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IBM Power Systems for SAS Viya 3.5 Deployment Guide

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Preface

This IBM® Redbooks® publication provides options and best practices for deploying SAS Viya 3.5 on IBM POWER9™ servers.

SAS Viya is a complex set of artificial intelligence (AI) and analytics solutions that require a properly planned infrastructure to meet the needs of the data scientists, business analysts, and application developers who use Viya capabilities in their daily work activities.

Regardless of the user role, the underlying infrastructure matters to ensure performance expectations and service level agreement (SLA) requirements are met or exceeded. Although the general planning process is similar for deploying SAS Viya on any platform, key IBM POWER9 differentiators must be considered to ensure that an optimized infrastructure deployment is achieved.

This guide provides useful information that is needed during the planning, sizing, ordering, installing, configuring, and tuning phases of your SAS Viya deployment on POWER9 processor-based servers.

This book addresses topics for IT architects, IT specialists, developers, sellers, and anyone who wants to implement SAS Viya 3.5 on IBM POWER9 servers. Moreover, this publication provides documentation to transfer the how-to-skills to the technical teams, and solution guidance to the sales team.

This book compliments the documentation that is available in IBM Knowledge Center and aligns with the educational materials that are provided by the IBM Systems Software Education (SSE).

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Travis Siegfried is a solutions thought leader with over 25 years of detailed knowledge. Creating and deploying solutions and strategies that enable Fortune 500 corporations to achieve positive return on their capital investments. He uses IBM system Business Partners to create AI-based solutions that work with IBM and open source to make better informed decisions, augment teams' creativity, and increase revenue.

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1

What is SAS Viya 3.5

This chapter provides the initial steps for planning your deployment of SAS Viya 3.5 on IBM Power Systems.

SAS Viya 3.5 is a complex set of artificial intelligence (AI) and analytics solutions. This solution requires a properly planned infrastructure to meet the needs of the data scientists, business analysts, and application developers who use SAS Viya 3.5 capabilities in their daily work activities.

Regardless of the user role, the underlying infrastructure matters to ensure performance expectations and service level agreement (SLA) requirements are met or exceeded. Although the general planning process is similar for deploying SAS Viya 3.5 on any platform, key IBM POWER9 differentiators must be considered to ensure that an optimized infrastructure deployment is achieved.

This guide provides useful information that is needed during the planning, sizing, ordering, installing, configuring, and tuning phases of your SAS Viya 3.5 deployment on IBM POWER9 processor-based servers.

This chapter includes the following topics:

1.1 Overview

Throughout the last four decades in a competitive marketplace, SAS Institute is a leader in analytics, helping organizations solve the most challenging world problems from financial fraud detection to COVID-19 epidemiology predictive model. SAS provides innovative services and analytics software and solutions to transform data into intelligence, which gives customers the power of knowledge.

SAS Institute's vast portfolio of analytics and broad industry knowledge empowers 91 out of the top 100 companies on the 2019 Fortune 500 to extract incredible insights from data at the speed of thought. In 147 countries, SAS software is running at more than 83,000 business, government, and university sites[1].

Artificial Intelligence (AI) has been a part of SAS software. Throughout decades of research, this technology consistently delivers embedded AI technologies, state-of-the-art natural language processing, computer vision, machine learning, deep learning, forecasting, and optimization in solutions across the SAS Institute's portfolio. Hence, customers in every industry can capitalize on advancements in the AI segment.

These worldwide, proven capabilities are boosting customers' confidence in strategic decision making. Visual appealing charts, maps, and other images sustain resonant narratives that are based on data to solidify previous decisions or drive relevant changes and ultimately maximize the organization's contribution to society.

The spirit of innovation is continuously reshaping SAS to meet market demands. Customers are now pursuing cloud solutions for enabling digital transformation to achieve the full potential of their analytics and AI investments. This specific request is fulfilled by SAS, which is not only cloud-ready, but also cloud-native. Establishing SAS as the go-to partner in this unavoidable journey supports the correct analytics technology to the correct place at the correct time: on-premises, public cloud, or private cloud.

The long-standing partnership between IBM and SAS extends across over 40 years in the making. IBM ever-evolving infrastructure platform seamlessly underpinned this partnership by using SAS industry-leading analytics. The IBM POWER9 processor with the high-throughput capability enables organizations to drive agility, reduce risk, and eliminate bottlenecks for on-premises installations. IBM Cloud, with high security and reliability, is providing advanced data management resources in the cloud.

The Artificial Intelligence of Things (AIoT) is a combination of IoT-gathered data that is processed by AI and analytics to speed up operations, introduce new digital services, improve employee productivity, and decrease costs. Early adopters of AIoT reported exceeding expectations results. By embedding AI, such as machine learning into IoT solutions to automate business decisions, SAS is paving the way in making AIoT a reality.

