

# IBM Power Systems L and LC Server Positioning Guide

Tonny Bastiaans

Andrew Laidlaw



**Power Systems**





## IBM Power Systems L and IBM OpenPOWER LC Server Positioning Guide

This IBM® Redpaper™ publication is written to assist you in locating the optimal server/workload fit within the IBM Power Systems™ L and IBM OpenPOWER LC product lines. IBM has announced several scale-out servers, and as a partner in the OpenPOWER organization, unique design characteristics that are engineered into the LC line have broadened the suite of available workloads beyond typical client OS hosting. This paper looks at the benefits of the Power Systems L servers and OpenPOWER LC servers, and how they are different, providing unique benefits for Enterprise workloads and use cases.

The Power L and OpenPOWER LC servers are shown in the following figure.



## The IBM POWER8 processor

IBM POWER8® technology is used in a family of superscalar, symmetric multiprocessors based on the IBM Power Architecture®. POWER8 is designed for big data, so IBM designed a massively multithreaded chip, with each of its cores capable of handling eight hardware threads simultaneously. The processor uses very large amounts of on-chip and off-chip eDRAM caches, and on-chip memory controllers enable very high bandwidth to memory and system I/O.

In 2016, a revised version of the POWER8 chip was announced: the POWER8 with NVLink processor variant. This new processor includes the NVIDIA bus technology NVLink, enabling high bandwidth, low latency connections to four NVLink capable devices directly to the chip. This is an industry-first processor technology that directly links accelerators into the processor architecture, providing coherent access to system memory with 2.5x the bandwidth of PCIe Gen3 for GPU to CPU connections. It also provides the same high-bandwidth connection between GPUs within the system, creating a coherent mesh or CPU and accelerators.

## Linux on IBM Power Systems

In 1999, IBM announced support for the open source Linux operating system. Since then, IBM invested considerable financial, technical and marketing resources to foster the growth, development, and use of Linux technology, and made significant contributions to the community on which Linux relies. IBM's commitment to Linux comes from the belief that Linux is a world-class operating system that provides flexibility, choice, and an attractive total cost of ownership that can benefit IBM customers.

IBM engineers also contribute to other aspects of open source development that are required to deliver enterprise-level functions. Participation in the community involves contributing code that is developed at IBM and augmenting, testing, and deploying code that is developed by others to ensure that it meets community and user expectations.

Supported on every Power Systems server IBM makes, Linux on Power Systems offers the capability to run your workload on both scale-out and scale-up systems, depending on your business needs. Linux uses the advanced hardware and software capabilities of POWER8 technology, which provide economic advantages that scale as your business grows. Clients can confidently run highly scalable, highly reliable, and highly flexible Linux environments on POWER8 processor-based servers. The benefits of Power Systems are realized whether a client is deploying new applications or wants to improve the performance of existing applications.

**Linux on Power Systems:** Although this paper specifically describes the Linux only Power Systems servers, all Power Systems models built on POWER8 technology can run Linux workloads, with full Enterprise Support available.

Although the IBM operating systems IBM i and IBM AIX® have traditionally worked with big endian data formats, the IBM POWER® processor architecture can work with both big endian and little endian data. For Linux operating systems, Power Systems can run both big endian and little endian distributions, and support for each distribution depends on the distribution that is chosen. Using virtualization, both big endian and little endian virtual machines (VMs) can be run on the same host. On the OpenPOWER LC servers, bare metal installations are supported only for little endian Linux distributions, which includes Ubuntu 16.04 and later, and Red Hat Enterprise Linux (RHEL) 7.2 and later.

## The OpenPOWER Foundation



The OpenPOWER Foundation was formed in 2013 as an open technical membership organization that enables data centers to rethink their approach to technology. The founding members were IBM, Google,

Mellanox, NVIDIA, and Tyan. Member companies are encouraged to customize POWER processors and systems, adding their own innovations to meet their unique business needs. These innovations include custom systems for large or warehouse scale data centers, workload acceleration by using GPU, FPGA, or advanced I/O, platform optimization for software appliances, or advanced hardware technology usage. OpenPOWER members are actively pursuing all of these innovations and more, and welcome all parties to join them in moving the state-of-the-art OpenPOWER system designs forward. As of September 2016, more than 250 companies, institutes, and organizations were members of the OpenPOWER foundation.

IBM is taking advantage of innovations from the OpenPOWER Foundation by designing and building systems with other members, which are marketed as the OpenPOWER LC servers.

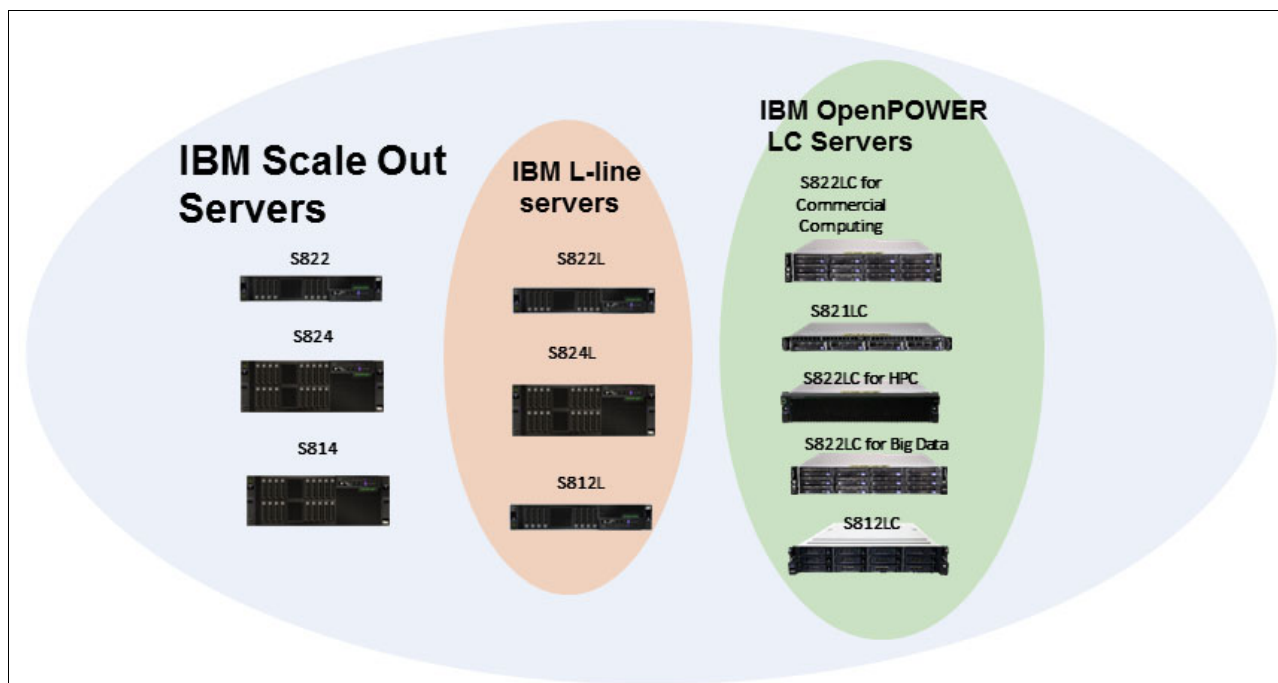
For more information, see the following website:

<http://www.openpowerfoundation.org>

## IBM scale-out servers

Power Systems scale-out servers are affordable, easy-to-deploy, and energy-efficient application servers, consolidation servers, or stand-alone servers for AIX, IBM i, and Linux workloads. Available with up to 24 cores, these one-socket and two-socket servers offer better cloud economics and security for businesses that need smaller or scale-out deployment options for data-centric applications.

