapter port (2 ports per card) can be used by many client partitions
 - Supported with PowerVM Express, Standard, and Enterprise Edition
 - Supports AIX 5.3 and AIX 6.1 partitions
 - Power 520, 550, 560, and 570, with



- ✓ Enables use of existing storage management tools
- ✓ Simplifies storage provisioning (i.e. zoning, LUN masking)
- ✓ Enables access to SAN devices including tape libraries

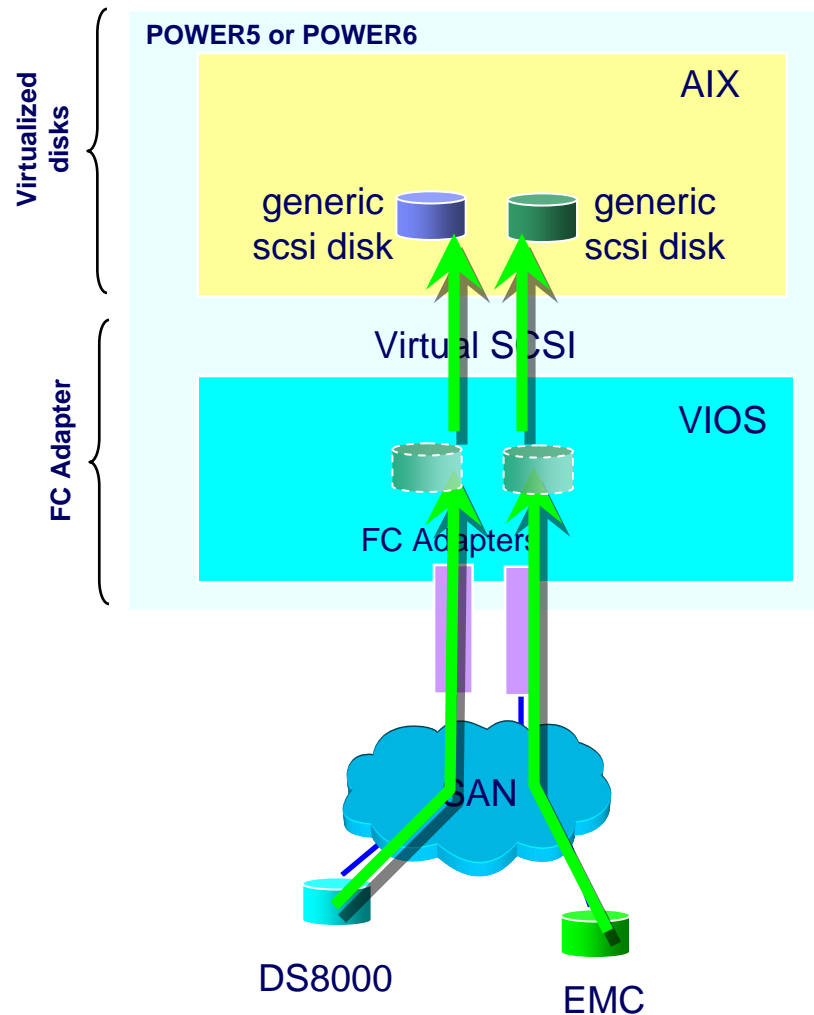
- Statement of Direction

- IBM intends to support N_Port ID Virtualization (NPIV) on the POWER6 processor-based Power 595, BladeCenter JS12, and BladeCenter JS22 in 2009.
- IBM intends to support NPIV with IBM i and Linux environments in 2009.

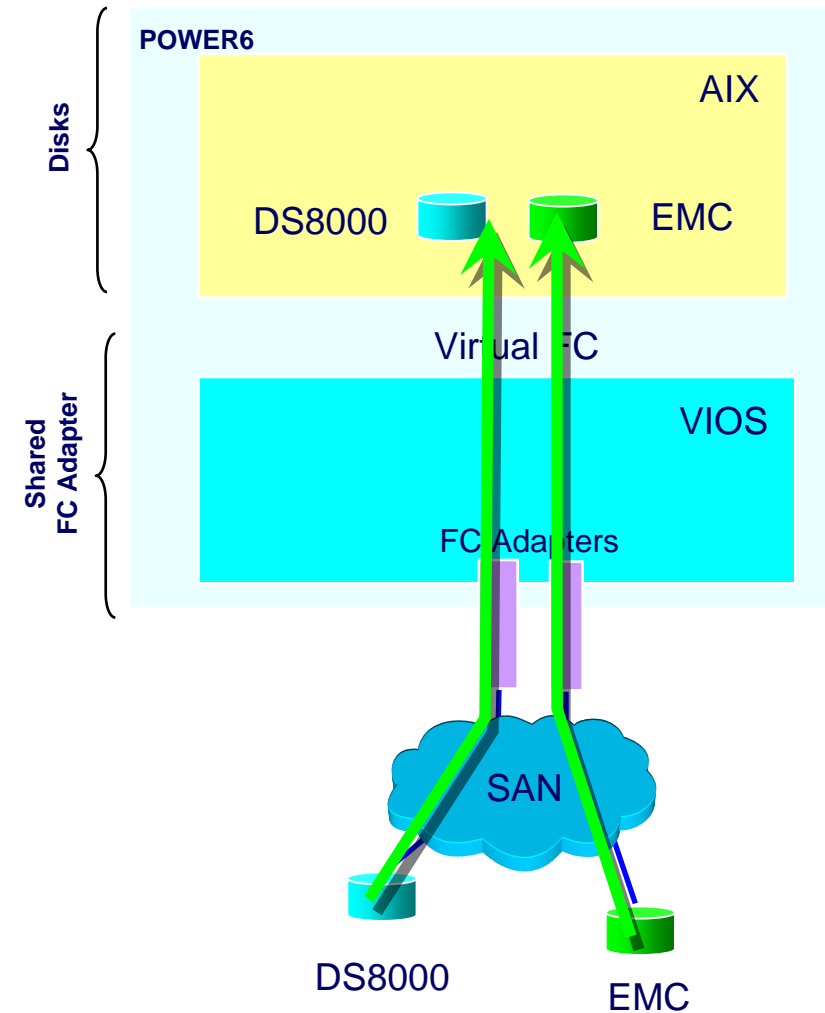


NPIV Simplifies SAN Management

Current Virtual SCSI model

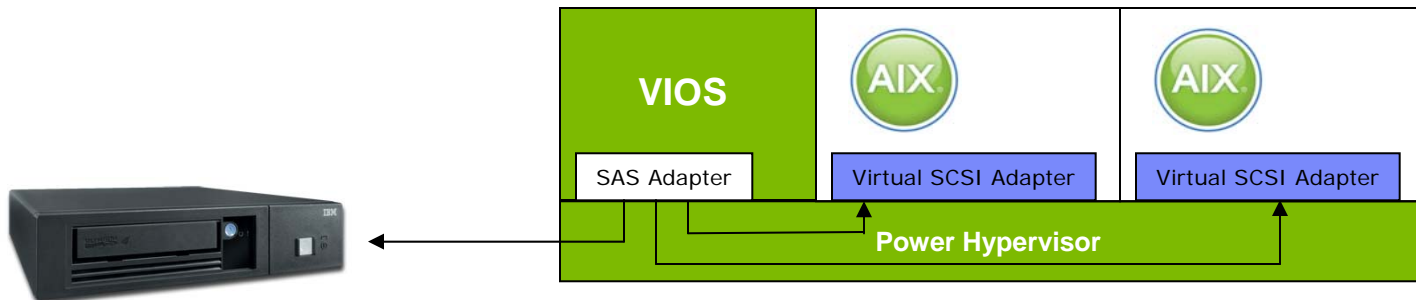


N-Port ID Virtualization



VIOS Virtual Tape Support

- Enables client partitions to directly access selected SAS tape devices, sharing resources and simplifying backup & restore operations
 - SAS adapter is owned by VIOS partition
 - Included with PowerVM Express, Standard, or Enterprise Edition
 - Supports AIX 5.3 & 6.1 partitions
 - POWER6 processor-based systems



Tape drives supported

- DAT72: Feature Code 5907
- DAT160: Feature Code 5619
- HH LTO4: Feature Code 5746

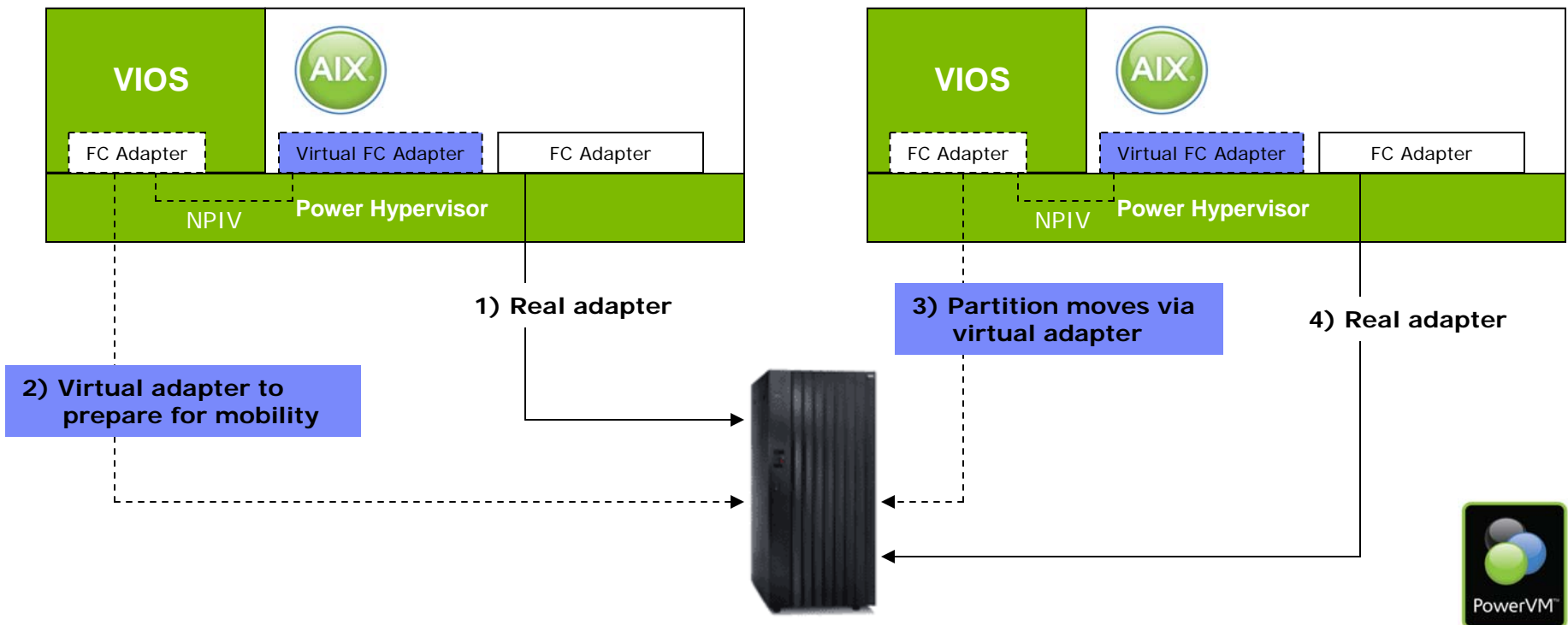
- Statement of Direction

- IBM intends to support VIOS virtual tape capabilities with IBM i and Linux environments in 2009.



Dynamic Heterogeneous Multi-Path I/O

- Delivers flexibility for Live Partition Mobility environments
- Provides efficient path redundancy to SAN resources
 - Supported between virtual NPIV and physical Fibre Channel Adapters
 - AIX 5.3 and 6.1 partitions
 - POWER6 processor-based servers



Live Partition Mobility Enhancement

- Partitions may be migrated between systems that are managed by two different HMCs supporting larger and more flexible configurations
 - Supported for AIX 5.3, AIX 6.1, and Linux partitions on POWER6 processor-based servers



SOD: PowerVM Active Memory Sharing



- ***IBM intends to enhance PowerVM with Active Memory Sharing, an advanced memory virtualization technology, in 2009. Active Memory Sharing will intelligently flow memory from one partition to another for increased utilization and flexibility of memory usage.***
- Memory virtualization enhancement for Power Systems
 - Memory dynamically allocated based on partition's workload demands
 - Contents of memory written to a paging device
 - Improves memory utilization
- Extends Power Systems Virtualization Leadership
 - Capabilities not provided by Sun and HP virtualization offerings
- Designed for partitions with variable memory requirements
 - Low average memory requirements
 - Active/inactive environments
 - Workloads that peak at different times across the partitions
- Planned to be available with PowerVM Enterprise Edition
 - AIX 6.1, Linux and i 6.1 partitions that use VIOS and shared processors
 - POWER6 processor-based systems

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



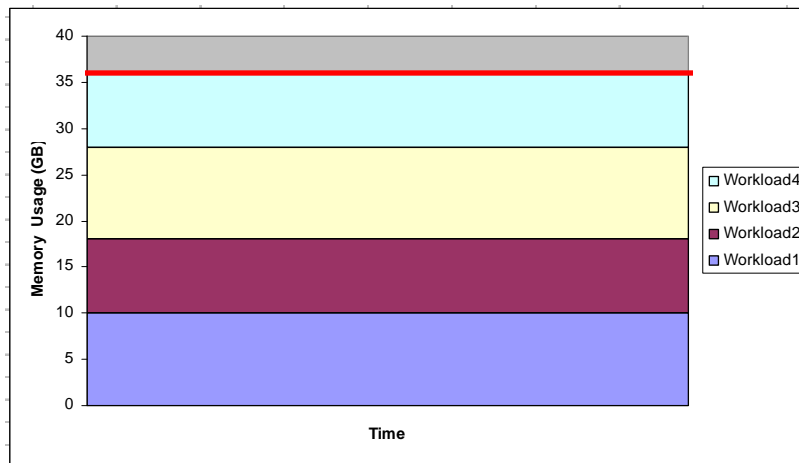
Reducing Costs with Active Memory Sharing

- Intelligently flow memory among partitions with variable workloads demands
- Reduces memory requirements

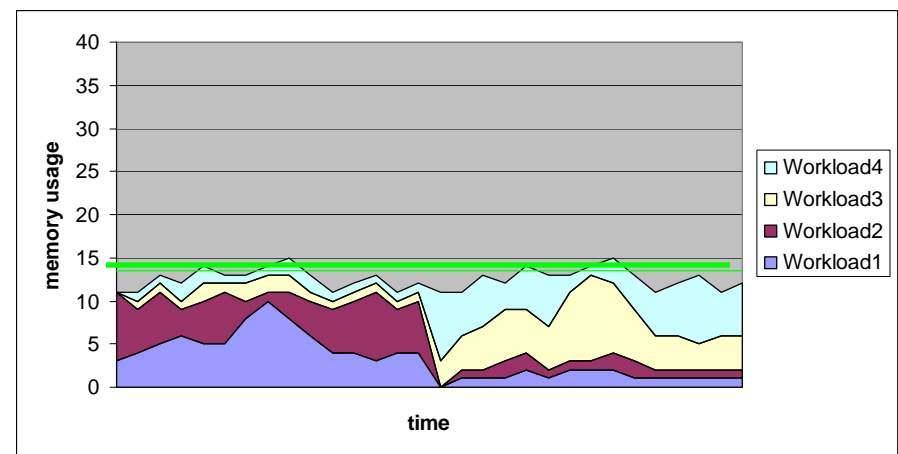
Active / Inactive Partitions	Required Physical Memory
Dedicated Memory 	36 GB
Shared Memory 	14 GB
Dedicated Memory Cost*	40GBx\$16K/8GB = \$80K
Shared Memory Cost*	16GBx\$16K/8GB = \$32K
Shared Memory Savings*	24GBx\$16K/8GB = \$48K

* Based on cost of 8GB Memory Dimms

4 Partitions with Dedicated Memory



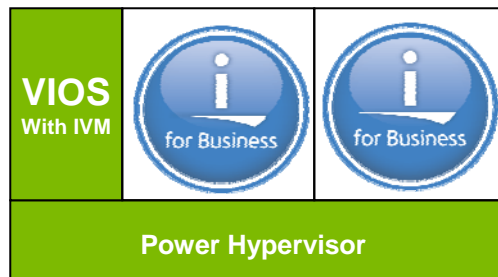
4 Partitions with Shared Memory



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

IVM support for i partitions

- PowerVM Integrated Virtualization Manager provides an easier to use, lower cost of entry virtualization solution
 - Supports virtualization without an HMC
 - Provided with PowerVM Express, Standard, and Enterprise Editions
- i 6.1 partitions are now supported with IVM on Power 520 (8203) and 550 (8204) systems
 - VIOS partition owns disk, DVD and Ethernet hardware resources
 - i is a purely virtual partition