In addition, SAS is a paramount player in the Data for Good movement that strongly believes in data and analytics' power to address humanitarian issues, such as poverty, health, human rights, education, and the environment for improving the human condition.

In hindsight, SAS designs their solutions to empower better decisions, which enables organizations to stand out from the competitors through higher efficiency, more jobs, and economic stability. SAS technology helps customers deal with our era's most pressing issues by defining the path from data to action by using analytics and AI.

[1] SAS 2019-2020 Annual Report
https://www.sas.com/content/dam/SAS/documents/corporate-collateral/annual-report/company-overview-annual-report.pdf

1.2 SAS 9.4 history and overview

Contrary to popular belief, SAS Viya 3.5 does not replace SAS 9.4. SAS Viya 3.5 interoperates with SAS 9.4, and these platforms complement each other in multiple aspects. We expect experienced SAS customers to run in parallel by using the most suitable platform for the required use case and workload. They share some functions; however, their usage might be based on the enterprise context of people skill sets and a licensed portfolio of tools.

In July 2013, SAS 9.4 initial release was shipped, which provided at that time highly advanced key features, such as the ability to deploy in cloud environments, high-performance analytics to analyze a massive amount of data quickly, and integrated data management, governance, and control.

SAS's maintenance release history includes the following milestones:

- SAS shipped the first maintenance release in December 2013, the second maintenance release in August 2014, and the third maintenance release in July 2015.
- The fourth maintenance release for SAS 9.4, shipped in November 2016, included bridges to SAS Viya.
- The fifth maintenance release was shipped in September 2017, which provided greater integration with SAS Viya, and introduced procedures to connect to Cloud Analytic Services (CAS) Server, which is a fundamental part of SAS Viya.
- The sixth maintenance release was shipped in November 2018, which expanded integration with SAS Viya Cloud Analytic Services (CAS) engines.
- SAS shipped the SAS 9.4 seventh maintenance that was released in August 2020.

SAS Grid Manager 9.4 and SAS Viya 3.5 both implement distributed computing among multiple computers on a network. They complement each other in providing a highly available and scalable environment to process massive amount of data.

SAS Grid Computing is a SAS 9.4 environment where computing tasks are distributed under the SAS Grid Manager's control. SAS commissioned Forrester to conduct a Total Economic Impact study, in June 2017, and highlighted 67% ROI within 20-month payback period, including 50% performance improvement, for a specific customer[2].

Cloud Analytics Services (CAS), the third generation of the high-performance in-memory engine, is the power behind SAS Viya 3.5. SAS High-Performance Analytics and SAS LASR Analytic Server from SAS 9 were previous generations of high-performance processing in-memory technology. The CAS in-memory engine provides a similar ability to its predecessor's engines to perform processing in memory and distribute processing across nodes in a cluster. Then, relevant headways of CAS in-memory engine consisted of a highly efficient inter-node communication, which is a mechanism to determine optimal nodes for a specific job that is suitable for on-premises and cloud deployments.

CAS worker nodes and CAS sessions processes are independent of each other in SAS Viya 3.5. This configuration provides higher availability with superior fault tolerance than SAS LASR Analytic Server architecture. A failed node can affect others on that server. In CAS, a distributed server can continue processing requests, even after losing connectivity to some nodes.

[2] The Total Economic Impact of SAS Grid Manager: https://www.sas.com/content/dam/SAS/en_us/doc/whitepaper2/forrester-total-economic-impact-sas-grid-manager-108924.pdf

SAS 9.4 requires the use of multiple management tools, including SAS Management Console and SAS Deployment Manager. However, SAS Viya 3.5 provides more cohesive analytics management with centralized control over all analytics assets, which simplifies installation, configuration, and management.

CAS in-memory engine interacts with multiple interfaces, including a specific SAS Studio version. SAS Viya 3.5 provides an increased openness through third-party languages, where customers can further use skill sets in Python, R, Lua, or Java programming.

Nevertheless, SAS Viya 3.5 was designed to coexist with SAS 9.4 implemented solutions. Although SAS 9 uses SAS programming language, you can make SAS 9.4 data available to SAS Viya 3.5 and remotely submit SAS 9 code to run in SAS Viya 3.5 through SAS/CONNECT bridge. This relationship allows SAS 9.4 users that use familiar projects, interfaces, and SAS code to take advantage of, for example, SAS Viya 3.5 new Data Mining and Machine Learning algorithms with distributed in-memory performance.

