Power Systems Strategy - Linux

Open Innovation to Put Data to Work

Franz Bourlet
Power Systems Technical Sales
IBM Belgium & Luxembourg
How IBM is deploying Linux in data centers

- 1100+ servers WW
- Internal Linux Projects:
    - redundant Linux servers
  - IGS Internet Vulnerability Security Scanning
    - 61 System x scanning 30k IP addresses/week
  - Performance monitoring
    - 24 System x servers
    - 75% fewer Linux servers than Windows servers for same workload
  - IBM Global e-Mail Anti-virus Management
    - Linux servers scan incoming/outgoing mail for viruses
  - 300mm Wafer Manufacturing Equipment Control
    - Much more reliable than Windows
    - 300-400 systems

IBM consolidated more than 3,900 distributed servers onto just 33 mainframes running Linux. This drove HUGE savings ... including an 80 percent reduction in energy consumption over 5 years
How IBM is deploying Linux on clients

**Vision:** Employees get right tool at the right time for the right cost. To realize this:

- Higher productivity through collaboration
- Drive to Web through lightweight platforms
- Roles based dynamic delivery of IT resources

**Increased interoperability and flexibility**

- **Open standards, open source, open architecture**
  - IBM Productivity Tools
  - Open Client (Linux, Win, OS X)
  - IBM Workplace Managed Client

**Deliver increased value through strategic open standards**

- Provide better choices
- Increase interoperability
- Optimize document interchange

**Historical Timeline**

- **1998**: First Linux desktop introduced
- **2003**: Microsoft Office
- **2008**: Open Client (Linux, Win, OS X)
- **2013**: ODF Strategic standard for document interchange

**Important Technologies**

- Lotus SmartSuite
- Lotus Notes 7.01: Linux / Mac
- Eclipse-based Expeditor / Sametime IM 7.5
- Lotus Symphony
- IBM Workplace Managed Client

**IBM Workplace Managed Client**

- **Lotus SmartSuite**
- **Windows 95/98**
- **OS/2**
- **Lotus Notes 8 & Productivity Tools**
- **Windows 2000 / XP**
IBM Open Client for Linux penetration

Open Client for Linux Red Hat Edition

75000 Active Linux Users within IBM

John A. Walicki | Jan 17 | 12 Comments | 372 Visits

On January 17th, 2014 the Open Client for Linux usage metrics reported that there are over 75000 active Linux client workstations within IBM. An active system is defined as a system that has checked in during the prior 90 day period.

[Image of Client Statistics Portal]

Total number of Active clients: 75,002
Broken down as follows: RHEL 69,914, Fedora 271, OCDC 4,806, Other 11
IBM's contribution to Linux and open source

IBM has been an active Linux community member since 1999
IBM is the leading systems vendor contributing to Linux
IBM has over 600 full-time developers working with Linux and open source
IBM is actively involved into over 100 open source projects

### Linux Kernel & Subsystem Development
- Kernel Base Architecture Support
- GNU
- Security
- Systems Management
- Scalability
- RAS
- Virtualization
- Special Projects
- Filesystems (JFS eg),, and more...

### Expanding the Open Source Ecosystem
- Apache & Apache Projects
- Eclipse
- Mozilla Firefox
- OpenOffice.org
- PHP
- Samba, and more...

### Foster and Protect the Ecosystem
- Software Freedom Law Center
- Free Software Foundation (FSF)
- Open Invention Network, and more...

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Linux in IBM's offerings

- In 1999, IBM announced 1 billion dollar investment to enable Linux throughout the company. As a result:
  - Hardware: all IBM HW platforms can run the Linux operating system.
  - Software: all IBM SW solutions can run on Linux.
  - Services: over 30 Linux Technology Centers (LTC) WW whose mission is to promote Linux.

- IBM is consistently among the top contributors of Linux code, with more than 600 IBM developers involved in over 100 open source projects.

- In 2013, the Linux Journal gave IBM the “Best Linux Server Vendor” Award for 2012, for the third year in a row.

- In 2013, IBM successively announced 1 billion dollar investment on Linux on Power systems and the OpenPOWER Foundation.