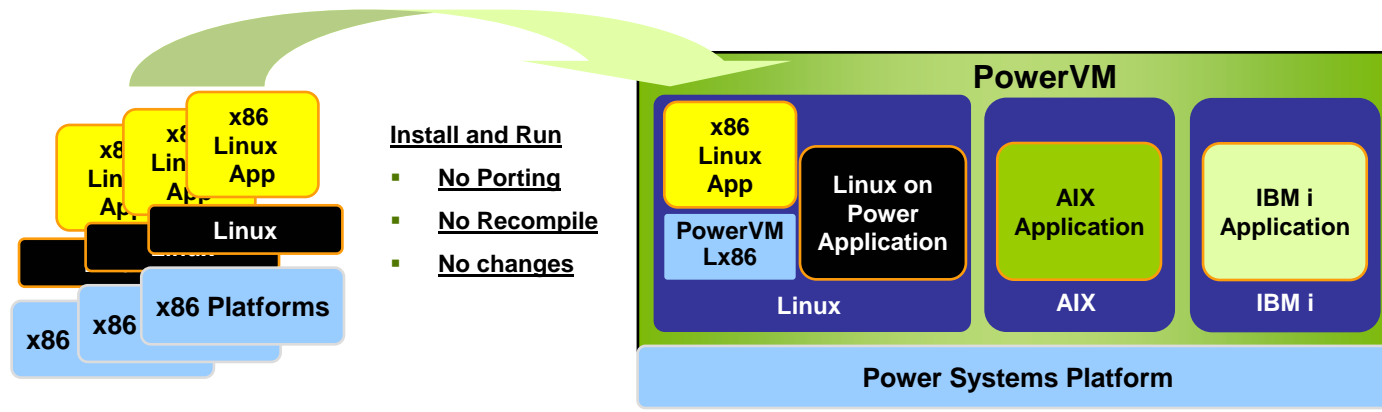


- PowerVM Express Edition available for i clients
 - Entry solution supporting up to 3 partitions – VIOS plus 2 others

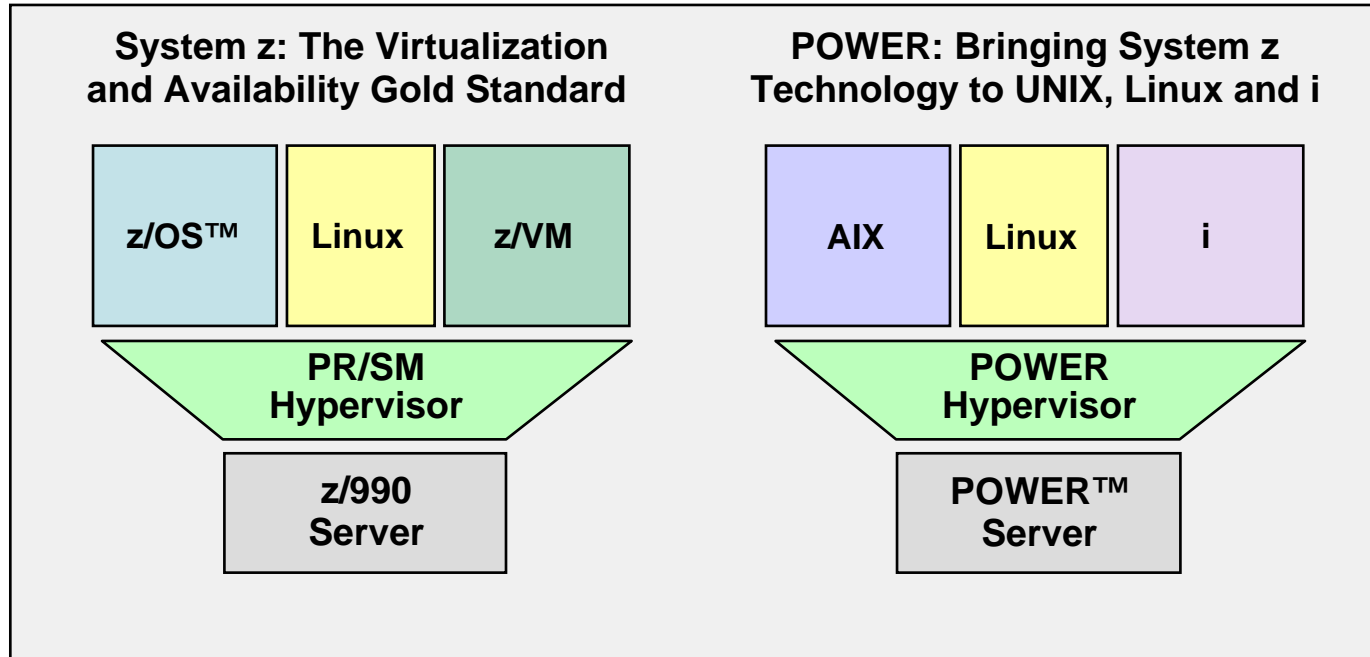


PowerVM Lx86 v1.3 Enhancements

- Improved Performance
- Support for additional Linux operating systems
 - SUSE Linux Enterprise Server 10 Service Pack 2 for Power
 - Red Hat Enterprise Linux 4 update 7 for Power
- Simplified installation
 - IBM Installation Toolkit for Linux v3.1 now includes the installation of PowerVM Lx86 v1.3
 - Archiving previously installed environment for backup or migration to other systems.
 - Automate installation for non-interactive installation and installation from an archive.
 - SELinux is supported by PowerVM Lx86 when running on RHEL
- Provided with PowerVM Express, Standard, and Enterprise Editions



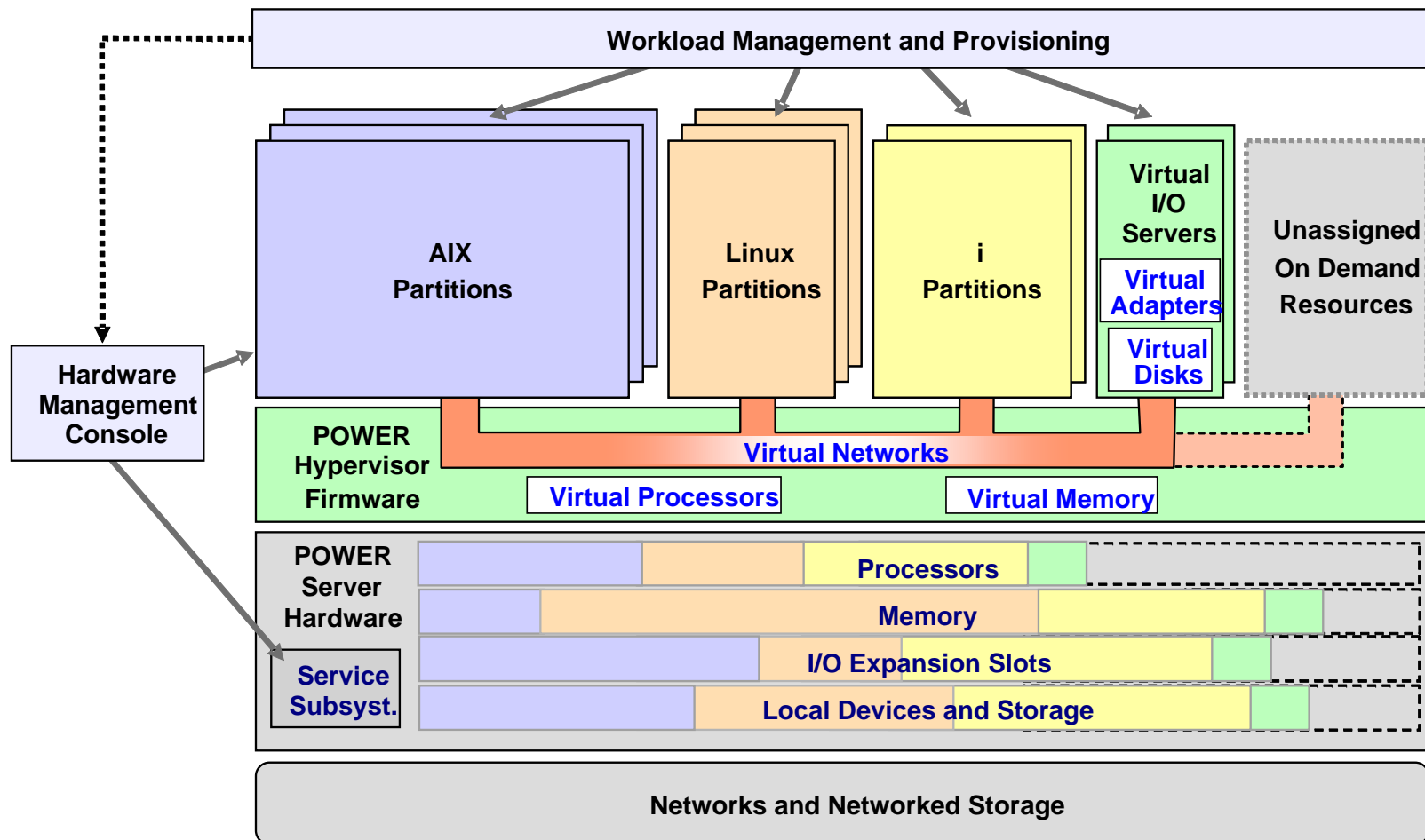
High Availability Hypervisors: System z Heritage



The System z and POWER Hypervisors are designed to provide business-critical availability

- Integrated server firmware is optimized for hypervisor role - "lean and mean"
- Intelligent machine check processing
 - Machine check interrupts are used to localize hardware failures to individual partitions
- CPU Gard™
 - If the rate of soft failures on a given processor crosses a threshold, then a spare (COD) processor is substituted transparently or the failing processor is taken offline
- Mature and field-proven technology
 - PR/SM widely used since 1988; POWER Hypervisor based on System i hypervisor, since 1999

Power™ Systems Isolates I/O Virtualization with the Virtual I/O Server



Virtualization of POWER5 and POWER6 servers is accomplished using two layers of firmware:

- A thin core hypervisor that virtualizes processors, memory, and local networks
- One or more Virtual I/O Server partitions that virtualize I/O adapters and devices

Device Drivers Frequently Cause System Failures

- Device drivers are a significant source of system failures.
- Device drivers have a high failure rate for four reasons:
 - **Skills.** Drivers are typically written by device manufacturers rather than by operating system developers with extensive kernel programming experience.
 - **Methodology.** Drivers are frequently created by copying and editing code templates from existing drivers, often without complete understanding, leading to subtle bugs.
 - **Complex Kernel Environments.** Kernel programming environments have many unenforced or poorly-documented conventions about synchronization and memory access, making kernel-mode programming and debugging challenging, at best.
 - **Device Complexity.** Driver programming often requires understanding the operation of complex asynchronous devices, their control protocols, and their failure modes.

Sources:

“An Empirical Study of Operating Systems Errors”, Proc. Of the 18th Symposium on Operating Systems Principles, Oct. 2001.

“Nooks: An Architecture for Reliable Device Drivers”, University of Washington, Seattle, WA 98195, USA



IBM PowerVM vs. Sun Microsystems Server Virtualization Technologies

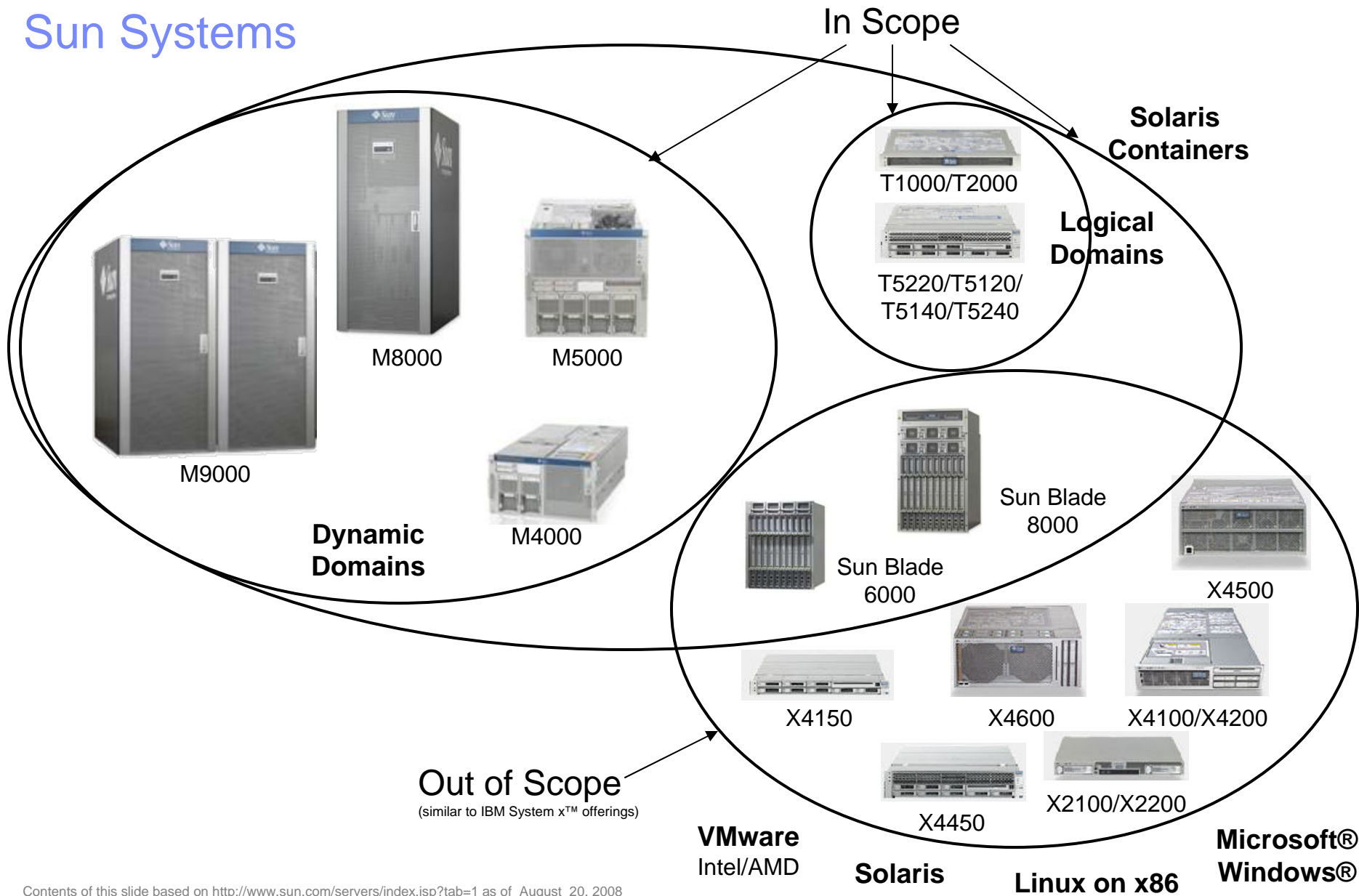
Agenda

- Scope
- Sun Virtualization Technologies
- Sun Dynamic Domains
- Sun Logical Domains (LDOMs)
- Sun Containers

Scope

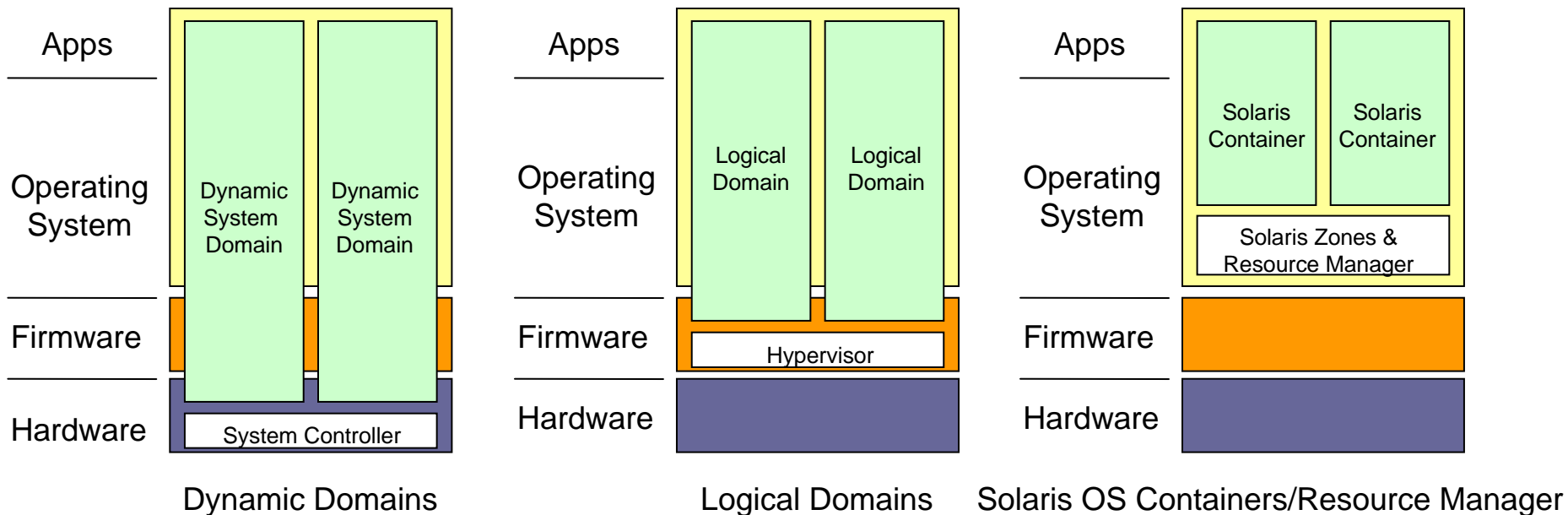
- Sun produces servers based on a variety of processor lines
- These processor lines are
 - UltraSPARC T1/T2/T2 Plus
 - SPARC64-VI/VII
 - AMD Opteron™
 - Intel® Xeon™
 - Sun UltraSPARC IV/IV+
 - Sun UltraSPARC IIIi
 - Sun UltraSPARC Ili
 - SPARC64-V
- According to Sun, “Sun's new Sun SPARC Enterprise Servers provide mainframe-class RAS and industry leading virtualization”
- Sun's SPARC Enterprise line of servers are based on either an UltraSPARC T1/T2/T2 Plus processor, or a SPARC64-VI/VI processor. The SPARC Enterprise line of servers does not include any Intel, AMD, SPARC64-V, or UltraSPARC Ili/IIIi/IV/IV+ based servers.
- This set of slides compares the virtualization technologies offered on the SUN SPARC Enterprise line of servers (Dynamic Domains, Logical Domains, and Solaris Containers) to those offered on the IBM System p line of servers (PowerVM Editions and AIX Workload Partitions)

