IBM Power Systems Virtualization Operation Management for SAP Applications

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Enrico Joedcke
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Note: Before using this information and the product it supports, read the information in “Notices” on page v.

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Preface

Businesses are leveraging IBM® Power Systems and Linux to consolidate multiple SAP workloads onto fewer systems, increasing infrastructure utilization, reliability, availability, serviceability, scalability, and reducing cost.

This IBM Redpaper publication describes key hardware and software components of such SAP solution stack. Furthermore, this book addresses non-functional items like reliability, availability, serviceability and security, and issue handling. Practical help for planning, implementation, configuration, installation and monitoring of such a solution stack are provided.

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This paper was produced in close collaboration with the IBM SAP International Competence Center (ISICC) in Walldorf, SAP Headquarters in Germany and IBM Redbooks®.

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Chapter 1. Introduction

This chapter provides a brief summary of the contents of the publication.

This chapter contains the following:

- Preface
1.1 Preface

Businesses are leveraging IBM Power Systems and Linux to consolidate multiple SAP workloads onto fewer systems, increasing infrastructure utilization, reliability, availability, serviceability, scalability, and reducing cost.

This publication describes key hardware and software components of an SAP solution stack in Chapter 2, “Server virtualization” on page 3 and Chapter 4, “KVM and Red Hat Virtualization management and operations” on page 51. Furthermore, this book addresses non-functional items such as reliability, availability, serviceability and security in Chapter 3, “IBM PowerVM management and operations” on page 17.

Due to the complexity of the topic, this publication cannot cover all aspects in full detail. Instead, it provides an introduction to a topic and reference to other publications for further details.
Server virtualization

This chapter discusses the IBM Power Systems servers virtualization features.

This chapter contains the following:

- Introduction
- Server and hypervisor options
- Hypervisors
2.1 Introduction

Server virtualization is the process of using software (a so-called hypervisor) on a physical server to create multiple partitions or virtual instances each capable of running independently. Whereas on a single dedicated server the entire machine has only one instance of an operating system. On a virtual server the same machine can be used to run multiple server instances each with independent operating system configurations and separate CPU core, Memory and disk configurations.

2.2 Server and hypervisor options

On IBM POWER8® and POWER9™ systems the customer must choose between two virtualization technologies together with the selection of the hardware model in the ordering process. The two virtualization technologies are IBM PowerVM® hypervisor and the OpenSource Kernel Virtual Machine (KVM). The virtualization technology cannot be changed after the hardware is shipped to the customer.

2.2.1 IBM Power Systems models supporting PowerVM versus KVM

The focus of the IBM PowerVM hypervisor is high performance, reliability and scalability for the operating systems IBM AIX, IBM i and Linux. Although KVM is focused on providing fast virtualization for Linux guests on small and medium sized systems. The first product supporting KVM on Power Systems was called IBM PowerKVM with support for SAP solutions, but this product is no longer supported by IBM (see IBM United States Withdrawal Announcement 916-171 at the following link: https://ibm.co/2sPIuXw). Currently the product with support for SAP solutions using KVM technology on IBM Power Systems is Red Hat Virtualization (RHV). The support for SAP NetWeaver on Red Hat KVM/RHV is documented in the SAP Note 1400911 (https://launchpad.support.sap.com/#/notes/1400911).

2.2.2 Overview of POWER8 and POWER9 hardware models

This section provides an overview of IBM POWER9 server models as shown in Table 2-1.

<table>
<thead>
<tr>
<th>IBM Power Systems Model number</th>
<th>Processor</th>
<th>Max cores</th>
<th>Max RAM</th>
<th>IBM PowerVM</th>
<th>KVM / RHV</th>
<th>IBM Redbooks</th>
</tr>
</thead>
<tbody>
<tr>
<td>E980 9080-M9S</td>
<td>POWER9</td>
<td>192</td>
<td>64 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E950 9040-MR9</td>
<td>POWER9</td>
<td>48</td>
<td>16 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S924 9009-42A</td>
<td>POWER9</td>
<td>24</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H924 9223-42H</td>
<td>POWER9</td>
<td>24</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S922 9009-22A</td>
<td>POWER9</td>
<td>20</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H922 9223-22H</td>
<td>POWER9</td>
<td>20</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S914 9009-41A</td>
<td>POWER9</td>
<td>20</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L922 9008-22L</td>
<td>POWER9</td>
<td>24</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
IBM POWER8 server models are shown in Table 2-2.

Table 2-2  POWER8 server models

<table>
<thead>
<tr>
<th>IBM Power Systems</th>
<th>Model number</th>
<th>Processor</th>
<th>Max cores</th>
<th>Max RAM</th>
<th>IBM PowerVM</th>
<th>KVM / RHV</th>
<th>IBM Redbooks</th>
</tr>
</thead>
<tbody>
<tr>
<td>E880C</td>
<td>9080-MHE</td>
<td>POWER8</td>
<td>192</td>
<td>32 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2PkiLPv">https://ibm.co/2PkiLPv</a></td>
</tr>
<tr>
<td>E870C</td>
<td>9080-MME</td>
<td>POWER8</td>
<td>64</td>
<td>16 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2YKbRWW">https://ibm.co/2YKbRWW</a></td>
</tr>
<tr>
<td>E880</td>
<td>9119-MHE</td>
<td>POWER8</td>
<td>192</td>
<td>32 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/38xYtcV">https://ibm.co/38xYtcV</a></td>
</tr>
<tr>
<td>E870</td>
<td>9119-MME</td>
<td>POWER8</td>
<td>80</td>
<td>16 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2YI1WgHh">https://ibm.co/2YI1WgHh</a></td>
</tr>
<tr>
<td>E850C</td>
<td>8408-44E</td>
<td>POWER8</td>
<td>48</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2tiPPiB">https://ibm.co/2tiPPiB</a></td>
</tr>
<tr>
<td>E850</td>
<td>8408-E8E</td>
<td>POWER8</td>
<td>48</td>
<td>4 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2LRMZHC">https://ibm.co/2LRMZHC</a></td>
</tr>
<tr>
<td>S824</td>
<td>8286-42A</td>
<td>POWER8</td>
<td>24</td>
<td>2 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2PGLv7P">https://ibm.co/2PGLv7P</a></td>
</tr>
<tr>
<td>S822</td>
<td>8284-22A</td>
<td>POWER8</td>
<td>20</td>
<td>1 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/34lyRfY">https://ibm.co/34lyRfY</a></td>
</tr>
<tr>
<td>S814</td>
<td>8286-41A</td>
<td>POWER8</td>
<td>1 TB</td>
<td>X</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2LOWbwk">https://ibm.co/2LOWbwk</a></td>
</tr>
<tr>
<td>S824L</td>
<td>8247-42L</td>
<td>POWER8</td>
<td>24</td>
<td>2 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2sSCsvQ">https://ibm.co/2sSCsvQ</a></td>
</tr>
<tr>
<td>S822L</td>
<td>8247-22L</td>
<td>POWER8</td>
<td>24</td>
<td>1 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/36wulax">https://ibm.co/36wulax</a></td>
</tr>
<tr>
<td>S812L</td>
<td>8247-21L</td>
<td>POWER8</td>
<td>12</td>
<td>512 GB</td>
<td>X</td>
<td>X</td>
<td><a href="https://ibm.co/36q0n8">https://ibm.co/36q0n8</a></td>
</tr>
<tr>
<td>S822LC</td>
<td>8335-GGA 8335-GTA</td>
<td>POWER8</td>
<td>20</td>
<td>1 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2EcggbI">https://ibm.co/2EcggbI</a></td>
</tr>
<tr>
<td>S822LC</td>
<td>8001-22C</td>
<td>POWER8</td>
<td>22</td>
<td>512 GB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/2RW4mdY">https://ibm.co/2RW4mdY</a></td>
</tr>
<tr>
<td>S812LC</td>
<td>8348-21C 8001-12C</td>
<td>POWER8</td>
<td>10</td>
<td>1 TB</td>
<td>X</td>
<td></td>
<td><a href="https://ibm.co/38ybBwy">https://ibm.co/38ybBwy</a></td>
</tr>
</tbody>
</table>

2.2.3 Comparison of PowerVM and KVM/Red Hat Virtualization (RHV)

Table 2-2 on page 5 compares IBM PowerVM and KVM/RHV features.
Example 2-1  PowerVM and KVM/RHV

<table>
<thead>
<tr>
<th>Feature</th>
<th>IBM PowerVM</th>
<th>KVM/RHV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adding devices to the guest</td>
<td>Dynamic LPAR</td>
<td>Hot plug</td>
</tr>
<tr>
<td>Different editions</td>
<td>Yes (Standard, and Enterprise)</td>
<td>Yes, RHEL (&lt;= 4 guests) and RHV (1 to n guests)</td>
</tr>
<tr>
<td>Dynamic logical partition</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Guests running in Big and LittleEndian</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>License</td>
<td>Proprietary</td>
<td>Open source</td>
</tr>
<tr>
<td>Live partition mobility</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Memory compression</td>
<td>Yes (IBM Active Memory Expansion)</td>
<td>No (zswap can be installed manually)</td>
</tr>
<tr>
<td>Memory page sharing</td>
<td>Yes (Described as Active Memory Data Deduplication)</td>
<td>Yes (Described as Kernel SamePage Merging, or KSM)</td>
</tr>
<tr>
<td>IBM Micro-Partitioning® / Shared processors</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Shared Processor Pools</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Guaranteed minimum entitlement</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Hard Capping of VMs</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Capacity on Demand</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>NPIV</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PCI pass-through</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Shared storage pools</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sparse disk storage</td>
<td>Yes (thin provisioning)</td>
<td>Yes (qcow2 image)</td>
</tr>
<tr>
<td>Supported machines</td>
<td>All non-LC IBM Power Systems</td>
<td>All LC model IBM Power systems and some L model IBM Power systems</td>
</tr>
<tr>
<td>Supported operating systems in the guest</td>
<td>IBM AIX IBM i Linux</td>
<td>Linux</td>
</tr>
</tbody>
</table>

2.3 Hypervisors

This section describes the hypervisors available in Power Systems.

2.3.1 PowerVM introduction

IBM PowerVM is the virtualization technology offered by IBM Power Systems. PowerVM server virtualization can consolidate multiple workloads onto fewer systems, increase server utilization and reduce cost. PowerVM provides a secure and scalable server virtualization environment for AIX, IBM i and Linux operating systems built upon the advanced Remote Access Service (RAS) features and leading performance of the Power Systems platform.
Multiple different PowerVM features like Live Partition Migration (LPM), Live Kernel Update (LKU) and Single Root I/O Virtualization (SR-IOV) can be deployed by customers to meet their enterprise requirements. PowerVM handles all virtualization aspects needed in a Data center with ease. The Hardware Management Console (HMC) can be utilized to easily create and administer Logical Partitions on Power Systems using either a GUI or a simple CLI interface. It also provides tools to monitor the performance and change resource allocations at any time. Advanced features like dynamic LPAR configuration (DLPAR), Active memory Expansion (AME) to adjust CPU and memory usage of an LPAR can be deployed. Dynamic Processor Optimization (DPO) can be used to manage the Logical Partition (LPAR) CPU and memory placements to improve their affinity. All this can be managed easily through the HMC. These and other features of PowerVM will be described in more detail in the following sections.

A Virtual I/O Server (VIOS) is a special partition provided by PowerVM. This LPAR facilitates sharing of physical I/O resources between client logical partitions within the server. The VIOS provides storage virtualization using virtual SCSI and virtual Fibre Channel. Network Virtualization is provided using Shared Ethernet Adapter (SEA), SRIOV, virtual Network Interface Controller (vNIC) or SRIOV Virtual Functions (SRIOV-VF). The VIOS is also used to provide Active Memory Sharing capability to client logical partitions within the system, Suspend/Resume and remote restart features to AIX, IBM i, and Linux. It can be configured to provide failover and disaster recovery functionality to LPARs. Physical storage and network adapters are typically assigned directly to the VIOS to make them available to all logical partitions on the server. This is a prerequisite for Live Partition Mobility (LPM), Remote/Restart and other disaster recovery used in PowerVM. It also reduces the number of physical adapters required for Power Systems as a single adapter can be utilized by multiple LPARs. This increases the utilization of a given adapter and reduces datacenter infrastructure complexity.

The following is a list of a few important PowerVM features and how they relate to SAP and the Linux operating system.

**LPAR virtualization options**

Logical partitioning is a feature provided by PowerVM, which is used to separate the resources of a physical system into subsets called logical partitions (LPARs). Processors, memory, and input/output devices can be individually assigned to logical partitions, or LPARs can share the resources from a common pool. Each LPAR runs its own version of an operating system because LPARs run as independent logical servers with the resources allocated to them.

PowerVM allows the creation of different types of logical partitions that have unique characteristics. These types are dedicated LPARs or shared processor LPARs with or without micropartitioning.

**Dedicated LPARs**

Dedicated LPARs allocate their CPU resources for exclusive use. This means that one or more physical processors are fully owned by this LPAR. Consequently, the number of dedicated LPARs on a Power Systems server is limited by the number of available physical processors. The processor capacity of a dedicated LPAR must be high enough to fulfill the requirements of the expected peak load. If a peak load is higher than the configured CPU resources, other processing capacity in the server might remain unused.
CPUs in a dedicated LPAR are reserved for only this LPAR, however the LPAR can be configured so that it donates unused processor cycles to a configured shared processor pool. This is configured within the partition profile as shown in Figure 2-1.

