



# Linux on IBM Z

Modernize for hybrid cloud  
with the Linux platform providing  
security and efficiency, and helping  
on your sustainability goals



## Linux at its best

Using open-source Linux® solutions is a smart way to run your IT and cloud services.

Since hybrid IT is real, most of you are looking for solutions that leverage the investments and the strengths of the existing IT and cloud services in a seamless way.

Linux on IBM Z® provides you an impressive Linux and on-premise cloud computing environment, especially for workloads that require high levels of resilience, flexibility, and security.

Colocating workloads on IBM Z — running Linux workloads side-by-side and integrating them with IBM z/OS®, IBM z/TPF, z196 VSE™, or Red Hat® OpenShift® Container Platform workloads—can not only benefit from great performance and operational efficiency, but also leverages your investments in existing assets.

Linux on IBM Z benefits from the strengths and capabilities of outstanding IBM Z technology, such as extreme scalability, high utilization, encryption everywhere, and unparalleled resiliency and availability.

Linux on IBM Z provides you the Linux and cloud computing environment you need with security and efficiency, and helping on your sustainability goals.

## Linux on IBM z16™

The IBM z16 product portfolio – IBM z16 multi frame, IBM z16 single frame, and IBM z16 rack mount – is built helping to innovate with flexibility and agility and accelerate your modernization and transformation with on-chip AI acceleration to enable decision velocity, quantum-safe technologies designed to help protect your business now and into the future, a flexible infrastructure to meet the resiliency and compliance demands, and with capabilities to integrate IBM z16 seamlessly into your hybrid cloud.

## Highlights

- Reduced energy consumption and physical footprint
- Data protection and privacy at scale through confidential computing
- High levels of scalability, flexibility, and utilization
- Low latency and high throughput via colocation
- Delivering superior quality of service with reduced cost of computing

“Running applications on z/OS side-by-side with Linux has given us the operational flexibility on IBM Z to gradually modernize our clients’ applications, while still leveraging our extensive experience with the trusted and highly reliable IBM platform.”

IBM z16 provides a strong Linux and cloud computing environment, as well as the other IBM Z servers:

- IBM z16 helps you achieve a sustainable IT infrastructure that cuts costs and reduces your carbon footprint.
- IBM z16’s on-chip Integrated Accelerator for AI is designed for high-speed and real-time inferencing at scale.
- IBM z16 quantum-safe technology is designed to enable you to act now to help to protect data and keys against a potential future quantum attack.
- The Crypto Express8S is designed to meet FIPS 140-3 certification at Level 4 for cryptographic modules.
- IBM z16 multi frame has a maximum of 200 client-configurable cores running at 5.2 GHz, enabling a high workload density.
- The IFL processors on the IBM z16 multi frame also provide an optional IBM z16 multi-threading technology; with the multi-threading function enabled, the performance capacity of an IFL is expected to typically be up to 25% higher than without the multi-threading function enabled.<sup>2</sup>
- RoCE Express3 10 GbE and 25 GbE LR and SR, in support of the SMC-R and SMC-Rv2 protocols, as well as use by Linux for all networking communications protocols.
- IBM z16 Dynamic Partition manager is designed to enable system administrators and system programmers with an intuitive and guided user experience.
- The IBM Z Security and Compliance Center is designed to help to take out the complexity of your compliance workflow and the ambiguity out of audits.

IBM z16 provides the foundation for application modernization and cloud computing by delivering leading on-premise cloud infrastructure in support of the optimization of Linux based applications and data.

IBM z16 and the accompanying software deliver a broad set of open and industry-standard tools, including container and Kubernetes technologies, and an agile DevOps methodology to accelerate modernization. As an example, with IBM Cloud Infrastructure Center<sup>3</sup> you can get an infrastructure-as-a-service management solution that can do the deployment of a database-as-a-service.

These capabilities deliver speed to market and agility for both development and operational teams as IBM z16 integrates as a critical component of hybrid cloud.

### **Reduce your carbon footprint while improving your efficiency**

IBM z16 is designed to make a powerful improvement in sustainability by decreasing electricity consumption, reducing the number of standing servers, and enabling high compute and resource utilization.

IBM z16 design is aligned with best practices for reducing electricity consumption, including that clients require a small number of physical systems, that IBM z16 is a highly energy-efficiency system, and that it enable high compute and resource utilization.

Consolidating Linux workloads on an IBM z16 single frame or rack mount instead of running them on compared x86 servers with similar conditions and location can reduce energy consumption by 75% and space by 67%.<sup>4</sup>

Running workloads on a centralized infrastructure such as IBM Z can contribute to fewer greenhouse gas emissions and a more environmentally sustainable IT environment.