1.3 SAS Viya 3.5 overview

SAS Viya 3.5 encompasses a complex set of AI and analytics solutions. Cloud Analytics Services (CAS) is the distributed in-memory engine for SAS Viya 3.5, which is deployed on-premises and in cloud environments, in single-machine (non-distributed) with symmetric processing, and cluster architecture (distributed) with massively parallel processing (MPP). SAS Programming Runtime Environment (SPRE) is a data processing environment for running the classic SAS program code. The Service Layer for SAS Viya 3.5 is composed of microservices, infrastructure servers, and web applications.

SAS Viya 3.5 optimal performance is achieved when CAS is separated from SPRE/Service Layers and split into multiple CAS workers nodes, which allows parallel processing. For high availability, splitting CAS Controller into primary and secondary (backup) provides fault tolerance. CAS Backup Controller must use the same shared filed system of CAS Primary Controller[3]. Red Hat Ansible is the method for deploying SAS Viya 3.5 that involves multiple hosts with different cluster roles.

SPRE possesses two different techniques to access foundational SAS service: one based on traditional SAS 9 integration technologies and the other by using the new SAS Viya architecture principles[4]. SPRE can use a significant amount of CPU, memory, and particularly disk I/O. Avoid placing SPRE on other mission-critical hosts, such as CAS servers. SPRE might be deployed on multiple hosts for higher availability, but it does not provide failover protection. A new session is required if a host fails.

SAS Viya 3.5 contains several services that are referred to as *microservices*, which runs\ in its process and communicates by using the HTTP protocol. Upgrades to a specific microservice can be done dynamically. Stop and start each microservice individually. High availability and load balancing are implemented by spreading microservices into multiple host groups.

The underlying infrastructure of SAS Viya 3.5 is instrumental in delivering insights on time for competitive business advantages. IBM POWER9 offers many unique deployment options for SAS Viya 3.5, meeting the IT department's goals, involving massive data processing with agility, resiliency, and responsiveness.

[3] SAS Viya 3.5 Administration - CAS Backup Controller: https://documentation.sas.com/?cdcId=calcdc&cdcVersion=3.5&docsetId=calserverscas&docsetTarget=n05000viyaservers000000admin.htm&locale=en#n05022viyaservers000000admin

[4] Deploying the SPRE in SAS Viya: https://communities.sas.com/t5/SAS-Communities-Library/Deploying-the-SPRE-in-SAS-Viya-3-4/ta-p/602891

In 2019, SAS Viya 3.5 debuted support for Red Hat Enterprise Linux 7.6 ALT on IBM POWER9 servers, including PowerVM virtualization-based systems and Power Advanced Compute accelerated servers.

Note: SAS Viya 3.5 cannot run on IBM POWER8®, other Linux distributions, or different back-level support versions.

1.4 Planning your deployment

The primary step in planning your deployment is to understand your users' requirements. It is important to know which SAS Viya 3.5 capabilities are to be used, who is going to use them, and what data is going to be used. These fundamentals factors determine the optimal infrastructure environment to support the users, on-premises, or cloud. Another important factor in deciding is whether the SAS Viya 3.5 environment must integrate with an existing SAS 9.4 environment.

This information and the users' performance expectations help determine each server's size and configuration and how many servers need an initial SAS Viya 3.5 deployment.

SAS provides a deployment guide for SAS Viya 3.5 on Linux only. This guide must be read and used during the planning phase to understand the SAS Viya 3.5 deployment modes and other software and environmental requirements. You can find the latest guide at this web page.

IBM Power Systems also offers several other flexible deployment options for SAS Viya. For more information about these options, see Chapter 3, "IBM POWER9 deployment options" on page 17.

Although the deployment options provide examples as to the SAS Viya 3.5 workload's servers options, clients must engage their SAS Account Team to size their workload from the SAS Enterprise Excellence Center (EEC) sizing team. This process ensures that the hardware environment is correctly sized for the client's specific SAS workload.

In a multi-machine deployment, SAS recommends that machines provide similar roles for SAS Viya 3.5, such as all CAS machines, to use identical operating system versions and patches. SAS 9.4 runs on the IBM AIX operating system, but it does not share a similar role with SAS Viya 3.5 in an interoperation scenario. Therefore, PowerVM technology is ideal for integrating SAS 9 running on AIX environments with SAS Viya 3.5 running on Red Hat Enterprise Linux in the same physical IBM POWER9 machine.

IBM PowerVM provides an enterprise-level virtualization solution for the scale-up architecture servers; for example, IBM Power Systems Enterprise E950 and E980. This unique and powerful technology grants advanced reliability and availability to help clients control costs although enhancing performance and energy efficiency, delivering a flexible, dynamic IT infrastructure and virtualization benefits without limits. The mixed IBM POWER9 server environment is a SAS Viya 3.5 deployment option that takes full advantage of PowerVM, scalability, and resiliency simultaneously.