The IBM scale-out servers portfolio consists of the IBM Power Systems S822, S814, and S824 servers, which can run multiple operating systems, the Linux only Power Systems L servers, and the OpenPOWER LC servers, which are optimized to run Linux workloads only. The Power S822, Power S814, and the Power S824 servers are not described in this paper. The three groups of server offerings are shown in the following figure.



## Power Systems L servers

Linux only Power Systems (the Power Systems L servers) running Ubuntu, SUSE, or Red Hat Linux are priced to compete with commodity alternatives while offering superior performance and return on investment (ROI) for compute-intensive and data-intensive applications. With both IBM PowerVM® and open source KVM virtualization options available, these systems offer the flexibility that is needed to quickly integrate innovative technology solutions, avoid vendor lock-in, and accelerate business results.

The Power Systems L servers are based on the traditional IBM scale-out servers, and have the same reliability, availability, and serviceability (RAS) features as the IBM scale-out servers. This differentiates them from the OpenPOWER LC servers, which have a different design base. The increased level of RAS makes them ideal for small-scale or single-system deployments, providing extra resiliency that is not available on comparable systems.

The Power Systems L servers are designed alongside traditional Power Systems servers, so the management tools that are used are the same as the ones that are used in other Power Systems environments. These tools should be familiar to systems administrators, and include tools like the Hardware Management Console (HMC) when using PowerVM virtualization features. They can also be integrated into a cloud environment by using tools such as IBM Cloud PowerVC Manager, or as part of a multi-platform Hybrid Cloud deployment by using tools such as IBM Cloud Orchestrator.

The Power Systems L servers are built by using parts, which are also used in other Power Systems servers, including the scale-out models and the Enterprise systems. This results in a higher level of reliability for the final system by using advanced RAS features, which are ideal for single-system deployments.

Although the Power Systems L servers are built to the same design point as other IBM scale-out servers, they support only Linux operating systems. These servers can be virtualized by using PowerVM or KVM on Power to support multiple Linux VMs on a single system.

## **OpenPOWER LC servers**

By incorporating innovations from the members of the OpenPOWER Foundation community, the Linux only OpenPOWER LC servers are different by design. These servers are engineered to offer higher performance and be more open than anything else on the market. The OpenPOWER LC servers have a low acquisition cost through system optimization, use of industry-standard components, focused configurations, focused I/O and expansion, and an industry-standard warranty. By design, the OpenPOWER LC servers are optimized for specific workloads.

The OpenPOWER LC servers are managed by using tools that are familiar to Linux administrators from other platforms. They use standards and components that are commonly used in other systems, including the Baseboard Management Controller (BMC) for hardware management. The BMC supports the Intelligent Platform Management Interface (IPMI V2.0) and Data Center Management Interface (DCMI V1.5) for system monitoring and management. The OpenPOWER LC servers have standard serial, USB, and VGA ports on board to simplify management and installation further.

The use of open source KVM solutions for virtualization ensures compatibility with common infrastructure management tools, including those tools that are built on the OpenStack standards. Cloud management tools such as IBM Cloud Orchestrator can also be used for hybrid cloud deployments because they can be used to manage multiple platforms.

The OpenPOWER LC servers are largely built from industry standard components that are commonly used in other systems, such as memory DIMMs and low-cost SATA storage devices. This makes it easier to maintain parts for a mixed architecture environment, and reduces the overall cost of running these systems. Although benefiting from the increased reliability and resiliency characteristics of the POWER8 processor and technology, further resiliency can be added to workloads at the cluster level, or through software.

The OpenPOWER LC server range includes systems that can optionally include cutting edge technology, such as NVIDIA NVLink connectivity, high-performance NVMe storage devices, and the latest 100 GBps (EDR) InfiniBand adapters, thanks to the various members of the OpenPOWER Foundation. These systems offer the widest choice of storage types, and the widest choice of high-speed networking connectivity. The OpenPOWER LC server range is the first servers to support new innovative technologies from the OpenPOWER collaboration.

All of the OpenPOWER LC servers support accelerators to further improve performance for enabled workloads, which includes massively parallel GPUs, and workload-specific FPGAs that can use the Coherent Accelerator Processor Interface (CAPI) connectivity.

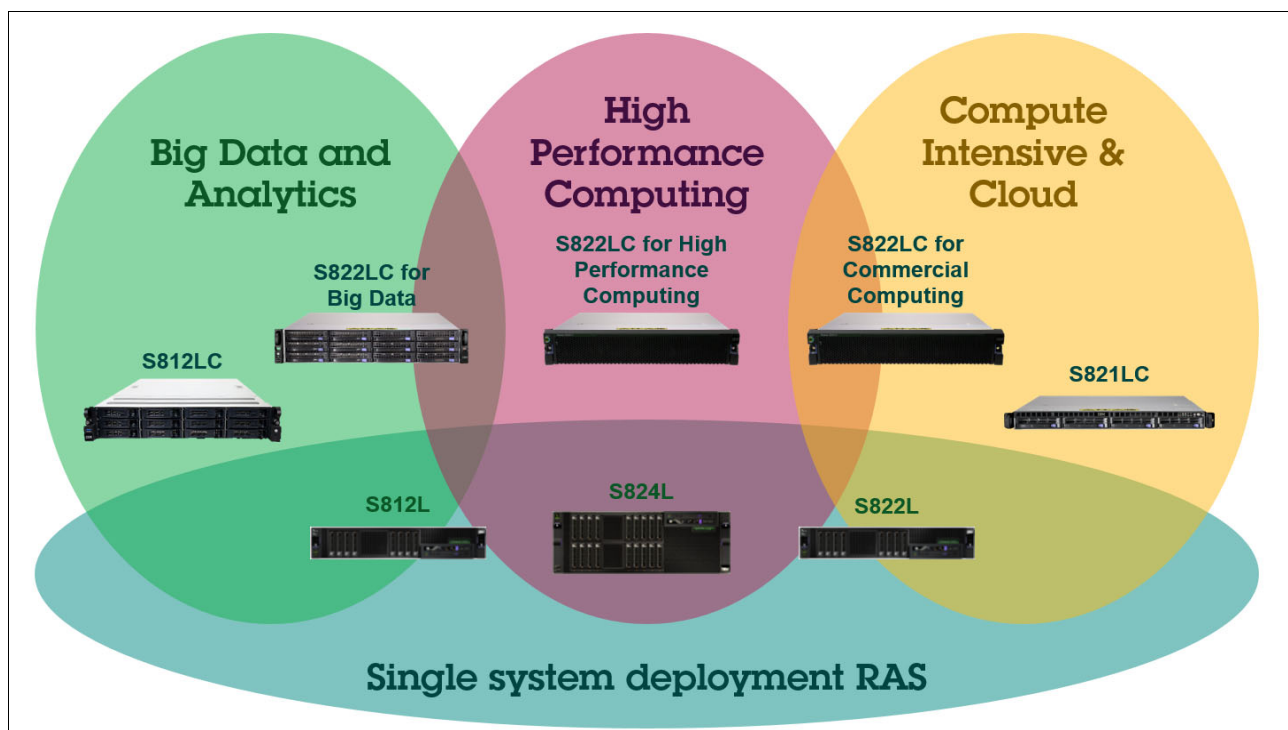
The OpenPOWER LC servers support only bare metal installation of little endian Linux operating systems, which can include Linux installations that are used as a KVM host, to support multiple Linux VMs on a single system.