![Partition profile pane - Processing mode dedicated](image)

Figure 2-1   Partition profile pane - Processing mode dedicated

You can specify to donate unused processor cycles only when the partition is not running (Figure 2-1) or also when the partition is active.
**Shared Processor LPARs and micropartitioning**

Shared processor LPARs (SPLPARs) are designed to maximise the use of the available physical processor resources. All processor resources that are not configured for dedicated, non-donating LPARs are available in the shared processor pool. The processing capacity of an SPLPAR can be sized as small as 1/20th of a processor, with increments of 1/100th of a processor, allowing to define much more SPLPARs on a Power Systems machine compared to dedicated LPARs. Besides the fine granularity in processor capacity sizing SPLPARs do not exclusively own the processing capacity, which means that SPLPARs always donate unused capacity to the shared processor pool. On the other hand, those LPARs can be configured as *Uncapped* to consume more processing capacity from the shared processor pool at times it is needed to fulfill peak load requirements. Refer to figure Figure 2-2.

![Figure 2-2   Partition profile pane - Processing mode share](image)
Shared Processor Pools (SPP)

All processor resources not configured for dedicated LPARs are assigned to a global shared processor pool. Initially, all shared processor resources belong to the DefaultPool as shown in Figure 2-3, but can be configured in up to 64 shared processor pools. Those shared processor pools are subsets of and contained within the global shared processor pool.

Assigning SPLPARs to a shared processor pool allows to limit the processing capacity available to the SPLPAR, for example, to have control over license fees based on processor capacity.

Simultaneous multithreading

Simultaneous multi-threading (SMT) is a hardware feature of the POWER processor that provides the ability for a single physical processor to simultaneously dispatch instructions from more than one instruction thread context. POWER8 and POWER9 technology-based systems provide up to eight parallel threads (SMT8). For these processors, when SMT mode is activated, a single physical processor appears to the operating system as eight logical processors in the case of SMT8 or four logical processors in the case of SMT4, independent of the partition type. For example, in SMT4 mode, a partition with one dedicated physical processor operates with four logical processors. Similarly, in SMT8 mode, a shared processor partition with two virtual processors appear as a logical 16 processor partition. SMT is active by default. SMT provides a capacity increase as it can interleave instructions from multiple instruction streams (runqueues) on a single core. For example, process A stores a value, without SMT and process B’s instruction has to wait until the store is complete. If the store takes 5 cycles, 4 cycles go unused until process B can be executed. With SMT, process A’s
store is executed and processed, and on the 2nd processor cycle, process B’s instruction is executed. In essence, process B executes 4 cycles earlier than without SMT.

The performance improvement of SMT is application dependent; however, most commercial applications see a significant performance increase. For SAP environments, it is recommended to enable SMT because the mix of many parallel online users, RFC, and batch tasks significantly benefits from this feature.

PowerVM Management and Operations, provides useful examples of Hardware Management Console (HMC) functionality that simplify the operations to virtualize SAP landscapes on PowerVM.

**Dynamic logical partitioning (DLPAR)**

Dynamic logical partitioning (DLPAR) provides the capability to manually move resources (such as processors, memory, and I/O devices) to, from, and between running logical partitions without the requirement to shutdown or restart the partitions. This feature was first introduced with POWER4 systems.

By allowing LPARs to redefine available system resources online, DLPAR supports customers’ needs to avoid potentially costly planned downtimes.

The following examples describe situations in which customers might consider employing DLPAR:

- Moving processors from a test partition to a production partition in periods of peak demand, then moving them back again as demand decreases.
- Moving memory to a partition that is doing excessive paging.
- Moving an infrequently used I/O device between partitions, such as a CD-ROM for installations or a tape drive for backups.
- Releasing a set of processor, memory, and I/O resources into the available pool so that a new partition can be created from those resources.
- Configuring a set of minimal logical partitions to act as backup to primary logical partitions and keeping some set of resources available.
- Assigning resources from a failed primary logical partition to a backup logical partition to continue workload processing
- Temporarily assigning more capacity to an LPAR during an upgrade or migration to reduce SAP system downtime.

A DLPAR-safe program is one that does not fail as a result of DLPAR operations. Application which are aware of the system topology can encounter problems if they do not expect the topology to be dynamic. For example, if the application is NUMA aware but discovers the topology only at startup and NUMA nodes appear or disappear through DLPAR operations, unexpected results can occur. Most programs however are DLPAR-safe.

A program is DLPAR-aware if it anticipates system topology to be dynamic and adjusts its use of resources accordingly. For example, to reduce NUMA effects, an application can create a pool of NUMA node bound worker threads. DLPAR operations can increase or reduce the number of LPAR CPUs on NUMA nodes. Consequently, the application can choose to adjust the number of worker threads in a NUMA node pool. A new NUMA node might also be introduced to the LPAR topology. In that case, the application might create a new worker thread pool.

---

**Note:** For support status of DLPAR operations with SAP HANA, check the following SAP note: SAP HANA: 2055470 - HANA on POWER Planning and Installation Specifics - Central Note (https://launchpad.support.sap.com/#/notes/2055470).
Dynamic Platform Optimizer (DPO)

Introduced on IBM POWER7® servers, Dynamic Platform Optimizer (DPO) is a PowerVM virtualization feature that aims to reduce NUMA effects by optimizing the placement of LPAR processor and memory resources on the server. By increasing processor-to-memory affinity and reducing the distances to memory, applications can experience significant performance improvements depending on the workload.

LPAR topologies can be sub-optimal (Figure 2-4) for example due to:

- Dynamic creation and deletion of partitions
- DLPAR operations that add and remove processors or memory
- Restarting with processor or memory configuration changes
- Hibernation (suspend or resume) operations
- LPM operations
- CHARM – central electronics complex (CEC) Hot add, Repair, & Maintenance

![Figure 2-4 Suboptimal topology layout](image)

Figure 2-4 shows some examples of sub-optimal LPAR topologies that can be improved:

- LPAR 1 has processors and memory physically separated on different sockets
- LPAR 2 has processors and memory allocated over multiple sockets
- LPAR 3 has processors and memory allocated over multiple system nodes

To assist with assessing the current topology, DPO can calculate an affinity score for each LPAR. This provides a quantified assessment of the LPAR layout ranging from 0 (poor) to 100 (best).

To improve the LPAR affinity, DPO determines an optimal resource placement strategy and executes a series of memory and processor relocations. For an estimate of improvement before executing DPO rebalance, a predicted affinity score can also be queried.
Figure 2-5 depicts an improved topology after a DPO operation.

DPO can be applied to individual logical partitions or to the entire system. Specific LPARs can be listed and prioritized in a DPO operation. Likewise, LPARs can also be explicitly listed to be excluded from the operation. Those LPARs will not experience a topology change. LPARs which are not explicitly included nor excluded will be implicitly included but not prioritized for optimization. This means also that those LPARs might be negatively impacted.

A DPO operation can be executed on online and offline partitions. Online optimization allows for continued operation without the need for planned downtimes. However, for applications which are NUMA aware, both the OS and the application need to react to a new LPAR topology to take advantage to the operation.

Note: For support status of online DPO operations with SAP HANA, check the following SAP notes: SAP HANA: 2055470 - HANA on POWER Planning and Installation Specifics - Central Note (https://launchpad.support.sap.com/#/notes/2055470).

Be aware that a DPO operation can take a significant amount of time. In this time, system performance will be degraded and all LPARs can be impacted including those that were excluded from operation.

2.3.2 Kernel-based virtual machine (KVM) introduction

A kernel-based virtual machine (KVM) is a part of the open source virtualization infrastructure that turns the Linux kernel into an enterprise-class hypervisor. QEMU is another part of this infrastructure. When the term KVM is used it usually refers to the QEMU and KVM stack of software. To work efficiently KVM requires hardware virtualization extensions. Hardware-assisted virtualization is a platform feature that enables the KVM hypervisor to take advantage of the underlying hardware when virtualizing guest operating systems. IBM Power Systems introduced virtualization assisted hardware with the POWER5 family of servers.
For additional information refer to IBM PowerKVM: Configuration and Use, SG24-8231-01 at the following website: http://www.redbooks.ibm.com/abstracts/sg248231.html?Open.

KVM is composed of the following software stack:

**KVM performance**
Because KVM is a thin layer over the firmware, it can deliver enterprise-grade performance to virtual machines and can consolidate a large amount of work on a single server. An important advantage of virtualization is the possibility of using resource overcommitment.

**QEMU**
QEMU is open source software that administers the virtual machines on a KVM hypervisor. It manages and monitors the virtual machines and performs the following basic operations:
- Create virtual image disks
- Change the state of a virtual machine:
  - Start virtual machine
  - Stop a virtual machine
  - Suspend a virtual machine
  - Resume a virtual machine
  - Take and restore snapshots
  - Delete a virtual machine
- Handle the I/O between guests and the hypervisor
- Migrate virtual machines

In a simplified view, the QEMU acts as the user space process for handling virtualization and KVM the kernel space module. QEMU can also work as an emulator, but this topic is not documented in this publication.

**IBM OpenPOWER Abstraction Layer**
IBM OpenPOWER Abstraction Layer (OPAL) is a small layer of firmware that is available on POWER8 and POWER9 servers. It provides support for the KVM software stack and for partitions running without a hypervisor (bare metal). OPAL is part of the POWER firmware and provides an interface between the hardware and the KVM hypervisor. OPAL development is done on public GitHub community. The code resides in the following repository:

https://github.com/open-power

**Resource overcommitment**
Overcommitment is a mechanism to expose more CPU, I/O, and memory to the guest machine than exists on the real server, increasing server resource use and improving overall server utilization.

**CPU virtualization**
CPU virtualization is a technique that allows a virtual CPU to run on top of another CPU (virtual or physical). On Power Systems the CPU virtualization of the guest instructions run directly on the physical CPU, which reduces translation overhead.

**CPU overcommitment**
CPU overcommitment allows an under-utilized CPU to be shared with other virtual machines. The CPU overcommit is usually enabled when the virtual machines are not expected to use...
all of the CPU resources at the same time. Therefore, when one virtual machine is not using its share of the CPU, another virtual machine can use it. A CPU assigned to a virtual machine is called virtual CPU (vCPU). In an overcommitment scenario, the number of vCPUs is larger than the number of physical CPUs available.

**NUMA**

Non-Uniform Memory Access (NUMA) describes an environment where memory access to different portions of memory can take significantly different amounts of time. In a NUMA environment a given processors usually has direct (local) access to memory connected to it. To access memory connected to a different but close processor a longer data access path has to be taken (remote memory). In the case of memory allocated from a processor in a different enclosure an even longer path is taken (distant memory). The longer the path, the longer it takes to retrieve data from memory, so for best performance a KVM guest must use local memory. Within KVM it is possible to define a NUMA environment for a guest. If a defined NUMA environment fits to the physical architecture of the system, it will result in increased performance. To link the virtual processors of a NUMA guest to the underlying physical CPU pinning can be used.

**CPU pinning**

CPU pinning allows the virtual CPUs of a guest virtual machine to be pinned to a given physical CPU or set of CPUs. The hypervisor will then schedule work of a guest virtual machine only on CPUs that the guest is pinned to, by default the guest can be scheduled on any CPU. The advantage of pinning a virtual machine is to reduce time to access memory and when its execution threads share data or instructions in the processors cache, runtime improves due to reduced number of memory accesses.

**CPU shares**

In a kernel-based virtual machine (KVM), the virtual machines run as processes on the host. This means that they are scheduled to run on host CPUs just like any other process. The implication is that CPUs are shared by default. This CPU sharing allows CPU overcommitment, that is, creating more vCPUs than there are CPUs on the system. The Linux scheduler spreads the vCPUs among the CPU cores. However, when there is overcommitment, multiple vCPUs can share a CPU core. Shares are configured to balance the amount of time a virtual machine is allotted compared to another virtual machine.

**Memory allocation**

Guest memory is allocated by the host according to the guest configuration. It is possible to set a maximum amount of memory and a current amount. The guest will have the maximum amount of memory available, but it can choose to use only the current amount and release the remaining amount to the host.

**Memory ballooning**

Memory ballooning is a technique that allows the guest memory to be increased or decreased cooperatively, depending on the amount of memory available on the guests and host. When memory ballooning is enabled on the guest, the hypervisor can remove and add memory to the guest dynamically. This technique can be used if the memory is overcommitted, which means assigning the guests in sum more memory that the system provides. In case a guest needs more memory and another guest needs less memory at the same time, the memory is used more efficiently. But if all guests need their assigned overcommitted memory, this can cause bad performance because the host starts swapping memory to disk.
2.3.3 What is Red Hat Virtualization (RHV)?

Red Hat Virtualization (RHV) is a virtualization management solution for virtualized servers and desktops. RHV enables central and effective management of the entire virtual environment, including virtual data centers, virtual clusters, hosts, guest servers and guest desktops, networking and storage. The RHV hypervisor is based on kernel-based virtual machine (KVM) technology and provides support for VLANs, network bonding and a wide range of network devices. RHV supports all storage systems certified on Red Hat Enterprise Linux (RHEL).

For additional information, refer to the following website:


RHV manager introduction
Red Hat Virtualization Manager (RHV-M) provides a centralized management system with a web-based graphical interface. The self-service user portal enables end users to self provision virtual machines (VMs), define templates, and administer their own environments.

Workload management
Additional memory and CPU resources can be added without disrupting applications. The build-in advanced SLA manager lets administrators define VM policies for CPU, memory, and network. These policies ensure guaranteed quality of service. Administrators can also define per-user quotas for disk space, CPU usage, and memory.

Live migration
Guest live migration allows a seamless move of VMs from one host to another within a Red Hat Virtualization cluster. Storage live migration allows for a single (or multiple concurrent) running VM disks to be moved within the storage infrastructure, without interruption to users or the VM.