Consolidating Linux workloads on 5 IBM z16 systems instead of running them on compared x86 servers under similar conditions can reduce energy consumption by 75%, space by 50%, and the CO2e footprint by over 850 metric tons annually. This is equivalent to consuming about 362,000 fewer litres (95,600 gallons) of gasoline each year.<sup>5</sup>

### **Data protection and privacy at scale through confidential computing**

IBM z16 represents a breakthrough in data security. Quantum-safe cryptography is embedded in the system, along with classical cryptography, to protect the Linux based applications and data against quantum-computing attacks now and in the future.

IBM z16 will position clients to use quantum-safe cryptography along with classical cryptography as they begin modernizing existing applications and building new applications.<sup>6</sup>

Pervasive encryption is enabled with Linux on IBM Z. It is transparent to existing applications and designed to improve the usability and performance of encrypting/decrypting, leveraging the continuously improved on-processor cryptography and the Crypto Express accelerators.

With IBM z16, scale up your I/O intensive Linux applications and protect your data at rest with up to 12 million read-only I/O operations per second and 10 million R/W operations per second to an encrypted filesystem with FCP attached storage.<sup>7</sup>

To meet regulatory and auditing needs, the IBM RACF<sup>®</sup> Security Server for IBM z/VM<sup>®</sup> provides a security system that includes access control and auditing functionality, handles resource authorization, privileged command access, and logon controls.

Secure Execution for Linux is a Trusted Execution Environment (TEE) on IBM Z designed to deliver better security at greater scale than alternative offerings. It enables workloads to run in full isolation with protection from both internal and external threats across a hybrid cloud, ensuring the integrity of each application and its data. It is supported for KVM based virtual machines, hosting a supported Linux distribution.

It is important to mention that IBM Z is the world's only server with the high level EAL5+ hardware security certification. It guarantees that the IBM Z principal security features are reliably applied, allowing for isolation and protection of the deployed workloads, while the isolation capability inside the server offers significant operational simplicity.

To speed compliance and audit readiness, the IBM Z Security and Compliance Center helps to take the complexity out of your compliance workflow and the ambiguity out of audits through automated fact collection and mapping to help you comply with security standards PCI DSS, NIST SP800-53, and CIS – ready to strive for regulatory compliance of the Linux on IBM Z ecosystems.

IBM Z clients surveyed anticipate that by using the IBM Z Security and Compliance Center on IBM z16, they can potentially reduce audit preparation timelines from one month to one week.<sup>8</sup>

## High levels of scalability, flexibility, and utilization

The high workload density, with up to thousands of virtual Linux servers on an IBM z16 multi frame, usually means fewer components, lower management effort, and fewer software licenses compared to competitive platforms.

Run the Yahoo Cloud Serving Benchmark (YCSB) on MongoDB without sharding on IBM z16 multi frame with 6 IFLs in total and achieve the same throughput as on MongoDB with 4 shards on compared x86 systems with 144 cores in total, which provides a 24:1 core consolidation ratio in favor of IBM z16 multi frame.<sup>9</sup>

Using IBM Java™ 8 SR7 or IBM Semeru Runtime Certified Edition 11, run Business Rules Processing with IBM Operational Decision Manager 8.11.00 on Linux on IBM z16 for up to 70% higher throughput per core versus running the same application on a compared x86 server.<sup>10</sup>

Impressive scalability—horizontal and vertical—is provided with the IBM Z capabilities in combination with the virtualization technologies z/VM and KVM. Resources can be prioritized dynamically and efficiently between workloads, delivering them whenever and wherever they are needed.

- z/VM virtualization technology offers deep integration with IBM Z, allowing for high levels of resource sharing, data-in-memory techniques, outstanding I/O bandwidth, availability, and security.
- KVM virtualization enables the use of Linux administration skills on IBM Z. KVM is delivered with the Linux distributions for IBM Z, and is optimized to benefit from the IBM Z capabilities.

The high flexibility of IBM Z is not only shown in the hardware capabilities, the available solution portfolio for Linux on IBM Z, products and frameworks, from IBM, independent software vendors, and open source is immense. To name only one, the .NET 7.0 framework is available on IBM Z with selected Red Hat Enterprise Linux distribution.

IBM Dynamic Partition Manager provides a simplified configuration for Linux servers, allowing for a quick and easy adoption of Linux on IBM Z z/VM, and KVM.