IBM POWER9 based scale-out systems, including S922 and L922, provide leadership capabilities in non-accelerated computing spaces, such as in-memory databases, advanced analytics, and hybrid multi-cloud architectures, which deliver performance and RAS reliability, availability, and scalability (RAS) that is needed for mission-critical applications.

IBM Power System Advanced Compute (AC) AC922 server, bare-metal only system, is the best scale-out server for AI. It helps customers explore modern AI, high-performance computing (HPC), and heavy analytics workloads.

This system embraces accelerated computing technology by using the IBM POWER9 processor technology with a myriad of modern connectivity capabilities. This configuration delivers the only architecture that enables NVLink between the CPU and the Graphical Processing Unit (GPU). The latter is a specialized processing unit for multiple computations in parallel, which is seamlessly adapted for training AI and deep learning models. This feature unlocks new potential for data-intensive analytics workloads and can be used with the SAS Viya 3.5 product, Visual Data Mining, and Machine Learning (VDMML).

Another option is to collocate SAS Viya 3.5 on the same IBM POWER9 physical server with the primary data source. By using PowerVM, clients can dynamically reallocate computational resources on-demand among logical partitions (LPAR). This approach facilitates a physical networked connection with proven enhanced throughput technology of IBM Power Systems to SAS Viya 3.5 nodes and data source. In addition to simplifying SAS environment management, this approach offers flexibility to add GPU enabled servers whenever SAS VDMML workload requires accelerated servers.

Referring to SAS Viya 3.5 cloud deployment, improper installations can result in the environment installation being unsatisfactory compared to similar on-premises hardware settings. Even worse, it can cost much more processing capacity to achieve a consistent throughput.

In general, the performance of analytics solutions relies on disk I/O throughput and SAS Viya 3.5 is no different. Cloud deployment requires extra attention to ensure proper storage configuration meeting users' service level agreement (SLA), which matches the enterprise C-Level expectations of the return of investments in the cloud.

Contact your IBM and SAS sales representatives for any questions or assistance with selecting the correct IBM POWER9 deployment and configuration for your needs.

1.5 For more information

For more information about SAS Viya 3.5 on IBM Power Systems, contact your IBM representative or IBM Business Partner, or visit this web page.

2

Advantages of IBM POWER with SAS Viya 3.5

This chapter describes the advantages of the use of SAS Viya 3.5 on IBM POWER9.

As an in-memory AI and analytics platform, SAS Viya 3.5 workloads are data-intensive and require high throughputs of communication with memory and external disks. IBM Power Systems is optimized for workloads that process large amounts of data, which provides high bandwidth, performance, and resilience. Those characteristics are-well suited for workloads, such as SAS Viya 3.5, and can provide a more efficient execution environment and accelerate time-to-insights.

This chapter includes the following topics:

2.1 IBM and SAS: IBM continuously delivering data-intensive SAS workloads

Over the years, data is becoming a valuable asset to companies. They use it in analytical processes to get insights that improve business decisions and differentiate them from their competition.

Their data scientists are creating analytical models to help make data-driven and real-time decisions in many areas: understanding customer needs, product features design, market campaigns, and supply chain efficiency.

SAS Institute is a software developer development company that is providing analytical solutions for over 40 years at the time this publication was written. Organizations use those solutions to process massive amounts of data, which generates critical business insights, but places heavy demands on the IT infrastructure.

For many years, IBM developed infrastructure solutions that support those massive data-driven workloads. IBM Power Systems and IBM Storage Solutions are consolidated platforms in the marketplace that were developed to help those types of workloads. One of its key aspects is the broad set of capabilities to offer an optimized infrastructure for analytic solutions, such as SAS Viya 3.5.

IBM Power Systems is an open, secure, and flexible platform designed for data solutions. It has high memory and I/O bandwidths capable of handling massive amounts of data.

2.1.1 IBM Power Systems architecture

After all the traditional SAS analytical platform and now with the SAS Viya 3.5 platform, IBM infrastructure capabilities offer key differentiators for SAS workloads, including traditional and Viya.

IBM and SAS have a long history of collaboration and have been business partners for over 40 years. IBM provides infrastructure capabilities with industry-leading performance, allowing SAS customers to accelerate time to insights.