## Workload differentiation

The Linux only Power Systems servers are optimized for different workload types with different requirements. In this paper, the workloads are in the categories of Big Data and Analytics, High Performance Computing (HPC), and Compute Intensive and Cloud. However, there is some overlap for these workloads because some applications fall between these categories. Although these servers are optimized for different workload types, this does not exclude them for usage in other areas.

In particular, the Power Systems L servers are designed to support multiple types of workload, where the OpenPOWER LC servers are optimized for particular use cases.

The systems that are best suited for each workload and characteristic are shown in the following figure. Some servers have more than a single strength.



Another differentiator is the presence of higher-level RAS features that are inherited from Power Systems Enterprise servers, which differentiate the Power Systems L servers from the OpenPOWER LC servers. This makes the Power Systems L servers better suited to traditional core business applications that require the extra resiliency, and for single-server deployments. The OpenPOWER LC servers are targeted at larger scale-out cluster and cloud deployments where additional resiliency is built in at the cluster level.



# Systems for Big Data and Analytics

*Big data* is an evolving term that describes any voluminous amount of structured, semi-structured, and unstructured data that has the potential to be mined for information. It encompasses a number of application types, depending on customer needs.

*Analytics* refers to applications that are designed to manipulate and process data sets to provide additional insights. These can be used for reporting on historical data, or for predicting future trends.

**Example use cases:** Here are some typical use cases.

<b>Healthcare</b>	Genomics sequencing and patient records generate large amounts of data. You can use this data to identify trends and help treat people faster and more effectively.
<b>Retail</b>	Customer data includes purchase history, online interactions, and social media usage that can provide insight to improve marketing and product positioning.
<b>Manufacturing</b>	Analytics applications are used to optimize supply chain and manufacturing processes to save money and increase time to market.

The Power Systems range provides a number of servers that are ideally suited to big data or analytics workloads. These workloads commonly require the following features:

- ▶ High local storage capacity for resilient distributed file systems
- ▶ High local storage throughput to support large-scale data processing
- ▶ Large memory capacities for in-memory analytics programs, such as Apache Spark

**Apache Spark:** An open-source framework that is designed to process big data workloads in a faster, more efficient manner than previous technologies. It uses in-memory technologies and optimizations to increase performance on the appropriate hardware. IBM BigInsights® and Hortonworks Data Platform use Apache Spark technologies, as do other commercial and open-source offerings.

## IBM Power System S822LC for Big Data (8001-22C)



The Power S822LC for Big Data was built in collaboration with the OpenPOWER Foundation members to create a system that built for the demands of big data workloads. It provides a high-performance infrastructure for Big Data and Analytics applications, such as Apache Hadoop based offerings, and those based on Apache Spark.

This one- or two-socket system includes up to 12 internal large form factor (LFF) or small form factor (SFF) storage devices, allowing up to 96 TB of storage capacity in a single node. There are also solid-state device (SSD) and NVMe storage options for higher storage throughput. It also includes the following items:

- ▶ Up to 22 cores and up to 512 GB of memory in each node
- ▶ Up to 115 GBps memory throughput within a single system
- ▶ Capability to add NVIDIA Tesla K80 or P100 GPUs via PCIe or CAPI-enabled accelerators

For more information, see *IBM Power System S822LC for Big Data Technical Overview and Introduction*, REDP-5407.

### IBM Power System S812LC (8347-21C)

The Power S812LC server provides a high-capacity, storage-focused solution to support large-scale distributed file systems such as Hadoop Distributed File System (HDFS). With a large maximum memory capacity, it also supports memory-intensive workloads such as in-memory databases. It is ideally suited to workloads that require very large storage capacities without requiring complex processing, or in-memory analytics packages such as those based on Apache Spark.



This system supports up to 14 LFF storage devices, allowing for up to 84 TB raw storage. The maximum memory capacity of 1 TB per node ensures that memory-intensive workloads can run efficiently, and the high memory bandwidth ensures increased levels of utilization. It also benefits from the following items:

- ▶ Either an eight-core or 10-core POWER8 processor that is designed for data.
- ▶ Up to 115 GBps memory bandwidth and 32 GBps of I/O bandwidth per node.
- ▶ The design is optimized for clustered workloads and built on open standards.

The Power S812LC server is used as the compute node within the IBM Data Engine for Hadoop and Spark (IDEHS) solution.

For more information, see *IBM Power System S812LC Technical Overview and Introduction*, REDP-5284.

**Apache Hadoop:** An open-source framework that supports large-scale data sets and analytics by using a distributed file system (HDFS) and a distributed data processing engine (MapReduce). It is designed to be run on a massively scale-out architecture, commonly on low-cost commodity hardware. IBM BigInsights and Hortonworks Data Platform are some of the commercial software products that include Hadoop technologies.

### IBM Power System S812L (8247-21L)



The Power S812L server provides a highly resilient environment to run enterprise-critical workloads processing and analyzing large data sets. It uses single-server deployment RAS features to provide higher performance and reliability than comparable systems. With a range of internal storage options and expansion options, including SAS expansion drawers and connectivity to Enterprise storage area networks (SANs), this system offers flexibility in how the environment is configured for single-system and small-scale analytics.

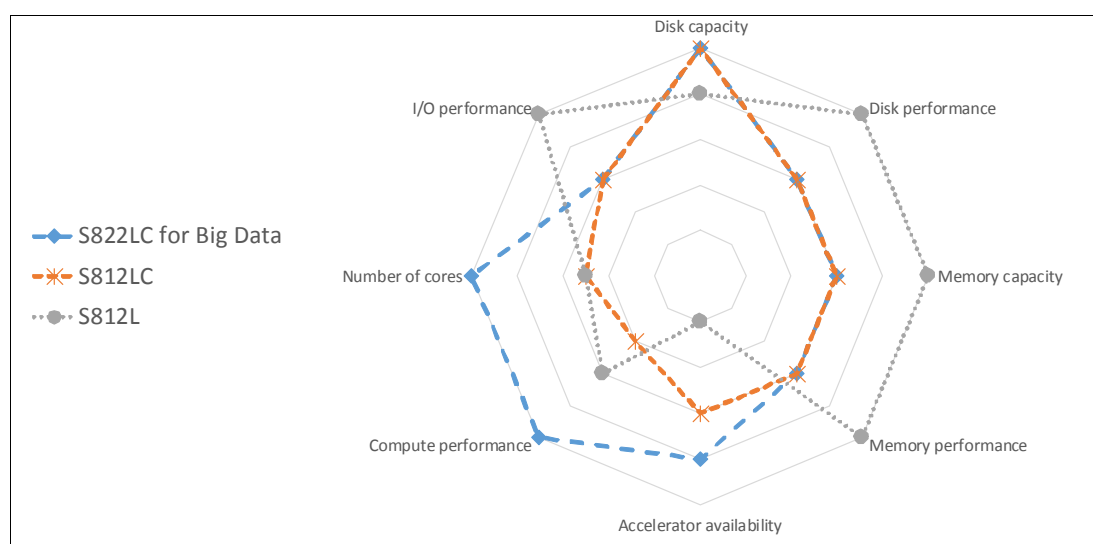
This system supports up to six PCIe expansion cards, the EXP24S storage expansion drawer, and the PCIe Gen3 I/O expansion drawer, providing huge expansion capability. It also benefits from the following items:

- ▶ Up to 512 GB memory capacity and up to 192 GBps of memory bandwidth per node
- ▶ Up to 96 GBps I/O bandwidth for external connections
- ▶ Advanced RAS capabilities, including the following ones:
  - Hot-swappable disks
  - Hot-pluggable PCIe adapters
  - Concurrent firmware updates

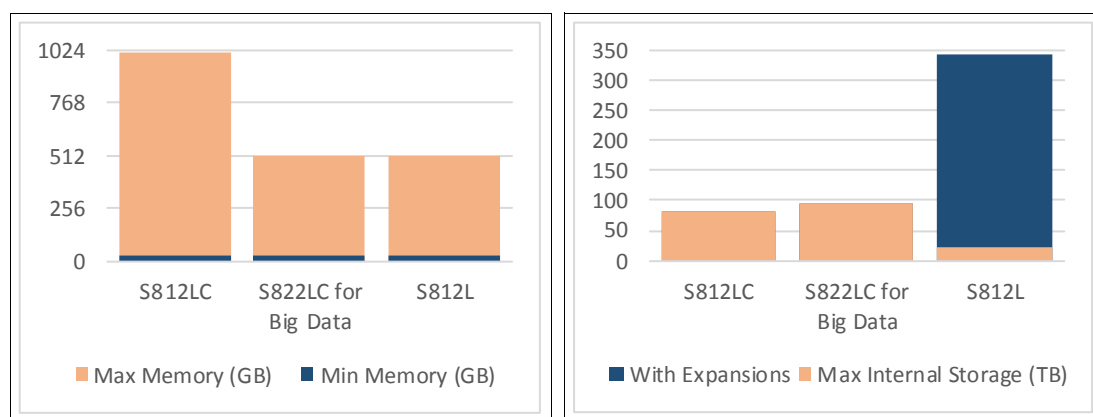
For more information, see *IBM Power Systems S812L and S822L Technical Overview and Introduction*, REDP-5098.

## Comparisons

Each of the systems that are described in this section are suited for a different type of big data or analytics workload. They demonstrate different capabilities that make them suitable for a wider range of application types and use cases. The following figure shows a comparison of the benefits of the different systems.



The OpenPOWER LC servers are specifically developed for Big Data and Analytics workloads. They provide balanced compute and memory performance and large internal storage capacities to provide an optimized solution at the lowest cost. These systems are designed for scale-out big data workloads that are spread across a cluster of systems. The various capacities for memory and storage are shown in the following figure.



The Power S812L server provides greater flexibility in its configuration, allowing for larger memory capacities and connectivity options. Using storage expansion devices such as the EXP24S storage expansion enclosure can extend the storage capacity of the system to hundreds of terabytes, although this requires more rack space. This system is ideally suited to small-scale or single-server deployments, such as in-memory analytics by using IBM DB2® with BLU acceleration, or business analytics by using tools such as IBM Cognos® BI.

# Systems for High Performance and Technical Computing

*High-performance computing (HPC)* is the use of large clusters of parallel processing for running advanced scientific applications efficiently, reliably and quickly.

*Technical computing* is the application of mathematical and computational principles to support scientific workloads to solve practical problems of industrial interest.

**Example use cases:** Here are some typical use cases.

**Automotive design** Computational fluid dynamics (CFD) applications are used to increase efficiency, and modeling and simulation allows virtual crash testing.

**Industrial Manufacturing** New products are brought to market faster by using virtual modeling and testing, and simulations increase production efficiency.

**Research** Using cutting edge scientific computation methods, researchers see results faster, and create more accurate models in a shorter time.

Along with members of the OpenPOWER Foundation, IBM created specific servers that meet the requirements of HPC and technical computing workloads. These workloads commonly require the following items:

- ▶ High levels of parallel compute performance in large clusters
- ▶ Balanced system designs to increase total throughput
- ▶ Large memory throughput increasing processor efficiency

Many workloads support accelerators such as GPUs to improve performance, particularly for highly parallel applications.

**NVLink:** A unique connectivity option for NVIDIA GPUs that provides much higher bandwidth and lower latency than traditional PCIe connected devices. It allows connectivity between multiple NVIDIA Tesla P100 GPUs and POWER8 with NVLink processors. Each connection allows up to 80 GBps of data movement between devices, removing a common bottleneck for accelerated computing.

For more information, see the following website:

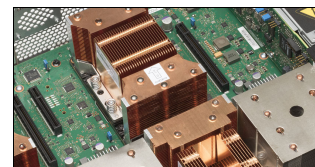
<http://www.nvidia.com/object/nvlink.html>

## IBM Power System S822LC for High Performance Computing (8335-GTB)



The Power S822LC for High Performance Computing server was designed and built in collaboration with OpenPOWER Foundation partners NVIDIA, Mellanox, and Wistron to tackle high-performance and technical computing workloads. It is the first server to incorporate NVIDIA NVLink technology into the processor technology.

It is designed to provide the highest performance and greatest efficiency for workloads that use GPU acceleration, including CFD and molecular modeling applications. GPU acceleration is also used extensively in machine learning, deep learning, and cognitive workloads.



This system supports up to four NVIDIA Tesla P100 GPUs, which are connected through NVIDIA NVLink, and each node can include up to 1 TB of DDR4 memory. With support for Mellanox 100 Gbps (EDR) InfiniBand adapters for interconnect, large clusters accommodate high-speed interconnect between nodes. This is the first system that is available in the industry that supports NVLink connection of multiple NVIDIA GPUs directly into the processor architecture, allowing coherent memory access. It also includes the following items:

- ▶ Choice of air-cooled or water-cooled models for greater thermal efficiency
- ▶ Option of NVMe based storage devices for greater performance
- ▶ 100 Gbps InfiniBand adapters that use Mellanox ConnectX-4 technology

For computationally rich high performance or technical computing workloads that do not benefit from GPU acceleration, there is the similarly designed IBM Power System S822LC for Commercial Computing, which is described in “IBM Power System S822LC for Commercial Computing (8335-GCA)” on page 14.

For more information, see *IBM Power System S822LC for High Performance Computing Introduction and Technical Overview*, REDP-5405.