Simplified infrastructure management is provided with IBM Cloud Infrastructure Center<sup>3</sup> for compute, network, and storage resources for virtual machines based on z/VM and Red Hat KVM running Linux and Red Hat OpenShift. Key use cases of Cloud Infrastructure Center are the deployment of a database-as-a-service, simplified experience with virtualization on IBM Z via the vendor-agnostic technology for simplified IaaS management, and the infrastructure-as-a-service management for service providers supporting to provide tenant-safe services.

IBM Z technologies are designed to support high efficiency. One example, the compression acceleration on the processor chip, can enable the reduction in the size of data to save storage space and also increase data transfer rates, not only for Linux applications and data.

As well, IBM Z servers provide the ability to grow inside an existing server, simply by adding system resources. Hence, Linux on IBM Z can grow ‘on-demand’—on the fly—without affecting the existing business.

## Low latency and high throughput via colocation

Colocation can make a big difference. Businesses and IT organizations must provide fast access to data, and since most enterprise workloads are multi-tiered workloads, running across web, application, and database tiers, it is not easy to achieve.

When these multi-tiered workloads have communication patterns that are network intensive, meaning they either frequently communicate or exchange many messages to complete a single transaction, or they exchange large amounts of data, then the physical location and proximity of the tiers can make a difference.

The IBM Z technologies IBM HiperSockets™, Shared Memory Communication (SMC-D), and zdsfs enable to communicate efficiently. On IBM Z you can colocate workloads not only to support reductions in latency and improvements in throughput, operational efficiency, and security and availability to meet service levels, but also leverages investments in existing assets.

Bottom line, cloud-native and noncontainerized applications can be located close to existing workloads, empowering organizations to integrate and modernize without disrupting current services.

## Delivering superior quality of service with reduced cost of computing

IBM Z helps to avoid or recover from failures to minimize business disruptions, realized through component reliability, redundancy and features that assist in providing fault avoidance and tolerance, as well as permitting concurrent maintenance and repair.

IBM z16 is designed to deliver superior performance for mission-critical applications in transaction processing, data sharing and mixed workloads, where nothing can be compromised. The system is massively scalable with the ability to add capacity on demand and grow processing with minimal impact to energy usage, floor space and staffing.

IBM z16 is architected for balanced performance with multiple layers of cache, massive I/O capabilities, and integrated accelerators to drive high utilization and processor efficiency.

Further strengthening resilience of the Linux and cloud workloads, are solutions such as:

- Live Guest Relocation, enabled with the z/VM SSI<sup>11</sup> feature, allowing for the non-disruptive move of running virtual Linux servers from one member of a cluster to another.
- IBM GDPS<sup>®</sup> can provide multi-platform resiliency for Linux servers. It allows for disaster and failure recovery and ensures data consistency across multiple sites. When running GDPS with z/OS, you can benefit from a single point of control for the z/OS and Linux environments.
- IBM Storage Scale (former IBM Spectrum<sup>®</sup> Scale) is designed to provide high availability through advanced clustering technologies, dynamic file system management and data replication.
- Unlike with distributed systems or public clouds—resilience, availability, and failover capabilities can be expected for Linux on IBM Z.

Operational efficiency is supported by running up to thousands of virtual Linux servers on one IBM z16 multi frame, with outstanding scalability, horizontal and vertical, based on the immense total IBM Z capacity. Usually this results in less effort for maintenance and administration compared to other platforms and provides potential cost reduction in several areas.

IBM internal tests show that when running IBM WebSphere<sup>®</sup> and IBM Db2<sup>®</sup> workloads, IBM z16 multi frame requires 16 times fewer cores than the compared x86 servers. If you scale this up to a complete IT solution this means when running this workload, the IBM z16 multi frame Max 125 would be doing the work of about 2000 cores of the compared x86 servers.<sup>12</sup>

The ability to add resources to an existing server on the fly, to share and reconfigure resources dynamically, and to run Linux side-by-side with other operating systems—benefiting thereby from unique arrangements for the system—also support operational efficiency.

With the DevOps software portfolio, developers and administrators can deliver automation to develop, deploy, and manage cloud-native applications while utilizing the portability and agility through tight integration with tools and runtimes. In one IBM Z server, existing back-office data and applications are colocated, and integrate with cloud native.

Red Hat Ansible<sup>®</sup> Automation Platform has emerged as a powerful solution on IBM Z, used to automate a wide range of IT tasks, from configuration management and application deployment to enforcing security and compliance.

Considering all the aspects mentioned above – reduced carbon footprint, privacy and protection, high levels of scalability, flexibility, and utilization, colocation benefits, superior quality of service – it seems obvious that they can also provide an economic advantage when running Linux on IBM Z compared to other platforms.