Sun Systems



Contents of this slide based on <http://www.sun.com/servers/index.jsp?tab=1> as of August 20, 2008

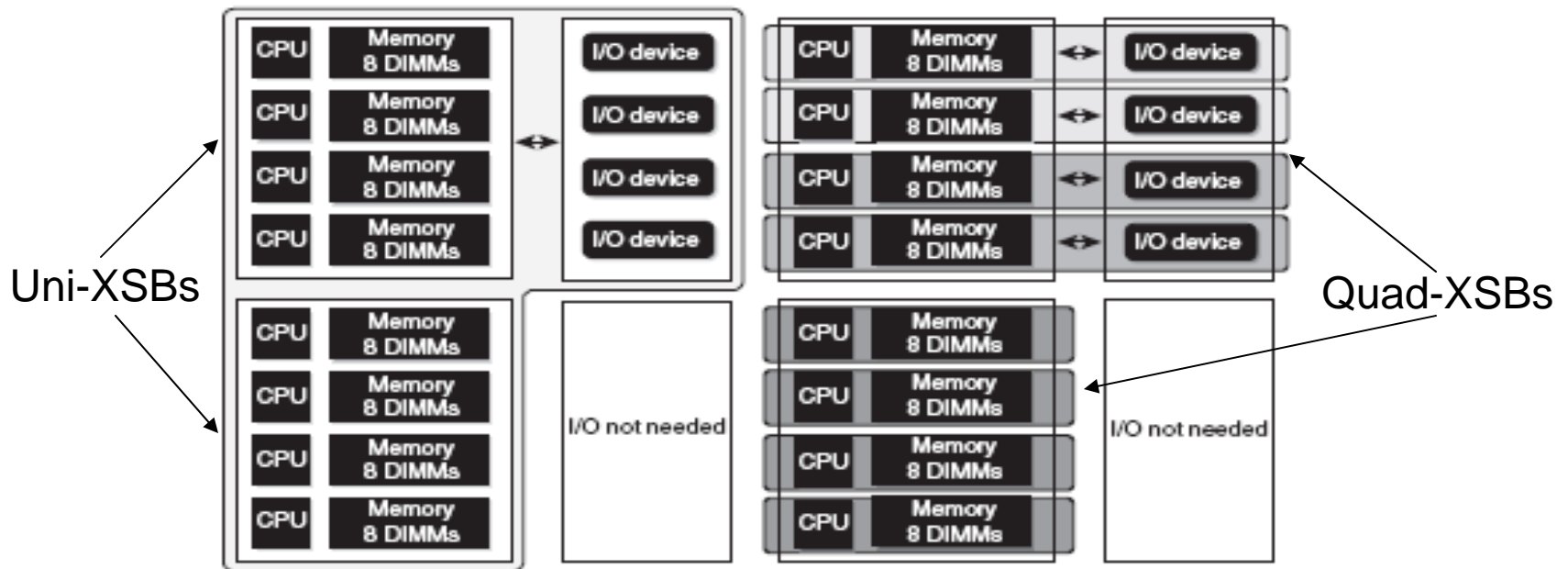
Sun's Virtualization Options



- **System level virtualization technologies**
 - Dynamic Domains – A hardware-based technology that allows one large system to appear to be several smaller completely (ie electrically) isolated systems.
 - Logical Domains – A firmware (hypervisor) / hardware-based technology that allows one large system to appear to be several smaller systems that can share some, but not all, resources.
 - In the Sun paradigm, Logical Domains and Dynamic Domains are mutually exclusive technologies. Dynamic Domains are supported on Sun's High End and Mid Range (SPARC64-VI/VIIbased) systems while Logical Domains are supported on Sun's Low End (UltraSPARC T1/T2/T2 Plus based) systems.
- **OS level virtualization technology**
 - Solaris OS Containers/Resource Manager – A software based technology that allows one operating system to selectively share and isolate resources across/between applications.
- **System level and OS level virtualization technologies can be, and often are, combined.**

Contents of this slide based on <http://www.sun.com/servers/index.jsp?tab=2> and <http://www.sun.com/servers/index.jsp?tab=1> as of August 29, 2008, and p. 2 of "Beginners Guide to LDom: Understanding and Deploying Logical Domains for Logical Domains 1.0 release," Part No. 820-0832-21, Revision: 2.1, 10/9/2007, Edition: July 2007 <http://www.sun.com/blueprints/0207/820-0832.pdf>

Sun Dynamic Domains (Hardware Partitioning)



- Physical (hardware) Partitioning technology that allows a server with multiple “XSBs” to be split into “domains” that contain at least one “XSB”
- Two types of XSBs
 - Uni-XSB – An entire system board containing 4 CPUs, 32 DIMMs, and all I/O attached to the system board.
 - Each domain consisting of entirely Uni-XSBs is completely (i.e. electrically) isolated and shares no resources with any other domain.
 - Analogous to removing system boards from one large server and placing them in separate chassis to create several smaller servers.
 - Similar to technology IBM pioneered 40 years ago on the mainframe
 - Quad-XSB mode – One quarter of a system board containing 1 CPU, 8 DIMMs, and a quarter of the I/O attached to the system board.
 - Trades off the isolation provided by Uni-XSBs for finer granularity.
- A system board is either in Uni-XSB or Quad-XSB mode.
- A domain can contain any combination of Uni-XSBs and Quad-XSBs.

IBM PowerVM Editions vs. Sun Dynamic Domains

*IBM PowerVM Editions offers significant **business advantages** well beyond those offered by Sun's Dynamic Domains simple consolidation play.*

<i>Virtualization capability</i>	<i>IBM PowerVM Editions</i>	<i>Sun Dynamic Domains</i>	<i>Business Value</i>
Linux OS Support	Yes	No ¹	Support for a broader range of applications
Support for Shared Processors	Yes	No ²	Higher server utilization and consolidation ratios
Partitioning Granularity	1/100 th of a CPU, 16 MB or RAM, fraction of an I/O adapter	¼ of a system board (1 processor, 8 DIMMS, and ¼ of I/O attached to the board) ³	Coarser granularity prevents over allocating resources in a sub-optimal manner to workloads
Live Partition Mobility	Yes	No	Decrease downtime in your enterprise
Support for Shared I/O	Yes	No ²	Share a resource that is typically underutilized

Substantiation for IBM PowerVM Editions vs. Sun Dynamic Domains

- (1) "Each Domain runs its own copy of the Solaris OS." From p. 3 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf>
- (2) "Each instance of the Solaris OS running in a Dynamic Domain has access to its own resources, providing complete isolation of one Solaris instance from any other instance running on the same server." From p. 1 of "Introduction to Dynamic Reconfiguration and Capacity On Demand For Sun SPARC Enterprise Servers", Part No. 820-2084-10, Revision 1.0, 4/22/07, Edition: April 2007, <http://www.sun.com/blueprints/0407/820-2084.pdf>
- (3) "Each of the four XSBs contains one-quarter of the total board resources: 1 CPU, 8 DIMMS, and I/O" From p. 49 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf>

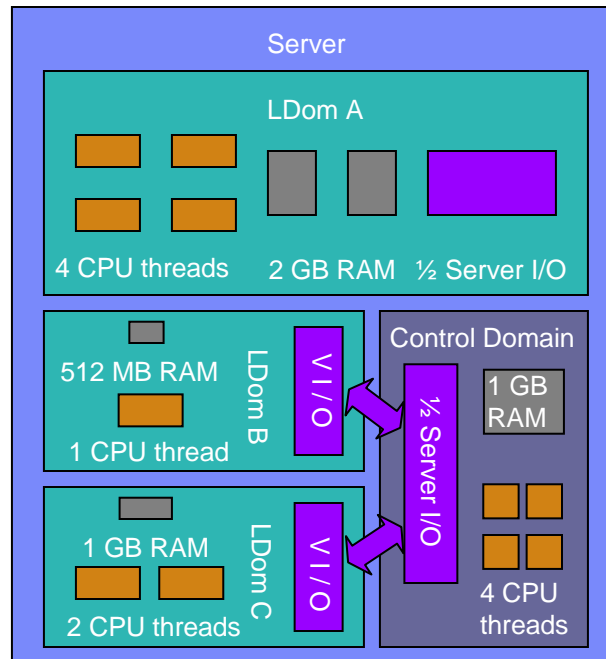
Competitive Differentiators: IBM PowerVM Editions vs. Sun Dynamic Domains

	IBM PowerVM Editions	Sun Dynamic Domains
OS Supported	IBM AIX, Red Hat Enterprise Linux®, SUSE Linux Enterprise	Sun Solaris 10 ¹
Partition Scalability	Up to all 64 CPUs on machine and 4 TB of memory	Up to all 64 CPUs on machine and 2 TB of memory ²
Servers Supported	Entire current System p line of servers	SUN SPARC Enterprise High End and Mid Range Servers ³ . Entry level servers not supported.
Move/add/remove active (running a workload) resources between/to/from active partitions without a reboot	Yes (CPU, Memory, and I/O)	Limited. Dynamic resource operations are performed at a granularity of ¼ of a system board ⁴ . System boards containing kernel memory require an active partition to be suspended to perform a move/remove ⁵ . Running processes must manually be unbound from a processor before performing a move/remove operation on the ¼ system board the processor is attached to ⁶ .
Share Processing Resources between partitions	Yes, up to 10 partitions/CPU	No ⁷
Dynamically allocate processing resources between partitions	Yes, 1/100 th of a processor or more evaluated and dynamically allocable every 10 milliseconds	No ⁷
Dedicate Processing Resources to a partition	Yes, as little as one CPU / partition and up to all processors in the machine	Yes, at least ¼ of a system board (One processor, eight DIMMs, and ¼ of I/O attached to the board) / partition ⁸
Share I/O Resources between partitions	Yes	No ⁷
Dedicate I/O Resources to a partition	Yes, as little as one dedicated I/O adapter slot / partition and up to all I/O slots in the machine	Yes, at least ¼ of a system board (One processor, eight DIMMs, and ¼ of I/O attached to the board) / partition ⁸
Dedicate Memory Resources to a partition	Yes, as little as 16 MB of RAM and up to 4 TB	Yes, at least ¼ of a system board (One processor, eight DIMMs, and ¼ of I/O attached to the board) / partition ⁸

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. Sun Dynamic Domains

- (1) "Each Domain runs its own copy of the Solaris OS." From p. 3 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf>
- (2) "[The Sun SPARC Enterprise M9000-64 server] supports up to 64 dual core SPARC64 VI 64-bit Chip Multithreading (CMT) processors (up to 128 cores), 2 TB of memory" From p.1 of "Sun SPARC Enterprise Servers System and Resource Management", <http://www.sun.com/servers/sparcenterprise/SPARCEnt-ResMan-Final.pdf>
- (3) See Table 4-1 "Boards, Domains, and Domain ID Numbers" on p. 52 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf> and <http://www.sun.com/servers/index.jsp?tab=1>
- (4) "Each of the four XSBs contains one-quarter of the total board resources: 1 CPU, 8 DIMMS, and I/O" From p. 49 and "Assign the hardware resources (XSBs) to the domain" p. 56 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf>
- (5) "Then, the kernel memory on the system board to be deleted is copied into memory on the selected copy-destination system board. The system is suspended while the copying is in progress." From p. 2-8 of "Sun SPARC Enterprise Mx000 Servers Dynamic Reconfiguration User's Guide", Part No. 819-5992-12, April 2008, Revision A <http://dlc.sun.com/pdf/819-5992-12/819-5992-12.pdf>
- (6) "A CPU to be deleted must meet the following conditions: No running process is bound to the CPU to be deleted. If a running process is bound to the target CPU, you must unbind or stop the process." From p. 2-5 of "Sun SPARC Enterprise Mx000 Servers Dynamic Reconfiguration User's Guide", Part No. 819-5992-12, April 2008, Revision A <http://dlc.sun.com/pdf/819-5992-12/819-5992-12.pdf>
- (7) "Each instance of the Solaris OS running in a Dynamic Domain has access to its own resources, providing complete isolation of one Solaris instance from any other instance running on the same server." From p. 1 of "Introduction to Dynamic Reconfiguration and Capacity On Demand For Sun SPARC Enterprise Servers", Part No. 820-2084-10, Revision 1.0, 4/22/07, Edition: April 2007, <http://www.sun.com/blueprints/0407/820-2084.pdf>
- (8) "A domain must have, at a minimum, 1 CPU, 8 DIMMs, and I/O" From p. 51 of "Sun SPARC Enterprise Mx000 Servers Administration Guide", Part No. 819-3601-13, April 2008, Revision A <http://dlc.sun.com/pdf/819-3601-13/819-3601-13.pdf>

Sun Logical Domains (Logical Partitioning)



- Sun Logical Domains (LDoms) are a logical partitioning technology available on Sun CMT-based processors. Currently, LDoms and Sun Dynamic System Domains are offered on two separate server lines, and therefore cannot be combined.
- LDoms is similar to Dynamic Domains (ie one to one mapping between virtual server resources and physical server resources). Unlike Dynamic Domains, however, LDoms does not allow for electrical isolation.
- LDoms does allow I/O resources to be shared (ie many to one mapping) by multiple domains.
- Processor thread resources are not sharable between domains, however they can be reassigned while partitions are running. However, reassignment of memory and I/O resources require a reboot as well as some careful planning since only one outstanding reassignment is allowed at a time before a domain must be rebooted.
- LDoms requires a control domain that runs an instance of Solaris 10. In addition, Sun recommends that the control domain is used exclusively to manage other LDoms and recommends dedicating 4 CPU threads, 1 GB of RAM, and ½ the I/O of the server to the control domain.

IBM PowerVM Editions Offers Business Advantages Compared to Sun Logical Domains for Clients Doing Server Consolidation

<i>Virtualization capability</i>	<i>PowerVM Editions</i>	<i>Sun Logical Domains 1.0.3</i>	<i>Business Benefit</i>
Support across entire product line	All POWER5, POWER6 and BladeCenter JS21 and JS22 servers	Sun UltraSPARC T1, T2, and T2 Plus-based servers only ¹	Standardize on one virtualization solution across an entire line of servers
Graphical User Interface	Yes	No ²	Easily change system configuration without getting carpel tunnel
Dynamic Logical Partitioning	Yes	CPU only (no memory or I/O) ³	Adapt to changes without downtime
Support for Live Partition Mobility	Yes	No	Decrease downtime in your enterprise
Support for dedicated I/O	Yes	No ⁴	Superior performance for I/O intensive workloads

(1) Logical Domains 1.0.3 Release Notes, July 2008 Revision A p2 <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>; (2) Logical Domains 1.0.3 Administration Guide, May 2008 Revision A p4 <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf> "The Logical Domains Manager provides a command-line interface (CLI) for the system administrator to create and configure logical domains."; (3) Logical Domains 1.0.3 Administration Guide, May 2008 Revision A p6 <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf> "Dynamic reconfiguration (DR) is the ability to add or remove resources while the operating system is running. The Solaris 10 OS supports only the adding and removing of virtual CPUs (vcpus). Dynamic reconfiguration of memory and input/output is not supported in the Solaris 10 OS."; (4) Logical Domains 1.0.3 Administration Guide, May 2008 Revision A p5 <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>, "This lack of direct physical I/O device access is addressed by implementing a virtualized I/O model."