**Computational fluid dynamics:** A computationally intense workload that uses numerical analysis to model and simulate fluid flows and interactions. It is used extensively in industrial design. CFD workloads deliver greater accuracy and faster results when greater computational power is available. Applications such as the open-source project OpenFOAM are commonly used, and show performance benefits when run on optimized hardware. For more information, see the following website:

<http://www.openfoamonpower.co.uk/>

## IBM Power System S824L (8247-42L)



The Power S824L server is a 4U server that can accommodate up to 2 TB of high performance, highly resilient memory, and up to two NVIDIA Tesla K80 GPUs for accelerated workloads. This makes it ideal for memory-intensive workloads, including those (such as CFD) that are optimized for use with GPUs. There is great flexibility in the configuration, allowing for system designs that meet specific requirements.

The higher level of RAS than is found in comparable servers ensures that this server is well-suited to workloads that require high memory capacities in a single node. It also ensures that support is available for workloads that require high memory capacities and bandwidth, and GPU acceleration.

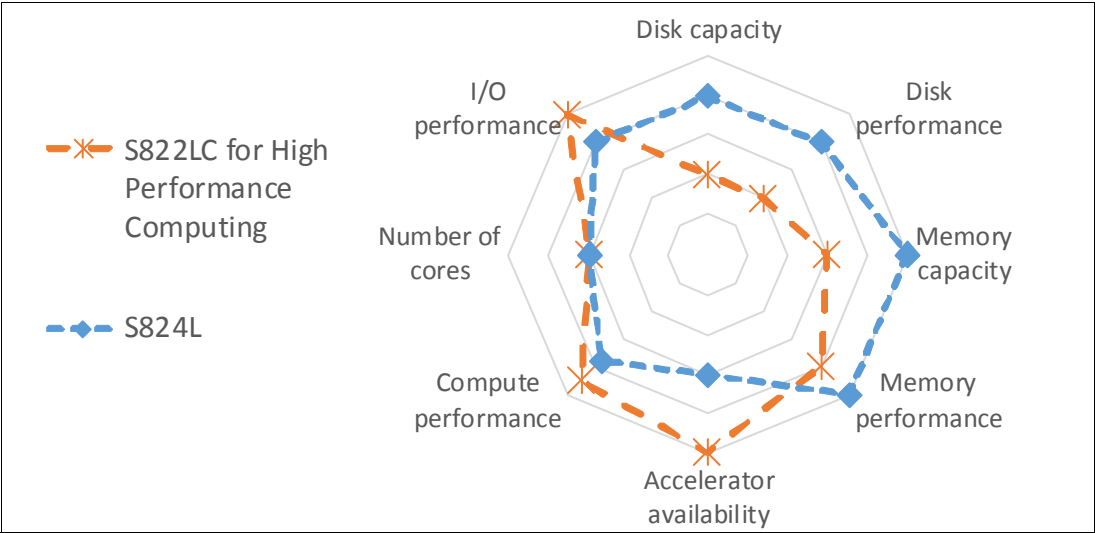
This two-socket system is available with internal and external storage options, and various PCIe adapters for connectivity to high-speed networks and expansion devices. It also benefits from the following items:

- ▶ Up to 192 GBps memory bandwidth per socket, with up to 2 TB memory capacity
- ▶ Up to 96 GBps I/O bandwidth across 11 PCIe adapter slots for increased connectivity
- ▶ Support for NVIDIA Tesla K80 GPUs and CAPI-capable devices for acceleration

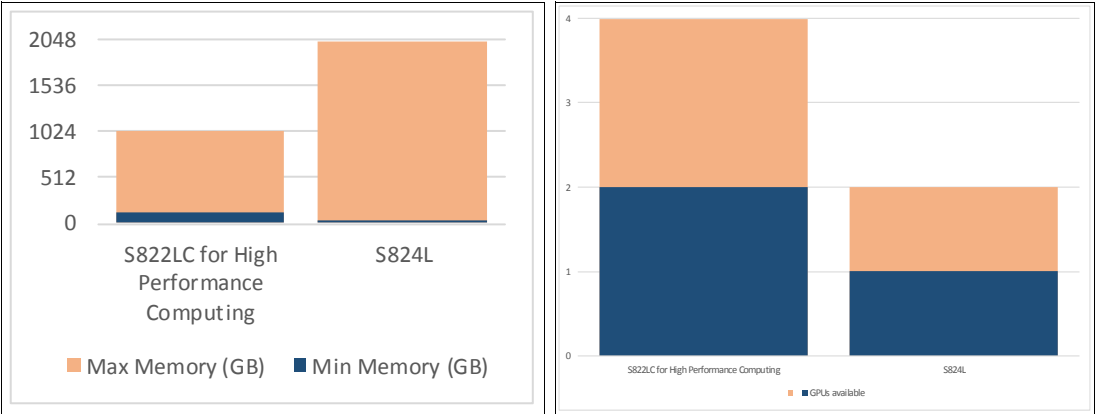
For more information, see *IBM Power System S824L Technical Overview and Introduction*, REDP-5139.

Comparisons

Each of the servers that are described in this section is designed for a different type of HPC or technical computing workload. They demonstrate different capabilities, which make them suitable for a wider range of application types and use cases. The following figure shows a comparison of the benefits of the different systems.



The Power S822LC for High Performance Computing server is designed with OpenPOWER Foundation partners, including NVIDIA, Mellanox, and Wistron, to create an optimized design for modern high-performance and technical computing workloads. It incorporates industry-standard components for cost efficiency while adding unique innovations such as NVLink and high-speed InfiniBand adapters for the highest possible throughput. The Power S822LC for High Performance Computing is designed to operate in large-scale clusters to deliver the highest possible throughput for many HPC applications and workloads. The various capacities for memory and GPUs are shown in the following figure.



The Power S824L server provides a more flexible environment for demanding workloads. This system can be configured with up to 2 TB of memory per node to support the most memory-intensive workloads. This memory can be supplemented with up to two NVIDIA Tesla K80 GPUs to provide greater performance for accelerated applications. The Power S824L server is designed to provide a large memory capacity and bandwidth for memory-intensive applications. As these are generally restricted to a single node, they benefit from the higher reliability and resiliency characteristics of the Power Systems L servers.

## Systems that are designed for Compute-Intensive and Cloud workloads

*Compute-intensive* refers to any computer application that requires much computational power, such as meteorology programs and other scientific applications. It also often applies to any computing application that requires the resources of many computers, such as grid or cluster computing.

*Cloud computing* is the delivery of on-demand computing resources to a user, often by using virtualization technologies to consolidate multiple workloads onto each individual node. Commonly, this is delivered by clusters of machines, managed by using advanced automation, and by using standardization of hardware and workloads.

**Example use cases:** Here are some typical use cases.

<b>E-commerce</b>	Large deployments of workloads that are hosted on scale-out platforms, such as IBM WebSphere® Application Server, which can scale rapidly to meet consumer demand.
<b>Finance</b>	Risk analysis processes by using Monte Carlo-like simulations, which require high computational performance to deliver timely results for faster trades.
<b>Web hosting</b>	Having a flexible cloud deployment running common frameworks such as the Linux, Apache (web server), MariaDB / MySQL / MongoDB, and PHP / Python (LAMP) stack allows hosting companies to increase usage and reduce cost.