Resiliency, recovery and maintenance
The high availability feature allows critical VMs to be restarted on another host in the event of hardware failure with three levels of priority. Snapshots allow cold or live snapshots to preserve a VM’s current state. The maintenance mode allows one-click VM migration to put a RHV host into maintenance mode for upgrade or hardware updates. Affinity and anti-affinity workload grouping can be used to define workload affinity policies on how VMs run, either together on the same host or separately on different hosts.
IBM PowerVM management and operations

This chapter discusses PowerVM management and operation.

This chapter contains the following:

- Shared processor LPARs
- Selecting and adjust simultaneous multithreading
- Live Partition Mobility (LPM)
- Dynamic Platform Optimizer (DPO) and Dynamic Logical Partitions (DLPAR) operations
### 3.1 Shared processor LPARs

This section describes how to configure shared processor LPARs (SPLPAR).

#### 3.1.1 Configuring a shared processor LPAR

It is fairly simple to change a dedicated LPAR to a shared processor LPAR. All it requires is a small change in the existing profile followed by a restart of the LPAR. SPLPARs share their resources with other SPLPARs, however, not all of these LPARs will have the same importance to the business. If a test partition requests all shared resources a production LPAR might suffer performance degradation and money is lost. In order to protect the business PowerVM supports the creation of a policy to protect running workloads.

This policy determines the relative weights, guaranteed entitlements and the number of virtual processors (VCPUs) for each logical partition.

The number of VCPUs is set so it reflects the expected peak workload requirements. The entitlement (=processing units) represents the minimum processing capacity allotted to a SPLPAR. The weight determines the relative priority between SPLPARS in the same pool. Examples are online versus batch, production versus non-production and others.

Dynamic tools (DLPAR operations) can be used to fine-tune this policy during operation to address a load change. SAP monitoring reports and other monitoring tools can be used to determine the LPAR resource requirements for each SAP system.

A new profile or a change to an existing profile can be used to change an LPAR from dedicated to shared. The following steps show how to alter an existing profile, save it, and restart the partition:

1. Login to the HMC and navigate to the LPAR. From the menu on the left select Partition Actions → Profiles → Manage Profiles to access the Manage Profiles panel.

2. Select the profile to be changed and choose Actions → Edit. Alternatively, create a copy of the profile, and then change the new profile as shown in Figure 3-1.

![Figure 3-1 Managing Profiles pane - Creating a copy of a profile](image)
3. The profile opens, as shown in Figure 3-2. Select the Processors tab, select the Shared option, and change the resources accordingly to your requirements.

![Figure 3-2 Processor pane - Setting up the partition settings](image)

Figure 3-2 shows the partition requesting 3 physical CPUs and is guaranteed a minimum of one and a maximum of 8. The operating system in the partition sees 4 CPUs and DLPAR operations can reduce this to 1 or increase it to 16 CPUs. The LPAR is configured as Uncapped, which means it is able to use more processing resources if it requires them, and if free resources in the pool are available. Uncapped is the recommended sharing mode for SAP environments with PowerVM.

4. Shut down the LPAR and start it by activating the new or altered profile.

**Micropartition design options**

The SPLPARs come in two main flavours: those with strict resource definitions and those with flexible limits.

Strict resource definitions are achieved by defining the entitlement of the LPAR and capping the LPAR. The entitlement is the resource capacity that is guaranteed to the LPAR and is always available to it. Capping the LPAR restricts it from using any resources beyond this entitlement, and therefore the chosen entitlement must be large enough to fulfill the processing requirements of the peak workload.
LPARs with strict limits are some sense similar to a dedicated LPARs, with two exceptions: Other SPLPARs can use the resources when not used by this partition (the implementation is more flexible than dedicated donating partitions) and fractions of processors can be assigned although dedicated LPARs always require whole processors.

LPAR entitlements act like reserved capacity: The sum of the entitlements of all the SPLPARs sharing the pool cannot exceed the number of physical processors in the pool, so that the entitlements can be guaranteed. Therefore, large SPLPAR entitlements can limit the number of SPLPARs active in the shared processor pool.

To achieve the best processor sharing, it is recommended to keep the entitlements small and the partitions uncapped. Uncapped partitions can utilize resources in the shared pool beyond their own guaranteed entitlement. This is the most common approach for combined SAP landscapes because the SPLPARs can adapt to the workload requirements and the resource distribution can adapt to the changing workload patterns in multiple SPLPARs. The shared processor pool can experience contention if workloads are heavily competing for resources.

There are several options to enforce a priority policy and relative importance of the SPLPARs, which are referred to as implicit capping. They provide the means to control the resource allocation, although still providing the flexibility and efficiency of resource sharing.

**Implicit capping of SPLPARs**

Most LPAR settings can be dynamically altered during runtime by DLPAR (dynamic LPAR) operations using the HMC. Using this functionality, the behavior of the LPARs can be changed.

The number of VCPUs available to a partition limit the number of whole physical processors that this LPAR can use, because one virtual processor represents at maximum one physical processor. The LPAR is therefore effectively capped at a maximum physical processor utilization that is equal to its number of configured VCPUs.

By reducing the SPLPAR weight, the LPAR is not actually capped, only its ability to compete for additional resources over its actual entitlement is reduced. If there is no competition for these resources, the SPLPAR is only restricted by its number of configured VCPUs, which allows it to be both flexible and not harmful to other workloads with higher priority (greater weights).

The advantage of implicit capping versus explicit capping is:

- The flexibility that is gained by low reserved entitlement, which allows more SPLPARs to be defined on the same number of physical processors versus a second implicit entitlement that can be guaranteed.
- SPLPARs with low weights can be protected from uncapped SPLPAR with higher weights using all the resources.
- Limit the maximum processors in hosting environments.
- Can be adjusted using dynamic LPAR operations.

**Note:** A partition that is capped and a partition that is uncapped with a weight of 0 are functionally identical. In terms of performance the results will be the same, as the processor utilization can only go up to the partition's entitled capacity. The monitoring of an SAP system can be impacted because a partition shows up as uncapped but behaves like a capped partition. When monitoring an uncapped SPLPAR it is recommended to always check the weight value.
Managing multiple shared processor pools

Multiple shared processor pools are useful in SAP landscapes in several ways, including the ability to separate workloads and to create subpools, which can be used to limit software license costs when they are based on the number of available processors.

To configure a shared processor pool, click *Shared Processor Pool* from the HMC task list on the left as shown in Figure 3-3. This opens a new window showing the configuration of the available shared processor pools.

![Configure the shared processor pool][1]

As shown in Figure 3-3, initially all processors (processing units) are available in the *DefaultPool*. To create another shared processor pool, for example, *SharedPool01*, processing units have to be assigned as shown in Figure 3-4.

![Create a new shared processor pool][2]

---

[1]: #/image/1337-HANAP-9119-MME-SN656666B.png
[2]: #/image/ish337-HANAP-9119-MME-SN656666B.png
Click **OK**. Figure 3-5 shows the new created shared processor pool named *SharePool01*.

![Figure 3-5  Shows the new shared processor pool](image)

After the shared processor pool has been created, a partition can be assigned to the pool using the same interface. Click **Partitions** tab, and select the partition name, as shown in Figure 3-6.

![Figure 3-6  Assign to a partition a shared processor pool](image)
Now, select the shared processor pool to be assigned to this partition as shown in Figure 3-7.

![Assign Partition to a Pool - ish337-HANAP-9119-MME-SN656666B](image1)

*Figure 3-7  Select the shared processor pool to assign to the partition*

As a result, the partition can now only consume the processor capacity that is available in SharedPool01 as shown in Figure 3-8.

![Shared Processor Pool: ish337-HANAP-9119-MME-SN656666B](image2)

*Figure 3-8  Shared processor pool resources for the partition*

**Enable Pool Utilization Authority**

In a shared processor pool environment, the Pool Utilization Authority (PUA) can be used to restrict visibility of monitoring data of an LPAR. This can be useful for example in hosted environments, where customers are not be able to collect information about the hosting system. However, monitoring processor usage in SAP systems will likely require additional metrics from the shared processor pool.

The PUA is configured separately for each partition. To explicitly grant the Pool Utilization Authority to an SPLPAR, click *Enable Performance Information Collection* on the HMC.
Select the SPLPAR in the HMC and open the General Properties page. Click Advanced to show the advanced properties of the partition and scroll down. Click Enable Performance Information Collection, and Click Save to immediately activate the change as shown in Figure 3-9.

![General pane - General Properties section](image)

3.2 Selecting and adjust simultaneous multithreading

Simultaneous Multithreading (SMT) was introduced as two-way multithreading (SMT-2) with POWER5 processors, followed by SMT4 in POWER7 and SMT8 with POWER8.

With POWER9 most workloads will perform best using SMT-8 which is also the default when a LINUX LPAR is booted. There are a few single threaded applications that benefit from lower SMT levels.

The SMT level is set with operating system commands, it can be switched on or off, or the number of hardware threads can be set explicitly. Changes to the SMT mode affect the whole partition and take effect immediately.

It is important to note that after a reboot, a Linux LPAR always defaults to the maximum supported SMT level, regardless of the SMT level that was active before the LPAR had been shut down. If the LPAR must run with a lower SMT level, then it must be set manually upon each reboot, for example, within a `boot.local` startup script.

The SMT mode of a Linux LPAR is managed with the `ppc64_cpu` command, using parameter `--smt`. It can be set to either on or off, or the SMT mode can be set directly. To switch on SMT, execute the command:

```
# ppc64_cpu --smt=on
```

or:

```
# ppc64_cpu --smt=8
```

To switch off SMT, execute the command:

```
# ppc64_cpu --smt=off
```
or:

```
# ppc64_cpu --smt=1
```

To select SMT-4 explicitly, execute the command:

```
# ppc64_cpu --smt=4
```

The current SMT setting is displayed with the command:

```
# ppc64_cpu --smt
SMT=4
```

### 3.3 Live Partition Mobility (LPM)

Live Partition Mobility (LPM) is a component of PowerVM enterprise edition and provides the ability to move AIX, IBM i and Linux logical partitions from one physical system to another.

LPM is widely used in SAP Landscapes to reduce planned downtime. SAP has included LPM operations into their products such as LAMA to take advantage of the mobility capability.

The mobility process transfers the system environment including the processor state, memory, attached virtual devices, and connected users. When the mobility process is ongoing end-users of an LPAR are not affected, are not exposed to what is happening in background. Most times LPM is taken into consideration when the administrator of the Power Systems decides on maintenance of the system, other planned outage or resource consideration.

When performing LPM, it is required to have another Power Systems, configured in almost the same way as the initial Power Systems in terms of network and storage. Errors in setup or connectivity can lead LPM to fail.

The following are a few requisites that must be considered when performing a LPM:

```
Note: Source and destination system firmware levels: Destination firmware level must be the same as the source or later if compatible. To check for compatibility, visit the following link:

https://ibm.co/2rFE1X1
```

- Check the logical memory block (LMB) matches on both systems. Log into the HMC and use the following command:
  
  `lshwres -r mem -m <machine name> --level sys -F mem_region_size`

- Check the destination system has enough memory to support the mobile partition.
- Check the destination system has enough processor to support the mobile partition.
- Check source and destination VIOS levels.
- Check the Mover Service Partition (MSP) attribute is selected on at least one VIOS in both systems.
- Check that SEA VLAN used for the logical partition to be moved, is present on the destination system.
- Check that all disks:
  - If mapped using VSCSI, are shared with one of the VIOS at the destination.
– If NPIV, the WWPN for Virtual Client adapter is both masked and zoned properly on the switch and the storage.

  ▶ Logical partitions must not have any physical hardware attached to them. All the storage and network connections to the LPAR must be virtual.

For more on the checklist, refer to the following documentation:

http://www.redbooks.ibm.com/abstracts/tips1184.html?Open#contents
https://ibm.co/2snNWQU

### 3.3.1 Types of LPM

There are two types of LPM that can be performed on an LPAR:

  ▶ Active partition mobility
  ▶ Inactive partition Mobility

Active partition mobility as the name suggest, is performed on a running LPAR. Running applications on the LPAR are not interrupted although all resources of an LPAR are moved to a different server.

Inactive partition mobility moves an LPAR that is in not activated state. It is often used to preserve the LPAR features, like storage, OS images, data disks, and most importantly the partition profile, which can be used to activate the LPAR again. This option is mainly used to decongest a Power Systems.

When LPM is performed, the minimum requirement of migrating the LPAR need to be checked. Before LPM is performed a validation check is executed, which checks for storage, network, OS level and other aspects which can result in LPM failure. Before migrating an LPAR it is always suggested to run a validation and if errors occur they need to be corrected. Otherwise the migration might fail and in extreme cases LPAR data might be corrupted.

Installations of SAP HANA can take advantage of IBM Live Partition Mobility (LPM), if the target infrastructure is supported and all prerequisites from SAP Note 2055470 (https://launchpad.support.sap.com/#/notes/2055470) are fulfilled. Before the LPM process HANA must be stopped. It is recommended to have a valid full backup before moving LPARs between host systems and to follow all recommendations of the solution vendor.

SAP HANA must be stopped as the LPAR placement can change after an LPM operation. For more on LPAR placement, refer to “NUMA” on page 15.

Concerns of functional issues can arise after LPM on an active HANA database. The NUMA placement of an LPAR is likely to change after migration. The SAP HANA database is a NUMA aware application, therefore SAP requires a restart of HANA in production systems after LPM to adapt to the new topology.