Linux on IBM Z, integrated seamlessly into your hybrid cloud, can provide benefits that span across operations, cost optimization, business growth, and can accelerate your modernization.

### Workloads that fit well

Workloads with per core pricing. Linux workloads that have a software license price per processor (or socket) are strong candidates for deployment from a financial perspective. This is due to different server architectures and processor speeds, Linux workloads on IBM Z can requires less processor cores than on distributed servers.

Workloads with variable resource requirements and activity fluctuations are very well suited. IBM Z servers provide compute elasticity, and resource sharing, so that memory, CPU, and I/O can be allocated to workloads with diverse timeline requirements.

Workloads with I/O demands, such as databases, messaging, and stream processing, tend to be I/O driven and can accelerate response times by leveraging IBM Z's FICON<sup>®</sup> or Fibre Channel Protocol (FCP) designed to enhance data transfer and to increase sustained CPU utilization through advanced workload management capabilities.

Workloads with high availability requirements can leverage IBM Z's built-in redundancy and resiliency. Capacity Backup (CBU) for IBM Z allows hardware engines to be used for disaster recovery without incurring additional software charges if the production server is temporarily unavailable.

Workloads with low latency and high transaction requirements can benefit from the colocation benefits of low latency and high throughput, since the workloads must constantly access another system over the network

Workloads with high security requirements. Workloads that access sensitive data are typically placed on IBM Z to minimize the possibility of a security event. IBM Z provides unique security benefits to lower the risk of a data or privacy breach.

IBM Z is designed to provide a highly secure, resilient, and efficient Linux and cloud environment, with containers and Kubernetes to build and modernize cloud services, with potential competitive advantages in operational efficiency and business economics, extreme scalability, high resource sharing and utilization, encryption enablement, data privacy and server isolation, continuous operations, and cyber resiliency.

## **Why IBM?**

As you transform your business and differentiate yourself in a trust economy, IBM remains your partner.

We have the total expertise in systems, software, delivery, and financing to help you create a secure and intelligent foundation for the future.

Our experts can help you configure, design, and implement Linux on IBM Z, optimized for your needs.

## **For more information**

To learn more about Linux on IBM Z, please contact your IBM representative, your Red Hat representative, or IBM Business Partner.