The Power Systems range includes a number of systems that are optimized for Compute-Intensive and Cloud workloads. These workloads commonly require the following items:

- ▶ High density of compute power in an SFF enclosure
- ▶ Balance of compute and memory capacity to support virtualized environments
- ▶ High I/O bandwidth to connect nodes throughout the cluster

**LAMP:** Linux, Apache (web server), MariaDB / MySQL / MongoDB, PHP / Python. This is a generic name for a common platform of web-based applications, built largely on open-source software products. Many frequently used frameworks such as WordPress use the LAMP stack as a platform, and enterprise applications such as Magento and SugarCRM. Applications that are built on the LAMP stack are often highly scalable and suit cloud deployments.



## IBM Power System S822LC for Commercial Computing (8335-GCA)



The Power S822LC for Commercial Computing server was designed and developed with other OpenPOWER Foundation members to provide a compute-rich environment for cluster and cloud deployments.

This two-socket system supports up to 1 TB of memory, with various adapter options to connect it to high-speed networks. It also supports various virtualization options that are based on the open source Kernel Virtual Machine (KVM) technologies. It also includes the following items:

- ▶ Up to 230 GBps of memory bandwidth, which is 2x greater than any comparable system.
- ▶ Optional support for up to two GPUs and two CAPI-capable adapters for acceleration.
- ▶ Run up to 160 workload threads in a single node.

The Power S822LC for Commercial Computing is used in the IBM Power Systems HPC Cluster offering, which is an integrated solution combining compute nodes (with optional GPU accelerators), Elastic Storage Server parallel storage, and high-speed, low-latency network interconnects.

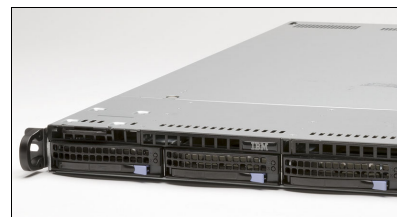
For more information, see *IBM Power System S822LC Technical Overview and Introduction*, REDP-5283.

**Kernel Virtual Machine (KVM):** A group of open source technologies that provides a virtualization environment for Linux workloads. This includes the hypervisor, commonly known as KVM, which can be used to host VMs, and tools to manage these VMs. KVM can be run on a range of different hardware architectures.

Commercial KVM versions are available from companies such as Red Hat and Canonical (Ubuntu), although community versions are also available.

## IBM Power Systems S821LC (8001-12C)

The Power S821LC server provides a highly dense compute environment with up to two sockets in a single 1U node. It is designed to provide high-compute performance, balanced with memory and I/O capabilities in a minimal footprint, which allows for over 6,500 compute threads in a single rack. It is well-suited for cloud deployments, such as multitenanted LAMP deployments.



This system can be deployed as a one- or two-socket system, with up to four LFF storage devices providing up to 32 TB of internal storage capacity. There are also SSD options for higher storage throughput. It also includes the following items:

- ▶ Up to 512 GB memory, with up to 96 GBps bandwidth for higher usage levels
- ▶ Higher utilization that is driven by open source virtualization and up to 160 threads per node
- ▶ Optional acceleration with NVIDIA Tesla K80 or P100 GPU and CAPI-capable adapters

For more information, see *IBM Power System S821LC: Technical Overview and Introduction*, REDP-5406.



## IBM Power Systems S822L (8247-22L)



Based on the same design as the Power S812L server (see “IBM Power System S812L (8247-21L)” on page 8), the Power S822L server is a two-socket server that is developed to provide a highly resilient environment for enterprise workloads that require high levels of compute power. It is designed to balance compute, memory, and I/O performance

to get the highest usage for various workloads. With a range of internal and external storage options, and a selection of PCIe adapters that are available for expansion and connectivity, the Power S822L server provides the flexibility to configure a system to match individual workload requirements.

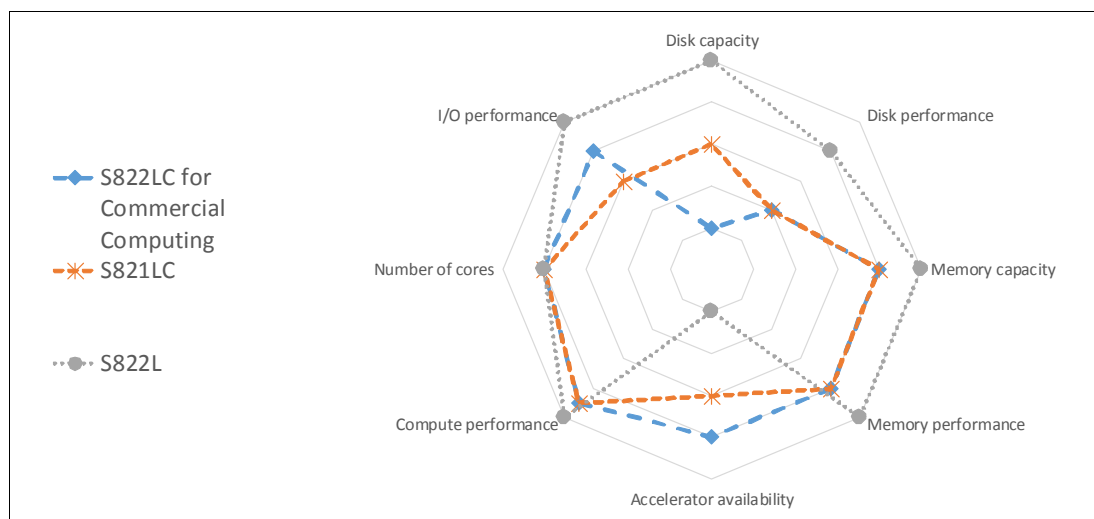
This system supports up to 10 PCIe adapters within the system, with Fibre Channel, Ethernet, and InfiniBand adapters optionally available, along with other adapters, including CAPI-capable cards. It also benefits from the following items:

- ▶ Up to 1 TB memory capacity and up to 384 GBps of memory bandwidth per node
- ▶ Up to 192 GBps I/O bandwidth for external connections
- ▶ Advanced RAS capabilities, including the following ones:
  - Hot-swappable disks
  - Hot-pluggable PCIe adapters
  - Concurrent firmware updates

For more information, see *IBM Power Systems S812L and S822L Technical Overview and Introduction*, REDP-5098.

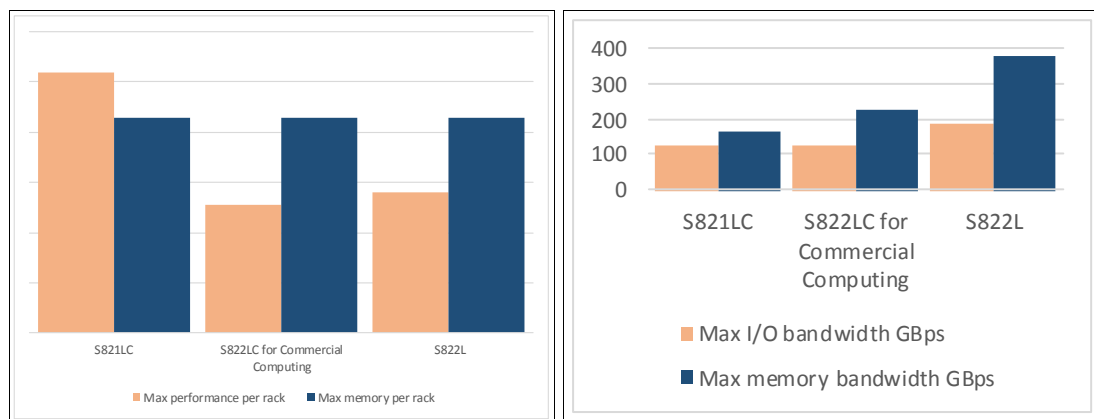
## Comparisons

Each of the systems that are described in this section is designed for a different deployment style, depending on the required use case. They demonstrate different capabilities that make them suitable for a wider range of application types and use cases. The following figure is a comparison of the benefits of the different systems.