Before attempting LPM on a Linux LPAR ensure the Linux version is at least at the minimum supported level for LPM on Power Systems:

  ▶ Minimum SUSE Linux for Power V10 SP1
  ▶ Minimum Red Hat Linux for Power Version 5.1

The following sections demonstrate partition mobility of a HANA LPAR. Screenshots from the HMC console are used to visualize the process.
Throughout this demonstration the name of the LPAR to be migrated using LPM is *ls30021-3ac0eacd-000000f6*. This is the name of the managed system on the HMC. Its hostname on operating system level is *ls30021*, and will be used as a short name going forward. As shown in Figure 3-10, the LPAR *ls30021* has allocated 12 CPUs and 1000 GB memory and is in running state. **An active LPM** is performed, and to execute an **inactive LPM**, the LPAR has to be shutdown first.

Figure 3-10   Partitions pane
Figure 3-11 shows a snapshot of the properties of lsh30021. It is connected to the network using SEA and all attached disks use NPIV. The operating system is SUSE Linux SLES 12 SP3.

![Figure 3-11](image1)

Figure 3-11   Shows a snapshot of partition lsh30021

Figure 3-12 shows all virtual networks associated with the selected logical partition.

![Figure 3-12](image2)

Figure 3-12   Virtual Networks table
Figure 3-13 shows the virtual storage channels assigned to the PowerVM configuration.

![Virtual Storage assigned to the PowerVM configuration](image)

**Figure 3-13  Virtual Storage assigned to the PowerVM configuration**

**NUMA and HANA status**

Example 3-1 shows the output of `numactl --hardware` which documents the current NUMA topology. At this point, the LPAR has 96 logical CPUs (SMT threads) and 1000 GB of memory, all located on node 1. The same command is used to check the NUMA topology after the LPM is completed.

**Example 3-1  Output of the current NUMA topology**

```
[root@lsh30021 ~]# numactl --hardware
available: 2 nodes (0-1)
node 0 cpus:
node 0 size: 0 MB
node 0 free: 0 MB
node 1 cpus: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58
59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
89 90 91 92 93 94 95
node 1 size: 1022928 MB
node 1 free: 774444 MB
node distances:
node   0   1
0:  10  40
1:  40  10

[root@lsh30021 ~]# su - db1adm
db1adm@lsh30021:/usr/sap/DB1/HDB00> HDB info
USER PID PPID %CPU VSZ RSS COMMAND
db1adm 21902 21901 0.2 112960 5312 -sh
db1adm 21982 21902 0.0 112064 4096 _/bin/sh /usr/sap/DB1/HDB00/HDB info
db1adm 22013 21982 0.0 118784 8576 _/bin/sh /usr/sap/DB1/HDB00/HDB info

```

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The commands illustrated in Example 3-2 indicate the HANA database is up and running.

**Example 3-2 Checks status of HANA database**

```
24.05.2019 08:25:09
GetProcessList
OK
```

**Example 3-3 Stopping HANA**

```
24.05.2019 08:40:43
Stop
OK
Waiting for stopped instance using: /usr/sap/DB1/SYS/exe/hdb/sapcontrol -prot NI_HTTP -nr 00 -function WaitforStopped 600 2
```

HANA is now stopped as a preparation for LPM as shown in Example 3-3.
Example 3-4 and Example 3-5 shows performing checks to verify HANA has stopped.

**Example 3-4  Confirms HANA stopped**

```
Example 3-4   Confirms HANA stopped

db1adm@lsh30021:/usr/sap/DB1/HDB00> HDB info
USER       PID  PPID  %CPU  VSZ   RSS COMMAND
db1adm     21902  21901  0.0   112960   5440  -sh
db1adm     30903  21902  0.0   112064  4096  _/bin/sh /usr/sap/DB1/HDB00/HDB info
db1adm     30934  30903  0.0   118784  8512  _ ps fx -U db1adm -o
user:8,pid:8,ppid:8,pcpu:5,vsz:10,rss:10,argv
Example 3-5   Additional checks to confirm HANA has stopped

db1adm@lsh30021:/usr/sap/DB1/HDB00> HDB proc
USER       PID  PPID  %CPU  VSZ   RSS COMMAND
db1adm     30949  21902  0.0   112064  4160  _/bin/sh /usr/sap/DB1/HDB00/HDB proc
db1adm     30982  30949  0.0   112064  1024  _/bin/sh /usr/sap/DB1/HDB00/HDB proc
```

**Example 3-5  Additional checks to confirm HANA has stopped**

```
Example 3-5  Additional checks to confirm HANA has stopped

db1adm@lsh30021:/usr/sap/DB1/HDB00> sapcontrol -nr 00 -function GetProcessList
24.05.2019 08:42:57
GetProcessList
OK
name, description, dispstatus, textstatus, starttime, elapsedtime, pid
hdbdaemon, HDB Daemon, GRAY, Stopped, , , 23993
```

After confirming HANA has stopped, a LPM migration is performed using the HMC GUI.

First select the partition to be migrated and then select the **Migrate** option in the **Partition Actions** menu.
The *Partition Migration* dialog opens at the *Migration Information* step as shown in Figure 3-14. Each step asks for migration relevant information. The default is often sufficient, but can always be changed by the user.

![Partition Migration dialog](image)

*Figure 3-14  Partition Action - Migration Information*
Figure 3-15 shows the Profile Name pane to create a new migration profile with the current state of the partition.
Figure 3-16 shows one HMC is managing the source and the destination system, so the *Remote Migration* check box in the *Remote HMC* step stays unselected. If the destination system is managed by a different HMC, the destination HMC information needs to be entered in this step.

Figure 3-16   Remote HMC pane - Specify remote HMC and user for partition migration
Select the destination system in the *Destination* step as shown in Figure 3-17. It can be selected from a drop-down list supplied by the destination HMC.

![Partition Migration - Destination selection](image)

*Figure 3-17  Partition Migration - Destination selection*

The *Validation Errors/Warnings* step runs through a large number of tests to check if a LPM can be executed successfully. If this step indicates an error, a LPM cannot be performed between the systems. Carefully evaluate and correct any errors.

**Note:** Checks issuing a warning might or might not inhibit a successful migration. Evaluate warnings carefully and validate potential issues.
Figure 3-18  Partition Migration - Validation of errors and warnings

Validation Errors/Warnings

Mover Service Partitions
VLAN Configuration
Virtual Storage Adapters
Wait Time
Summary

HSCLA4CC The management console cannot maintain the source Virtual I/O Server (VIOS) slot number 11 for virtual SCSI adapter 3 on the destination VIOS partition 2*8408-44E*10C3751.
HSCLA4CD The management console cannot maintain the source Virtual I/O Server (VIOS) slot number 12 for virtual fibre channel adapter 6 on the destination VIOS partition 2*8408-44E*10C3751.
HSCLA4CD The management console cannot maintain the source Virtual I/O Server (VIOS) slot number 5 for virtual fibre channel adapter 4 on the destination VIOS partition 1*8408-44E*10C3751.
Figure 3-18 on page 36 and Figure 3-19 on page 37 indicate no errors but a few warnings. This case does not prohibit a successful migration.
The *Mover Service Partitions* step enables the definition of mover service partitions or MSPs. MSPs are VIOS installations on Power Systems which perform the actual work during the migration. One MSP has to be selected on the source system and one on destination system as shown in Figure 3-20. By default, the HMC pre-selects one VIOS but it can be changed in this step.

![Figure 3-20 Mover Service Partitions pane](image-url)

---

**Figure 3-20** Mover Service Partitions pane
Next, the network information is gathered as shown in Figure 3-21.
Net the storage information is gathered as shown in Figure 3-22.

![Virtual Storage Adapters gathering pane](image)

**Figure 3-22** Virtual Storage Adapters gathering pane
In the *Wait Time* step, a timeout value is set and prefilled by the HMC as shown in Figure 3-23. The wait time value is the time to wait for applications to acknowledge that a migration is happening. This value might have to be increased depending on the configuration of the migrated partition.

![Diagram of Wait Time pane - Partition migration timer](image)

*Figure 3-23  Wait Time pane - Partition migration timer*
The Summary step lists all the inputs selected during this process as shown in Figure 3-24. Carefully review the values and click Finish to start the migration.

Figure 3-24  Summary pane
The migration started and a progress bar is displayed as shown in Figure 3-25.

![Partition Migration Status pane](image)

**Figure 3-25**  Partition Migration Status pane

The progress bar continues to count up to 100% until LPM successfully completes. Figure 3-26 shows a successfully completed migration.

![Partition Migration Status pane - Progress completion](image)

**Figure 3-26**  Partition Migration Status pane - Progress completion
After the successful migration, LPAR *ish30021* is no longer listed on the managed system *ish360* as shown in Figure 3-27.

![Figure 3-27 Partitions information pane](image)

*ish40021* is now available and running on the destination system *ish369* as shown in Figure 3-28. The entire migration has been performed through a graphical interface, and the user did not need in-depth knowledge of the technical details of the migration.

![Figure 3-28 Partitions information pane - Partition now in destination](image)

It is recommended to log into the LPAR and perform any functional checks to ensure the applications are running smoothly on the new host.
As the partition is likely on different CPUs compared to the old host, the NUMA configuration is likely different, and can be checked again just like in the beginning of the migration as shown in Example 3-6.

Although on the old host all CPUs were allocated on node 1, now 48 logical CPUs reside on node 0 and 48 logical CPUs are allocated on node 1. All memory is still allocated on node 1. HANA was stopped before the migration exactly because of this kind of scenario. HANA assumes CPU 0-48 still being on node 1 and due to NUMA optimizations within HANA which helps performance on the old host might now negatively impact performance as the topology is not as HANA assumes.

Example 3-6   Checking the NUMA configuration

```
[root@lsh30021 ~]# numactl --hardware
available: 2 nodes (0-1)
node 0 cpus: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
node 0 size: 0 MB
node 0 free: 0 MB
node 1 cpus: 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95
node 1 size: 1022928 MB
node 1 free: 794788 MB
node distances:
node   0   1
0:  10  40
1:  40  10
[root@lsh30021 ~]#
```

HANA is started successfully in the new topology as shown in Example 3-7.

Example 3-7   Start HANA

```
dbladm@lsh30021:/usr/sap/DB1/HDB00> HDB start

StartService
Impromptu CCC initialization by 'rscpCInit'.
  See SAP note 1266393.
OK
OK
Starting instance using: /usr/sap/DB1/SYS/exe/hdb/sapcontrol -prot NI_HTTP -nr 00 -function StartWait 2700

24.05.2019 08:43:29
Start
OK
24.05.2019 08:45:33
StartWait
OK
dbladm@lsh30021:/usr/sap/DB1/HDB00> HDB proc

USER   PID   PPID  %CPU   VSZ   RSS COMMAND
dbladm 1148  21902  0.0 112064  4160  /_ /bin/sh /usr/sap/DB1/HDB00/HDB proc
dbladm 1181  1148  0.0 112064 1024  /_ /bin/sh /usr/sap/DB1/HDB00/HDB proc
dbladm 31779     1  0.0 10048  4928 sapstart pf=/hana/shared/DB1/profile/DB1_HDB00_lsh30021.sap.corp
dbladm 31801 31779  0.3 412416 78080  /_ /usr/sap/DB1/HDB00/lsh30021.sap.corp/trace/hdb.sapDB1_HDB00 -d -nw -f /usr/sap/DB1/HDB00/lsh30021.sap.corp/daemon.ini
pf=/usr/sap/DB1/SYS/profile/DB1_HDB00_lsh30021.sap.corp
dbladm 31819 31801  92.3 8777152 3764992  /_ hdbnameserver
```

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Example 3-8 shows HANA functioning in the new partition.

**Example 3-8 Checking HANA functionality**

db1adm@lsh30019:/usr/sap/DB1/HDB00> sapcontrol -nr 00 -function GetProcessList

24.05.2019 09:18:34
GetProcessList
OK
name, description, dispstatus, textstatus, starttime, elapsedtime, pid
hdbdaemon, HDB Daemon, GREEN, Running, 2019 05 24 08:43:30, 0:35:04, 31801
hdbcompileserver, HDB Compileserver, GREEN, Running, 2019 05 24 08:43:39, 0:34:55, 32066
hdbindexserver, HDB Indexserver-QH1, GREEN, Running, 2019 05 24 08:43:40, 0:34:54, 32117
hdbnameserver, HDB Nameserver, GREEN, Running, 2019 05 24 08:43:31, 0:35:03, 31819
hdbpreprocessor, HDB Preprocessor, GREEN, Running, 2019 05 24 08:43:39, 0:34:55, 32069
hdbweb_dispatcher, HDB Web Dispatcher, GREEN, Running, 2019 05 24 08:43:40, 0:34:54, 32120

The LPM process works much the same way if an offline migration is performed. The only difference is that the OS in the partition is not active during the migration.

To provide a great level of flexibility for Power Systems owners, it is possible to migrate up to 32 LPARs in parallel.

The latest version of VIOS (v3.1) introduces data encryption and compression support during migration and 100 Gbit Ethernet cards. This increases data security and reduces migration duration. Starting with server firmware FW920, HMC version V9 R1.920.0 and Novalink 1.0.0.10, the data sent between the servers is automatically encrypted for better security and compressed for better performance.

Fast data transfer speeds are especially important in HANA environments as the in-memory character of HANA tends to allocate a lot of memory, and therefore large amounts of memory need to be transferred.

For more information about these new features refer to this link:
https://ibm.co/2LQeNfi

The following links provide important SAP notes for LPM:
https://launchpad.support.sap.com/#/notes/1102760
https://launchpad.support.sap.com/#/notes/994025
3.4 Dynamic Platform Optimizer (DPO) and Dynamic Logical Partitions (DLPAR) operations

This section describes features enhancing logical partitions, hence providing additional capabilities for applications running on Power Systems servers.