That partnership history resulted in the following key outcomes:

- IBM and SAS International Competency Center
- IBM and SAS strategic alliance formed
- IBM POWER7® and IBM Enterprise Storage Server Storage optimization for SAS analytics
- IBM POWER8 and IBM Enterprise Storage Server Storage optimization for SAS analytics
- SAS 9 on AIX on IBM Power Systems
- Use of IBM Spectrum® LSF® System through an OEM agreement as to the technology behind SAS Grid Manager for Platform
- SAS Grid Manager for Platform for AIX on IBM Power Systems
- SAS Viya 3.5 for Linux on IBM Power Systems

2.1.2 Alliance with SAS and IBM

From the Scale-Out systems, such as the IBM Power System AC922 to the Scale-Up systems (for example, the IBM Power System E980), IBM Power Systems are designed to handle large amounts of data to drive performance for data-driven workloads, such as traditional SAS and SAS Viya 3.5.

Its architecture includes the following key features:

- Built-in virtualization, which provides flexibility and resource use efficiency. IBM PowerVM technology is built-in virtualization that can help IBM customers consolidate analytical workloads by creating client partitions (LPAR) that share resources, optimize its use for higher efficiency, and better total cost of ownership.
- High performance and parallelism capabilities are well suited for processing analytical workloads. IBM Power Systems is a multi-core processor that provides high performance per core compared to other market alternatives by using several published benchmarks. It also offers high parallelism with Simultaneous Multi-Threading (SMT), which scales up to eight threads per core (4 times better than x86, at the time of this writing).
- High I/O bandwidth, which eliminates bottlenecks for data processing. At the time of this writing, IBM POWER9 provides 1.8x more bandwidth than other x86 alternatives. This result is based on a 230 GBps per socket comparison with a 128 GBps per socket x86 scalable platform.
- Enhanced Reliability, Availability, and Serviceability (RAS) capabilities reduce the risk of downtime. IBM Power Systems is embedded with a series of features that improve its reliability and availability, which is critical for SAS workloads to attend business SLAs. According to Information Technology Intelligence Consulting (ITIC) 2020 Global Server Hardware, Server OS Availability Survey[1], IBM Power Systems is ranked as the second most reliable server (only behind IBM Z®), and consistently delivers more than 99.999% uptime.
- On-demand scaling by dynamically allocating capacity based on workloads needs. This scaling is also realized by using Capacity on Demand and Enterprise Pools technologies and the implementation of infrastructure as a service deployment based on IBM PowerVC.
- Support for GPU accelerators. IBM POWER9 supports NVIDIA GPUs by using the NVLink bus and NVLink 2.0 protocol, which allows for massively parallel processing capabilities for accelerating Advanced Analytics Machine Learning and Deep Learning workloads by SAS Viya 3.5.
- Simplified management through high-level orchestrators, such as Red Hat OpenStack or VMware VRealize that integrates with IBM PowerVC for single-pane management of infrastructure and operations, as shown in Figure 2-1 on page 10.

[1] ITIC 2020 Global Server Hardware Survey: https://www.ibm.com/downloads/cas/DVOXZV6R