The Power S821LC server offers the highest compute performance that is available for a given amount of space, and the Power S822LC for Commercial Computing server and the Power S822L server offer higher memory to core ratios for memory-intensive workloads. The Power S822L server provides the greatest flexibility of configuration, so is ideal for purpose-built, compute-intensive workloads. It also offers the highest memory and I/O bandwidths.

The Power S821LC server provides a highly dense cluster of systems, providing the highest compute power for a given space. The Power S822LC for Commercial Computing server provides a slightly reduced density, but with a higher memory bandwidth for memory-intensive workloads. These performance metrics are compared in the following figure.



For large-scale, multi-purpose cloud deployments, the LC models provide the best balance of performance and cost, and the Power S822L server can be configured to meet an exact need. The Power S822LC for Commercial Computing server also supports NVIDIA K80 GPUs for acceleration, and is ideally placed for compute-intensive HPC or technical computing workloads.

With the higher levels of RAS that are available, the Power S822L server is ideally suited to small-scale or single-system deployments, including traditional core business applications and single open source database instances.

## Summary

In this paper, the Linux only on Power Systems server ranges were described, including the Power Systems L servers and the OpenPOWER LC server range. It looked at some common workload types, and the system characteristics that are best suited to those applications:

- ▶ POWER8 technology provides a high-performance processor architecture that is designed specifically for servers and enterprise workloads:
  - These processors offer high-compute performance that is balanced with high memory and I/O bandwidths.
  - They incorporate advanced RAS features that are not found in comparable systems.
- ▶ The Power Systems L servers are ideally suited to single-server deployments or small-scale use cases, as they incorporate RAS features that are not found in comparable systems to increase resiliency.
- ▶ The Power Systems L servers offer greater flexibility of configuration, and are suited to a wider range of applications and use cases.

- ▶ The OpenPOWER LC servers are workload-optimized systems that are designed with other members of the OpenPOWER Foundation, and are designed to be different:
  - They benefit from OpenPOWER member innovations such as 100 GBps interconnects and NVMe storage drives and adapters.
  - They all support accelerator technologies, such as GPUs and FPGAs, with innovative interconnects, such as NVIDIA NVLink and CAPI.
  - They offer the widest selection of storage types, including SATA, SAS, NVMe, Fibre Channel, and Ethernet connected options.
- ▶ The OpenPOWER LC server range includes systems that are designed and optimized for the following areas:
  - Big Data and Analytics workloads.
  - High Performance and Technical Computing.
  - Compute-Intensive and Cloud workloads.
- ▶ The OpenPOWER S822LC for High Performance Computing server is the first server in the world to incorporate NVIDIA NVLink technology into the processor architecture, providing 2.5x the bandwidth of standard PCIe connected accelerators and coherent access to system memory.

## Reference

The following pages provide technical details for the Linux only on Power Systems server offerings. These are provided for reference purposes, and some details are subject to change. Review the latest information at IBM Knowledge Center:

<https://www.ibm.com/support/knowledgecenter/>

# Systems for Big Data and Analytics

The following table shows a summary of the technical details of the systems that are designed for Big Data and Analytics workloads.

Category	Power S822LC for Big Data server	Power S812LC server	Power S812L server
Machine and model	8001-22C	8348-21C	8247-21L
<b>Processor</b>			
Sockets	One or two	One	One
Cores	8, 10 or 11 (one socket), 16, 20 or 22 (two sockets)	8 or 10	10 or 12
Speeds	3.32, 2.92 or 2.89 GHz	3.32 or 2.92 GHz	3.42 or 3.02 GHz
<b>Memory</b>	DDR4	DDR3	DDR3
Minimum	32 GB	32 GB	16 GB
Maximum	512 GB	1 TB	512 GB
Memory bandwidth	57 GBps (one socket) 115 GBps (two sockets)	115 GBps	192 GBps
<b>Storage</b>			
Internal bays <sup>a</sup>	12 front LFFs or SFFs <sup>b</sup>	12 front LFFs + 2 rear LFFs	12 SFFs or 8 SFFs + six 1.8-inch SSDs
Maximum capacity	96 TB <sup>b</sup>	84 TB	21.6 TB internal only, 300 TB+ with expansions
Maximum SSD capacity	45.6 TB <sup>b</sup>	53.2 TB	18.6 TB internal only, 300 TB+ with expansions
<b>I/O</b>			
PCIe adapter slots	2 (one socket) 5 (two sockets)	4	6
CAPI-enabled slots	1 (one socket) 4 (two sockets)	2	4
GPU accelerator options	None, one, or two NVIDIA Tesla K80 or P100 GPUs (PCIe)	None or one NVIDIA Tesla K80 or P100 GPUs (PCIe)	None
NVLink connections	0	0	0
I/O bandwidth	64 GBps (one socket) 128 GBps (two sockets)	64 GBps	96 GBps
<b>Physical</b>			
System size	2 U	2 U	2 U (+ 2 U for each expansion drawer)

a. LFF = 3.5 in., SFF = 2.5 in.

b. If the Power S822LC for Big Data system includes two GPUs, only eight LFF bays are available for use, reducing the maximum capacity to 64 TB, and maximum SSD capacity to 30.4 TB.

# Systems for High Performance and Technical Computing

The following table shows a summary of the technical details of the systems that are designed for High Performance and Technical Computing workloads.

Category	Power S822LC for High Performance Computing server	Power S824L server with GPUs	Power S824L server without GPUs
Machine and model	8335-GTB	8247-42L	8247-42L
<b>Processor</b>			
Sockets	Two	Two	Two
Cores	16 or 20	20 or 24 with GPUs	16 or 24
Speeds	3.26 GHz or 2.86 GHz	3.42 GHz or 3.02 GHz with GPUs	4.15 GHz or 3.52 GHz
<b>Memory</b>	DDR4	DDR3	DDR3
Minimum	128 GB	32 GB	32 GB
Maximum	1 TB	2 TB	2 TB
Memory Bandwidth	230 GBps	384 GBps	384 GBps
<b>Storage</b>			
Internal bays <sup>a</sup>	2 SFFs	12 SFFs or 18 SFFs + eight 1.8-inch SSDs	12 SFFs or 18 SFFs + eight 1.8-inch SSDs
Maximum capacity	4 TB	32.4 TB internal only, 300 TB+ with expansions	32.4 TB internal only, 300 TB+ with expansions
Maximum SSD capacity	7.6 TB	46.6 TB internal only, 300 TB+ with expansions	46.6 TB internal only, 300 TB+ with expansions
<b>I/O</b>			
PCIe adapter slots	3	11	11
CAPI-enabled slots	3	4	4
GPU accelerator options	Two or four, NVLink connected NVIDIA Tesla P100 GPUs	One or two NVIDIA Tesla K40 GPUs, or one or two NVIDIA Tesla K80 GPUs	None
NVLink connections	4	0	0
I/O bandwidth	64 GBps PCIe	192 GBps	192 GBps
NVLink bandwidth	320 GBps (160 GBps CPU-GPU 160 GBps GPU-GPU)	0	0
<b>Physical</b>			
System size	2 U	4 U	4 U

a. LFF = 3.5 in., SFF = 2.5 in.

