IBM PowerVM for Growing Businesses: Reduce Total Cost of Computing, and More, in a Virtual Environment

IBM Redbooks Solution Guide

This IBM® Redbooks® Solution Guide describes the IBM PowerVM® virtualization technologies on IBM Power Systems™ servers. PowerVM, the industrial-strength virtualization solution for IBM Power Systems servers and blades, can help you to build a dynamic infrastructure, reducing costs, managing risk, and improving service levels. It offers a secure, scalable virtualized environment for IBM AIX®, IBM i, and Linux applications.

A companion solution guide (TIPS1091, see "Related information") serves as an introduction to the management and monitoring solution offered by PowerVM. This solution guide expands on those ideas, and delves into the reduction in total cost of computing with PowerVM. This solution guide is for you if you have the drive to reduce the total cost of computing and to maximize the efficiencies of management and monitoring activities. Figure 1 presents the IBM Power Systems family of products.

Figure 1. PowerVM provides virtualization technologies for the IBM Power Systems family of products

Did you know?

A virtualized environment replaces not a single server, but dozens and sometimes hundreds of difficult-to-manage, underutilized, stand-alone servers. The advantages that are provided by virtualization (infrastructure simplification, energy savings, flexibility, and responsiveness) also include increased manageability.

Business value

Businesses can turn to PowerVM virtualization to increase server utilization and reduce costs and to improve the efficiency of management and monitoring activities. As you look for ways to maximize the return on your IT infrastructure investments, consolidating workloads becomes an attractive proposition. IBM Power Systems, combined with PowerVM technology, are designed to help you consolidate and simplify your IT environment. This solution provides workload consolidation that helps you to control costs by improving overall performance, availability, flexibility, and energy efficiency.

PowerVM is available on IBM Power Systems™, and IBM BladeCenter® servers as optional editions, and is supported by the IBM AIX®, IBM i, and Linux operating systems. You can use this set of comprehensive systems technologies and services to aggregate and manage resources by using a consolidated, logical view. Deploying PowerVM virtualization and IBM Power Systems offers you the following benefits:

- Lower energy costs through server consolidation
- Reduced cost of your existing infrastructure
- Better management of the growth, complexity, and risk of your infrastructure

PowerVM virtualization

To achieve these benefits, PowerVM virtualization makes available several technologies. Each is briefly described in this solution guide; details are in *IBM PowerVM Virtualization Managing and Monitoring,* SG24-7590 (see "Related information"):

- *IBM Micro-Partitioning® technology:* Shared processor pools help manage the processor capacity of a group of micro-partitions. If you have partitions that are running with dedicated processors, you can convert them to micro-partitions (also known as *shared processor partitions*).

- *Multiple Shared Processor Pools:* A system administrator can use this capability to create a set of micro-partitions with the purpose of controlling their combined physical shared processor pool consumption.

- *N_Port ID Virtualization (NPIV):* NPIV allows a single Fibre Channel port (FCP) to register multiple worldwide port names (WWPN) with a fabric name server. Each registered WWPN is assigned a unique N_Port ID. With NPIV, a single FCP port can appear as multiple WWPNs in the FCP fabric.

- *PowerVM Live Partition Mobility:* This technology allows for the movement of an active (running) or inactive (not activated) partition from one system to another with no application downtime.

- *IBM Active Memory™ Sharing (AMS):* The goal of AMS is to improve the overall use of physical memory. The hypervisor dynamically allocates physical memory from a shared pool to virtual servers, based on workload demands. AMS allows over-commitment of logical memory, which enables more virtual servers to run on a memory footprint. It can also allow virtual servers to run with larger memory configurations.

- *Active Memory Expansion (AME):* AME provides compression of in-memory data to expand the effective memory capacity of an IBM POWER7 or IBM POWER7+™ system. It is configurable on a per-partition basis.

- *Active Memory Mirroring (AMM):* Similar to two mirrored disks, AMM is based on the mirroring between DIMMs managed by the same POWER7 socket. The main purpose of AMM (or hypervisor mirroring) is to protect the hypervisor memory of selected Power Server models against non-correctable memory failures which might lead to the outage of an entire server.