3.4.1 Viewing current topology information

From a Linux LPAR, the CPU and memory resource topology detected by the OS can be inspected with the `numactl` command as shown in Example 3-9.

Example 3-9  Checking the hardware topology information

```
# numactl --hardware
available: 2 nodes (0-1)
node 0 cpus: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
node 0 size: 0 MB
node 0 free: 0 MB
node 1 cpus: 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63
node 1 size: 260811 MB
node 1 free: 141305 MB
node distances:
   node   0   1
0:  10  20
1:  20  10
```

This `numactl` output (Example 3-9) shows an LPAR with CPU resources equally allocated on numa node 0 and numa node 1. Memory resources however are allocated only from numa node 1.

A system level view of the topology can be collected with a system resource dump from the HMC as shown in Example 3-10.

Example 3-10  System topology view using a system resource dump

```
hscroot@hmc1:~> startdump -m SystemA-9119-MME-SN65C4D3D -t resource -r 'hvlpconfigdata -affinity -domain'
hscroot@hmc1:~> cat /dump/RSCDUMP.65C4D3D.04000004.20190527045853

<table>
<thead>
<tr>
<th>Domain</th>
<th>Proc Units</th>
<th>Memory Units</th>
<th>Proc Units</th>
<th>Memory Units</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEC PRI</td>
<td>Total Free</td>
<td>Total Free</td>
<td>Total Free</td>
<td>Total Free</td>
<td></td>
</tr>
<tr>
<td>0 0</td>
<td>4000 400</td>
<td>8192 1452</td>
<td>2 200 200</td>
<td>16 16</td>
<td>1772</td>
</tr>
<tr>
<td></td>
<td>1000 200</td>
<td>2048 834</td>
<td>6 400 400</td>
<td></td>
<td>2036</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 100 100</td>
<td>640 640</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13 100 100</td>
<td>512 512</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>15</td>
<td>1 1</td>
<td></td>
</tr>
<tr>
<td>1 1</td>
<td>1000 200</td>
<td>2048 452</td>
<td>1 200 200</td>
<td>16 16</td>
<td>1103</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 400 400</td>
<td>1024 1024</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>199 200 200</td>
<td>512 512</td>
<td></td>
</tr>
<tr>
<td>2 2</td>
<td>1000 0</td>
<td>2048 154</td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>
```
Example 3-10 on page 47 shows resource dump information for LPAR 6 matching the information collected with `numactl` as shown in Example 3-9 on page 47.

### 3.4.2 Dynamic Logical Partitioning (DLPAR)

This section describes how to identify partitions enabled for dynamic partitioning and its capabilities.

#### DLPAR capable LPARs

Example 3-11 shows the `lspartition -dlpar` command executed in the HMC indicating whether a LPAR is capable of executing DLPAR operations.

```
Example 3-11 Check LPAR capabilities for Dynamic Logical Partitioning

# lspartition -dlpar
<#178> Partition:<1*9179-MHD*10226D4, ish356v1.wdf.sap.corp, 10.17.102.142>
Active:<1>, OS:<AIX, 6.1, 6100-09-06-1543>, DCaps:<0x14f8f>, CmdCaps:<0x4000003b, 0x3b>, PinnedMem:<2111>
<#179> Partition:<3*9080-M9S*7816D78, lsh30220.wdf.sap.corp, 10.17.103.26>
Active:<1>, OS:<Linux/SuSE, 4.4.140-94.42-default, 12>, DCaps:<0x0>, CmdCaps:<0x0, 0x0>, PinnedMem:<0>
<#180> Partition:<20*9119-MME*65C4D3D, lsh30078.wdf.sap.corp, 10.17.102.144>
Active:<1>, OS:<Linux/SuSE, 4.4.162-94.72-default, 12>, DCaps:<0x2c7f>, CmdCaps:<0x40000019, 0x19>, PinnedMem:<0>
<#181> Partition:<2*9119-MHE*1092627, ish329v2.wdf.sap.corp, 10.17.102.21>
Active:<1>, OS:<AIX, 6.1, 6100-09-06-1543>, DCaps:<0x14f8f>, CmdCaps:<0x4000003b, 0x3b>, PinnedMem:<2507>
```
A $Dcaps$ value of 0x0 indicates that DLPAR operations are not available for the LPAR. The most common cause for not supporting DLPAR operations is an inactive RMC (Resource Monitoring and Control) connection. To enable this connection, install the DynamicRM and ServiceRM filesets in the Linux OS.

The following RPMs must be installed in the order listed:

- src
- rsct.core.utils
- rsct.core
- csm.core
- csm.client
- devices.chrp.base.ServiceRM
- DynamicRM

**DLPAR operation examples**

The `chhwres` command on the HMC is used to perform DLPAR operations. Refer to the man page for a complete description.

Use the syntax as follows to add, remove, or move memory:

```
chhwres -r mem -m managed-system -o {a | r | m} {-p partition-name | --id partition-ID} [-t target-partition-name | --tid target-partition-ID] -q quantity [-w wait-time] [-d detail-level] [--force]
```

For example, the following command removes 256 GB memory from the LPAR with id 6 on the managed system:

```
chhwres -r mem -m SystemA-9119-MME-SN65C4D3D -o r -id 6 -q 256
```

Use the syntax as follows to add, remove, or move processing resources:

```
```

For example, the following command adds 3 processors to the LPAR with id 6 on the managed system:

```
chhwres -r proc -m SystemA-9119-MME-SN65C4D3D -o a -id 6 -procs 3
```

### 3.4.3 Dynamic Platform Optimizer (DPO)

This section describes DPO and its characteristics.

**Affinity scores**

The command `lsmemopt` is used on the HMC to determine affinity scores for the system as a whole or for individual logical partitions:

```
lsmemopt -m managed-system [-r {sys | lpar}] [-o {currscore | calcscore}] [-p partition-names | --id partition-IDs] [-x partition-names | --xid partition-IDs] [--filter "filter-data"] [-F [attribute-names] [--header]] [--help]
```

Refer to the man page for a complete description.
The affinity score is a number in the range 0 - 100, 0 represents the worst affinity and 100 represents perfect affinity.

When used with the option `currscore`, the current processor to memory affinity scores are displayed.

When used with the option `calcscore`, the predicted or potential affinity score is calculated and displayed, which is an estimate of the affinity score that can be achieved after a DPO operation.

**DPO priority order**

DPO operations are executed in order of priority. To determine the priority the LPAR attribute `affinity_group_id` is evaluated. This attribute supports values between 1 (lowest priority) to 255 (highest priority).

Multiple LPARs can share the same value, this directs the hypervisor to attempt to collocate the LPARs on the same chip or node as much as possible. Among LPARs with the same `affinity_group_id`, priority is set based on cpu and memory resource allotments.

**Starting DPO**

The HMC command `optmem` executes DPO operations:

```
optmem -m managed-system -o start -t affinity [-p partition-names | --id partition-IDs] [-x partition-names | --xid partition-IDs]
```

where:

-x partition-names or --xid partition-IDs specifies the list of logical partition names or logical partition IDs that must NOT be affected by the optimization operation.

-p partition-names or --id partition-IDs specifies the list of logical partition names or logical partition IDs selected for optimization.

**Viewing DPO progress**

Depending on size and utilization of LPARs, DPO operations can take a significant amount of time. The current status can be displayed with the `lsmemopt` command as shown in Example 3-12.

```
Example 3-12  Shows current status of DPO

# lsmemopt -m SystemA-9119-MME-SN65C4D3D
in_progress=0,status=Finished,type=affinity,opt_id=1,
progress=44,requested_lpar_ids=none,protected_lpar_ids=none,"impacted_lpar_ids=6"
```
KVM and Red Hat Virtualization management and operations

KVM and Red Hat Virtualization (RHV) are providing fast virtualization for Linux guests on small and medium sized systems.

This chapter contains the bare metal firmware configuration, bootstrap, installation of KVM host operating system and the Red Hat Virtualization software.

This chapter contains the following:
- Bare Metal getting started and prepare server
- Bootstrap of bare metal Power Systems hardware
- Install RHEL OS as KVM host on bare metal Power Systems hardware
- Red Hat Virtualization
4.1 Bare Metal getting started and prepare server

The bare metal installation (BMI) is a direct installation of an operating system on top of the firmware. Here explicitly the installation of a RHEL Linux operating system on local disks.

This section contains information about configuration, firmware updates of server and integrated RAID-adapters.

**Note:** The system firmware is a combination of the BMC firmware and the processor NOR (PNOR) firmware. To update the system firmware, update both the BMC firmware and the PNOR firmware by using the BMC.

4.1.1 Prepare bare metal firmware

Use the Quick Start Guide for Installing Linux on Linux Cloud and Cluster (LC) servers. This guide helps you to install Linux on a Power Systems server (Figure 4-1):


4.1.2 Petitboot bootloader

Petitboot is a bootloader based on kexec used in IBM POWER8 and POWER9 systems to boot the initial Linux operating system.
After the Power Systems powers on, the petitboot bootloader scans local boot devices and network interfaces to find boot options that are available to the system. Petitboot presents a list of boot options valid the running system. In the case of a static IP or no provided boot arguments for a network boot server, details have to be provided to petitboot. Petitboot can be configured to find the boot device with the following instructions:

https://ibm.co/34oYD3e

The petitboot configuration can be adjusted. For example: To change the amount of time before petitboot automatically boots, use these instructions:

https://ibm.co/38LAPdh

After selecting to boot the ISO media for the Linux distribution of choice, the installer wizard for this Linux distribution appears and is used to setup disk options, root password, time zones, and others.

To read more information about the petitboot bootloader program, refer to the following link:

https://www.kernel.org/pub/linux/kernel/people/geoff/petitboot/petitboot.html

### 4.1.3 Configuring the BMC IP address

To set up or enable a network connection to the Baseboard Management Controller (BMC), use the Petitboot bootloader interface. Follow these steps:

1. Power on your server using the power button on the front of your system. Your system powers on to the Petitboot bootloader menu. This process takes about 1 to 2 minutes to complete. Do not walk away from your system. When Petitboot loads, your monitor becomes active, and you need to push any key to interrupt the boot process.

2. At the Petitboot bootloader main menu, select Exit to Shell.

3. Run the `ipmitool lan print` command. If this command returns an IP address, verify that it is correct and continue. To set a static IP address, follow these steps:
   a. Set the mode to static by running this command:

   ```bash
   ipmitool lan set 1 ipsrc static
   ```

   b. Set your IP address by running this command:

   ```bash
   ipmitool lan set 1 ipaddr <ip_address>
   ```

   Where `ip_address` is the static IP address that you are assigning to this system.

   c. Set your netmask by running this command:

   ```bash
   ipmitool lan set 1 netmask <netmask_address>
   ```

   Where `netmask_address` is the netmask for the system.

   d. Set your gateway server by running this command:

   ```bash
   ipmitool lan set 1 defgw ipaddr <gateway_server>
   ```

   Where `gateway_server` is the gateway for this system.

---

e. Confirm/check the IP address by running again the command:

   ipmitool lan print 1

   **Note:** This network interface is not active until after you perform the following steps.

4. To reset your firmware, run the following command:

   ipmitool mc reset cold

   This command must complete before continuing the process; however, it does not return any information. To verify that this command has completed, ping your system BMC address (the same IP address used in your `ipmitool` command). When the ping returns successfully, continue to the next step.

   **Note:** If your ping does not return successfully within a reasonable amount of time (2 - 3 minutes), try these additional steps:

   a. Power your system off with this command:

   ipmitool power off

   b. Unplug the power cords from the back of the system. Wait 30 seconds and then apply power to boot BMC.

### Logging on to the BMC GUI

To log on to the BMC GUI, complete the following steps:

1. Open a supported web browser. In the address bar, enter the host name or the IP address of the BMC to connect to. For example, use the format `http://1.2.3.4` or `http://hostname.example.com` in the address bar of the web browser.

2. On the BMC logon page, enter the Username and Password that is assigned to you.

   **Notes:**

   a. The default user ID is ADMIN and the default password is ADMIN (admin).

   b. If you forgot your assigned password, enter your user name and click **Forgot Password**? Follow the window instructions.

3. Click **Login**.

### 4.1.4 BMC Setting up password controls

Password controls can be setup for the BMC LAN access on Power Systems servers. This section shows how to set up password control for two users (default user with user ID 1 and the null user) in the LAN channel.

   **Note:** To reduce vulnerability, the IPMI LAN interface must be enabled only in a trusted environment where the system is secure, or where it is connected to a dedicated secure or private network.

The BMC can be configured to support multiple users and passwords for all channels except the Open channel. Typically the same user and same password can be used for all the BMC channels. Instructions to set up password control for other channels are not included in this example. The instructions can only be used for the LAN channel.
User IDs and privilege levels are unique for each channel. To view the current user IDs that are in use and the related information for the LAN channel (0x1), run the following command:

```
# ipmitool user list 1
```

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Callin Link</th>
<th>Auth IPMI</th>
<th>Msg</th>
<th>Channel</th>
<th>Priv</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>USERID</td>
<td>true</td>
<td>false</td>
<td>true</td>
<td>ADMINISTRATOR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** On all IBM BMCs, the default user ID 1 is USERID with a password of PASSWORD.

To change the name of user ID 1, run the following command:

```
# ipmitool user set name 1 <New User ID>
```

To set a new password for user ID 1, run the following command:

```
# ipmitool user set password 1 <New Password>
```

You can also use a null user for anonymous login. To change the password for the null user (user ID 1) on the LAN channel, run the following command:

```
# ipmitool lan set 1 password <New Password>
```

You can list the users that you have set up and find the new name (user ID) for user ID 1 user. The null user is not listed by running the following command when it is disabled in the BMC BIOS settings:

```
# ipmitool user list 1
```

### 4.1.5 Update firmware using the ipmitool

The Intelligent Platform Management Interface (IPMI) is an open standard for monitoring, logging, recovery, inventory, and control of hardware that is implemented independent of the main CPU, BIOS, and OS. These LC servers provide one 10M/100M baseT IPMI port.