- In 2014, The OpenPOWER Foundation was elected in Linux. Com's top 5 enterprise open source projects to follow
IBM provides complete Linux solutions: top-to-bottom, end-to-end

IBM Global Services

IBM Systems Software

IBM Systems Storage

IBM System x

IBM Power Systems

IBM System z

IBM Global Financing

Linux provides common benefits across all IBM platforms
Introducing the IBM z13
The mainframe optimized for the digital era

- Performance, scale, intelligent I/O and security enhancements to support transaction growth in the mobile world
- More memory, new cache design, improved I/O bandwidth and compression help to serve up more data for analytics
- Enterprise grade Linux solution, open standards, enhanced sharing and focus on business continuity to support cloud

10% Single thread capacity improvement over zEC12
Up to 40% Total capacity improvement over zEC12
Up to 10 TB 3X more available memory to help z/OS* or Linux* workloads
2 zKVM* and GDPS* virtual appliance for Linux on IBM zSystems™ opens the door for more Linux*
Configurable cores – CP, zIIP, IFLs, ICFs, SAP

Upgradeable from IBM zEnterprise® 196 (z196) and IBM zEnterprise EC12 (zEC12)

1 Based on preliminary internal measurements and projections. Official performance data will be available upon announce and can be obtained online at LSPR (Large Systems Performance Reference) website at: https://www-304.ibm.com/servers/resourcelink/lib03060.nsf/pages/lsprindex?OpenDocument. Actual performance results may vary by customer based on individual workload, configuration and software levels

* All statements regarding IBM’s future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.
Do you know ARM Ltd?

- Founded in November 1990 – www.arm.com
  - Spun out of Acorn Computers
- Runs 95% of mobile phones and tabs
- Arm designs a range of RISC processor cores but does not fabricate silicon itself
- Licenses ARM core designs to semiconductor partners who fabricate and sell to their customers
  - Examples include Apple, Samsung, Nvidia, Qualcomm,...
- Also develops technologies to assist with the design-in of the ARM architecture
  - Software tools, boards, debug hardware, application software, bus architectures, peripherals, etc
POWER is becoming the ARM of the datacenter

IBM Research: Innovation Strengthens the Stack

IBM is Unique in the World
- No other company plays in all the layers. IBM is world-class in all layers
- Those that play in multiple layers are world-class only in few.

IBM R&D investment
- $6 Billion annually
- Human capital and culture
- 3000+ Researchers
- 6478 U.S. patents in 2012
- Patent leader past 20 years

As CMOS scaling slows, Value comes from Innovating across the Stack
OpenPOWER and Innovation

OpenPOWER: Bringing Partner Innovation to Power Systems

IBM Stack

Research And Innovation

IBM POWER8

Google IDC System, Software Stack

CAPI / PCI G3
Directly Integrate Partner IP into Power8 Chip protocols

Mellanox
World class Networking and Switching

NVIDIA
World class GPU Compute Capabilities

TYAN
OpenPower Open Innovation

IBM

Google

Mellanox

NVIDIA

TYAN
The goal of the OpenPOWER Foundation is to create an open ecosystem, using the POWER Architecture to share expertise, investment and server-class intellectual property to serve the evolving needs of customers.
A modern development environment is emerging based on this type of tools and services.
Open Sourced BIOS Helps Power8 Compete With X86

July 15, 2014 by Timothy Prickett Morgan

IBM is deadly serious about fostering an open ecosystem around the Power8 processor and its follow-ons, and has taken the next step in advancing its OpenPower cause by open sourcing the microcode that manages the boot sequence on the Power8 chips.

This may sound like a small thing, but it has important ramifications for IBM and the OpenPower Foundation partners who are making motherboards based on the Power8 processor. At the moment, this includes a single-socket board made by Tyan aimed at software developers and early system builders and a two-socket board made by Google for its own internal testing. Google has been testing IBM and homegrown Power8 systems since earlier this year, and both companies were showing off their Power8 boards at IBM's Impact2014 conference back in April. In February, EnterpriseTech reported that Google was testing homegrown Power8 systems and that the company's software engineers were working on the Linux kernel for the Power8 architecture.
POWER8 CAPI

Coherent Accelerator Processor Interface (CAPI)

Virtual Addressing
• Accelerator can work with same memory addresses that the processors use
• Pointers de-referenced same as the host application
• Removes OS & device driver overhead

Hardware Managed Cache Coherence
• Enables the accelerator to participate in “Locks” as a normal thread
• Lowers Latency over IO communication model

Customizable Hardware Application Accelerator
• Specific system SW, middleware, or user application
• Written to durable interface provided by PSL

Processor Service Layer (PSL)
• Present robust, durable interfaces to applications
• Offload complexity / content from CAPP
OpenPOWER CAPI Developer Kit for POWER 8

What is CAPI?