- *Active Memory Deduplication (AMD):* AMD is a feature of PowerVM AMS technology. It detects and removes duplicated memory pages to optimize memory usage in partitions that use a shared memory pool.

- *Partition suspend and resume:* Suspend and resume operations allow the partition state to be suspended and resumed later. A suspended logical partition indicates that it is in a hibernated state, and all of its resources can be used by other partitions. A resumed logical partition means that the partition state has been successfully restored from a suspend operation.

- *Shared storage pools:* Shared storage pools are a feature in PowerVM Standard and Enterprise Editions. It is server-based storage virtualization that provides distributed storage access to Virtual I/O Server (VIOS) partitions for their client partitions.

- *Dynamic Platform Optimizer (DPO)*: DPO is a PowerVM virtualization feature that enables users to improve partition memory and processor affinity across the logical partitions in a Power Systems server.

See an overview of the availability of the PowerVM features by Power Systems models:
http://www.ibm.com/systems/power/software/virtualization/editions/features.html

What is PowerVM

PowerVM provides the industrial-strength virtualization solution for IBM Power Systems servers and blades. This solution has proven workload consolidation that helps clients control costs and improves overall performance, availability, flexibility and energy efficiency. Primary features and technologies (including function provided by) of PowerVM are indicated in the following list. Details of these features are in *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940 (see "Related information").

- PowerVM Hypervisor (hardware platform)
- Logical partitioning (hypervisor)
- Micro-partitioning (hypervisor)
- Dynamic logical partitioning (hypervisor)
- Shared-processor pools (hypervisor)
- Integrated Virtualization Manager (hypervisor, IVO, IVM)
- Shared storage pools (hypervisor, VIOS)
- Virtual I/O Server (hypervisor, VIOS)
- Virtual SCSI (hypervisor, VIOS)
- Virtual Fibre Channel (hypervisor, VIOS)
- Virtual optical device and tape (hypervisor, VIOS)
- Live partition mobility (hypervisor, VIOS)
- Partition suspend/resume (hypervisor, VIOS)
- Active Memory Sharing (hypervisor, VIOS)
- Active Memory Deduplication (hypervisor)
- Active Memory Mirroring (hypervisor)
- Host Ethernet Adapter, or HEA (hypervisor)

The following complimentary technologies (with function provided by) are also frequently mentioned together with PowerVM and are also described in SG24-7940 (see "Related information"):

- IBM POWER® processor compatibility modes (hypervisor)
- Capacity on Demand (hypervisor)
- Simultaneous Multithreading (hardware, AIX)
- Active Memory Expansion (hardware*, AIX); hardware available only on IBM POWER7 Systems™ and later
- AIX Workload Partitions (AIX**; available only on AIX version 6.1 or later)
- System Planning Tool, known as SPT (SPT)

PowerVM editions

Three versions of PowerVM are available, each suited to various purposes:

- *PowerVM Express Edition:* This edition is designed for customers who want an introduction to more advanced virtualization features at a highly affordable price.

- *PowerVM Standard Edition:* This edition provides the most complete virtualization functionality for AIX, IBM i, and Linux operating systems in the industry. PowerVM Standard Edition is supported on Power Systems servers and includes features that help businesses increase system utilization.

- *PowerVM Enterprise Edition:* This edition includes all the features of PowerVM Standard Edition plus two new industry-leading capabilities known as Active Memory Sharing and Live Partition Mobility.

Upgrading is possible: from Express Edition to either Standard or Enterprise Edition, and from Standard Edition to Enterprise Edition. Specifications for upgrading are included in *IBM PowerVM for Growing Businesses: Managing and Monitoring a Virtual Environment* TIPS1091 (see "Related information").

Solution overview

This section outlines the overall capabilities of PowerVM, then focuses on the capabilities of network virtualization.

PowerVM virtualization capabilities

The primary virtualization capabilities that PowerVM offers are as follows:

- Processor virtualization: The virtualization of physical processors in IBM Power Systems introduces an abstraction layer that is implemented within the IBM POWER Hypervisor™. The POWER Hypervisor abstracts the physical processors and presents a set of virtual processors to the operating system within the micro-partitions on the system.