Competitive Differentiators: IBM PowerVM Editions vs. Sun Logical Domains

	IBM PowerVM Editions	Sun Logical Domains
OS Supported	IBM AIX, Red Hat Enterprise Linux, SUSE Linux Enterprise	Sun Solaris 10 ¹
Partition Scalability	Up to all 64 CPUs on machine and 2 TB of memory	Up to 8 CPUs on machine and 64 GB of memory ²
Servers Supported	Entire current System p line of servers	SUN SPARC Enterprise Low End Servers ³ . High End and Mid Range servers not supported.
Move/add/remove active (running a workload) resources between/to/from active partitions without a reboot	Yes (CPU, Memory*, and I/O)	Limited. CPU dynamic reconfiguration is disabled on all domains that contain a cryptographic unit ⁴ . Memory and I/O reconfiguration require a reboot and only one domain may have outstanding memory or I/O reconfiguration requests before a reboot must occur ⁵ .
Share Processing Resources between partitions	Yes, up to 10 partitions/CPU	Yes, up to 4 (UltraSPARC T1-based systems) or 8 (UltraSPARC T2-based systems) partitions/CPU. ⁶
Dynamically allocate processing resources between partitions	Yes, 1/100 th of a processor or more evaluated and dynamically allocable every 10 milliseconds	No. Virtual CPUs are tied to specific physical CPU threads. ⁷
Dedicate Processing Resources to a partition	Yes, as little as one CPU / partition and up to all processors in the machine	Yes, as little as one CPU / partition and up to all processors in the machine ⁸
Share I/O Resources between partitions	Yes	Yes ⁹
Dedicate I/O Resources to a partition	Yes, as little as one dedicated I/O adapter slot / partition and up to all I/O slots in the machine	Limited. For UltraSPARC T1-based systems, only one partition outside the control domain can have I/O dedicated to it. ¹⁰
Dedicate Memory Resources to a partition	Yes, as little as 16 MB of RAM and up to 2 TB	Yes, as little as 8 KB of RAM and up to 64 GB ¹¹

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. Sun Logical Domains

- (1) "The guest domain must run an operating system that understands both the sun4v platform and the virtual devices presented by the hypervisor. Currently, this is the Solaris 10 11/06 OS at a minimum." From p. 47 of "Logical Domains (LDoms) 1.0.3 Administration Guide", Part 820-4894-10, May 2008, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>
- (2) See Table 1 "Supported Servers" from p. 2 of "Logical Domains (LDoms) 1.0.3 Release Notes", Part No. 820-3269-10, May 2008, Revision A, <http://dlc.sun.com/pdf/820-3269-10/820-3269-10.pdf>.
- (3) See Table 1 "Supported Servers" from p. 2 of "Logical Domains 1.0.3 Release Notes, May 2008", Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>.
- (4) "DR of virtual CPUs is completely disabled on all active logical domains that contain any cryptographic units" From p. 12 of "Logical Domains 1.0.3 Release Notes, July 2008", Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>.
- (5) "Dynamic reconfiguration (DR) is the ability to add or remove resources while the operating system is running. The Solaris 10 OS supports only the adding and removing of virtual CPUs (vcpus). Dynamic reconfiguration of memory and input/output is not supported in the Solaris 10 OS." and "Also, when there is a delayed reconfiguration outstanding for one logical domain, reconfiguration requests for other logical domains are severely restricted and will fail with an appropriate error message" From p. 6 and 7 of "Logical Domains 1.0.3 Administration Guide, May 2008 ", Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>
- (6) "From a Logical Domains Manager perspective, each of the threads in a system appear to be virtual CPUs, and as such, can be allocated independently to any domain in the system. In reality, threads are grouped into cores; for example, there are 4 threads per core in the Sun Fire and SPARC Enterprise T1000 CMT processors." From p. 25 of "BEGINNERS GUIDE TO LDOMS: UNDERSTANDING AND DEPLOYING LOGICAL DOMAINS for Logical Domains 1.0 release", Part No 820-0832-21, Revision 2.1, 10/9/2007, Edition: July 2007, <http://www.sun.com/blueprints/0207/820-0832.pdf>

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. Sun Logical Domains

(7) “The domain and the virtual CPU number within the domain, which correspond to a given physical CPU number, can be determined with the following procedures.” From p. 100 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

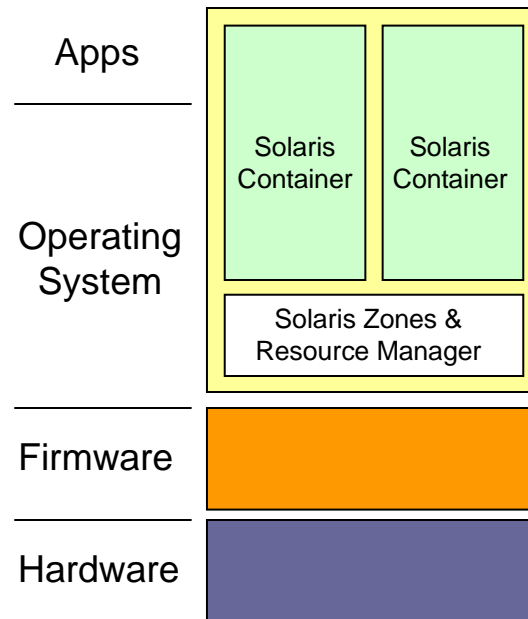
(8) “Also, there are hardware resources that are provided on a per-core basis and, therefore, are shared between the threads on that core. For the purposes of this discussion, the level 1 cache is an important such resource. Because of this, if the threads within a core are allocated to two or more separate domains, this could lead to suboptimal performance of those threads, due to cache thrashing. For that reason, to get the best performance from caches and other shared processor resources, it is best to avoid allocating the threads of a core to separate domains, if at all possible.” From p. 25 of “BEGINNERS GUIDE TO LDOMS: UNDERSTANDING AND DEPLOYING LOGICAL DOMAINS for Logical Domains 1.0 release”, Part No 820-0832-21, Revision 2.1, 10/9/2007, Edition: July 2007, <http://www.sun.com/blueprints/0207/820-0832.pdf>

(9) “In Logical Domains 1.0.3 software, the virtualized I/O functionality comprises support for virtual networking, storage, and consoles.” From p. 5 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

(10) “I/O domain: Domain that has direct ownership of and direct access to physical I/O devices ... The number of I/O domains you can have is dependent on your platform architecture. For example, if you are using a Sun UltraSPARC® T1 processor, you can have a maximum of two I/O domains, one of which also must be the control domain.” From p. 4 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

(11) “The memory can be allocated in increments as small as 8KB chunks” From p. 15 of “BEGINNERS GUIDE TO LDOMS: UNDERSTANDING AND DEPLOYING LOGICAL DOMAINS for Logical Domains 1.0 release”, Part No 820-0832-21, Revision 2.1, 10/9/2007, Edition: July 2007, <http://www.sun.com/blueprints/0207/820-0832.pdf> and See Table 1 “Supported Servers” from p. 2 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

Sun Solaris Containers



- A completely software based partitioning technology that allows the physical resources assigned to an operating system to be selectively shared and isolated at a very fine granularity.
- Since Containers is completely hardware and firmware agnostic, Containers can be deployed on any system that supports Solaris.
- Resources are grouped together into entities known as Zones.
- Applications can run within a Zone and can be isolated from applications running in other Zones.
- All Zones share the same kernel
 - Pro: Easy to apply to apply updates that are intended to affect all Zones.
 - Con: The kernel is exposed to the outside world and can be compromised. If the kernel crashes, all Zones crash as well.
- Containers are appropriate for workloads that can tradeoff the isolation provided Logical Domains and Dynamic Domains for very fine granularity.
- Containers can be, and often are, combined with either Logical Domains, or Dynamic Domains.

Contents of this slide based on "Beginners Guide to LDomS: Understanding and Deploying Logical Domains for Logical Domains 1.0 release," Part No. 820-0832-21, Revision: 2.1, 10/9/2007, Edition: July 2007 <http://www.sun.com/blueprints/0207/820-0832.pdf> and "The Sun BluePrints™ Guide to Solaris™ Containers Virtualization in the Solaris Operating System", Part No. 820-0001-10, Revision 1.0, 10/11/06, <http://www.sun.com/blueprints/1006/820-0001.pdf>

Sun Solaris Containers vs. IBM AIX V6.1 Workload Partitions (WPARs)

<i>Virtualization Capability</i>	<i>AIX WPARs</i>	<i>Solaris Containers</i>	<i>Business Value</i>
Live relocation of Workload Partitions / Containers across servers	yes	no	Decrease downtime in your enterprise
Policy based relocation of Workload Partitions / Containers	yes	no	Easily deploy new WPARs based on policies
Workload Partition / Container resource isolation for process, thread and paging	yes	yes	Enjoy a highly secure environment
Workload Partition / Container processor regulation based on percentage and / or hard maximum	yes	no	Management flexibility for advanced configuration settings

Contents of this slide based on "The Sun BluePrints™ Guide to Solaris™ Containers Virtualization in the Solaris Operating System", Part No. 820-0001-10, Revision 1.0, 10/11/06, <http://www.sun.com/blueprints/1006/820-0001.pdf>

Backup Charts

Sun Quotes – Dynamic Domains

- If a dynamic reconfiguration operation fails, the domain may need to be rebooted.
 - “If the DR processing executed by the deleteboard(8) or addboard(8) commands fails, the target system board cannot be restored it's the previous status. Identify the cause of failure based on the error messages output by the commands and Solaris OS messages, and then take appropriate corrective action. Note that some errors require the domain to be rebooted.”¹

(1) From p. 3-23 of “Sun SPARC Enterprise Mx000 Servers Dynamic Reconfiguration User's Guide”, Part No. 819-5992-11, September 2007, Revision A <http://dlc.sun.com/pdf/819-5992-11/819-5992-11.pdf>

Sun Quotes – Logical Domains

- Network performance is substantially worse in a logical domain guest than in a non-LDoms configuration
 - “The virtual networking infrastructure adds additional overhead to communications from a logical domain. All packets are sent through a virtual network device, which, in turn, passes the packets to the virtual switch. The virtual switch then sends the packets out through the physical device. The lower performance is seen due to the inherent overheads of the stack.”¹
- Inconsistent console behavior when not using the virtual console
 - “Console behavior on the control domain is inconsistent when a graphics device and keyboard are specified for console use..”²
- Logical Domains Manager does not retire resources on guest domain after a panic and reboot
 - “If a CPU or memory fault occurs, the affected domain might panic and reboot. If FMA attempts to retire the faulted component while the domain is rebooting, the Logical Domains Manager is not able to communicate with the domain, and the retire fails..”³
- Addition of virtual disk or network devices under delayed reconfiguration can fail
 - “If virtual devices are added to an active domain, and virtual devices are removed from that domain before that domain reboots, then the added devices do not function once the domain reboots..”⁴

From p. 24 of “Logical Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>. (2) From p. 28 of “Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>. (3) From p. 30 of “Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>. (4) From pp. 34 of “Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>.

Sun Quotes – Logical Domains (Continued)

- Logical Domains Manager returns successful (0) instead of failed (1) exit code in some situations
 - “If an attempt to use dynamic reconfiguration to remove CPUs from a domain using the Logical Domains Manager CLI fails (that is, the request to unconfigure the CPUs results in an error being returned from the guest OS) a failure message is reported to the screen, but the exit code of the associated `ldm` subcommand is incorrectly set to 0. This can cause scripts that check the exit status of `ldm` subcommands in order to determine success or failure to incorrectly assume that the command succeeded when in fact it did not.”¹
- The Control Domain is a single point of failure.
 - “Q: Can a control domain be a single-point-of-failure (SPOF)? A: Yes. As of this release, other logical domains will not keep running when the control domain is not operational. The control domain cannot be restarted without affecting other logical domains.”²
- The Logical Domains Manager is a single point of failure
 - “The Logical Domains Manager is used to create and manage logical domains. There can be only one Logical Domains Manager per server.”³

(1) From p. 40 of “Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>. (2) From p. 69 of Beginners Guide to LDoms: Understanding and Deploying Logical Domains for Logical Domains 1.0 release” Part No. 820-0832-21, Revision: 2.1, 10/9/2007, Edition: July 2007 <http://www.sun.com/blueprints/0207/820-0832.pdf> (3) From p. 3 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

Sun Quotes – Logical Domains (Continued)

- Plan an environment carefully, because only up to 8 system configurations can be saved on a machine.
 - “Currently, there is a limit of 8 configurations that can be saved on the SC, not including the factory-default configuration.”¹
- Solaris 10 11/06 OS Net Installation Fails on Guest Domain
 - “On Sun UltraSPARC T1-based servers, JumpStart™ installations of the Solaris 10 11/06 OS on guest domains can hang sometimes depending on the memory configuration. Typically, this happens on guest domains with 1024 megabytes of memory (+/- 20 megabytes).”²
- The Control Domain should be hardened and not used for general purposes
 - “The driver (ldm_control-secure.driver) that Solaris Security Toolkit uses to harden the Solaris OS on the control domain is specifically tailored so that the Logical Domains Manager can run with the OS ... The ldm_control-secure.driver provides a baseline configuration for the control domain of a system running the Logical Domains Manager software. It is intended to provide fewer system services than typical for a Solaris OS domain, reserving the control domain for Logical Domains Manager operations, rather than general usage.”³
- Significant physical resources should be dedicated to the Control Domain
 - “If you are not using ZFS to deliver disk services, 1 GB of memory should be adequate. If you are using ZFS to deliver disk services, assign a complete core of 4 virtual CPUs and at least 4 GB of memory. You may need to assign additional complete cores for heavier I/O loads.”⁴

(1) From p. 43 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf> (2) From p. 41 of “Logical Domains 1.0.3 Release Notes, July 2008”, Part No. 820-4895-10, <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>. (3) From p. 11 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf> (4) From p. 43 of “Logical Domains 1.0.3 Administration Guide, May 2008”, Part No. 820-4894-10, <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>

Resources – Dynamic Domains

- “Introduction to Dynamic Reconfiguration and Capacity On Demand For Sun SPARC Enterprise Servers”
 - Part No. 820-2084-10, Revision 1.0, 4/22/07, Edition: April 2007,
<http://www.sun.com/blueprints/0407/820-2084.pdf>
- “Sun SPARC Enterprise Servers System and Resource Management”
 - <http://www.sun.com/servers/sparcenterprise/SPARCEnt-ResMan-Final.pdf>
- “Beginners Guide to LDoms: Understanding and Deploying Logical Domains for Logical Domains 1.0 release”
 - Part No. 820-0832-21, Revision: 2.1, 10/9/2007, Edition: July 2007
<http://www.sun.com/blueprints/0207/820-0832.pdf>

Resources – Logical Domains

- “Sun SPARC Enterprise Servers System and Resource Management”
 - <http://www.sun.com/servers/sparcenterprise/SPARCEnt-ResMan-Final.pdf>
- “Logical Domains (LDoms) 1.0.3 Administration Guide”
 - Part No. 820-4894-10, May 2008,
 - <http://dlc.sun.com/pdf/820-4894-10/820-4894-10.pdf>.
- “Logical Domains (LDoms) 1.0.3 Release Notes”
 - Part No. 820-4895-10, July 2008,
 - <http://dlc.sun.com/pdf/820-4895-10/820-4895-10.pdf>.