IBM developed the Coherent Accelerator Processor Interface (CAPI) as a new means for solution architects to improve system-level performance.

Most FPGA Accelerators utilize PCIe as their link to the host. CAPI provides a unique alternative, allowing the FPGA accelerator to coherently attach to the fabric of a
POWER8™ chip and up to 1 TB of system memory.

This new hybrid solution has a simple programming paradigm while delivering algorithm acceleration and performance well beyond what’s available today.

Learn More About CAPI

IBM CAPI Home Page

CAPI Product Overview

IBM CAPI Presentation

IBM CAPI White Paper

© 2014 IBM Corporation
Business analytics acceleration

Traditional Model vs. Kernel Bypass Model

10x Higher Throughput

10x Lower Latency

Dramatically faster responsiveness to customers!

Utilizing high speed interconnect with RDMA (Ethernet, InfiniBand)

Leveraging POWER8 high throughput low latency I/O

“Applications that historically struggled with scalability and performance can now benefit from In-Memory processing,” said Terri Virnig, Vice President, IBM Power Ecosystem. “Our collaborative efforts with Mellanox resulted in a robust architecture with Power8-based systems and high-performance interconnects designed to tackle the Big Data processing requirements of today.”

IBM Power Systems and Mellanox® Technologies partnering to simultaneously accelerate the network and compute for NoSQL workloads.
IBM & NVIDIA Accelerating Computing

Next-Gen IBM Supercomputers and Enterprise Servers

Long term roadmap integration

OpenPOWER Foundation

Open ecosystem built on Power Architecture

POWER CPU + Tesla GPU

Google

Mellanox Technologies

TYAN

& 30+ more...

1st GPU-Accelerated POWER-Based Systems Available in Oct 2014
How GPU Acceleration Works
The Right Processor for the Job

Application Code

Compute-Intensive Functions
**Parallel Opportunity**

5% of Code

Rest of Sequential CPU Code

CPU

GPU
GPU Acceleration Coming to Java

- “Duimovich also referenced OpenPOWER, which is a new ecosystem around the POWER architecture driving innovation to the platform by leveraging the power of open markets and partners like NVIDIA. The Java on GPU development is one in a series of impacts of the OpenPOWER announcement.” - John Duimovich, IBM’s Chief Technology Officer of Java

Examples of OpenPOWER innovation

NoSQL KVS Acceleration with CAPI Flash (Sure Lock)
- IBM POWER8 Linux Server
- TMS Flash – CAPI attached
NoSQL based solution with IBM Flash and CAPI. Attaching large flash arrays to the processor, without overhead, to drive down costs of large NoSQL deployments.

Financial Risk Modeling with CAPI Accelerator (Monte Carlo) featuring Altera technology
- IBM POWER8 Linux Server
- Altera FPGA Computing Card
Monte Carlo financial simulations run on an Altera FPGA accelerator via CAPI compared to published non-CAPI best case performance for dedicated workload acceleration.

KVS Acceleration with RDMA (Gun Hill)
featuring Mellanox technology
- IBM POWER8 Linux Server
- Mellanox RDMA interface
- IBM Research HydraDB software
POWER8 network acceleration for Big Data utilities high speed RDMA networking with acceleration technology to reduce latency by 10x when working with big data, reducing infrastructure requirements.

Big Data and Java Workload Acceleration (Espresso) featuring NVIDIA technology
- IBM POWER8 Linux Server
- Apache Hadoop/Mahout
- NVIDIA GPU / CUDA
- IBM Java with new GPU Framework
Exploit GPUs for customized acceleration directly from Java. Ideal for Big Data and Analytic Java workloads. Demo uses GPU exploitation for 8x acceleration of a machine learning algorithm for Big Data segmentation.

KVS Acceleration with CAPI FPGA
featuring Xilinx technology
- IBM POWER8 Linux Server
- Xilinx FPGA Computing Card
Compare performance of Key Value Store on a normal configuration, to an acceleration using a Xilinx CAPI attached FPGA accelerator.