- Memory virtualization: POWER technology-based servers are very powerful and provide much processor capacity. Memory is therefore often the bottleneck that prevents an increase in the overall server utilization.

- I/O virtualization: Combined with features designed into the POWER processors, the POWER Hypervisor delivers functions that enable other system technologies, including logical partitioning technology, virtualized processors, IEEE VLAN-compatible virtual switch, virtual SCSI adapters, virtual Fibre Channel adapters, and virtual consoles.

The POWER Hypervisor is a basic component of the system's firmware and offers the following functions:

- o Provides an abstraction between the physical hardware resources and the logical partitions that use them.
- o Enforces partition integrity by providing a security layer between logical partitions.
- o Controls the dispatch of virtual processors to physical processors. Saves and restores all processor state information during a logical processor context switch.
- o Controls hardware I/O interrupt management facilities for logical partitions.

This solution guide focuses on this feature by describing benefits of network virtualization.

- Server virtualization: These features provide the following capabilities:

- o Live partition mobility: With this capability, you can move a running logical partition, including its operating system and running applications, from one system to another without any shutdown or without disrupting the operation of that logical partition. Inactive partition mobility allows you to move a powered off logical partition from one system to another.
- o Partition suspend and resume: The Virtual I/O Server provides Partition Suspend and Resume capability to client logical partitions within the IBM POWER7 systems. With suspend and resume operations, the partition's state can be suspended, and then resumed at a later time.

Network virtualization capabilities

Network connectivity in the virtual environment is extremely flexible. Here we describe how to run common configuration tasks and offer guidance for monitoring your virtualized network. More information about this task is in *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940 (see "Related information").

Managing network virtualization involves changing the IP or the VLAN in a virtualized environment, along with mapping management and tuning packet sizes for best performance. The primary tasks are as follows:

- Modifying IP addresses: Many hosts, regardless of operating system, have numerous IP addresses, depending on the number of network interfaces that are configured. Generally, one of these IP addresses is considered to be the primary IP address and is registered to the host name of the system. This is the interface that is used for most administrative tasks, and is the address that is registered in any directory services such as DNS. The remaining IP addresses are often used for specific tasks, such as point-to-point connections or access to other networks.

- Modifying VLANs: Changing the VLAN configuration of a partition can be a more in-depth process than changing the IP address of an interface. Because VLANs are configured lower in the networking model than IP, changes are likely to be required in more than one place to ensure that the connectivity is achieved. In addition, there are many ways to configure VLANs in a system to suit your network infrastructure.

- Modifying MAC addresses: In a Power Systems server, the hardware MAC address of a virtual Ethernet adapter is automatically generated by the HMC when it is defined. Enhancements that were introduced in POWER7 servers allow the LPAR administrator to perform these tasks, which further improve the flexibility and security of the PowerVM networking stack:

- o Specify the hardware MAC address of the virtual Ethernet adapter at creation time.
- o Restrict the range of addresses that are allowed to be configured by the operating system within the LPAR.

- Managing the mapping of network devices: One of the keys to managing a virtual environment is tracking what virtual objects correspond to what physical objects. In the network area, this can involve physical and virtual network adapters, and VLANs that span across hosts and switches. This mapping

is critical for managing performance and to understand what systems will be affected by hardware maintenance. In environments that require redundant network connectivity, this section focuses on the SEA failover method rather than the Network Interface Backup method of providing redundancy.

- SEA threading on the Virtual I/O Server: The Virtual I/O Server enables you to virtualize both disk and network traffic for AIX, IBM i, and Linux operating system-based clients. The main difference between these types of traffic is their persistence. If the Virtual I/O Server must move network data around, it must do so immediately because network data has no persistent storage. For this reason, the network services that are provided by the Virtual I/O Server (such as the Shared Ethernet Adapter (SEA)) run with the highest priority. Disk data for virtual SCSI devices is run at a lower priority than the network because the data is stored on the disk. Therefore, there is less of a danger of losing data because of timeouts. The devices are also normally slower.