Resources - Containers

- “Upcoming IBM AIX 6 features vs. Sun Solaris 10 and OpenSolaris”
 - by Julien Gabel on Thursday 24 May 2007, 11:31, <http://blog.thilelli.net/tag/WPAR> as of December 5, 2007
- “Sun SPARC Enterprise Servers System and Resource Management”
 - <http://www.sun.com/servers/sparcenterprise/SPARCEnt-ResMan-Final.pdf>
- “The Sun BluePrints™ Guide to Solaris™ Containers Virtualization in the Solaris Operating System”
 - Part No. 820-0001-10, Revision 1.0, 10/11/06, <http://www.sun.com/blueprints/1006/820-0001.pdf>

IBM PowerVM vs. HP Server Virtualization Technologies

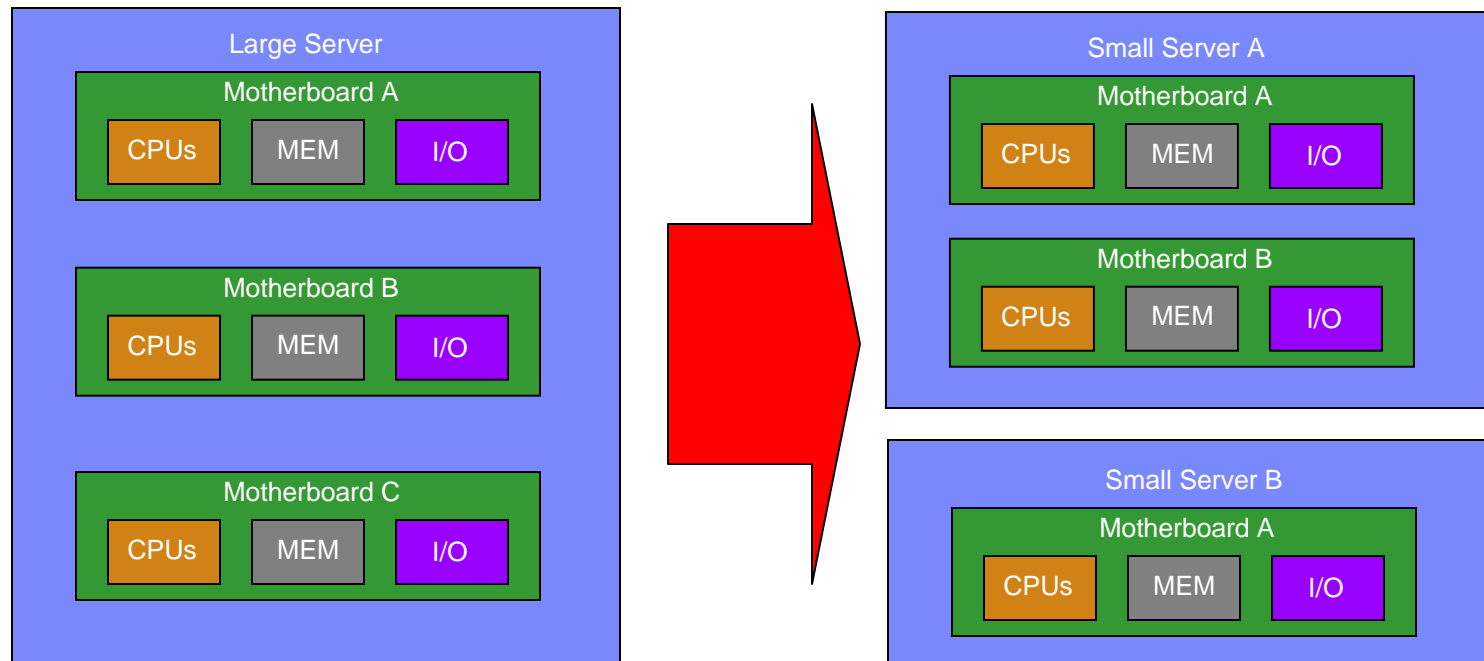
Agenda

- HP Virtualization Technologies
- PowerVM vs. HP nPartitions (nPars)
- PowerVM vs. HP Virtual Partitions (vPars)
- PowerVM vs. HP Integrity Virtual Machines (IVM)

HP Virtualization Technologies

- nPartitions – A hardware based technology that allows one large system to appear to be several smaller systems or “nPartitions”.
 - Dynamic nPartitions operations are available with HP-UX 11i v3. The Virtual Partitions enable dynamic operation through processor and memory migration among vPars.
- Dynamic nPartitions operations cannot be performed to a nPartition that is running vPars.
- An nPartition can
 - appear to be a single system and run a single workload (OS and applications)
 - be divided and appear to be multiple systems each dedicating resources to one workload utilizing HP's Virtual Partitions technology
 - be divided into multiple workloads that share all of the resources of the nPartition utilizing HP's Integrity Virtual Machines technology
 - There is a new requirement to reset Workload Manager if Dynamic nPartitions are used
- HP's Virtual Partitions and Integrity Virtual Machines technologies are mutually exclusive and CANNOT be used at the same time within an nPartition

HP nPartitions (Hardware Partitioning)



- Physical (hardware) Partitioning technology that allows a server with multiple “cells” (motherboards including CPU, memory, and I/O) to be split into “nPartitions” that contain at least one “cell”
- Each cellboard will hold 2-8 active processors
- Each nPartition is electrically (i.e. completely) isolated and shares no resources with any other nPartition
- Analogous to removing motherboards from one large server and placing them in separate chassis to create several smaller servers
- Similar conceptually to technology IBM pioneered 40 years ago on the mainframe

IBM PowerVM Editions Offers **Business Advantages** Compared to HP nPARs for Clients Doing Server Consolidation

<i>Virtualization capability</i>	<i>PowerVM Editions</i>	<i>HP nPARs</i>	<i>Business Benefit</i>
Dynamic Logical Partitioning	Yes	Yes	Adapt to changes without downtime
Support for Shared Processors	Yes	No ²	Higher server utilization and consolidation ratios
Partitioning Granularity	1/100 th of a CPU, 16 MB or RAM, fraction of an I/O adapter	≥ 1 cell board (4 processor sockets, ≥ 16 DIMMS, all I/O attached to cell) ³	Smaller granularity prevents over allocating resources in a sub-optimal manner to workloads
Support for Shared I/O	Yes	Yes	Share a resource that is typically underutilized
Support for Live Partition Mobility	Yes	No	Decrease downtime in your enterprise

(1) From nPartition Administrator's Guide "You must perform a reboot for reconfig of an active nPartition after you have added a cell to it." and "You must immediately perform a reboot for reconfig of an nPartition when you have removed an active cell from the nPartition." (2) From HP Partitioning Continuum for HP-UX11i on HP 9000 and HP Integrity servers "Because each nPar has its own CPU, memory, and I/O" (3) From nPartition Administrator's Guide, "Either one or two cells. Each cell has up to four processor sockets and up to 16 DIMMs" and "The Superdome 64-way/128-way server is a tightly interconnected dual-cabinet server that has from 4 to 16 cells, each with four processor sockets and up to 32 DIMMs." and "An nPartition includes one or more cells assigned to it (with processors and memory) and all I/O chassis connected to those cells."

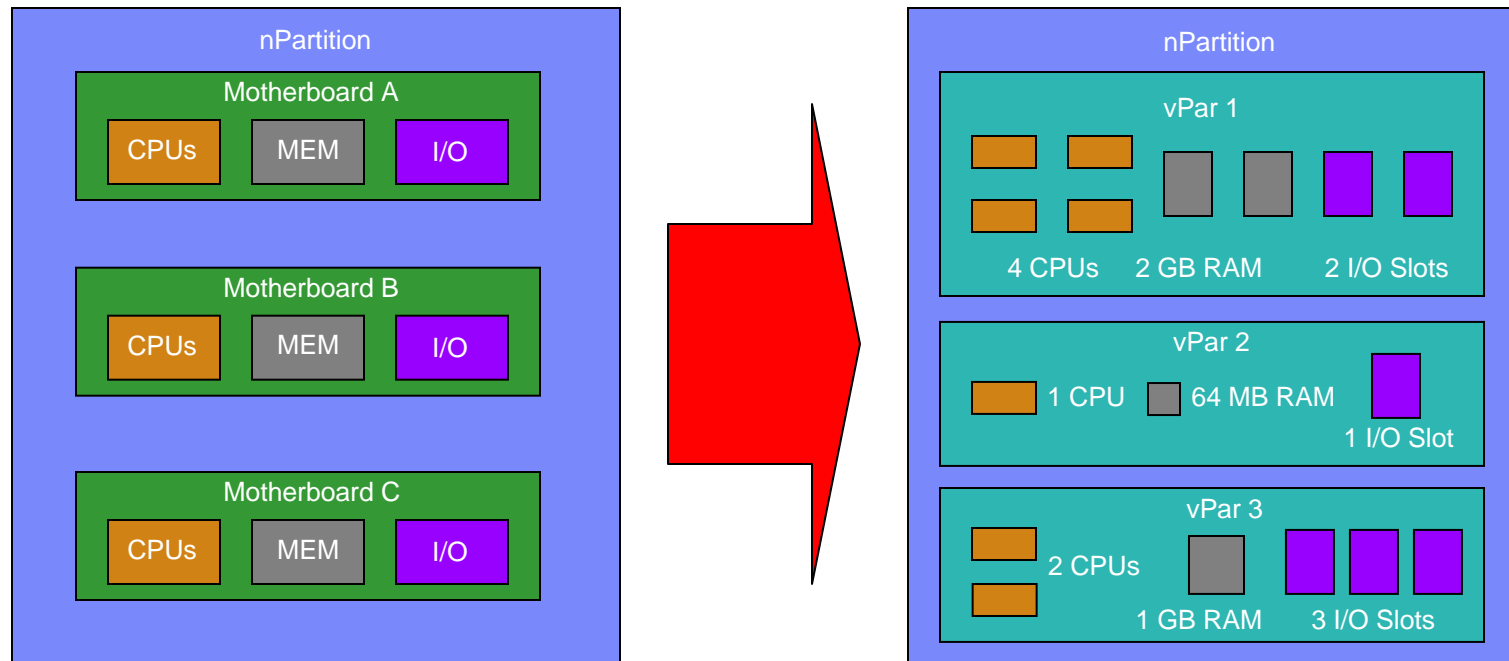
Competitive Differentiators: IBM PowerVM Editions vs. HP nPartitions

	IBM PowerVM Editions	HP nPartitions
OS Supported	IBM AIX, Red Hat Enterprise Linux, SUSE Linux Enterprise	HP-UX, HP Open VMS I64 8.2-1 and 8.3, Microsoft Windows Server 2003, Red Hat Enterprise Linux, SUSE Linux Enterprise ¹
Partition Scalability	Up to all CPUs on machine and 2 TB of memory	Dependent upon OS running in nPartition (maximums range from eight cores to all cores, 96 GB to all of memory, one I/O chassis to all I/O chassis) ²
Servers Supported	Entire current System p line of servers	HP 9000 and HP Integrity High End and Mid Range Servers ³ . Entry level servers not supported.
Move/add/remove active ⁴ (running a workload) resources between/to/from active partitions without a reboot	Yes (CPU, Memory, and I/O)*	Yes (Dynamic nPartitions)
Share Processing Resources between partitions	Yes, up to 10 partitions/CPU	Yes
Dynamically allocate processing resources between partitions	Yes, 1/100 th of a processor or more evaluated and dynamically allocable every 10 milliseconds	Yes
Dedicate Processing Resources to a partition	Yes, as little as one CPU / partition and up to all processors in the machine	Yes, at least one cell board (minimum of 4 sockets) / partition ⁷
Share I/O Resources between partitions	Yes	Yes
Dedicate I/O Resources to a partition	Yes, as little as one dedicated I/O adapter slot / partition and up to all I/O slots in the machine	Yes, at least one cell board (all I/O attached to cell) / partition ⁷
Dedicate Memory Resources to a partition	Yes, as little as 16MB of RAM and up to 2 TB	Yes, at least one cell board (minimum of 16-32 DIMMs) ⁷

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP nPartitions

- (1) From nPartition Administrator's Guide, see Table 1-1 "nPartition Operating System Support"
<http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007
Edition: First Edition
- (2) From nPartition Administrator's Guide, see Table 3-1 "Operating System Hardware Requirements"
<http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007
Edition: First Edition
- (3) From nPartition Administrator's Guide, see Table 1-2 "HP Servers Supporting nPartitions"
<http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007
Edition: First Edition
- (4) From HP-UX 11i v3 Dynamic nPartitions - Features and Configuration Recommendations "Cells that are assigned to an nPartition and have booted to form an nPartition are active cells"
http://docs.hp.com/en/10907/dynamic_nPars_WP.pdf 4AA0-7690ENW Published: October 2006
- (5) From nPartition Administrator's Guide "You must perform a reboot for reconfig of a modified nPartition after adding cells to it" and "You must immediately perform a reboot of an nPartition when you have removed an active cell from the nPartition." <http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007 Edition: First Edition
- (6) From HP Partitioning Continuum for HP-UX11i on HP 9000 and HP Integrity Servers "Because each nPar has its own CPU, memory, and I/O" <http://h71028.www7.hp.com/ERC/downloads/5982-9141EN.pdf> 5982-9141EN, Rev. 1 February 2006
- (7) From nPartition Administrator's Guide, "Either one or two cells. Each cell has up to four processor sockets and up to 16 DIMMs" and "The Superdome 64-way/128-way server is a tightly interconnected dual-cabinet server that has from 4 to 16 cells, each with four processor sockets and up to 32 DIMMs." and "An nPartition includes one or more cells assigned to it (with processors and memory) and all I/O chassis connected to those cells." <http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007 Edition: First Edition

HP vPars (Logical Partitioning)



- A logical (software/firmware/hardware) partitioning technology that allows the resources of an nPartition to be split up at a granularity (1 CPU, 64 MB of RAM, one I/O slot) finer than that (one cell) allowed by the hardware based nPartition technology.
- vPars is similar to nPars (ie ties virtual server resources to physical resources). vPars trades off the electrical isolation provided by nPars for finer granularity.
- Like nPars, vPars dedicates resources to partitions (ie no processor and I/O sharing like PowerVM Editions)
- vPars allows does allow processor and memory resources to be reassigned while partitions are running. However, reassignment requires some careful planning before partitions are created and is not as flexible as PowerVM Editions
- Similar to IBM Power4 partitioning technology

IBM PowerVM Editions Offers Business Advantages Compared to HP vPARs for Clients Doing Server Consolidation

<i>Virtualization capability</i>	<i>PowerVM Editions</i>	<i>HP vPARs</i>	<i>Business Benefit</i>
Linux OS Support	Yes	No ¹	Support for open standards
Support for Shared Processors	Yes	No ²	Higher server utilization and consolidation ratios
Dynamic Logical Partitioning	Yes	Limited ³	Adapt to changes without downtime
Support for Shared I/O	Yes	No ⁴	Share a resource that is typically underutilized
Support for Live Partition Mobility	Yes	No	Decrease downtime in your enterprise

(1) From page 18 of HP-UX Virtual Partitions Administrator's Guide "vPars is a Virtual Partitions product that enables you to run multiple instances of HP-UX simultaneously on one hard partition by dividing that hard partition further into virtual partitions." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (2) From page 20 of HP-UX Virtual Partitions Administrator's Guide "A virtual partition uses only the cores and memory that you assign to it; cores are not time-sliced across virtual partitions." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (3) From HP-UX Virtual Partitions Administrator's Guide, p. 47, Table 2-4 Dynamic Migration "Dynamic I/O Migration – No" AND "Dynamic CPU Migration – Yes for non-boot processors" AND "Dynamic Memory Migration – Yes for float. For base, can only add base memory (cannot delete online)" <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (4) From Booting, Installing, Recovery, and Sharing in a vPars Environment from DVD/CDROM/TAPE/Network Version 2.0 11/05/2005 "The concept of "sharing" needs to be clarified for the purposes of this document. Within a vPars environment, I/O, including CD/DVDs and Tape drives, may not be shared internally across vpars. This means that I/O is assigned to one and only one vpar and other vpars cannot see or access it through any internal means, such as the vPars software." http://docs.hp.com/en/5760/vPars_DVD_TAPE_NET_Usage_V2.pdf

Competitive Differentiators: IBM PowerVM Editions vs. HP vPars

	IBM PowerVM Editions	HP vPars
OS Supported	IBM AIX, Red Hat Enterprise Linux, SUSE Linux Enterprise	HP-UX ¹
Partition Scalability	Up to all CPUs on machine and 2 TB of memory	Up to size of nPartition (currently limited to eight cells) ^{2 3}
Servers Supported	Entire current System p line of servers	HP 9000 and HP Integrity High End and Mid Range Servers ⁴ . Entry level servers are not supported.
Move/add/remove active (running a workload) resources between/to/from active partitions without a reboot	Yes (CPU, Memory, and I/O)	Limited. All CPU resources can be added/moved/removed except one boot processor/partition ⁵ . Memory designated as "float" can be added/removed. Memory designated as "base" can be added, but not removed ⁶ . ¼ to ½ memory/partition must be designated as "base." ⁷ I/O resources cannot be added or removed. ⁸
Share Processing Resources between partitions	Yes, up to 10 partitions/CPU	No ⁹
Dynamically allocate processing resources between partitions	Yes, 1/100 th of a processor or more evaluated and dynamically allocable every 10 milliseconds	No ¹⁰
Dedicate Processing Resources to a partition	Yes, as little as one CPU / partition and all processors in the machine	Yes, as little as one CPU / partition ¹¹ and up to all processors in the nPartition ² . Only eight vPars are allowed per nPartition. ¹³
Share I/O Resources between partitions	Yes	No ¹²
Dedicate I/O Resources to a partition	Yes, as little as one dedicated I/O adapter slot / partition and up to all I/O slots in the machine	Yes, as little as one dedicated I/O adapter slot / partition ¹¹ and up to all I/O slots in the nPartition ² Only eight vPars are allowed per nPartition. ¹³
Dedicate Memory Resources to a partition	Yes, as little as 16 MB of RAM and up to 2 TB	Yes, as little as 64 MB of RAM ¹¹ and up to all available memory in the nPartition ² Only eight vPars are allowed per nPartition. ¹³

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP vPars

(1) From page 18 of HP-UX Virtual Partitions Administrator's Guide "vPars is a Virtual Partitions product that enables you to run multiple instances of HP-UX simultaneously on one hard partition by dividing that hard partition further into virtual partitions." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