Watson on Power in SoftLayer (Tornado)
- IBM POWER8 Linux Server
- Watson Engagement Advisor
- Watson ISV (MD Buyline) Smart Advisor
SoftLayer is now providing Watson as a service on a Power System, and Tornado demonstrates that service with an application.
Non-IBM POWER8 products

The Tyan reference (ATX) board, SP010, measures 12” by 9.6”
- one single-chip module (SCM)
- four DDR3 memory slots
- two Gigabit Ethernet network interfaces
- keyboard and video
- intended for developers

The Google reference board
- two single-chip module (SCM)
- four modified SATA ports
- Google use only

Available from October 2014:
TYAN GN70-BP010
Customer reference system
http://www.tyan.com/campaign/openpower/

http://www.enterprisetech.com/2014/04/28/inside-google-tyan-power8-server-boards/
POWER8 Processors

Open Innovation to put Data to work

• More threads
  – Up to 12 cores per socket
  – SMT8 mode for up to 96 threads per socket

• More bandwidth
  – 2.3 x memory bandwidth per socket over POWER7+ (4 x x86)
  – On chip PCIe3 controller for I/O adapters
  – CAPI interface for accelerators

• More performance
  – Higher performance per core (35% over POWER7+, 2 x Ivy Bridge for Java)
  – Larger caches and additional L4 cache
  – Transactional memory

50x performance improvement for Analytics workloads

2 socket POWER8 running DB2 and Cognos versus similarly specified 2 socket Ivy Bridge solution with alternative Database and Cognos
Linux on Power – Hypervisor choice

Market need: customer wants to avoid coping with multiple virtualization engines:

- Skills
- Migration issues
- Processes
- Licensing

Fact: KVM is the only virtualization available on every platform:

- KVM is a versatile virtualization engine:
  - x86
  - Power
  - System z (zBX)
  - IBM Pure Systems
  - Others

- Optimized for POWER8

- KVM centers for excellence opened:
  - KVM Center of Excellence in Beijing
  - KVM Center of Excellence for Wall Street in NY
6 distributions are currently available on Power:

- 3 enterprise distributions with official support:
  - Red Hat Enterprise Linux (RHEL) : 6.5BE, 7.1 BE
  - Suse Linux Enterprise Server (SLES) : 11 BE, 12 LE
  - Ubuntu Server : 14.04 LE, 14.10 LE

- 3 community distributions:
  - Fedora : [http://fedoraproject.org/get-fedora-options#2nd_arches](http://fedoraproject.org/get-fedora-options#2nd_arches)

- Expected Q1 2015:
  - CentOS : announced today
  - RHEL LE : beta available, GA February 2015
Linux support for POWER

- **RHEL 7**
  - POWER8 (native mode) and POWER 7/7+
  - Available June 2014

- **RHEL 6**
  - POWER8 supported with U5 (P7-compatibility mode)
  - Full support of POWER6 and POWER7 (native mode)

- **Fedora**
  - Fedora 16 was first release to re-launch POWER
  - Fedora 20 has POWER8 support

- **Supported add-ons**
  - JBoss
  - High Performance Network Add-on

- **SLES 12**
  - Anticipated to support POWER8 (native mode) and POWER 7/7+
  - Available October 2014

- **SLES 11**
  - POWER8 with SP3 (P7-compatibility mode)
  - POWER7+ encryption, RNG accelerators with SP3
  - Full support of POWER7 (native mode)

- **openSUSE**
  - openSUSE 12.2 re-launched for IBM POWER
  - openSUSE 13.2 includes POWER8 support

- **Ubuntu 14.10**
  - Continued support for POWER8
  - Anticipate 4Q14 availability

- **Ubuntu 14.04**
  - POWER8 enabled (native mode)
  - No official support for POWER7+ and older systems
  - No support for 32-bit applications. 64-bit only.
  - Supported in KVM only at this time
  - LTS

- **SUPPORTED add-ons**
  - JuJu Charms
  - MaaS (Metal as a Service)
  - Landscape

- **Debian**
  - Debian community now supports Power as of Sid release
Fostering open innovation for cloud based applications with Linux and Power Systems