- The shared Ethernet process of the Virtual I/O Server before Version 1.3 runs at an interrupt level that was optimized for high performance. With this approach, it ran with a higher priority than the virtual SCSI if there was high network traffic. If the Virtual I/O Server did not provide enough processor resources for both, the virtual SCSI performance could experience a degradation of service.

- Starting with Virtual I/O Server Version 1.3, the Shared Ethernet function is implemented by using kernel threads. This configuration allows an even distribution of the processing power between virtual disk and network.

With these technologies defined, we look at the aspect of network virtualization that involves modifying IP addresses.

Solution architecture

PowerVM is frequently upgraded to take advantage of new technologies incorporated in the architecture. IBM PowerVM V2.2.2 includes Virtual I/O Server 2.2.2.1-FP26, HMC V7R7.6 and Power Systems Firmware level 760, and contains the following enhancements for managing a PowerVM virtualization environment:

- Support for up to 20 partitions per processor, doubling the number of partitions that are supported per processor. This improvement provides more flexibility by reducing the minimum processor entitlement to 5% of a processor.

- Dynamic LPAR add or remove of virtual I/O adapters to or from a VIOS partition. HMC V7R7.6 or later now automatically runs the add/remove commands (`cfgdev/rmdev`) on the Virtual I/O Server for the user. Before this enhancement, you had to manually run these commands on the Virtual I/O Server.

- Ability for the user to specify the destination Fibre Channel port for any or all virtual Fibre Channel adapters.

- Improved Virtual I/O Server setup, tuning, and validation by using the Runtime Expert.

- Live Partition Mobility supports up to 16 concurrent LPM activities.

- Shared Storage Pools create pools of storage for virtualized workloads. These pools can improve storage usage, simplify administration, and reduce SAN infrastructure costs. The enhanced capabilities enable 16 nodes to participate in a shared storage pool configuration, which can improve efficiency, agility, scalability, flexibility, and availability. Shared storage pools provide these flexibility and availability improvements:

  o IPv6 and VLAN tagging (IEEE 802.1Q) support for intermodal shared storage pools communication

  o Cluster reliability and availability improvements

  o Improved storage utilization statistics and reporting

- o   Nondisruptive rolling upgrades for applying service
- o   Advanced features that accelerate partition deployment, optimize storage usage, and improve availability through automation

- New VIOS Performance Advisor analyzes Virtual I/O Server performance, and makes recommendations for performance optimization.
- PowerVM has the following new advanced features that are enabled by VMControl that accelerate partition deployment, optimize storage utilization, and improve availability through automation:

  - o   Linked clones allow for sharing of partition images, which greatly accelerates partition deployment and reduces the storage usage.
  - o   System pool management for IBM i workloads provides increased flexibility and resource utilization. More information about the appropriate IBM Systems Director VMControl™ release is at the following location:
    http://www.ibm.com/systems/software/director/vmcontrol/.

Usage scenarios

In this scenario, a client wants to set up network virtualization with PowerVM. The "Solution overview" section of this solution guide defines the PowerVM virtualization capabilities, with a focus on network virtualization, including modifying IP addresses. This section provides more detail on that topic.

Many hosts, regardless of operating system, have numerous IP addresses, depending on the number of network interfaces that are configured. Generally, one of these IP addresses is considered to be the primary IP address and is registered against the host name of the system. This is the interface that is used for most administrative tasks, and is the address that is registered in any directory services such as DNS. The remaining IP addresses are often used for specific tasks such as point-to-point connections or access to other networks.

This section describes how to change the IP addresses assigned to the Virtual I/O Server and client partitions, and the implications of these changes.

> **Important:** If the IP address you are modifying is the address that is used for RMC connectivity between the HMC and your partition, verify that this
> connectivity still exists after the address changes. Otherwise, dynamic LPAR operations will be disabled.

Virtual I/O Server

The primary IP address of the Virtual I/O Server is used for these purposes:

- RMC communication for dynamic LPAR operations on the Virtual I/O Server.
- Remote access to the Virtual I/O Server through Telnet or Secure Shell (SSH).
- NIM operations.

This address can be configured in one of the following ways:

- On a stand-alone interface that is dedicated solely to system administration.
- On top of a Shared Ethernet Adapter device.