The `ipmitool` is a utility for managing and configuring devices that support IPMI. It provides a simple command-line interface to the service processor. The `ipmitool` can be installed from the Linux distribution packages in your workstation, sourceforge.net, or another server (preferably on the same network as the installed server).

The *Minimum ipmitool Code Level* required by the System Firmware for managing the system. OpenPOWER requires `ipmitool` level v1.8.15 or later to execute correctly on the OP910 firmware. It must be capable of establishing a IPMI v2 session with the IPMI support on the BMC. Verify your `ipmitool` level on your Linux workstation using the following command:

```
# ipmitool -V
```

**ipmitool version 1.8.18**

**Important:** The syntax can be different under Linux and windows, and connection problems can be caused by outdated firmware.

To connect to your host system with IPMI, you need to know the IP address of the server and have a valid password. To power on the server with the `ipmitool`, follow these steps:

1. Open a terminal program.
2. Power on your server with the `ipmitool`:

   ```
   ipmitool -I lanplus -H bmc_ip_address -U ipmi_userid -P ipmi_password power on
   ```

**Tip:** In case of connection problems, this can be due to an outdated firmware.
3. Activate your IPMI console:

```
ipmitool -I lanplus -H bmc_ip_address -U ipmi_userid -P ipmi_password sol activate
```

Information on the `ipmitool` and the firmware update process can be read in the IBM Knowledge Center at the following website:


For example:

1. Verify your current firmware level by running the following command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password fru list
```

   Look for the section titled FRU Device Description: System Firmware (ID xx). Then find the value under Product version. This value is your current firmware level.

2. Download your firmware fix from Fix central at the following website http://www-933.ibm.com/support/fixcentral/. Click Select Product. Choose Power from Product Group and Scale-out LC from the Product. Select your server model and the fixes that you want to download. Click Continue.

3. Your system must be in standby state to update the firmware. Power off the system using the following command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password chassis power off
```

4. Reset the hardware to a known state with the following command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password command mc reset cold
```

   This command must complete before continuing the process. To verify that this command has completed, ping your system BMC address (the same IP address used in your `ipmitool` command). When the ping returns successfully, continue to the next step.

5. To protect the BMC network and IPMI settings, run the following command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password raw 0x32 0xba 0x18 0x00
```

   **Note:** This command does not return any output.

6. To flash the BMC and PNOR firmware, run this command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password hpm upgrade firmware_update_name -z 30000 force
```

   **Note:** The update process for this firmware version can require up to 30 minutes to complete per BMC.

7. Restart your system by running the following command:

```
ipmitool -H bmc_ip_ipaddress -I lan -U ipmi_user -P ipmi_password chassis power on
```

   **Important:** If the update process is ended before it completes, wait at least 30 minutes before retrying. You can also reset the firmware and try again immediately by running this command:

   `ipmitool mc reset cold`

**Helpful ipmitool commands**

The following `ipmitool` commands are useful:

- Command line help:
# ipmitool help

- To display the history of your system event log:
  # ipmitool sel list

- The ipmitool chassis command can be used to obtain information and the status of a system locally or remotely:
  # ipmitool chassis status

### 4.1.6 Update the firmware using OpenBMC CLI

The process of updating firmware on the OpenBMC managed servers is documented in this section.

The following events must happen in sequence:

1. Power off the Host
2. Update and Activate BMC
3. Update and Activate PNOR (processor NOR (PNOR) flash chip)
4. Reboot the BMC (applies new BMC image)
5. Power on the Host (applies new PNOR image)

The OpenBMC firmware updates (BMC and PNOR) for the servers can be managed by way of the command line with the openbmctool.

The openbmctool is obtained using the IBM Support Portal at the following website:

1. Go to the IBM Support Portal.
2. In the search field, enter your machine type and model. Then click the correct product support entry for your system.
3. From the downloads list, click openbmctool for your machine type and model.
4. Follow the instructions to install and run the openbmctool. You need to provide the file locations of the BMC firmware image tar and PNOR firmware image tar that must be downloaded from Fix Central for the update level needed.

Information on the openbmctool and the firmware update process can read in the IBM Knowledge Center at the following website:
[https://ibm.co/2svfPGW](https://ibm.co/2svfPGW)

Example for the command-line:

```
# cd firmware-update-directory

# openbmctool -U root -P OpenBmc -H powerbmc firmware flash bmc -f obmc-witherspoon-ibm-v2.0.ubi.mtd.tar

# openbmctool -U root -P OpenBmc -H powerbmc fru print | grep Activ

# openbmctool -U root -P OpenBmc -H powerbmc firmware flash pnor -f witherspoon-IBM-OP9_v1.19_1.192.pnor.squashfs.tar

# openbmctool -U root -P OpenBmc -H powerbmc fru print | grep Activ

# openbmctool -U root -P OpenBmc -H powerbmc mc reset cold
```
Helpful openbmctool commands

The following are helpful openbmctool commands:

- `openbmctool -H <hostname> -U root -P OpenBmc chassis power -h`
- `openbmctool -H <hostname> -U root -P OpenBmc chassis power status`
- `openbmctool -H <hostname> -U root -P OpenBmc chassis power softoff`
- `openbmctool -H <hostname> -U root -P OpenBmc chassis power on`

4.1.7 Update the system firmware using the BMC Web GUI

Another method to update the system firmware is by using the baseboard management controller (BMC) Web GUI. For more information refer to the following link:

https://ibm.co/391E5kI

**Note:** System firmware update from the BMC Web GUI is only supported on Google Chrome and Mozilla Firefox browsers.

Complete the following steps to update the BMC firmware:

1. Log in to the BMC by entering the user name and password. Then, press Enter.
2. From the Maintenance list on the BMC dashboard, select BMC Update as shown in Figure 4-2.

![BMC Update pane](Figure 4-2  BMC Update pane)

3. In the BMC Update window, select Enter Update Mode. Click OK.
4. In the BMC Upload window, choose the .bin file from your local system folder and click Upload Firmware. Wait for the file to be uploaded. Then, click OK.
5. The existing and new versions of the BMC firmware are displayed as shown in Figure 4-3 on page 59. Ensure that the Preserve Configuration check box is selected and the Preserve SDR check box is not selected. Click Start Upgrade.

**Note:** You cannot perform other activities by using the BMC interface until the firmware update is complete.
6. The upgrade progress of the firmware update is displayed as shown in Figure 4-4. After the BMC update is complete, the system is restarted.

After the restart of the system is complete, verify the firmware revision level in the System menu of the BMC dashboard.

Complete the following steps to update the PNOR firmware:
1. Log in to the BMC by entering the user name and password. Then, press Enter.
2. From the maintenance list on the dashboard, select PNOR Update as shown in Figure 4-5.

![PNOR Upload pane - Select the image to upload](image1)

Figure 4-5  PNOR Upload pane - Select the image to upload

3. In the PNOR Upload window, choose the .pnor file from your local system folder and click Upload PNOR. Wait for the file to be uploaded. Then, click OK.

4. The existing and new dates of the PNOR firmware are displayed. Click Start Upgrade.

   **Note:** You cannot perform other activities by using the BMC interface until the PNOR update is complete.

5. The progress of the PNOR update is displayed as shown in Figure 4-6. After the PNOR update is completed, the system must be restarted to finish installation of the new PNOR firmware.

![PNOR Update pane - upgrade progress](image2)

Figure 4-6  PNOR Update pane - upgrade progress

For more information about updating the firmware using the BMC, refer to the following link: [https://ibm.co/2Pu1ucZ](https://ibm.co/2Pu1ucZ)

### 4.1.8 iprconfig – IBM Power RAID Configuration Utility

The following section describes how to configure the internal disks with the IBM Power RAID controller installed.
First in the petitboot menu go to → Exit to shell as shown in Figure 4-7.

![Figure 4-7 Petitboot menu - Exit to shell](image)

At the prompt, enter the `iprconfig` command. The following menu appears as shown in Figure 4-8.

![Figure 4-8 IBM Power RAID Configuration Utility menu](image)

Enter option 2 to work with disk arrays as shown in Figure 4-9.

![Figure 4-9 Work with Disk Arrays](image)

### 4.1.9 arcconf – Adaptec RAID Controller CLI

The following section describes how to configure the internal disks with the Adaptec RAID controller installed.
In the petitboot menu → Exit to shell as shown in Figure 4-10.

![Petitboot menu pane - Exit to shell](image)

At the prompt, type the `arcconf` command and the UCLI pane appears as shown in Figure 4-11.

![UCLI pane - Help window](image)

Check the physical disks before you start to create the arrays:

```bash
# arcconf getconfig 1 PD
```

To make the output more compact, use the following command:

```bash
# arcconf getconfig 1 pd|egrep "Device #|State>|Reported Location|Reported Channel| S.M.A.R.T. warnings"
```

To delete a logical drive, use the following command:

```
arcconf DELETE <Controller#> LOGICALDRIVE <ld#>
```

For example, to delete logical drive 0, use the following command:

```bash
# arcconf DELETE 1 LOGICALDRIVE 0
```

or to delete all the drives, use the following command:

```bash
# arcconf DELETE 1 LOGICALDRIVE ALL
```

To set up a hardware-based RAID, create a logical drive using the following command:

```
CREATE <Controller#> LOGICALDRIVE [Options] <Size> <RAID#> <Channel# ID#>
```

For example, to create a **RAID 0**, maximum size, drives on Channel 0, Port 0, 1, 2 and 3, no confirmation, you can use the following command:

```bash
# arcconf CREATE 1 LOGICALDRIVE MAX 0 0 0 1 0 2 0 3 noprompt
```

To create a **RAID 5**, maximum size, drives on Channel 0, Port 0, 1, 2 and 3, no confirmation, use the following command:

```bash
# arcconf CREATE 1 LOGICALDRIVE MAX 5 0 0 0 1 0 2 0 3 noprompt
```
To create a RAID-10, maximum size, drives on Channel 0, Port 0, 1, 2 and 3, no confirmation, use the following command:

```
# arcconf CREATE 1 LOGICALDRIVE MAX 10 0 0 0 1 0 2 0 3 noprompt
```

To create a RAID-6, maximum size, drives on Channel 0, Slot 0 - 12, no confirmation, use the following command:

```
# arcconf CREATE 1 LOGICALDRIVE MAX 6 0 0 0 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 0 10 0 11 0 12 noprompt
```

To get the logical drive information, use the following command:

```
# arcconf getconfig 1 LD
```

### 4.1.10 storcli – Supermicro RAID Controller configuration and firmware update

The section describes how to configure the internal disks with the Supermicro RAID controller installed. For additional information, refer to the following website:

[https://ibm.co/2MkgFgN](https://ibm.co/2MkgFgN)

This controller type is for use with the PCIe adapter feature codes EKAA and EKEA.

If the `storcli` utility command has not been installed, download the utility from Broadcom [https://www.broadcom.com/](https://www.broadcom.com/). It can be found by searching the site for `storcli`. Download the latest version of *MegaRAID Storcli*. To install the driver, extract the file and follow the corresponding documentation for:

**RHEL**

1. Navigate to the linux-ppc folder then to the Little Endian folder.
2. Install the package by running the following command, where x.xx-x equals the version of the utility:

   ```
   rpm -ivh <StorCLI-x.xx-x.noarch.rpm>
   ```

**Ubuntu**

1. Navigate to the Ubuntu folder.
2. Install the debian file by using this command:

   ```
   dpkg -i storcli_x.xx-x._all.deb
   ```

**Preboot and petitboot**

**Note:** After a reboot, the following steps must be performed again.

1. From the petitboot menu, exit to shell.
2. Important: Set the IP-Address, if no DHCP server is available in the network:

   ```
   ifconfig <nic-device> <ip-address> netmask <netmask> up
   route add default gw <gw_address> <nic-device>
   ```
3. Download the storcli64 binary file into the petitboot environment
   wget "ftp://ftp.supermicro.com/Firmware/Openpower/P9DSU-C/Storage/Broadcom/AOC-9361-8i (AOC-K-9361-8Is-18001)/007.0606.0000.0000_Unified_StorCLI.zip"

4. Extract the following files:
   a. Extract 007.0606.0000.0000_Unified_StorCLI.zip
   b. MR_SAS_Unified_StorCLI_7.6-007.0606.0000.0000-SCGCQ01639776\(1\).zip

5. Type the following command.
   cd versionChangeSet/univ_viva_cli_rel/


7. Type the following command:
   cd Unified_storcli_all_os/Linux-PPC/LittleEndian

8. Unzip the storcli64.zip file:
   unzip storcli64.zip

9. The storcli64 file can now be invoked by specifying the current directory:
   ./storcli64 -h

For details about managing RAID arrays, refer to the MegaRAID SAS Software User Guide at
the following website:
https://docs.broadcom.com/docs/DB15-001199-02

**Helpful StorCLI commands**

Use page=[x] as the last option in all the commands to set the page break.

- To show a summary of the drive and controller status:
  ./storcli64 show page=20

- To show a list of all controllers and drives that need attention:
  ./storcli64 show all page=20

**Note:**

/c[x] or /cALL = Controller number
/v[x] or /vALL = VirtualDrive number
/e[x] or /eALL = Enclosure ID
/s[x] or /sALL = Slot ID

- To view the adapter settings:
  ./storcli64 /c0 show personality

- To change the adapter settings:
  ./storcli64 /c0 set personality=JBOD|RAID

**Update firmware**

- To check the firmware level of the MegaRAID adapter:
  ./storcli64 /c0 show all|egrep "Bios Version|Firmware Package|Firmware Version"
To update the firmware level of the MegaRAID adapter:

```
./storcli64 /c[x] download file=mrxxxxfw.rom [ResetNow]
```

**Note: ResetNow**

The ResetNow option is necessary when the old firmware is still active after flushing the adapter.

Figure 4-12 shows an example without the ResetNow option.

![Command to flash the controller firmware without the resetnow option](image)

Figure 4-13 shows command to flash the firmware with the resetnow option.

![Command to flash the controller firmware with the resetnow option](image)

To show information about the drives, use the following command syntax:

```
```

![Table 9 Flashing Controller Firmware Input Options](image)

![Table 9 Flashing Controller Firmware Input Options (Continued)](image)
For example (Figure 4-14):

```
./storcli64 /c0/eALL/sALL show
```

Figure 4-14  Showing information about the drives

Figure 4-15 shows detail drive information.