1. IBM z/VSE has achieved end of life and has been replaced by z1CS VSEn. Support for z1CS VSEn is provided by z1CS. For more information, see z1CS website.
2. Based on internal measurements. Results may vary by customer based on individual workload, configuration and software levels. Visit LSPR website for more details at: <https://www-40.ibm.com/servers/resourcecenter/lib03060.nsf/pages/lspindex>
3. For more information refer to: [ibm.com/products/cloud-infrastructure-center](https://www.ibm.com/products/cloud-infrastructure-center)
4. Compared IBM Machine Type 3932 Max 68 model consisting of a CPC drawer and an I/O drawer to support network and external storage with 68 IFLs and 7 TB of memory in 1 frame versus compared 36 x86 servers (2 Skylake Xeon Gold Chips, 40 Cores) with a total of 1440 cores. IBM Machine Type 3932 Max 68 model power consumption was measured on systems and confirmed using the IBM Power estimator for the IBM Machine Type 3932 Max 68 model configuration. x86 power values were based on Feb. 2023 IDC QPI power values and reduced to 55% based on measurements of x86 servers by IBM and observed values in the field. The x86 server compared to uses approximately .6083 KWhr, 55% of IDC QPI system watts value. Savings assumes the Worldwide Data Center Power Utilization Effectiveness (PUE) factor of 1.55 to calculate the additional power needed for cooling. PUE is based on Uptime Institute 2022 Global Data Center Survey (<https://uptimeinstitute.com/resources/research-and-reports/uptime-institute-global-data-center-survey-results-2022>). x86 system space calculations require 3 racks. Results may vary based on client-specific usage and location.
5. Compared 5 IBM z16 Max 125 model consists of three CPC drawers containing 125 configurable cores (CPs, zIIPs, or IFLs) and two I/O drawers to support both network and external storage versus 192 x86 systems with a total of 10364 cores. IBM z16 power consumption was based on inputs to the IBM z16 IBM Power Estimation Tool for a memo configuration. x86 power consumption was based on March 2022 IDC QPI power values for 7 Cascade Lake and 5 Ice Lake server models, with 32 to 112 cores per server. All compared x86 servers were 2 or 4 socket servers. IBM Z and x86 are running 24x7x365 with production and non-production workloads. Savings assumes a Power Usage Effectiveness (PUE) ratio of 1.57 to calculate additional power for data center cooling. PUE is based on Uptime Institute 2021 Global Data Center Survey (<https://uptimeinstitute.com/about-ii/press-releases/uptime-institute-11th-annual-global-data-center-survey>). CO2e and other equivalencies that are based on the EPA GHG calculator (<https://www.epa.gov/energy/greenhousegas-equivalencies-calculator>) use U.S. National weighted averages. Results may vary based on client-specific usage and location.
6. IBM z16 with the Crypto Express 8S card provides hardware enabled quantum-safe APIs. The quantum-safe public key technology used in IBM z16 has been selected by NIST to become part of its post-quantum cryptographic standard. <https://www.nist.gov/news-events/news/2022/07/nist-announces-first-four-quantum-resistant-cryptographicalgorithms>
7. Performance result is extrapolated from IBM internal tests running the fio 3.19 benchmark tool in an IBM z16 LPAR with 12 IFLs and 64 GB memory on RHEL 8.5 (SMT mode) using the XFS filesystem format with luks2 encryption and two FICON Express 32S features. The fio benchmarking tool was run with 128 parallel threads using 8 volumes on FS9200 equally distributed over the two nodes and file size of 150GB on each volume. Results may vary.
8. IBM does not ensure regulatory compliance. The intent is to provide a point in time statement of your current posture for a specific group of resources. The responsibility of ensuring systems are configured in accordance with regulatory controls is on the individual businesses who are using the IBM Z security and compliance Center and IBM does not take responsibility for any compliance oversights or penalties associated with data breaches. The survey consisted of 9 responses across 6 unique customers. Sourced from the IBM zSCC Sponsor User Program and zDC.
9. Performance results based on IBM internal tests running YCSB 0.10.0 benchmark (read-mostly) on MongoDB Enterprise Release 5.0.6 with 3-node replication. On IBM z16 A01 MongoDB was setup without sharding but with two replicas. IBM z16 A01 configuration: LPAR with 4 dedicated cores and 2 LPARs with each 1 core, each with SMT and 128 GB memory, 1 TB FlashSystem 900. x86 config: 9 Intel® Xeon® Gold 5218 CPU @ 2.30GHz with Hyperthreading turned on, 192 GB memory, 1 TB local RAID5 SSD storage, RHEL 8.4 running MongoDB, driven remotely by YCSB using 2 x86 server with total 128 threads. Results may vary.
10. Performance results are based on the average of measurements done using IBM Operational Decision Manager (ODM) 8.11.0 with IBM Java 8.0.7.10 and IBM Semeru Runtime Certified Edition 11.0.15.0 on IBM z16 and on a compared x86 server. Two different configurations were tested: executing 2005 rules (from a ruleset containing 14560 rules), and executing 80 rules (from a ruleset containing 300 rules). IBM z16 configuration: Linux on IBM z16 LPAR with Red Hat Enterprise Linux 8.5 (Ootpa) and 4 IFLs (SMT). x86 server configuration: Red Hat Enterprise Linux release 8.6 (Ootpa) and 4 SMT-2 cores (Cascade Lake Intel(R) Xeon(R) Gold 6226R CPU @ 2.90GHz). Results may vary.
11. z/VM SSI = z/VM Single System Image, for more information: <https://www.vm.ibm.com/ssi/>
12. This is an IBM internal study designed to replicate a typical IBM customer workload usage in the marketplace. Results may vary. The core consolidation study targeted comparison of the following servers: IBM Machine Type 3931 Max 125 system consists of three CPC drawers containing 125 configurable processor units (IFLs) and two I/O drawers to support both network and external storage. Lenovo ThinkSystem SR650 (2U) with two 2nd Gen Intel® Xeon® Platinum processors 2.1 GHz, 16 cores per CPU. Both solutions had access to the same storage array. The workloads consisted of a transactional application running on WebSphere Application Server and IBM Db2 simulating core online banking functions. The actual test results were extrapolated to the stated above x86 servers using IDC QPI metrics and IBM sizing methodology using the following assumptions on a typical IT environment of a banking client using x86 servers. The production IT environment has 16 x86 servers running at 50% average utilization. There are 48 x86 servers in the non-production IT environments: development (4 environments with 2 servers each, 8 servers total), development test environment (4 servers), system integration test environment (8 servers), performance test environment (16 servers), user acceptance test environment (4 servers), production fix test environment (8 servers). A typical average CPU utilization is 7% across all non-production environments. An equivalent IBM Machine Type 3931 solution requires a single Max 125 server running at 85% average utilization across all IT environments separated using LPAR technology.

## Learn more:

[Linux on IBM Z](#)

[IBM z16](#)

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