Using either method, the IP address is transparent to client partitions, and can be changed without affecting their operation.

For example, if the IP address must be changed on en5 from 9.3.5.108 to 9.3.5.109, and the host name must be changed from VIO_Server1 to VIO_Server2, use the following command:

```
mktcpip –hostname VIO_Server2 –inetaddr 9.3.5.109 –interface en5
```

If you want to change only the IP address or the gateway of a network interface, use the **chtcpip** command:

```
chtcpip –interface en5 –inetaddr 9.3.5.109
```

To change the adapter at the same time, such as from the en5 adapter to the en8 adapter, complete these steps:

1. Delete the TCP/IP definitions on en5 by using the **rmtcpip** command.
2. Run **mktcpip** on the en8 adapter.

It is also possible to make these changes using the **cfgassist** menu system.

> **Important:** If the IP address you are modifying is configured on an SEA device, be careful not to modify or remove the layer-2 device (the ent device). Doing so disrupts any traffic that is serviced by the SEA. Only changes to the layer-3 device (the en device) are transparent to clients of the SEA.

Client partitions

Client partition IP addresses can be changed like a physical environment. There is no specific requirement to modify any configuration on the Virtual I/O Server if there is no requirement to change the VLAN configuration to support the new IP address. VLAN modifications are covered in *IBM PowerVM Virtualization Managing and Monitoring*, SG24-7590 (see "Related information").

● AIX: The primary interface on an AIX partition is used for the same tasks as on a Virtual I/O Server. The process to modify IP addresses is identical. For an AIX virtual I/O client, to change the IP address on a virtual Ethernet adapter use SMIT or the **mktcpip** command. This example involves changing the IP address from 9.3.5.113 to 9.3.5.112 and the host name from lpar03 to lpar02. The virtual Ethernet adapter can be modified in the same way you modify a physical adapter, using the following command:

   mktcpip -h lpar02 -a 9.3.5.112 -i en0

● IBM i: For an IBM i virtual I/O client, change the IP address on a physical or virtual Ethernet adapter by using the following procedure:

   1. Add a TCP/IP interface with the new IP address (9.3.5.123) to an existing Ethernet line description (ETH01) by using the **ADDTCPIFC** command as follows: **ADDTCPIFC INTNETADR('9.3.5.123') LIND(ETH01) SUBNETMASK('255.255.254.0')**

   2. Start the new TCP/IP interface by using the **STRTCPIFC** command: **STRTCPIFC INTNETADR('9.3.5.123')**

   3. The TCP/IP interface with the old IP address (9.3.5.119) can now be ended and removed by using the **ENDTCPIFC** and **RMVTCPIFC** commands: **ENDTCPIFC INTNETADR('9.3.5.119')** or **RMVTCPIFC INTNETADR('9.3.5.119')**

   Alternatively, you can use the **CFGTCP** command. Select **option 1. Work with TCP/IP interfaces**, which allows a menu-based change of TCP/IP interfaces.

   To change the host name for an IBM i virtual I/O client, use the **CHGTCPDMN** command.

- Linux: Changing the IP address of an interface using the `ifconfig` command will not persist through a reboot of the operating system.

  For systems that run Red Hat Enterprise Linux, the fastest method is to use the system-config-network application to make the changes. On SUSE systems, use the yast or yast2 applications. Both are menu driven systems that work in the command shell and update the necessary configuration files.

> **Note:** Red Hat Enterprise Linux Version 6 has deprecated the system-config-network package, and it is no longer installed by default. You have these options for network configuration:
>
> - Install the optional system-config-network-tui package.
> - Install the NetworkManager package.
> - Edit the interface.

Integration

Integration with the following components is described in this section:

- Hardware Management Console (HMC)
- Integrated Virtualization Manager (IVM)
- System Director VMControl

Hardware Management Console

The Hardware Management Console (HMC) is a dedicated Linux-based appliance that you use to configure and manage IBM Power System servers. The HMC provides access to logical partitioning functions, service functions, and various system management functions through both a browser-based interface and a command-line interface (CLI). Because it is a separate stand-alone system, the HMC does not use any managed system resources and you can maintain it without affecting system activity.