Moving Linux apps to Power has never been easier

Well-written Java applications written in scripting or interpretive languages will run as is

>95% applications written in C/C++ will require no source code change, only a recompile

Estimated >95% x86/Linux applications written in C/C++ will require no source code change, only a recompile
Growing portfolio of ISV applications for Linux on Power

Thousands of applications available on Linux on Power servers

For detailed and up to date support information see the IBM Global Solutions Directory: https://www.ibm.com/partnerworld/gsd
<table>
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<tr>
<th></th>
<th>Sandy Bridge EP</th>
<th>Ivy Bridge EP E5-26xx v2</th>
<th>Ivy Bridge EX E7-88xx v2</th>
<th>Haswell EP E5-26xx v3</th>
<th>POWER 7+ Systems</th>
<th>POWER8</th>
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Performance comparison => POWER8 vs x86 E5

- ALL data is PUBLISHED

<table>
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<tr>
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<th>x86 “Haswell”</th>
<th>IBM POWER S824</th>
<th>POWER8 vs. x86 Core Performance Ratio</th>
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<tr>
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<td>Intel Xeon E5-2699 v3 (except where noted)</td>
<td>POWER8 @ 3.5 GHz</td>
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<td># Cores</td>
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<td>50000 (6-core)</td>
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SAP results are based on the two-tier SAP SD standard application benchmark running SAP enhancement package 5 for the SAP ERP 6.0 application. Results valid as of September 8, 2014. Source: http://www.sap.com/benchmark

SPECcpu2006 results are submitted as of 9/8/2014. For more information go to http://www.specbench.org/cpu2006/results/

SPECjbb2013 results are submitted as of 9/8/2014. For more information go to http://www.specbench.org/jbb2013/results

SPECjEnterprise2010 results are valid as of 9/8/2014. For more information go to http://www.specbench.org/jEnterprise2010/results/

Oracle eBS 12.1.3 Payroll Batch Extra Large Kit and are current as of 3/24/2014. For more information go to http://www.oracle.com/us/solutions/benchmark/apps-benchmark/results-166922.html

Siebel 8.1.1.4 PSPP Kit and are current as of 3/24/2014. For more information go to http://www.oracle.com/us/solutions/benchmark/white-papers/siebel-167484.html
Core Performance – POWER8 vs. x86

- Industry Standard Benchmarks –
- All Intel performance numbers are IBM internal projections and publishes where available
- IBM S824 data is published/projected

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>x86</th>
<th>IBM Power S824</th>
<th>POWER8 vs. x86 Core Performance Ratio</th>
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<tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>x86 Util: 100%</td>
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</table>

**Legend:**
- Core Performance – POWER8 vs. x86
- Published
- Projected

**Notes:**
3. SPECcpu2006 results are submitted as of 9/8/2014. For more information go to http://www.specbench.org/cpu2006/results/.
4. SPECjbb2013 results are submitted as of 9/8/2014. For more information go to http://www.specbench.org/jbb2013/results.
5. SPECjEnterprise2010 results are valid as of 9/8/2014. For more information go to http://www.specbench.org/jEnterprise2010/results.
## IBM Power 822L pricing comparison ($US) – Scale-Out Cloud with KVM

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<th>Virtualization</th>
<th>Linux OS list price</th>
<th>Server model</th>
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<td>$5,697</td>
<td>Dell PowerEdge R720</td>
</tr>
<tr>
<td>$14,068</td>
<td>$2,998</td>
<td>$5,697</td>
<td>HP ProLiant DL380 G8</td>
</tr>
<tr>
<td>$14,895</td>
<td>$2,998</td>
<td>$4,489</td>
<td>IBM Power 822L</td>
</tr>
</tbody>
</table>

*Based on US pricing for Power S822L announcing on April 28, 2014 matching configuration table above. Source: hp.com, dell.com, vmware.com

**Comparable TCA**

Linux on Intel Ivy Bridge + KVM

Vs.