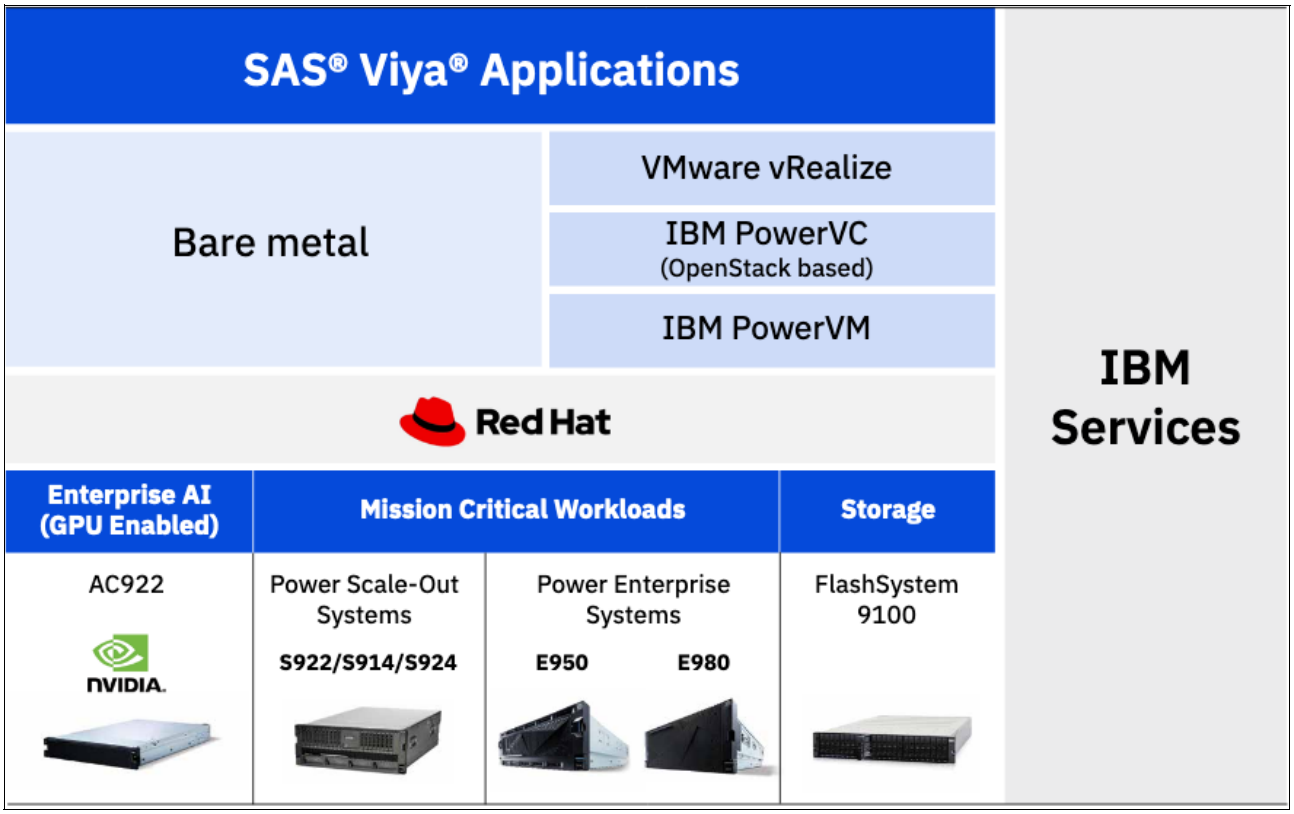

Figure 2-1 IBM full-stack solutions for SAS Viya 3.5

2.2 IBM POWER9: The processor designed for the AI era

In comparison to x86, the IBM POWER9 processor has four times more threads for high-performance cores. The I/O bandwidth increases more than five times the x86 bandwidth. In addition, approximately 1.8x more memory bandwidth is available per socket. The IBM POWER9 also incorporates PCIe Gen 4 and NVLink 2.0, which supports high-speed connectivity between the CPU and these connected devices by way of these methods.

With these features, the IBM POWER9 CPU is a workhorse for SAS Analytics, which makes it uniquely designed to manage the most complex SAS workloads, which are typically based on massive data movement. You can gain insights faster with superior power performance. Optimizing buffering, task deployment, and look ahead mechanisms result in increased throughput, which results in significant time efficiencies and drastically limits any bottlenecks.

The IBM POWER9 processor quickly adapts with extreme scalability to grow with the workload and absorb more capacity on the installed system (processing, memory, and I/O). The system optimizations and flexibility of resource allocation swiftly adjust on demand. Spectrum Scale drives a significant advantage in I/O bandwidth and overall speed to enhance this unparalleled scalability.

In comparison with x86, the IBM POWER9 chip has significant I/O advantages over x86 chips. Extreme optimizations are available in buffering and task deployment. Look ahead mechanisms also are available that result in increased throughput, which results in significant time efficiencies and drastically limiting bottlenecks.

Therefore, IBM POWER9 can quickly adapt to unparalleled scalability. It does so by growing with the workload and absorbing more capacity on the installed system (processing, memory, and I/O). The system optimizations and flexibility of resource allocation is another way in which this system is scalable. Finally, IBM Spectrum Scale drives a significant advantage in I/O bandwidth and overall speed.

2.2.1 SAS mixed analytics testing on IBM POWER9 and IBM FlashSystems

For large, diverse implementations, the overall solution is likely to be cross-platform and cross-technology, which requires a work effort for overlapping teams from a server, network, storage, and application. IBM POWER9 and IBM FlashSystems deliver the robust infrastructure that SAS large block and sequential I/O workload require. These types of hardware infrastructures can be heavily stressed with large-scale SAS workflows and are always able to handle the workload.

SAS Mixed Analytics Test

The SAS Mixed Analytics workload consists of a mix of jobs that run in a concurrent and back-to-back fashion. These jobs stress the compute, memory, and I/O capabilities of the infrastructure. The SAS test team described the testbed that they used as a good average SAS Shop set of workload mix.

One of the examples is the SAS Mixed Analytics 20-session workload. It has 20 individual SAS jobs, including 10 computing-intensive, two memory-intensive, and eight I/O-intensive jobs. The tests are a mixture of short-running (in minutes) and long-running (in hours) jobs and the tests are repeated to run concurrently and serially to achieve a 20-session workload.