IBM PowerVM technology and HMC is enhanced with the following features:

- Support for up to 16 concurrent Live Partition Mobility (LPM) activities.
- DLPAR Add or Remove of virtual I/O adapters to or from a VIOS.

HMC can now automatically attempt to run the add or remove commands (`cfgdev` or `rmdev`) on the VIOS for the user. Prior to this enhancement, the user had to manually run these commands on the VIOS.

Integrated Virtualization Manager

The Integrated Virtualization Manager (IVM) is used to manage selected Power Systems servers using a web-based graphical interface without requiring an HMC. This reduces the hardware needed for the adoption of virtualization technology, particularly for low-end systems.

This solution fits in small and functionally simple environments where only few servers are deployed or some advanced HMC-like functions are required.

The Integrated Virtualization Manager (IVM) is a basic hardware management solution, included in the VIO software that inherits key Hardware Management Console (HMC) features.

System Director VMControl

IBM Systems Director is a platform-management foundation that streamlines the way you manage physical and virtual systems across a heterogeneous environment. By using industry standards, IBM System Director supports multiple operating systems and virtualization technologies across IBM and non IBM x86 platforms. IBM Systems Director has three editions: Express, Standard, and Enterprise Editions.

IBM Systems Director VMControl is a plug-in for IBM Systems Director. It is a cross-platform suite of product that assists you in rapidly deploying virtual appliances to create virtual servers that are configured with the operating system and software applications that you want. With it, you can group resources into system pools, so you can centrally manage and control the workloads in your environment.

The IBM System Director VMControl plug-in is available in four editions: VMControl Express Edition, VMControl Standard Edition, VMControl Enterprise Edition, and IBM System Director VMControl for IBM PowerLinux™, each with an increasing set of functionality for virtualization management. Detailed descriptions of these editions are included in *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940 (see "Related information").

Supported platforms

PowerVM supports the following operating systems and operating components:

- Version 7, Release 1 of AIX
- Version 7, Release 1 of IBM i
- Version 2, Release 2, Modification 2, Fixpack 26 of the Virtual I/O Server
- Version 7, Release 7, Modification 6 of the HMC
- Version AL730, release 95 of the POWER7 System Firmware
- Version AL740, release 95 of the POWER7 System Firmware

Hardware requirements

The Virtual I/O Server can run on any POWER5 or later server that has the PowerVM Standard feature enabled. Also supported are IBM BladeCenter® Power Blade servers. With the PowerVM Standard or PowerVM Enterprise Edition, Virtual I/O Servers can be deployed in pairs to provide high availability.

PowerVM features are supported on the majority of the Power Systems offerings, however, some exceptions exist. The Availability of PowerVM features by Power Systems models web page has a summary of server models and features:
http://www.ibm.com/systems/power/software/virtualization/editions/features.html

Table 3 lists the Power technology levels that provide individual features.

Table 3. Virtualization features supported by POWER technology levels

Feature	POWER5	POWER6	POWER7
Virtual SCSI	Yes	Yes	Yes
Virtual Ethernet	Yes	Yes	Yes
Shared Ethernet Adapter	Yes	Yes	Yes
Virtual Fibre Channel	No	Yes	Yes
Virtual Tape	Yes	Yes	Yes
Logical partitioning	Yes	Yes	Yes
DLPAR I/O adapter add/remove	Yes	Yes	Yes
DLPAR processor add/remove	Yes	Yes	Yes
DLPAR memory add/remove	Yes	Yes	Yes
Micro-partitioning	Yes	Yes	Yes
Shared Dedicated Capacity	Yes*	Yes	Yes
Multiple Shared Processor Pools	No	Yes	Yes
Virtual I/O Server	Yes	Yes	Yes
Integrated Virtualization Manager	Yes	Yes	Yes
Suspend and resume	No	No	Yes
Shared Storage Pools	No	Yes	Yes
Thin provisioning	No	Yes	Yes
Active Memory Sharing	No	Yes	Yes
Active Memory Deduplication	No	No	Yes+
Active Memory Mirroring	No	No	Yes±
Live Partition Mobility	No	Yes	Yes