(2) From section "nPartition Operations" of HP-UX Virtual Partitions Administrator's Guide "Virtual Partitions exist within an nPartition, but they cannot span across nPartitions." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

(3) From HP-UX 11i Virtual Partitions (vPars) – Worldwide QuickSpecs "Each virtual partition can be supported in an nPartition with a maximum of 8 cells" http://h18004.www1.hp.com/products/quickspecs/12714_div/12714_div.HTML DA-12714 - Worldwide - Version 2 - June 5, 2007

(4) From HP-UX Virtual Partitions Ordering and Configuration Guide, see Table 4-4 "Server Support for vPars Releases" <http://docs.hp.com/en/1705/oc.pdf> Published: September 2007 Edition: Version 07.09.17

(5) From page 217 of HP-UX Virtual Partitions Administrator's Guide "These are all the other CPUs, because all CPUs, except the boot processor of each virtual partition can be dynamically migrated." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

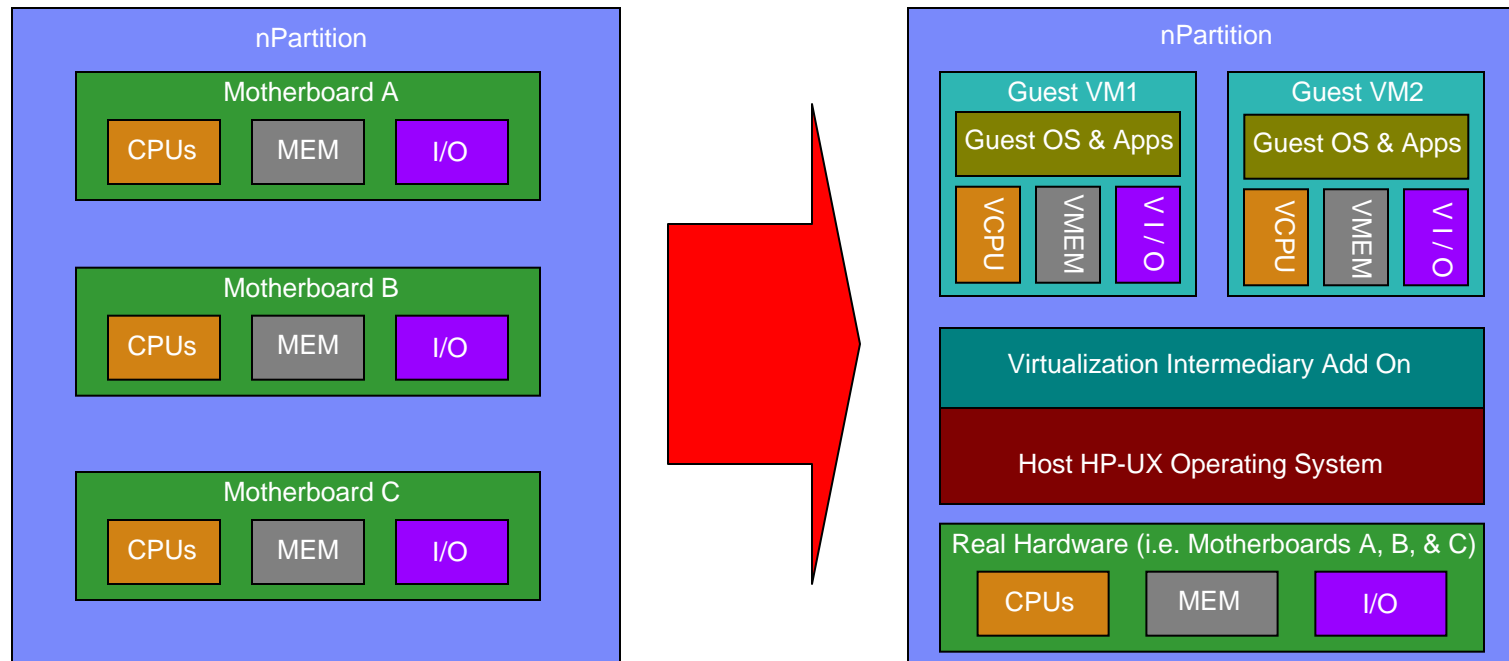
(6) From page 195 of HP-UX Virtual Partitions Administrator's Guide "Base memory *cannot be deleted* from a virtual partition when a virtual partition is up. When a virtual partition is up, base memory can *only be added* to a virtual partition. *To delete base memory, the target virtual partition must be down.*" and from page 196 "Float memory can be *added to as well as deleted from* a virtual partition while the virtual partition is up or down." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

(7) From page 367 of HP-UX Virtual Partitions Administrator's Guide, see Table F-1 Minimum Base Memory Requirements <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP vPars

- (8) From HP-UX Virtual Partitions Administrator's Guide, p. 47, Table 2-4 Dynamic Migration "Dynamic I/O Migration – No" <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13
- (9) From page 20 of HP-UX Virtual Partitions Administrator's Guide "A virtual partition uses only the cores and memory that you assign to it; cores are not time-sliced across virtual partitions." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13
- (10) From page 32 of HP-UX Virtual Partitions Administrator's Guide "Once a virtual partition is launched, the Monitor transfers ownership of the hardware to the virtual partitions. At that point, the Monitor is not involved in accessing I/O hardware, physical memory, or process to processor cycles: the individual HP-UX instances have complete ownership of their respective hardware resources." <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13
- (11) From HP-UX 11i Virtual Partitions (vPars) – Worldwide QuickSpecs "Resource granularities: processor core, 64 MB memory, I/O slot" http://h18004.www1.hp.com/products/quickspecs/12714_div/12714_div.HTML DA-12714 - Worldwide - Version 2 - June 5, 2007
- (12) From Booting, Installing, Recovery, and Sharing in a vPars Environment from DVD/CDROM/TAPE/Network Version 2.0 11/05/2005 "The concept of "sharing" needs to be clarified for the purposes of this document. Within a vPars environment, I/O, including CD/DVDs and Tape drives, may not be shared internally across vpars. This means that I/O is assigned to one and only one vpar and other vpars can not see or access it through any internal means, such as the vPars software." http://docs.hp.com/en/5760/vPars_DVD_TAPE_NET_Usage_V2.pdf Version 2.0 11/05/05
- (13) From HP-UX 11i Virtual Partitions (vPars) – Worldwide QuickSpecs "There can be a maximum of 8 virtual partitions per nPartition" http://h18004.www1.hp.com/products/quickspecs/12714_div/12714_div.HTML DA-12714 - Worldwide - Version 2 - June 5, 2007

HP Integrity Virtual Machines (Software Logical Partitioning)



- A logical (completely software) partitioning technology that allows the physical resources of an nPartition to be shared to support multiple workloads (OS and applications).
- A system administrator defines Guest Virtual Machines that appear to the OS and applications within the virtual machine to have physical resources (CPU, I/O, and MEM) that can be used to support the virtual machine's workload.
- The resources that appear to be physical within the virtual machine are actually virtual hardware interfaces.
- A virtualization intermediary host OS software package is installed on top of a specially tuned HP-UX operating system. The intermediary and OS combine to translate the commands sent to the virtual hardware interfaces into commands that are used on the physical hardware.
- The Host OS manages resource allocation between the guest virtual machines and is responsible for sharing the physical resources provided by the real hardware in a manner that supports the needs of the virtualized hardware interfaces.
- On the surface, it appears Integrity Virtual Machines (IVM) separation of virtual resources from physical resources provides many of the benefits of PowerVM Editions (ie. shared CPU, shared I/O, dynamic processor resource allocation, dynamic logical partitioning, etc.) However, IVM has significant limitations that cannot be simply overlooked.

IBM PowerVM Editions Offers Business Advantages Compared to HP Integrity Virtual Machine (IVM) for Clients Doing Server Consolidation

<i>Virtualization capability</i>	<i>PowerVM Editions</i>	<i>HP Integrity Virtual Machines 3.0</i>	<i>Business Benefit</i>
Partition scalability	64 CPUs 2TB RAM	8 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	CAPP/EAL 4+	Secured environment for mission critical applications
Support for dedicated I/O	Yes	Yes	Superior performance for I/O intensive workloads
Dynamic Processor Sharing	Yes	Yes	Highly flexible configuration, with automatic deployment of machine resources where and when they're needed
Support for Live Partition Mobility	Yes	No	Decrease downtime in your enterprise
Externally Published References	100 ⁷	1 ⁸	Rest assured knowing that PowerVM Editions is client proven and running on 40% of all System p5 and System p CPUs

¹*PowerVM Editions optional on most System p servers (1) HP Integrity Virtual Machines version 3.0 – Worldwide QuickSpecs DA-12715 - Worldwide - Version 3 - July 2, 2007 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 4AA1-1168ENW Rev 2.2, 3/2007 (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/12767-90024/12767-90024.pdf> HP Integrity Virtual Machines Installation, Configuration, and Administration HP Integrity Virtual Machines Version 2.0 HP Part Number: 12767-90024 Published: October 2006, Edition 2 p 155. Although they do not provide a full listing of these resources which can be changed dynamically, they do state that change of virtual CPU cannot happen without VM Reboot <http://forums1.lfc.hp.com/service/forums/questionanswer.do?threadId=122522>

⁴(4) IBM certification info at www.ibm.com/servers/aix/products/aixos/certifications/index.html (5) HP Integrity Virtual Machines version 3.0 – Worldwide QuickSpecs DA-12715 - Worldwide - Version 3 - July 2, 2007 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." p6 From Best Practices for Using Integrity Virtual Machines <http://docs.hp.com/en/9983/BestPractices2.2.pdf> p6 4AA1-1168ENW Rev 2.2, 3/2007 (7) Complete list of IBM System p Virtualization References at [http://www.ibm.com/software/success/csdb.nsf/advancedsearch/VW?SearchView&Query=\(Virtualization\)+AND+\(WebSiteProfileListTX\)=eserverseries&site=eserverseries&frompage=ts&Start=1&Count=30&cty=en_us](http://www.ibm.com/software/success/csdb.nsf/advancedsearch/VW?SearchView&Query=(Virtualization)+AND+(WebSiteProfileListTX)=eserverseries&site=eserverseries&frompage=ts&Start=1&Count=30&cty=en_us) (8) HP's single case study for Integrity Virtual Machines published at <http://h171023.www1.hp.com/erc/library/cellPage.aspx?pageId=38751&audience=US&status=US&code=US&lang=12&ERL=true&pageTitles=Enterprise%20Library%20Royal%20London>

Competitive Differentiators: IBM PowerVM Editions vs. HP IVM

	IBM PowerVM Editions	HP IVM
OS Supported	IBM AIX, Red Hat Enterprise Linux, SUSE Linux Enterprise	HP-UX, Windows Server 2003 Enterprise and Data Center, Red Hat Enterprise Linux ¹
Partition Scalability	Up to all CPUs on machine and 2 TB of memory	Up to 8 CPUs (max) ¹ and one CPU (recommended) ^{2,3} and 64 GB of memory ¹
Servers Supported	Entire current System p line of servers	HP Integrity Servers ⁴ . HP PA-9000 servers are not supported.
Move/add/remove active (running a workload) resources between/to/from active partitions without a reboot	Yes (CPU, Memory, and I/O)	CPU, ⁵ Storage Devices and Memory ⁶ resources can be added/moved/removed. Virtual Storage Adapters and Virtual Adapters can only be added/moved/removed if the virtual machine is powered off ⁶ . In order to modify the logical volumes attached to a virtual machine, the virtual machine must be powered off ⁷ .
Share Processing Resources between partitions	Yes, up to 10 partitions/CPU	Yes, up to 20 partitions/CPU ⁸
Dynamically allocate processing resources between partitions	Yes, 1/100 th of a processor or more evaluated and dynamically allocable every 10 milliseconds	Yes ⁹
Dedicate Processing Resources to a partition	Yes, as little as one CPU / partition and up to all processors in the machine	No ¹⁰
Share I/O Resources between partitions	Yes	Yes. However, IVM's hardware agnostic implementation requires all I/O operations to pass through the Integrity VM storage subsystem. ¹¹ In addition, all I/O operations go through a single IVM storage subsystem ¹² and the VM guests do not support multipathing ¹¹ .
Dedicate I/O Resources to a partition	Yes, as little as one dedicated I/O adapter slot / partition and up to all I/O slots in the machine	Yes, as little as one dedicated device / partition. ¹³ However, IVM's hardware agnostic implementation requires all operations to pass through the Integrity VM storage subsystem. ¹¹
Dedicate Memory Resources to a partition	Yes, as little as 16 MB of RAM and up to 2 TB	Yes, as little as 512 MB of RAM and up to 64 GB of memory ¹ . Memory is allocated in 64 MB chunks ¹⁴ .

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP IVM

- (1) From HP Integrity Virtual Machines (Integrity VM) version 3.0 – Worldwide QuickSpecs “Currently supports the following guest OSs: HP-UX 11i v2 and v3, Windows Server 2003 Enterprise and Datacenter SP1 and SP2 for 64 bit Itanium-based systems, Red Hat Enterprise Linux 4 Update 4” and “Each virtual machine is tuned for up to four virtual CPUs” and “512 MB – 64 GB memory per Virtual Machine”
http://h18004.www1.hp.com/products/quickspecs/12715_div/12715_div.HTML DA-12715 - Worldwide - Version 3 - July 2, 2007
- (2) From Best Practices for Using Integrity Virtual Machines, p. 6 “Uniprocessor Virtual Machines are More Efficient than Virtual SMPs” <http://docs.hp.com/en/9983/BestPractices2.2.pdf> 4AA1-1168ENW Rev 2.2, 3/2007
- (3) From Top Ten Tips for Using Integrity Virtual Machines, p. 7 “#9 – Set Entitlements Conservatively ... In general, you should use the minimum or default entitlements until one or more of the VMs are not receiving adequate CPU resources for their workloads.” <http://docs.hp.com/en/9985/TopTenTips2.5.pdf> 4AA1-1169ENW Rev 3.0, 8/2007
- (4) From Introduction to Integrity Virtual Machines “Support of low to high-end HP Integrity servers and blades: And future Integrity servers and blades.” http://docs.hp.com/en/9987/Intro_VM_2.1.pdf 4AA1-1167ENW Rev 3.0, 8/2007
- (5) From HP Partitioning Continuum for HP-UX 11i on HP 9000 and HP Integrity servers, p. 35 “CPU resources can be added to or removed from a partition without rebooting the partition. (Dot in Virtual Machines Column)”
<http://h71028.www7.hp.com/ERC/downloads/5982-9141EN.pdf> 5982-9141EN, Rev. 1 February 2006
- (6) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p. 120 “*Dynamic Memory* is an optional feature of Integrity VM that allows you to change the amount of physical memory in use by a virtual machine without rebooting the virtual machine. In this release of Integrity VM, dynamic memory is available on HP-UX guests only.” and p. 32 “You can modify storage devices while the virtual machine is running. It is not necessary to restart the virtual machine; however, it may be necessary to rescan for devices on the virtual machine.” and p. 72 “Using these commands, the VM Host administrator dynamically adds, deletes, and modifies storage devices on virtual machines.” and p. 93 “Virtual storage devices can be added or attached while the virtual machine is powered on or off. A new virtual storage adapter can be added only when the virtual machine is off.” and p. 94 “Integrity VM storage devices can be deleted or detached while the virtual machine is powered on or off. An Integrity VM storage adapter can only be removed when the virtual machine is off.” and p. 106 “To remove a VNIC from a virtual machine’s configuration, first stop the guest using the `hpvmstop` command. Then use the `-d` option to the `hpvmmodify` command.”
<http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP IVM

(7) From Best Practices for Using Integrity Virtual Machines “Logical volumes ... are easy to extend, import, or export ... provided the VM using those logical volumes has been shut down and powered off.”

<http://docs.hp.com/en/9983/BestPractices2.2.pdf> 4AA1-1168ENW Rev 2.2, 3/2007

(8) From HP Partitioning Continuum for HP-UX 11i on HP 9000 and HP Integrity servers, p. 8 “Granularity: Integrity VM can be configured with as little as 5% of one CPU” <http://h71028.www7.hp.com/ERC/downloads/5982-9141EN.pdf> 5982-9141EN, Rev. 1 February 2006

(9) From HP Partitioning Continuum for HP-UX 11i on HP 9000 and HP Integrity servers, p. 19 “Dynamic reallocation of CPU resources (Integrity VM has workload management technology built into the VM host that moves resources from idle guest operating system instances to busy operating system instances.)”