The testing uses a 20-session and a 30-session SAS MA workload. Therefore, for a single node 20-session workload, a total of 71 jobs are run. A similar scaling of the 30-session workload is used in which 101 jobs are running. Some jobs use existing data stores, and some jobs use data that is generated during the test run.

2.2.2 Empowering advanced analytics

Flexibility, cloud, and reliability are the three main factors that help SAS and IBM POWER9 empower advanced analytics. Regarding flexibility, most SAS Viya projects likely are with clients who use analytics with traditional SAS. They likely also have other mission critical workloads, such as databases (as perhaps SAP HANA), and other data lakes that are running Hadoop or other kinds of big data. It is important to know that most clients are sensitive to unplanned downtime and they do not tolerate their analytics platforms being unavailable for hours. As a result, the analytics are moving to enterprise servers and higher reliability environments.

Therefore, we can colocate on our enterprise server (for example, the E980 or E950) the new workload (such as SAS Viya), which is running on Red Hat Enterprise Linux and traditional SAS, which is running on AIX and even other mission critical data sources (for example, databases).

The ability to colocate SAS Viya and traditional workloads is important and creates flexibility for our clients. We combine this feature with the efficiency of the platform. This ability to be flexible and run PowerVM on our systems gives clients the ability to optimize the allocation of cycles for their dynamic analytics workload.

They also can optimize cycles between SAS Viya and other mission critical workloads. The flexibility never is found on a bare metal system or commodity hardware. You can still use bare metal systems, accelerated servers, or scale-out systems; however, for large clients who are deploying mission critical analytics in production, it is likely that they use enterprise servers.

SAS is making a strategic decision to fully focus on Red Hat. SAS announced that SAS Viya is a cloud-oriented product. Starting with the next release of Viya (Viya 4), the product is based on OpenShift and Kubernetes. A client that wants to deploy SAS Viya will move to Red Hat. Because Red Hat is part of IBM, we joined forces to create added value for our clients.

Furthermore, the reliability of the joint solution is a game changer. This feature is a more traditional value proposition, but important for SAS analytics. The ITIC 2020 Global Server Hardware Survey[2] shows that for the last 10 years, POWER has the best reliability for our clients compared to other competition, which enables the most reliable solution for our clients.

Finally, the joint partnership between SAS and IBM is the underpinning component that helps to hold up these points. Through POWER8 and POWER9, IBM became deeply involved with the development process at SAS R&D. SAS R&D validated that the new generations of POWER were compatible they showed a great influence in adding SAS Viya availability for IBM Power Systems on Linux. The joint testimony from SAS and our clients proves conclusively that we have something that the competition lacks.

Accelerate insights

A mix of computing demands requires a system that can meet the requirements of the SAS workload. Organization into categories of model building, deployment, and production is another way to accelerate. Putting models into production requires a constant recommendation engine and continuous scoring. Event stream processing requires consistent scoring of data streams (for example, drones capturing imagines and always scoring against the model).

Accelerate insights with IBM Power Systems

By using IBM Power Systems, you can obtain 1.8x larger memory bandwidth, 2x better I/O bandwidth, 2x better per-core performance, and reduce your organizations' IT burden with policy-based automation and self-service tools.

Unified solution

The unified solution stack, comprising server, storage, and services, reduces the compute time, controls costs, and maximizes the SAS environment's resilience with ultra-high bandwidth and highest availability.

Flexibility and choice of deployment that address all business needs from SAS applications helps to provide unity. Now, we can create a unified solution through dynamically scaling compute and memory, on-demand, with cloud deployment. This solution allows for increased automation that is required to operationalize analytics across an enterprise.

[2] ITIC 2020 Global Server Hardware Survey Reference is on Page 26: https://www.ibm.com/downloads/cas/DVOXZV6R

As you automate, much more iteration is needed during automated workflows. This need requires scalability to support iterations as new data comes into the pipeline and must be updated. Deploy multiple production workloads and multiple operating systems (for example, IBM i, AIX, Linux) in a server with workload isolation. End-to-end security is built in at all layers, from processor to the operating system, which allows for one integrated enterprise solution.

This robust and scalable system maximizes resiliency because it provides the highest availability non-mainframe Linux platform for over a decade. Therefore, it is providing uninterrupted analytics that are required for SAS Viya 3.5 workloads. It allows zero impact planned maintenance by effortlessly moving workloads across generations of IBM Power Systems.

IBM Power Systems (in fact, the entire IBM stack) is designed and built for big data. Consistently, we can deliver systems with ultra-fast I/O that can handle massive amounts of throughput. This feature was critical in the past with SAS 9 on AIX traditional workloads and even increases in importance with SAS Viya 3.5's in-memory parallel load approach. The ability to scale and deploy more threads and core allows IBM Power Systems to tackle a mix of computing demands at the scale and performance that is required, which helps our clients to meet their SLAs.