Table 3. Virtualization features supported by POWER technology levels (continued)

Feature	POWER5	POWER6	POWER7
Simultaneous multithreading	Yes**	Yes	Yes++
Active Memory Expansion	No	No	Yes
Capacity on Demand++	Yes	Yes	Yes
AIX Workload Partitions	Yes	Yes	Yes

* Only capacity from shutdown partitions can be shared
+ Need firmware level 7.4, or later
± Need mid-tier and large-tier POWER7 Systems or later, including Power 770, 780, and 795
** POWER5 supports two threads
++ POWER7 or later supports four threads

Licensing requirements

Before you use PowerVM, you must also have a valid license (or feature code). You must confirm that the feature code is included in your order. If you order an upgrade feature, you must input and activate the code first. The procedure to activate the code is described in *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940 (see "Related information").

Ordering information

Ordering information is shown in Table 4.

Table 4. PowerVM feature codes

Type and model of IBM Power System	Express Edition	Standard Edition*	Enterprise Edition**
7895-22X	5225	5227	5228
7895-23X	5225	5227	5228
7895-42X	5225	5227	5228
8202-E4B	5225	5227	5228
8202-E4C	5225	5227	5228
8205-E6C	5225	5227	5228
8205-E6B	5225	5227	5228
8231-E2B	5225	5227	5228
8231-E1C and 8231-E2C	5225	5227	5228
8233-E8B	7793	7794	7795
9117-MMB	Not offered	7942	7995
9117-MMC	Not offered	7942	7995
9117-MMD	Not offered	7942	7995
9119-FHB	Not offered	7943	8002
9179-MHB	Not offered	7942	7995
9179-MHC	Not offered	7942	7995
9179-MHD	Not offered	7942	7995

* The feature codes for the Standard Edition provide all functions supplied with the Express Edition.
** The feature codes for the Enterprise Edition provide all functions supplied with the Standard Edition.

Related information

For more information, see the following documents:

- IBM Offering Information page (to search on announcement letters, sales manuals, or both):
  http://www.ibm.com/common/ssi/index.wss?request_locale=en

  On this page, enter `IBM PowerVM`, select the information type, and then click **Search**. On the next page, narrow your search results by geography and language.

- *IBM PowerVM Virtualization Managing and Monitoring,* SG24-7590
  http://w3.itso.ibm.com/abstracts/sg247590.html?Open

- *IBM PowerVM Virtualization Introduction and Configuration*, SG24-7940
  http://www.redbooks.ibm.com/abstracts/sg247940.html

- *IBM PowerVM for Growing Businesses: Managing and Monitoring a Virtual Environment,* TIPS1091
  http://www.redbooks.ibm.com/abstracts/tips1091.html?Open

- *Integrated Virtualization Manager for Power Systems Servers*, REDP-4061
  http://www.redbooks.ibm.com/redpieces/abstracts/redp4061.html

- *IBM Systems Director VMControl Implementation Guide on IBM Power Systems*, SG24-7829
  http://www.redbooks.ibm.com/abstracts/sg247829.html

- Server virtualization with IBM PowerVM, The virtualization platform for UNIX, Linux and IBM i clients
  http://www.ibm.com/systems/power/software/virtualization/index.html

- 5765-PVS IBM PowerVM Standard Edition and PowerVM Enterprise Edition V2.2 (sales manual)
  http://ibm.co/I1ky6J

- Power Systems optimization with PowerVM virtualization, Optimize your Power Systems environment with PowerVM virtualization
  http://www.ibm.com/services/us/en/it-services/power-systems-optimization-with-powervm-virtualization.html

- Availability of PowerVM features by Power Systems models
  http://www.ibm.com/systems/power/software/virtualization/editions/features.html

- Hardware Management Console information
  http://pic.dhe.ibm.com/infocenter/powersys/v3r1m5/topic/ipha8/hwparent_hmc.htm

- IBM Fix Central to check the latest firmware version for HMC
  http://www.ibm.com/support/fixcentral/

- IBM Systems Director 6.3.x Information Center
  http://publib.boulder.ibm.com/infocenter/director/pubs/

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