<http://h71028.www7.hp.com/ERC/downloads/5982-9141EN.pdf> 5982-9141EN, Rev. 1 February 2006

(10) From HP Partitioning Continuum for HP-UX 11i on HP 9000 and HP Integrity servers, p. 35 “100% CPU entitlement is available, but CPU is not dedicated.” <http://h71028.www7.hp.com/ERC/downloads/5982-9141EN.pdf> 5982-9141EN, Rev. 1 February 2006

(11) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p.72 “The VM Host maintains complete control of the physical hardware and handles the virtual machine I/O operations just as it would be handled for any other user application. Thus, just as hardware is shared among normal applications running on the VM Host, virtual machine I/O is shared across the physical storage as well.” and p. 77 “Multipath solutions are supported on the VM Host only, not on virtual machines,” <http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3

(12) From HP Integrity Virtualization (VSE) Competitive Advantages vs. IBM System p, slide 18 “Shared I/O is handled directly by the VM host.” <http://pokgsa.ibm.com/~jhuston/public/HP/HPVirtapril2007.pdf>, 2006

Substantiation for Competitive Differentiators: IBM PowerVM Editions vs. HP IVM

- (13) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p.30
“Attached I/O devices, such as tape, DVD burner, and autochanger, are not presented as virtual devices; they are presented as direct I/O device. You specify both the physical device to allocate to the virtual machine and the virtual device name that the virtual machine will use to access the device.”
<http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3
- (14) From HP Integrity Virtual Machines A.03.00 Release Notes, p.34 “When you specify the guest memory, use a multiple of 64 MB.” <http://docs.hp.com/en/T2767-90047/T2767-90047.pdf> HP Part Number: T2767-90047 Published: June 2007
- (15) From New HP-UX 11i v3 Operating Environments, Latest release. “With HP-UX 11i v3 Update 2, HP introduces these new OEs, refreshing our leading UNIX packaging that has led the industry for 7 years. No other vendor—not Sun nor IBM—can touch this, leaving their customers to do the work themselves or pay for services to do the work.” <http://h20338.www2.hp.com/hpux11i/cache/585225-0-0-0-121.html> - September 8, 2008.
- (16) From HP-UX 11i Knowledge-on-Demand: Performance optimization best practices from our labs to you. <http://h71028.www7.hp.com/ERC/downloads/4AA1-4398ENW.pdf>
- (17) From HP Installation or updating guide. <http://docs.hp.com/en/5992-4165/5992-4165.pdf> HP Part Number: 5992-4183 Published: September 2008

Backup Charts

HP Quotes - nPars

- HP nPartitions alone is a very limited technology and PowerVM Editions like technologies provide the best of breed functionality.
 - “[nPartition like hardware based partitioning] technologies are limited in improving utilization because each CPU can be used in only one partition. Furthermore, because at least one CPU must be dedicated to each partition, the number of partitions is ultimately limited to the number of CPUs ... Integrity VM combines [an HP Technology which employs logical partitioning in a somewhat similar manner to IBM's PowerVM Editions] the best of both approaches. Multiple virtual machines can share the same physical resource, increasing hardware utilization”¹
- HP's dynamic nPartitions operations can take as long as one hour! DLPAR operations take on the order of seconds. Keep in mind, Dynamic nPartitions is not the same as DLPAR! All Dynamic nPartitions does is activate and deactivate resources that are already assigned to an nPartition without a reboot!³ It does not allow you to reallocate underutilized resources from one nPartition to another without a reboot! In addition, you must specify which cells are eligible for deactivation when you create the nPartition (i.e. you cannot remove any cell. You have to know which cells you want to be able to remove before activating the nPartition)!
 - “The Dynamic nPartitions operations are fairly heavyweight, so the fluctuations [of workloads resources are being rebalanced to/from] must be of significant duration, a few hours or more ... it is usual and expected to perform cell online activation to a partition that is overutilized, and the duration of such an operation is not expected to exceed 5 minutes ... An attempt to delete a cell from a partition with a high memory utilization level is could take as long as one hour.”²
- $\frac{1}{4}$ to $\frac{1}{2}$ ² of the memory of a cell cannot be dynamically deactivated. In addition, one must identify which cells can and cannot be deactivated when the nPartition before the partition is activated.
 - “A cell can be online activated as a base cell; therefore, every nPartition must contain at least one base cell ... the system administrator must configure each partition with a sufficient number of base cells ... the rule can be stated simply: configure at least one-quarter of the cells in a partition as base cells.”²
- System p PowerVM Editions can dynamically assign processing resources so it does not matter what order you define partitions in to distribute processing resources optimally.
 - “Define nPartitions in order of size ... This provides more appropriate cell assignments for larger nPartitions (those with more cells).”⁴
- HP's Dynamic nPartitions technology does not work with nPartitions that utilize vPars or IVM.
 - “Dynamic nPartitions operations cannot be performed to an nPartition that is running vPars ... Dynamic nPartitions operations cannot be performed to an nPartition that is running Integrity Virtual Machines”²

(1) Introducing HP Integrity Virtual Machines http://h20331.www2.hp.com/enterprise/downloads/Intro_VM_WP_12_Sept%2005.pdf 08 Sept. 2005 (2) HP-UX 11i v3 Dynamic nPartitions Features and Configuration Recommendations http://docs.hp.com/en/10907/dynamic_nPars_WP.pdf 4AA0-7690ENW Published: October 2006 (3) From HP-UX 11i v3 Dynamic nPartitions Features and Configuration Recommendations “The cell online activation operation is used to activate an inactive cell while the nPartition containing it continues to run. For this operation to be possible, ... that nPartition must contain a cell in the inactive state.” and “The cell online deactivation operation is used to deactivate an active cell while the nPartition containing it continues to run. For this operation to be possible, ... that nPartition must contain a cell that is eligible for deactivation, and any I/O resources on that cell must be inactive.” http://docs.hp.com/en/10907/dynamic_nPars_WP.pdf 4AA0-7690ENW Published: October 2006 (4) From nPartition Administrator's Guide <http://docs.hp.com/en/5991-1247B/5991-1247B.pdf> HP Part Number: 5991-1247B Published: February 2007 Edition: First Edition

HP Quotes - vPars

- PowerVM Editions supports using (check box in partition profile) the resources of a partition while it is down. vPars does not.
 - “When you create a virtual partition, the vPars monitor assumes you will boot and use the partition. Therefore, when a virtual partition is created, even if it is down and not being used, the resources assigned to it cannot be used by any other partition.”¹
- Potential issues for when vPars and nPars together
 - “When there is a pending reboot for reconfiguration for the involved nPartition, the target virtual partition of the vparload or vparboot commands will not be booted until all the virtual partitions have been shutdown and the vPars Monitor rebooted.”²
- HP forces you to choose between performance and flexibility
 - “When a virtual partition contains more base memory, this allows the OS to improve the memory performance of applications since there is more locked memory at its disposal. When a virtual partition contains more float memory in each virtual partition, this allows the user the flexibility to move memory between partitions based on the memory needs of each partition, but this will not be locked memory.”³
- vPars memory overhead
 - “When the nPartition boots, the ... Integrity firmware requires approximately 16-64 MB of each cell ... fPars is an interface/interpreter for the firmware on Integrity servers and vPars ... fPar0 requires 384 MB of memory for vPars ... fPar dump requires 128 MB ... Additionally, each virtual partition that is booted requires and fPar instance, which is an additional 32 MB per fPar instance.”⁴

(1) HP-UX Virtual Partitions Administrator's Guide, p. 155 <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (2) HP-UX Virtual Partitions Administrator's Guide, p. 159 <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (3) HP-UX Virtual Partitions Administrator's Guide, p. 197 <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13 (4) HP-UX Virtual Partitions Administrator's Guide, p. 363 <http://docs.hp.com/en/T1335-90078/T1335-90078.pdf> Manufacturing Part Number: T1335-90078 September 2007 Edition 13

HP Quotes – Integrity Virtual Machines – Storage I/O Subsystem

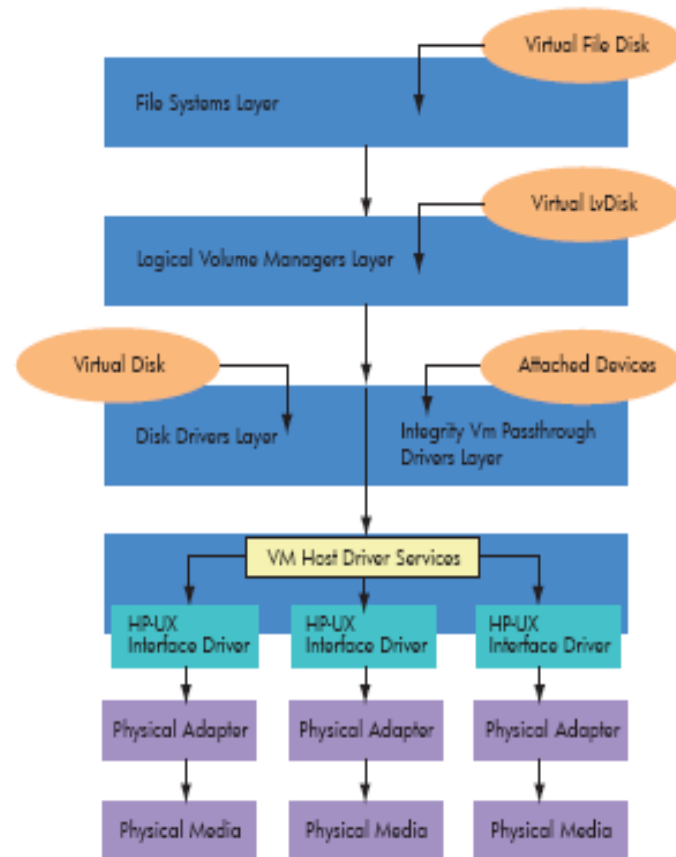
- “To provide the VM with complete control over [dedicated I/O] devices, the Integrity VM storage subsystem interprets I/O requests from the guest device drivers into I/O requests that can be completed by the VM Host storage subsystem on the guest’s behalf. In this process, the VM Host storage subsystem sends all the actual data and responses back [to] the guest device drivers.”¹
- “The virtual storage subsystem sends device responses to the Integrity VM pass-through driver, which sends the responses to the virtual machine”²
- “Using Integrity VM commands, the VM Host administrator determines the physical storage resources that each virtual machine can access. This storage isolation is maintained by the Integrity VM storage subsystem through DMA boundary checks on each virtual machine I/O operation, thereby insuring the that one virtual machine does not access the memory of another.”³

(1) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p. 73 <http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3 (2) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p. 74 <http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3 (3) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p. 72 <http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3

HP Quotes – Integrity Virtual Machines – Storage I/O Subsystem

- “For a virtual I/O operation to be completed, it has to travel round trip between the virtual storage adapter and the VM Host physical storage device. The longer the path is, the longer it takes for virtual I/O to be completed. As shown in Figure 7-1, a virtual I/O operation must traverse each software layer in order, from where it originates to the physical media.”¹
- “Attached” devices are equivalent to “Dedicated” devices in IBM terminology.
- With PowerVM Editions, dedicated devices do NOT have to go through a software intermediary, such as a VIOS or HP VM Host, to interface with the physical hardware. PowerVM Editions uses OS-firmware interfaces to allow firmware to program the hardware to ensure the device of one virtual machine cannot access the memory of another. Therefore, performance sapping software I/O operation interpretation, translation, and DMA boundary checks are NOT required on every I/O operation. The Guest OS interfaces directly with the hardware and the hardware ensures isolation is maintained.

Figure 7-1 Integrity VM Storage IO Stack



(1) From HP Integrity Virtual Machines A.03.00 Installation, Configuration, and Administration, p. 76 <http://docs.hp.com/en/T2767-90067/index.html> HP Part Number: T2767-90067 Published: April 2007, Edition 3

HP Quotes – Integrity Virtual Machines – I/O Subsystem

- HP states
 - “Shared I/O is handled directly by the VM Host.”
 - “Multipath solutions are supported on the VM Host only; not on virtual machines ... The VM Host does not return specific errors to Integrity VM for hardware path failures. Integrity VM does not detect such events and does not pass them on to the virtual machine.”²
- Industry experts state
 - “Drivers are the dominant source of crashes and bugs in operating systems ... Full-time kernel developers often bemoan the quality of code in drivers; one study found that the bug rate in drivers was actually three to seven times higher than in core kernel code.”²
- Despite what industry experts say about I/O device driver code, HP integrates shared I/O functionality with the VM Host. Therefore a device driver bug can bring down all virtual machines in the system. In addition, HP does not support redundant VM Hosts or multipathing solutions in the VM Guest that would allow the guest to maintain I/O connectivity by utilizing a backup path in the event a primary path dies.
- IBM separates the I/O Hosting system from the hypervisor so that I/O bugs do not bring down the entire machine.
- In addition, IBM supports Dual VIOs and multiplathing so a failure in one VIOS or one hardware path does cause the VM guest to lose I/O connectivity.

(1) From HP Integrity Virtualization (VSE) Competitive Advantages vs. IBM System p, Slide 18 <http://pokgsa.ibm.com/~jhuston/public/HP/HPVirtapril2007.pdf>, 2006 (2) From KHB: Recovering Device Drivers: From Sandboxing to Surviving, <http://lwn.net/Articles/217366/>, January 12, 2007

HP Quotes – Integrity Virtual Machines – Scalability

Uniprocessor Virtual Machines are More Efficient than Virtual SMPs

Generally speaking, uniprocessor systems are more efficient than multi-processor systems. Scheduling, memory access, and resource contention issues are all easier if only one processor is involved. The same is true for virtual machines.

Moreover, each virtual processor is allocated some minimum fraction of a physical processor's resources. So a VM with four virtual processors requires four times the processor resources that a VM with a single processor requires. 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. The CPU resources of a VM Host may be prematurely exhausted by the definition of a virtual SMP. For example, suppose the VM Host has four physical processors and a VM with four virtual processors, each with an entitlement of 25%. This would leave one to believe that three uni-processor VMs with 100% CPU entitlement can also be created since the remaining CPU resources on the VM Host is a total of 300%. Not true.

The resource guarantee mechanism in Integrity VM requires that 25% of four physical CPUs be available for the original virtual SMP (with four virtual CPUs). That leaves only 75% of three physical CPUs available for virtual processors. A virtual CPU may be scheduled on exactly one physical CPU, so the largest entitlement any virtual CPU can receive is 75%. So, the largest entitlement those 3 uniprocessor VMs can be defined with is 75%.¹

- Although Integrity VMs can have up to 4 virtual processors, HP recommends that they not be configured with more than one virtual processor. This is a major design flaw.
- IBM LPARs scale from <0.1 to 64 processors with high efficiency – since Aug. 2004.
- IBM's hypervisor can dynamically reallocate virtual processors across physical processors and can schedule multiple virtual processors from the same virtual machine on to the same physical processor if necessary.