```
./storcli64 /c0/e0/s0 show
```

To locate a physical disk by turning on the identify LED, use the following command:

```
./storcli64 /c[x]/e[x]/s[x] start locate
```

To turn off the identify LED, use the following command:

```
./storcli64 /c[x]/e[x]/s[x] stop locate
```

To show Predictive failure Count (Figure 4-16 on page 67), use the following command:
Figure 4-16  Showing the predictive failure count

To show information about virtual drives as shown in Figure 4-17, use the following command:

```
./storcli64 /c0/vALL show
```

Figure 4-17  Shows virtual drives information

The following commands, create the two virtual drives:

```
./storcli64 /c0 add vd type=r0 drives=8:1-2
./storcli64 /c0 add vd type=r6 drives=8:2,8-9
```

To create a virtual drive, use the following command:

```
./storcli64 /c[x] add vd type=[RAID0(r0)|RAID1(r1)|...] drives=[EnclosureID:SlotID|:SlotID-SlotID|:SlotID,SlotID]
```

For example, to create a RAID0 (Figure 4-18 on page 68), use the following command:

```
./storcli64 /c0 add vd type=r0 drives=8:1-2
```
For example, to create a RAID1 (Figure 4-19), use the following command:

```
./storcli64 /c0 add vd type=r1 drives=8:1-2
```

For example, to create a RAID5 (Figure 4-20 on page 69), use the following command:

```
./storcli64 /c0 add vd type=r5 drives=8:1-2,8-9
```
For example, to create a RAID6 (Figure 4-21), use the following command:

```bash
./storcli64 /c0 add vd type=r6 drives=8:1,2,8,9
```

If a more complex RAID (for example, RAID10) is required, it is necessary to additionally specify the number of discs per RAID:

```bash
./storcli64 /c[x] add vd type=r[x] drives=8:0-3 PDperArray=2
```

To initialize the virtual drive, the command syntax is as follows:

```bash
./storcli64 /c[x]/v[x] start init (force)
```

For example (Figure 4-22):

```bash
./storcli64 /c0/v0 start init
```

Figure 4-20   Shows the RAID5 configuration

Figure 4-21   Shows the RAID6 configuration

Figure 4-22   Initializing the drive
The progress can be monitored with the following command (Figure 4-23):

```
./storcli64 /c[x]/v[x] show init or ./storcli64 /c[x]/vALL show init
```

![Figure 4-23 Monitoring initialization progress](image)

To delete virtual drives, use the following command syntax:

```
./storcli64 /c[x]/v[x] del (force)
```

For example:

```
./storcli64 /c0/vALL del
```

To prepare a drive for removal, use the following command syntax:

```
./storcli64 /c[x]/(e[x])/s[x] spindown
```

### 4.2 Bootstrap of bare metal Power Systems hardware

This section describes the process to load and initialize the basic Linux OS on local disks.

#### 4.2.1 Attach a bootable DVD using the USB device and configuring Petitboot

After the system powers on, the Petitboot bootloader scans local boot devices and network interfaces to find boot options that are available to the system. To utilize an USB device, follow these steps:

1. Insert your bootable USB device into the front USB port. Petitboot displays the following option:

   ```
   Note: Select Rescan devices if the USB device does not appear. If your device is not detected, you have to try a different device type.
   ```

2. Record the UUID of the USB device. For example, the UUID of the USB device in the following example is 2015-10-30-11-05-03-00.

   ```
   [USB:sdb1 / 2015-10-30-11-05-03-00]
   Rescue a Red Hat Enterprise Linux system (64-bit kernel)
   Test this media & install Red Hat Enterprise Linux 7.x (64-bit kernel)
   * Install Red Hat Enterprise Linux 7.x (64-bit kernel)
   ```

3. Select Install Red Hat Enterprise Linux 7.x (64-bit kernel) and click e (Edit) to open the Petitboot Option Editor window.

4. Move the cursor to the boot arguments section, and add the following information:

   ```
   inst.text inst.stage2=hd:UUID=your_UUID
   ```
where your_UUID is the UUID that you recorded.

Petitboot Option Editor

qqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqqq
Device:  ( ) sda2 [f8437496-78b8-4b11-9847-bb2d8b9f7cbd]
(*) sdb1 [2015-10-30-11-05-03-00]
(  ) Specify paths/URLs manually

Kernel: /ppc/ppc64/vmlinuz
Initrd: /ppc/ppc64/initrd.img
Device tree:
Boot arguments: ro inst.text inst.stage2=hd:UUID=2015-10-30-11-05-03-00

[   OK   ]  [   Help   ]  [  Cancel  ]

5. Select OK to save your options and return to the Main menu.

6. Verify that Install Red Hat Enterprise Linux 7.x (64-bit kernel) is selected and then press Enter to begin your installation.

4.2.2 Attach ISO image using virtual media (BMC WebFrontend)

Baseboard Management Controller (BMC) Advanced Systems Management is a remote management controller used to access system information, status, and other process for your server. You can use the BMC Advanced Systems Management to set up your installation and provide the CD image as virtual media to the Power Systems. However, the actual installation requires a serial-over-LAN (SOL) connection through IPMI.

To access the BMC Advanced Systems Management, open a web browser to http://ip_address where ip_address is the IP address for the BMC. Log in using these default values:

Default user name: ADMIN
Default password: ADMIN or admin

There are two ways to connect an ISO image, either by way of the Java Console or by way of a Windows share. In order to fully use the BMC Advanced Systems Management, the IP address of the BMC firmware has to be added to the Exceptions list in the Java Control Panel of your notebook or PC. On a Windows system, this is usually done by selecting Control Panel → Control Panel for Java. On a Linux system, this is usually achieved by selecting Control Central and then selecting the Java web browser plugin. After accessing the Control Panel for Java, select Security tab. Then add the IP address of the BMC firmware to the Exceptions list, by clicking Edit Site List and then click Add. Enter the IP address and click OK.

To create a virtual CD/DVD, follow these steps:

1. Log into the BMC Advanced Systems Management interface from a PC or notebook using the default user name and password.
2. Select Remote Control → Console Redirection.
3. Select Java Console. As the console opens, you might need to direct your browser to open the jviewer.jnlp file by selecting to Open with Java Web Start and click OK. Accept the warning and click Run.
4. In the Console Redirection window (Figure 4-24), select Media → Virtual Media wizard from the menu.

![Console Redirection pane](image)

Figure 4-24   Console Redirection pane

5. In the Virtual Media wizard, select CD/DVD Media:1. Select CD Image and the path to the Linux distribution ISO file. For example, `/tmp/RHEL-7.2-20151030.0-Server-ppc64el-dvd1.iso`

Click Connect CD/DVD. If the connection is successful, the message Device redirected in Read Only Mode is displayed.

6. Verify that CD/DVD is shown as an option in Petitboot as sr0:

```
CD/DVD: sr0
```

Install
Repair

**Note:** Select Rescan devices if CD/DVD does not appear.

7. Select Install. After selecting Install, your remote console can become inactive. Open or reactivate your IPMI console to complete the installation.

**Note:** Be patient. It can sometimes take a couple minutes for the installation to begin.
Attach ISO Image over a Windows Share

This option allows you to share a CD-ROM image over a Windows Share with a maximum size of 4.7 GB. This image will be emulated to the host as an USB device.

1. Log into the BMC Advanced Systems Management interface from a PC or notebook using the default user name and password.
2. Click Virtual Media → CD-ROM Image.
3. Set shared host, path to image, optional user and Password.

**Note:** Use the ip-address if there are problems with name resolution in the network.

4. Click Save.
5. Click Mount.
6. Click Refresh Status as shown in Figure 4-25.

![BMC Advanced Systems Management interface pane](image1.png)

Figure 4-25  BMC Advanced Systems Management interface pane

Figure 4-26 shows part of the window visible when booting from CD/DVD, if the attach ISO image works correctly.

![Petitboot pane - Booting from CD/DVD](image2.png)

Figure 4-26  Petitboot pane - Booting from CD/DVD

4.3 Install RHEL OS as KVM host on bare metal Power Systems hardware

This section contains the RHEL installer options and requirements.
4.3.1 RHEL installer options

The Red Hat Virtualization 4.2 Installation Guide - Installing Red Hat Virtualization can be read at the following website:

https://access.redhat.com/documentation/en-us/red_hat_virtualization/4.2/

Hardware requirements

The minimum and recommended hardware requirements shown in Table 4-1 are based on a typical small to medium-sized installation. The exact requirements vary between deployments based on sizing and load.

Hardware certification for Red Hat Virtualization is covered by the hardware certification for Red Hat Enterprise Linux. For more information, see the following website:

https://access.redhat.com/solutions/725243

To confirm whether specific hardware items are certified for use with Red Hat Enterprise Linux, see the following link:

https://access.redhat.com/ecosystem/#certifiedHardware

Table 4-1  Red Hat Virtualization Manager hardware requirements

<table>
<thead>
<tr>
<th>Resource</th>
<th>Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>A quad core CPU or multiple dual core CPUs.</td>
</tr>
<tr>
<td>Memory</td>
<td>16 GB of system RAM.</td>
</tr>
<tr>
<td>Hard disk</td>
<td>50 GB of locally accessible, writable disk space. You can use the RHV Manager History Database Size Calculator to calculate the appropriate disk space for the Manager history database size.</td>
</tr>
<tr>
<td>Network interface</td>
<td>1 Network Interface Card (NIC) with bandwidth of at least 1 Gbps.</td>
</tr>
</tbody>
</table>

Storage requirements

Hosts require local storage to store configuration, logs, kernel dumps, and for use as swap space. The minimum storage requirements of Red Hat Virtualization Hosts are documented in this section. The storage requirements for Red Hat Enterprise Linux hosts vary based on the amount of disk space used by their existing configuration but are expected to be greater than those of Red Hat Virtualization Host.

The minimum storage requirements for host installation are listed as follows. However, Red Hat recommends using the default allocations, which use more storage space.

- / (root) - 6 GB
- /home - 1 GB
- /tmp - 1 GB
- /boot - 1 GB
- /var - 15 GB
- /var/log - 8 GB
- /var/log/audit - 2 GB
- swap - 1 GB (for the recommended swap size, see https://access.redhat.com/solutions/15244)
Anaconda reserves 20% of the thin pool size within the volume group for future metadata expansion. This is to prevent a ready for use configuration from running out of space under normal usage conditions. Over provisioning of thin pools during installation is also not supported.

- Minimum Total - 45 GB

If you are also installing the RHV-M Appliance for self-hosted engine installation, `/var/tmp` must be at least 5 GB.

### 4.3.2 Operating system requirements

The Red Hat Virtualization Manager must be installed on a base installation of Red Hat Enterprise Linux 7 that has been updated to the latest minor release using the following steps:

**Important:** Do not install any additional packages after the base installation, as these can cause dependency issues when attempting to install the packages required by the Virtualization Manager.

Do not enable additional repositories other than those required for the Virtualization Manager installation.

1. Set disk layout: Click INSTALLATION DESTINATION as shown in Figure 4-27.
2. Click Done as shown in Figure 4-28.
Figure 4-29 shows the selected disk.

![Figure 4-29](image-url)
Figure 4-30 helps to create the mounting point for the installation.

![Figure 4-30](image)

*Figure 4-30 Red Hat Enterprise Linux 7.6 Installation pane - Manual partitioning*
Figure 4-31 shows the pane for customizing the disk layout for the installation.
Click Done (Figure 4-31 on page 79), and accept changes in the Installation Summary of changes as shown in Figure 4-32.

![Red Hat Enterprise Linux 7.6 Installation pane - Installation summary](image)

**Figure 4-32  Red Hat Enterprise Linux 7.6 Installation pane - Installation summary**

### 4.4 Red Hat Virtualization

Red Hat Virtualization (RHV) is an x86 virtualization product produced by Red Hat, based on the KVM hypervisor.

This section describes the integration of a RHEL server installation into a KVM virtualization environment and an example of creating a Linux virtual machine.

#### 4.4.1 Host OS configuration

For the registration in the Satellite Server, the correct time and date are necessary.

**Tip:** When configuring the ntp-server during installation, for example, 0.rhel.pool.ntp.org, 1.rhel.pool.ntp.org, 2.rhel.pool.ntp.org, 3.rhel.pool.ntp.org, if the ntp-server is not configured, execute the following command:

```
# ntpdate 0.rhel.pool.ntp.org
```
Enabling the Red Hat Enterprise Linux Host Repositories

To use a Red Hat Enterprise Linux machine as a host, you must register the system with the Content Delivery Network, attach the Red Hat Enterprise Linux Server and Red Hat Virtualization subscriptions, and enable the host repositories using the following procedure.

1. Register your system with the Content Delivery Network, entering your Customer Portal user name and password when prompted:

   ```bash
   # subscription-manager register
   ```

2. Find the Red Hat Enterprise Linux Server and Red Hat Virtualization subscription pools and record the pool IDs:

   ```bash
   # subscription-manager list --available
   ```

3. Use the pool IDs to attach the subscriptions to the system:

   ```bash
   # subscription-manager attach --pool=poolid
   ```

   **Note:** To view currently attached subscriptions, use the following command:

   ```bash
   # subscription-manager list --consumed
   ```

   To list all enabled repositories (Figure 4-33), use the following command:

   ```bash
   # yum repolist
   ```

4. Configure the repositories:

   ```bash
   # subscription-manager repos \
   --disable='*' \
   --enable=rhel-7-server-rpms \
   --enable=rhel-7-server-rhv-4-mgmt-agent-rpms \
   --enable=rhel-7-server-ansible-2-rpms
   ```

   For Red Hat Enterprise Linux 7 hosts, little endian, on IBM POWER8 hardware:

   ```bash
   # subscription-manager repos \
   --disable='*' \
   --enable=rhel-7-server-rhv-4-mgmt-agent-for-power-le-rpms \
   --enable=rhel-7-for-power-le-rpms
   ```

   For Red Hat Enterprise Linux 7 hosts, little endian, on IBM POWER9 hardware:

   ```bash
   # subscription-manager repos \
   --disable='*' \
   --enable=rhel-7-server-rhv-4-mgmt-agent-for-power-9-rpms \
   --enable=rhel-7-for-power-9-rpms
   ```

5. Ensure that all packages currently installed are up to date:

   ```bash
   # yum update
   ```

6. Reboot the machine

---

Figure 4-33   Listing enable repositories from the command line

---

2 https://red.ht/2EFrblK
You can also list the available repositories using the Subscription Manager GUI (Figure 4-34) showing it using the following command:

```
# subscription-manager-gui
```

![Subscription Manager GUI - Installed products](image)

Figure 4-34 Subscription Manager GUI - Installed products

### 4.4.2 RHV Manager

The RHV Manager is the web GUI for the Red Hat Virtualization software. All administration and operation tasks on compute nodes, network and storage can be done using this GUI.

**Creating a new RHV cluster**

Before creating a new cluster, ensure that there is at least one host available to be assigned to it. All hosts in a cluster must have CPUs belonging to the same family as that selected for the cluster.

A data center can contain multiple clusters, and a cluster can contain multiple hosts. All hosts in a cluster must be of the same CPU type (Intel or AMD). It is recommended that you create your hosts before you create your cluster to ensure CPU type optimization. However, you can configure the hosts at a later time using the Guide Me button.

1. Select under Compute → the Clusters resource tab as shown in Figure 4-35 on page 83.
2. Click **New**.
3. Select the Data Center the cluster will belong to from the drop-down list.

---


4  [https://red.ht/2Q2RvUW](https://red.ht/2Q2RvUW)
4. Enter the **Name** and **Description** of the cluster.

5. Select a network from the **Management Network** drop-down list to assign the management network role.

6. Select the **CPU Architecture** and **CPU Type** from the drop-down lists. It is important to match the CPU processor family with the minimum CPU processor type of the hosts you intend to attach to the cluster, otherwise the host will be non-operational.

7. Select the **Compatibility Version** of the cluster from the drop-down list.

Add Host OS to RHV cluster

Adding a host to your Red Hat Virtualization environment can take some time, as the following steps are completed by the platform: virtualization checks, installation of packages, creation of bridge, and a reboot of the host. Use the details pane to monitor the process as the host and the Manager establish a connection.

1. Select under Compute → the **Hosts** resource tab.
2. Click **New**.
3. Use the drop-down list to select the **Data Center** and **Host Cluster** for the new host.
4. Enter the **Name** and the **Address** of the new host. The standard SSH port, port 22, is auto-filled in the **SSH Port** field.
5. Select an authentication method to use for the Manager to access the host.
   - Enter the root user’s password to use password authentication.
   - Alternatively, copy the key displayed in the **SSH PublicKey** field to
     `/root/.ssh/authorized_keys` on the host to use public key authentication.
6. Click the Advanced Parameters button to expand the advanced host settings.
   - Optionally disable automatic firewall configuration.

---

5  https://red.ht/34Jb9dK
– Optionally add a host SSH fingerprint to increase security. You can add it manually, or fetch it automatically.

7. Optionally configure power management, where the host has a supported power management card. For information about power management configuration, see Host Power Management Settings Explained in the Administration Guide at the following website:

   https://red.ht/36RCI68

8. Click OK as shown in Figure 4-36.

The new host displays in the list of hosts with a status of *Installing*, and you can view the progress of the installation in the details pane. After a brief delay the host status changes to *Up*.

![Figure 4-36  Compute Host pane - Edit Host](image)
4.4.3 Guest OS deployment and optimization

This section describes how to deploy a new virtual machine:

1. Select under Compute → the Virtual Machines resource tab as shown in Figure 4-37.

![Figure 4-37 Red Hat Virtualization pane]

2. Click New.
3. Start with General configurations as shown in Figure 4-38.

![Figure 4-38 Edit Virtual Machine pane - General configuration](image-url)
4. Configure the System as shown in Figure 4-39.

![Edit Virtual Machine pane - System configuration](image-url)
5. Configure the Console as shown in Figure 4-40.

![Figure 4-40: Edit Virtual Machine pane - Console configuration](image-url)
6. Configure the Host details as shown in Figure 4-41.

![Edit Virtual Machine pane - Configure the Host](image)

Figure 4-41  Edit Virtual Machine pane - Configure the Host
7. Configure NUMA as shown in Figure 4-42. Performance optimization used to pin VM to dedicated bare metal CPU sockets (NUMA Pinning and NUMA Topology).

Figure 4-42 NUMA Topology pane
8. Next configure the Resource Allocation for the VM as shown in Figure 4-43.
9. Configure Boot Options as shown in Figure 4-44.

![Edit Virtual Machine pane - Configure Boot Options](image1)

**Figure 4-44   Edit Virtual Machine pane - Configure Boot Options**


11. Click OK.

**Start, stop and remove guest OS**

To start, click Compute → in the Virtual Machines resource tab as shown in Figure 4-45.

![Red Hat Virtualization pane - Guest OS](image2)

**Figure 4-45   Red Hat Virtualization pane - Guest OS**
4.4.4 Guest OS monitoring

This section shows how to monitor guest OS.

**RHV Manager monitoring features**

Basic utilization of memory, CPU and network is displayed real time on the Virtual Machines overview panel as shown in Figure 4-46.

![Figure 4-46  Red Hat Virtualization - VM monitoring](image1)

**nmon for Linux**

nmon is short for Nigel's performance Monitor for Linux on Power, x86, x86_64, Mainframe & ARM (Raspberry Pi).

This tool provides a vast amount of important performance information in a simple terminal session as shown in Figure 4-47. It can output the data in two ways: Real time or save the data to a comma separated file for analysis and longer term data capture.

![Figure 4-47  nmon performance monitoring pane](image2)

The tool can be downloaded from the nmon Homepage:

[http://nmon.sourceforge.net](http://nmon.sourceforge.net)
Or from the IBM page: Tools for Linux on Power - Service and productivity tools:

To start a window (ssh shell) interactive nmon, run the following command:

```
[root@is334kvm: ~]# nmon
```

The interactive Mode Keys in Alphabetical Order are as follows:

- **Key --- Toggles on off to control what is displayed ---**
- **b** = Black and white mode (or use -b command line option)
- **c** = CPU Utilisation stats with bar graphs (CPU core threads)
- **C** = CPU Utilisation as above but concise wide view (up to 192 CPUs)
- **d** = Disk I/O Busy% & Graphs of Read and Write KB/s
- **D** = Disk I/O Numbers including Transfers, Average Block Size & Peaks
  (type: 0 to reset)
- **g** = User Defined Disk Groups
  (assumes -g <file> when starting nmon)
- **G** = Change Disk stats (d) to just disks
  (assumes -g auto when starting nmon)
- **h** = This help information
- **j** = File Systems including Journal File Systems
- **k** = Kernel stats Run Queue, context-switch, fork, Load Average & Uptime
- **l** = Long term Total CPU (over 75 snapshots) via bar graphs
- **L** = Large and Huge memory page stats
- **m** = Memory & Swap stats
- **M** = MHz for machines with variable frequency 1st=Threads 2nd=Cores 3=Graphs
- **n** = Network stats & errors (if no errors it disappears)
- **N** = NFS - Network File System
  1st NFS V2 & V3, 2nd=NFS4-Client & 3rd=NFS4-Server
- **o** = Disk I/O Map (one character per disk pixels showing how busy it is)
  Particularly good if you have 100's of disks
- **p** = PowerVM LPAR Stats from /proc/ppc64/lparcfg
- **q** = Quit
- **r** = Resources: Machine type, name, cache details &
  OS version & Distro + LPAR
- **t** = Top Processes: select the data & order 1=Basic, 3=Perf,
  4=Size, 5=I/O=root only
- **u** = Top Process with command line details
- **U** = CPU utilisation stats - all 10 Linux stats:
  user, user_nice, system, idle, iowait, irq, softirq, steal,
  guest, guest_nice
- **v** = Experimental Verbos mode - tries to make recommendations
- **V** = Virtual Memory stats

To start the nmon daemon to log long term CPU utilization data collection, the command syntax is as follows:

```
nmon -f [-s <seconds>] [-c <count>] [-T] [-m <directory>]
-f spreadsheet output format [note: default -s300 -c288]
 output file is <hostname>_YYYYMMDD_HHMM.nmon
-s <seconds> Time between snap shots -
 with "-c count" decides duration of the data capture
-c <number> The number of snapshots before nmon stops
-T Include Top Processes in the output and
 saves command line arguments in UARG section
-m <directory> nmon changes to this directory before saving to file
```

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For example,

```
[root@is334kvm: ~]# mkdir -p /tmp/nmon4html ; ~/nmon/nmon -f -T -s 20 -c 30 -m /tmp/nmon4html
```

**nmonchart - webpage graphs from nmon data**

After the nmon data collection, the collected data can be translated into HTML files using the `nmonchart` tool as shown in Figure 4-48.

The command syntax is:
```
nmonchart <nmon-file> <output-file>.html
```

For example:
```
nmonchart is330kvm_180807_1018.nmon is330kvm_180807_1018.html
```

![Figure 4-48 nmonchart graph](image)

### 4.4.5 SAP monitoring

This section provides details about SAP monitoring.

**Host OS and SAP monitoring enablement**

The SAP monitoring software (saposcol), which is installed and running on each KVM guest along with the SAP solution stack, requires access to platform metrics data available on the KVM host side only. To establish a channel between the host and the guest sides which facilitates the data transfer of these matrixes, the Virtual Host Metrics Daemon (vhostmd) is utilized. Vhostmd itself is using libvirt to collect the required host side metrics. For more information, refer to the SAP Note 2097317 at the following link:

[https://launchpad.support.sap.com/#/notes/2097317](https://launchpad.support.sap.com/#/notes/2097317)

**How to configure SAP Monitoring by using vhostmd in RHV?**

Machine monitoring for SAP applications uses the vhostmd VDSM hook, which is provided to hosts by the vdsm-hook-vhostmd package. Red Hat Virtualization Hypervisor hosts (RHVH)
include the vdsm-hook-vhostmd package by default. However, the vdsm-hook-vhostmd has to be installed on Red Hat Enterprise Linux hosts.

For more information refer to the following link:
https://access.redhat.com/solutions/69327

**Setup instructions**
The following steps illustrate installing the vdsm-hook-vhostmd package on the Red Hat Enterprise Linux host, enabling SAP monitoring for a virtual machine, and verifying the monitoring.

As root, install the vdsm-hook-vhostmd package on the Red Hat Enterprise Linux host:

```
# yum install vdsm-hook-vhostmd
```

**Guest OS and SAP monitoring**
1. Select under Compute → the Virtual Machines resource tab.
2. Select VM.
3. Edit Virtual Machine under Custom Properties → Add sap_agent as shown in Figure 4-49.

![Figure 4-49  Edit Virtual Machine pane - Configuring Custom Properties](image)
Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this paper.

IBM Redbooks

The following IBM Redbooks publications provide additional information about the topic in this document. Note that some publications referenced in this list might be available in softcopy only.

- IBM PowerKVM: Configuration and Use, SG24-8231-01
- IBM Power System E980: Technical Overview and Introduction, REDP-5510-00
- IBM Power System E950: Technical Overview and Introduction, REDP-5509-00
- IBM Power System S922, S914, and S924 Technical Overview and Introduction, REDP-5497-00
- IBM Power System H922 and H924 Technical Overview and Introduction, REDP-5498-00
- IBM Power System L922 Technical Overview and Introduction, REDP-5496-00
- IBM Power System LC921 and LC922: Technical Overview and Introduction, REDP-5495-00
- Live Partition Mobility Setup Checklist. TIPS-1184

You can search for, view, download or order these documents and other Redbooks, Redpapers, Web Docs, draft and additional materials, at the following website:

ibm.com/redbooks

Online resources

These websites are also relevant as further information sources:

- OpenPOWER Abstraction Layer
  https://github.com/open-power
- Red Hat Virtualization (RHV)
- Quick Start Guide for Installing Linux on Linux Cloud and Cluster (LC) servers
- nmon Homepage
  http://nmon.sourceforge.net
Help from IBM

IBM Support and downloads
ibm.com/support

IBM Global Services
ibm.com/services