Linux on POWER8 + KVM

<table>
<thead>
<tr>
<th>Server model</th>
<th>Processor / cores</th>
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<tr>
<td>Dell PowerEdge R720</td>
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</table>

* 3-year warranty, on-site
“OVH has become the first commercial partner outside of IBM to formally announce the deployment of POWER8 servers inside their data centre. These will deployed as bare metal servers for customers who have big data and analytics problems and want the most powerful solution that they can get access to. As part of this announcement, OVH will become an OpenPOWER Foundation member.”
U.S. government spending $425 million to build fastest supercomputers

...”The supercomputers, made with components from IBM, Nvidia and Mellanox, will run five to seven times faster than the United States' current fastest computers. Summit and Sierra will operate at 150 petaflops and 100 petaflops, respectively, compared to the world's current top super-computer, the Tianhe-2 in China, which performs at 55 petaflops, Nvidia said in a separate news release.”...
Demonstrating the Value of CAPI Attach Flash

- Identical hardware with 2 different paths to data

- Flash System 840

- Conventional PCIe I/O

- CAPI

- redislabs

- Nalliatech

- Atera

- Power S822I

- PCIe I/O vs CAPI + FPGA
  - IOPs per HW Thread
  - Latency (us)

- PCIe I/O
- CAPI + FPGA
IBM Solution for Hadoop – Power Systems Edition

A storage-dense integrated big data platform optimized to simplify & accelerate big data analytics:

**Benefits**

- Accelerate ROI: easy to procure, deploy, use and manage
- Higher ingest rates delivers **2.5x faster** insights than competitive hadoop solutions*
- Better reliability and resiliency with **73% fewer outages** and **92% fewer performance problems over x86**
- Tailor cluster resources to meet specific workload CPU, memory, I/O requirements

**Solution Components**

- **Compute nodes & storage**: IBM Power S822L Systems + SAS-attached DCS3700
- **Management software & install scripts**: IBM Platform™ Cluster Manager, automated installation scripts
- **Choice of Application Software Optimized for Linux on Power**: IBM InfoSphere® BigInsights™ with Platform Symphony for accelerated map reduce & GPFS FPO or IBM Platform Symphony Advanced Edition & IBM GPFS™

*Based on STG Performance testing comparing to Cloudera/HP published benchmark
Introducing the “Turbo LAMP Stack”

- Faster Innovation
- Performance and scalability
- Compliance and security

- Ubuntu
  Supported by Canonical
  Faster time to value via provisioning and orchestration in minutes

- Mellanox Technologies
  High performance, internet scale and availability across multiple locations

- IBM
  Continuous mobile application development for rapid innovation
  Exploitation of multi-threading, memory bandwidth and stack integration with Zend

- Orchestration - Juju
  (Ubuntu)

- High Speed Data Transfer (Mellanox)

- Open Innovation Platform
- Superior Cloud Economics
- Designed for Big Data

- PHP (Zend)
- Apache Web Server (Ubuntu)
- MariaDB (MariaDB)
- Linux (Ubuntu)
Recent Redbooks

IBM Power Systems S812L and S822L Technical Overview and Introduction

Outstanding performance based on POWER8 processor technology
2U scale-out rack-mount Linux server
Improved RAS features

IBM PowerKVM Configuration and Use

Server virtualization for IBM Linux servers
Advanced POWER7+ processor features
Virtualization, scale-out and big data

Performance Optimization and Tuning Techniques for IBM POWER8 processors, including IBM POWER8

Server virtualization for IBM Linux servers
Advanced POWER7+ processor features
Virtualization, scale-out and big data

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Link to search for “Linux” on the Power Systems Redbooks site
Where to find more information?

**Power Systems Linux Portal**
*(Product Information)*

[The Linux on Power Community](https://www.linuxonpower.com/)

[Power Systems Linux Portal](https://www.ibm.com/power/linux)

[The OpenPOWER Foundation](https://openpower.org/)

[The Linux on Power Community](https://linuxonpower.com/)
Further information

• Setup guide for PowerVM using HMC or IVM:
  – IBM PowerVM Getting Started Guide RedBook

• Introduction to Power Systems S822L model:
  – IBM S812L and S822L Overview RedPaper

• Guide to the VIO server and IVM management:
  – Integrated Virtualization Manager RedPaper

• Performance tools for Linux on Power:
  – IBM Advance Toolchain for PowerLinux

• IVM management video guides and tutorials:
  – Nigel Griffiths' YouTube IVM Playlist
    – With links to many other useful video tutorials

• Knowledge base for Power Systems hardware and software:
  – POWER8 on the IBM Knowledge Center