(1) From Best Practices for Using Integrity Virtual Machines, p. 6, <http://docs.hp.com/en/9983/BestPractices2.2.pdf> 4AA1-1168ENW Rev 2.2, 3/2007

HP Quotes – Integrity Virtual Machines – IVM Overhead

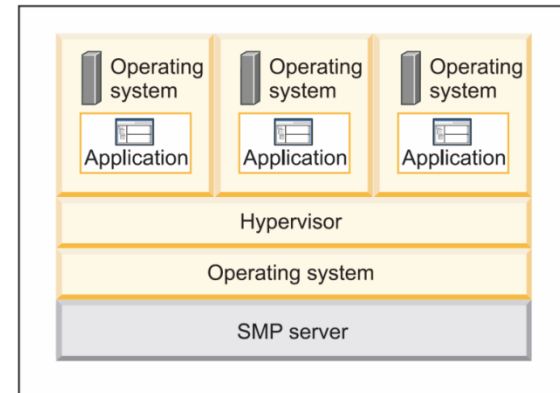
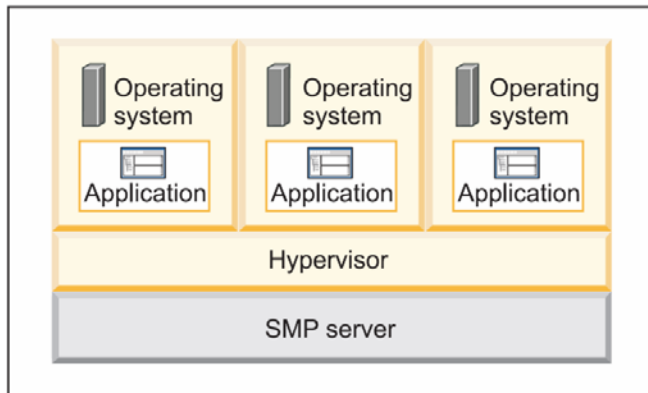
- IBM's hypervisor is built into the machine and does not require a separate installation like HP IVM.
 - “The Integrity VM software requires a ‘host system’ also known as the VM Host, which is a physical Integrity server running HP-UX 11i v2 update 2 or later.”¹
- HP IVM uses an existing full operating system environment to manage virtual machine. IBM focuses on streamlining the hypervisor to ensure high levels of reliability and efficiency. IBM's hypervisor was built from day one to manage virtual machines. It was never intended to be a full fledged OS.
 - “The Integrity VM software includes the HP-UX 11i Foundation Operating Environment (OE) which executes on the Integrity Server used to host virtual machines. Having the HP-UX 11i Foundation OE on the VM Host provides all of the basic HP-UX functionality including HP system management tools as well as a typical UNIX environment.”²
- HP IVM requires a lot of disk space. IBM's hypervisor is built into the machine and does not require any disk space.
 - “VM Host disk space = (VM Host OE Installation) + (4GB + Total Physical Memory) \approx 19 GB + (Total Physical Memory)”³
- HP IVM documentation indicates that IVM memory overhead is about 20% in realistic scenarios (i.e. machines with 8 GB of RAM).
 - “VM Host memory = 750 MB + 7.5% x (Total Physical Memory – 1 GB)”³
 - “The physical memory required for VMs is the sum of sufficient memory for its operating system and workloads plus an additional 7% of the VM's memory (as specified in its configuration) for VM Host data structures.”³

(1) From Migrating Virtual Partition (vPar) systems to Integrity Virtual Machines <http://docs.hp.com/en/7948/VparToVMIMigration.pdf> Version 1.0, 02/2006 (2) From Best Practices for Using Integrity Virtual Machines, p. 4 <http://docs.hp.com/en/9983/BestPractices2.2.pdf> 4AA1-1168ENW Rev 2.2, 3/2007 (3) From Hardware Consolidation with Integrity Virtual Machines, p. 14 <http://docs.hp.com/en/9984/Consolidation2.3.pdf> 4AA1-1171ENW Rev 2.4, 8/2007

IVM - Type 2 Hypervisor Design

“There are two types of hypervisors”

- “Type 1 hypervisors run directly on the system hardware”
- “Type 2 hypervisors run on a host operating system that provides virtualization services, such as I/O device support and memory management”¹



- IVM utilizes a type 2 hypervisor while PowerVM Editions utilizes a type 1 hypervisor and para-virtualization.
- Industry experts say “[Type-2 virtualization is] Less efficient than type-1 virtualization (especially comparing to para-virtualization)”²

(1) From Microsoft Virtualization Deep Dive: Current and Future Architecture, Slide 3, http://download.microsoft.com/documents/uk/msdn/events/Architect_Forum_28_November_06_Part_3.ppt, (2) From Operating System Research at ORNL: System Level Virtualization, Slide 16, <http://www.csm.ornl.gov/~engelmar/publications/engelmar07operating.ppt.pdf>

Summary

- **Performance** – HP IVM requires “host” and “guest” HP-UX instances, at least doubling the cost of every system instruction processed. **Additional Costs: for HP, additional processor and memory must be purchased to cover IVM overhead**
- **Scalability** – as HP nPars grow, performance drops, an effect of the incremental costs of using the crossbar switch that connects the cellboards. IBM performance scales linearly to the size of each server. **Additional Costs: for HP, additional processor and memory must be purchased to compensate for crossbar scaling limits**
- **Complexity** – HP uses 3 overlapping virtualization techniques (nPar, vPar, IVM), each with specific configurations, advantages, and limitations. IBM uses a single, uniform virtualization technique (LPAR) **Additional Costs: for HP, additional personnel time is needed to plan and implement 3 levels of virtualization**
- **Flexibility** – resources can be moved within HP nPars, but architectural choices made are difficult to change if initial considerations are not accurate (moving from IVM to vPar, for example, requires an outage and a re-installation). IBM LPARs allow all resources in each server to be dynamically changed as needed, without outages **Additional Costs: for HP, additional personnel time is needed to adjust the environment, which also requires system outages**
- **Memory Virtualization** – IBM LPAR allows dynamic growth, shrinkage, and reallocation of memory. To alter memory in any HP partition requires an outage. **Additional Costs: for HP, additional personnel time is needed to adjust the environment, which also requires system outages**
- **Granularity** – HP allows subprocessor allocation only with IVM which requires shared I/O and is not recommended for configurations of greater than one processor. IBM's LPAR granularity is from 1/10th of a processor to 64 processors and can have shared or dedicated I/O resources. **Additional Costs: for HP, additional personnel time is needed to plan and implement the environment; growing an OS instance from subprocessor to greater than 1 processor also requires system outages because you must move from HP IVM to vPAR**



IBM PowerVM vs. VMware Server Virtualization Technologies

Agenda

- VMware Virtualization Technologies
- PowerVM vs. VMware
- Where to go for more information

VMware's Virtualization Strategy

- Completely abstract physical and OS resources
- Separate management of physical and virtual resources
- Speed deployment of virtual machines
- Increase hardware utilization
- Reduce I/T management costs

VMWare Editions

VMWare Infrastructure Editions

	Foundation	Standard	Enterprise
VMWare ESX or ESXi	✓	✓	✓
▪ VMFS			
▪ Virtual SMP			
VirtualCenter Agent	✓	✓	✓
Consolidated Backup*	✓	✓	✓
Update Manager*	✓	✓	✓
VMWare HA*		✓	✓
VMotion*			✓
Storage VMotion*			✓
VMWare DRS*			✓

* These products require VirtualCenter Server which is icensed and sold separately.

The VMware Infrastructure Product Suite

■ Core Components:

- ESX Server installs on the “bare metal” and allows multiple unmodified operating systems and their applications to run in virtual machines that share physical resources. It includes a service console (linux-based) that also installs on the server.
- ESXi Server is thin version of ESX Server (it doesn't contain the service console).
- Virtual SMP allows a single virtual machine to utilize up to four physical CPUs
- VMFS (Virtual Machine File System) is a high-performance cluster file system

Source: VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 9/15/2008

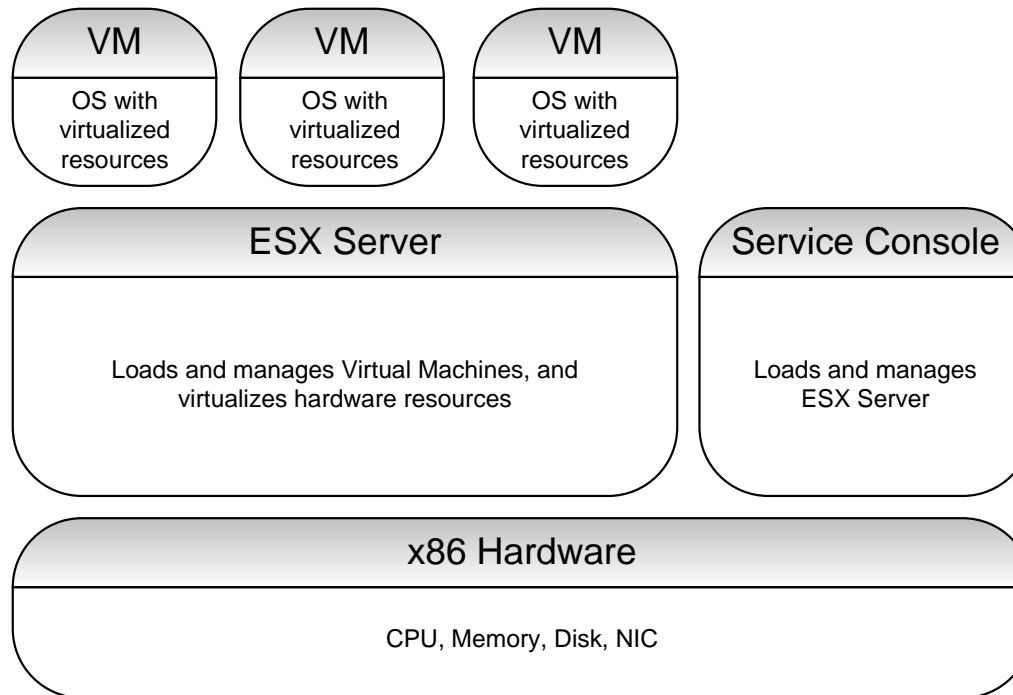
The VMware Infrastructure Product Suite

■ Optional Components:

- VMotion enables movement of Virtual Machines between physical servers
- Storage VMotion – enables movement of Virtual Machines disks from one shared storage location to another
- Update Manager – automated patch management for ESX hosts and Microsoft and Linux virtual machines
- Site Recovery Manager – create and manage recovery plans for servers managed by VirtualCenter between production and recovery sites
- DRS (Dynamic Resource Scheduling) automates allocation and balancing of physical resources
- HA (High Availability) restarts Virtual Machines in event of a physical server failure
- Consolidated Backup is VMware's proprietary backup solution for Virtual Machines
- Guided Consolidation is a wizard-driven interface which facilitates conversion of Windows operating system-based physical servers to Virtual Machines or between VMware platforms
- VirtualCenter provides centralized management of the virtual Infrastructure

Source: VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 9/15/2008

VMware ESX Server Architecture



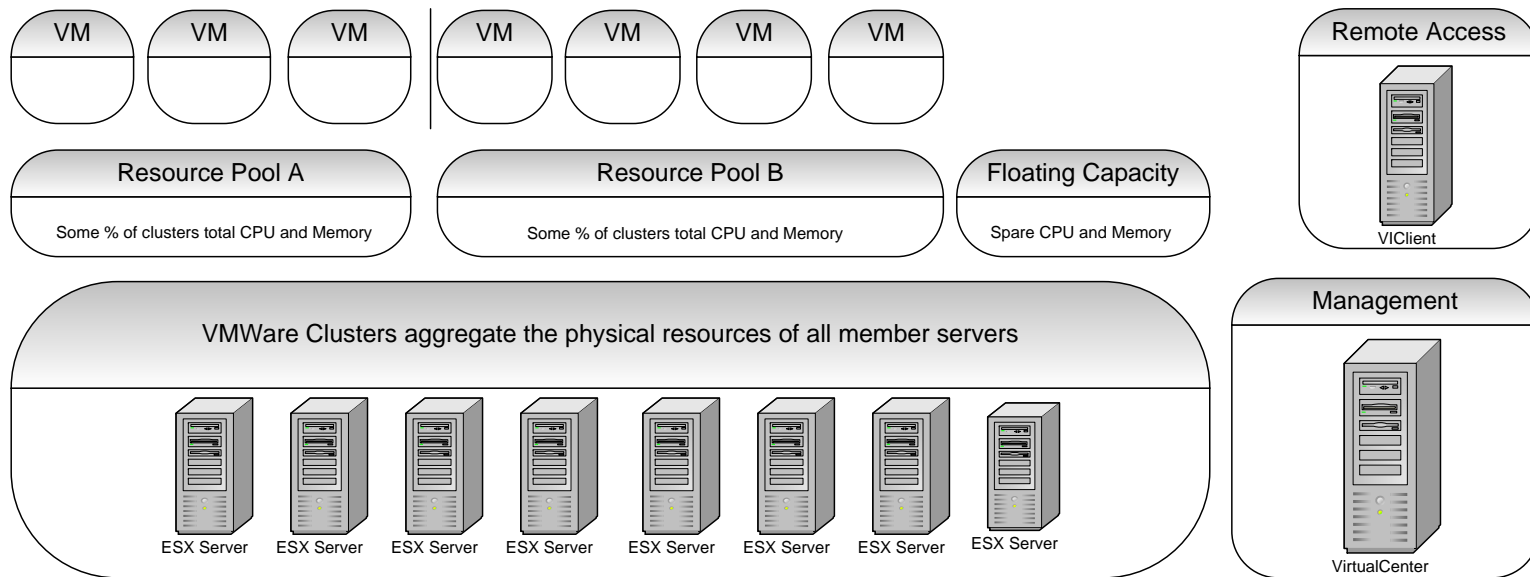
Source: VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 9/15/2008

VMware ESX Server

- ESX Server runs on x86 hardware and is supported by the integrated Service Console, a Linux-based application which loads and manages the server's kernel.
- At the core of ESX server is the Vmkernel, a type-1 hypervisor that manages interactions between VMs (virtual machines) and physical hardware.
- VMs are loaded and managed by the ESX Server, and support an array of operating systems including Windows, Linux, and Solaris (x86 version).
- ESX Servers can be clustered using VMware Infrastructure.

Sources: Architecture of VMWare ESXi http://www.vmware.com/files/pdf/vmware_esxi_architecture_wp.pdf. Current as of 05/26/2008, VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 9/15/2008

VMware Infrastructure



Source: VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 09/15/2008

IBM PowerVM Editions Offers **Business Advantages** Compared to VMware for Clients Doing Server Consolidation

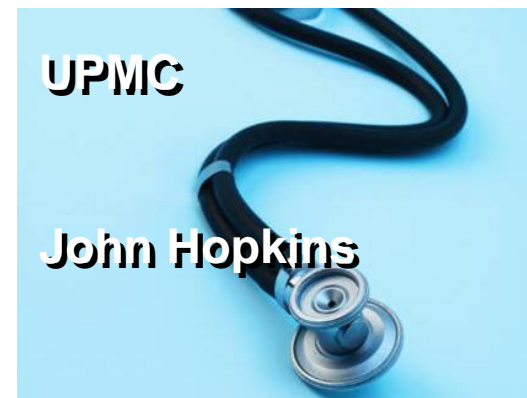
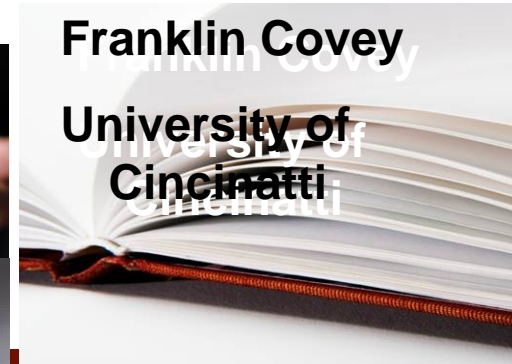
<i>Virtualization capability</i>	<i>PowerVM Editions</i>	<i>VMware Infrastructure 3 Enterprise on x86</i>	<i>Business Benefit</i>
Partition scalability System scalability	64 CPUs, 4 TB RAM 64 CPUs, 4 TB RAM	4 CPUs, 64 GB RAM ¹ 32 CPUs, 256 GB RAM	Helps improve TCO from consolidating more workloads
Dynamic Logical Partitioning	Yes	VM reboot ²	Adapt to changes without downtime
Security/fault isolation	CAPP/EAL 4+ ³	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

(1) VMware Configuration Maximums for VMware Infrastructure 3 http://www.vmware.com/pdf/vi3_35/esx_3/r35u2/vi3_35_25_u2_config_max.pdf current as of 8/15/2008 (2) Source: VMware Infrastructure 3 Online Library http://pubs.vmware.com/vi301/quick_start/vi_quick_start_manage.5.26.html "You cannot edit most virtual machine properties if the virtual machine is powered on" 10/11/07 (3) Sources: VMware ESX Server 2.5.0 and VirtualCenter 1.2.0 Validation Report, Version 1.7 March 27, 2006 http://www.commoncriteriaportal.org/files/epfiles/ST_VID10056-VR.pdf IBM Logical Partition Architecture for Power6 Validation Report, Version 0.1 Nov 7, 2007 http://www.commoncriteriaportal.org/files/epfiles/st_vid10178-vr.pdf (4) VMware Infrastructure Architecture Overview http://www.vmware.com/pdf/vi_architecture_wp.pdf. Current as of 09/15/2008

Additional Specifications for Detailed Comparisons

- *Configuration Maximums for VMware Infrastructure 3 – updated 8/15/2008:*
http://www.vmware.com/pdf/vi3_35/esx_3/r35u2/vi3_35_25_u2_config_max.pdf
- *Power Hardware Comparisons:*
<http://www-03.ibm.com/systems/power/hardware/compare/index.html>
- *AIX Facts & Features:*
<http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/TD103130>

Join the Thousands of Clients Running PowerVM



Source: Case studies for each named client are available at http://www-01.ibm.com/software/success/cssdb.nsf/topstoriesFM?OpenForm&Site=corp&cty=en_us

Trademarks and Notes

- IBM and the IBM logo are registered trademarks, and other company, product or service names may be trademarks or service marks of International Business Machines Corporation in the United States, other countries, or both. For a list of IBM trademarks, please see: <http://www.ibm.com/legal/copytrade.shtml>
- Intel and related trademarks and logos, IT Infrastructure Library and ITIL, Java and all Java-based trademarks and logos, Linux, Microsoft and Windows, and UNIX are trademarks or service marks of others as described under “Special attributions” at: <http://www.ibm.com/legal/copytrade.shtml>
- Other company, product and service names may be trademarks or service marks of others.
- References in this publication to IBM products or services do not imply that IBM intends to make them available in all countries in which IBM operates.
- IBM’s provision of products or services does not constitute the provision of legal advice, and IBM does not represent or warrant that its services or products will guarantee or assist your compliance with any laws or regulations. You are solely responsible for identifying, interpreting and ensuring your compliance with all applicable laws, regulations and rules relevant to your business needs and should seek competent legal advice as needed.