## Systems for Compute-Intensive and Cloud workloads

The following table shows a summary of the technical details of the systems that are designed for Compute-Intensive and Cloud workloads.

Category	Power S822LC for Commercial Computing server	Power S821LC server	Power S822L server
Machine and model	8335-GCA	8001-12C	8247-22L
<b>Processor</b>			
Sockets	Two	One or two	Two
Cores	16 or 20	8 or 10 (one socket), 16 or 20 (two sockets)	16, 20, or 24
Speeds	3.32 GHz or 2.92 GHz	2.32 GHz or 2.09 GHz	4.15 GHz, 3.42 GHz, or 3.02 GHz
<b>Memory</b>			
Minimum	32 GB	32 GB	32 GB
Maximum	1 TB	256 GB (one socket) 512 GB (two sockets)	1 TB
Memory Bandwidth	230 GBps	48 GBps (one socket) 96 GBps (two sockets)	384 GBps
<b>Storage</b>			
Internal bays <sup>a</sup>	2 front SFFs	4 front LFFs or SFFs	12 SFFs or eights SFFs + six 1.8-inch SSDs
Maximum capacity	1 TB	32 TB	21.6 TB internal only, 300 TB+ with expansions
Maximum SSD capacity	7.6 TB	15.2 TB	18.6 TB internal only, 300 TB+ with expansions
<b>I/O</b>			
PCIe adapter slots	5	2 (one socket) 4 (two sockets)	9
CAPI-enabled slots	4	1 (one socket) 3 (two sockets)	4
GPU accelerator options	None, one, or two NVIDIA Tesla K80 GPUs	None or one NVIDIA Tesla K80 GPUs	None
NVLink connections	0	0	0
I/O bandwidth	128 GBps	128 GBps	192 GBps
<b>Physical</b>			
System size	2 U	1 U	2 U

a. LFF = 3.5 in., SFF = 2.5 in.

## Virtualization and operating system support

There are many deployment options for Linux on Power Systems. These options include virtualization that is provided by IBM PowerVM technology, or by using Open Source KVM virtualization. These options are easily implemented into cloud management tools, such as IBM Cloud PowerVC Manager. It is also possible to run Linux operating systems in bare metal mode by using all of the system resources for a single image.

The following table summarizes the virtualization and operating system combinations on Power Systems for which there is Enterprise-level support. This support can be provided by the vendors themselves, or from IBM with an appropriate support contract.

Server	PowerVM <sup>a</sup>	KVM on Power <sup>bc</sup>	Bare metal <sup>c</sup>
Power S822LC for Big Data server		Red Hat Virtualisation Ubuntu KVM	RHEL 7.2 or later Ubuntu 14.04.5 or later Ubuntu 16.04.1 or later
Power S812LC server		PowerKVM Red Hat Virtualization Ubuntu KVM	RHEL 7.2 or later Ubuntu 16.04.1 or later Ubuntu 14.04.3 or later
Power S812L server	Supported	PowerKVM Red Hat Virtualization Ubuntu KVM	RHEL 7.2 or later Ubuntu 16.04 or later Ubuntu 14.04.2 or later
Power S822LC for High Performance Computing server			RHEL 7.3 or later Ubuntu 16.04.1 or later
Power S824L server with GPUs			Ubuntu 14.04.2 or later
Power S824L server without GPUs	Supported	PowerKVM Red Hat Virtualization Ubuntu KVM	RHEL 7.2 or later Ubuntu 16.04 or later Ubuntu 14.04.2 or later
Power S822LC for Commercial Computing server		PowerKVM Red Hat Virtualization Ubuntu KVM	RHEL 7.2 or later Ubuntu 16.04.1 or later Ubuntu 14.04.3 or later
Power S821LC server		Red Hat Virtualisation Ubuntu KVM	RHEL 7.2 or later Ubuntu 14.04.5 or later Ubuntu 16.04.1 or later
Power S822L server	Supported	PowerKVM Red Hat Virtualization Ubuntu KVM	RHEL 7.2 or later Ubuntu 16.04 or later Ubuntu 14.04.2 or later

a. PowerVM supports LPARs running Red Hat Enterprise Linux (RHEL) 6.6 or later, RHEL 7.1 or later, SUSE Linux Enterprise Server (SLES) 11 SP3 or later, SLES 12 or later, Ubuntu 14.04.3 or later, and Ubuntu 16.04 or later.

b. PowerKVM supports guests running RHEL 6.6 or later, RHEL 7.1 or later, SLES 11 SP3 and SP4, SLES 12 SP1 and above, Ubuntu 14.04.3 or higher, and Ubuntu 16.04 or higher. Red Hat Virtualization 4.0 supports RHEL guests, starting with RHEL 7.2. Ubuntu KVM virtualization supports Ubuntu 14.04.5 guests or higher, or Ubuntu 16.04.1 guests or higher.

c. The Linux distributions that are supported for bare-metal installation and as KVM hosts are all little endian variants, with the exception of PowerKVM, which is big endian.

## Authors

This paper was produced by a team of specialists from around the world working at the International Technical Support Organization, Austin Center.

**Tonny Bastiaans** is the European Product Manager for Power Systems, based in the Netherlands. He has more than 15 years of experience with Power Systems. He started his career at IBM as a customer engineer for IBM RS6000 systems. Later, he moved to IBM Systems where he has worked as a Pre-sales consultant for Power Systems. For the past few years, he has been working as Product Manager for Power Systems, first for BeNeLux and later for all of Europe. Tonny has been presenting the Power Systems message on different stages to customers, IBM Business Partners, and IBM employees.

**Andrew Laidlaw** is a Linux Specialist, working for Power Systems in the United Kingdom and Ireland. He has a bachelors degree in Mathematics from the University of Leeds in the UK. He has been working with Linux on Power since starting his career at IBM, and is a member of the Linux Foundation, and is a Certified Linux Administrator. Andrew has co-authored previous IBM Redpaper publications, and shares relevant information through social media and blog posts.

The project that produced this publication was managed by:

Scott Vetter  
**Executive Project Manager, PMP**

Thanks to the following people for their contributions to this project:

David Barron, Pradipta Kumar Banerjee, Emily Barrett, Alexandre Bicas Caldeira, Dylan Boday, Todd Boyd, David Chancellor-Maddison, Nigel Griffiths, Volker Haug, Ann Lund, Ben Mashak, Chris Parsons, Dipankar Sarma, Jeff Scheel, Alise Spence, Marty Voss, Erik Zedelmayer.  
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REDP-5414-00

ISBN 0738455814

Printed in U.S.A.

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