Given the growing focus on AI and ML/DL from SAS, we plan to bring to the market one of our deployment options: the IBM Power System AC922. This option is our GPU enabled system that is designed for Enterprise AI. These systems are the same systems that power the two fastest supercomputers in the world. Couple this feature with IBM POWER9 CPUs with enterprise-grade dependability and you can be sure of our intent to bring the best solution to the market for SAS Viya 3.5.

2.3 SAS paired with IBM Storage

This section describes pairing SAS with IBM Storage solutions.

2.3.1 IBM FlashSystem and IBM Elastic Storage Server GL6S

For the 30 session SAS MA tests, the solution used an IBM E980 as a baseline server. The server is paired with an IBM FlashSystem, a Fibre Channel (FC) switch that was configured for 16 GB, and an IBM Enterprise Storage Server GL6S that was configured for 100 GB with Mellanox Switches. The results show that these IBM FlashSystems reduce real-time writing and reads/writes much higher, as shown in Figure 2-2.

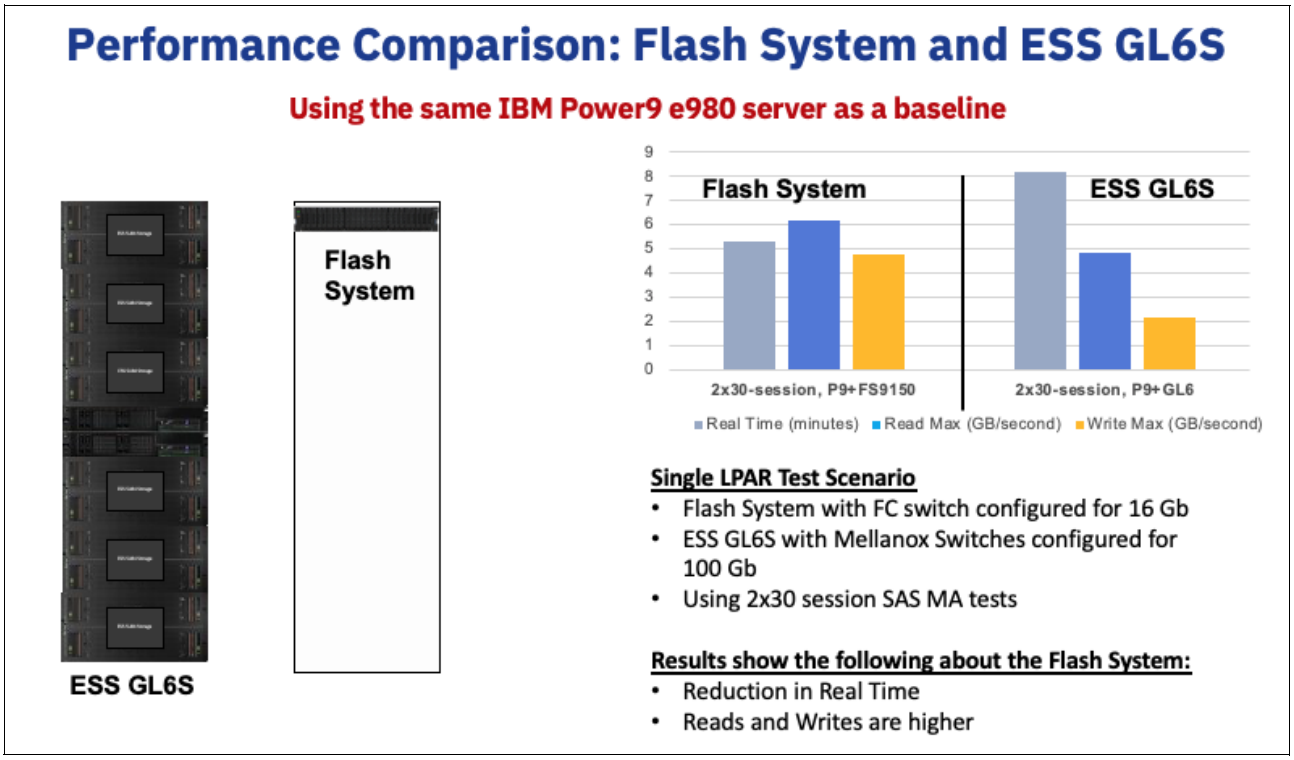

Figure 2-2 Performance Comparison: FlashSystem and Enterprise Storage Server GL6S

2.3.2 IBM Elastic Storage Server GL4 with Mellanox switch

SAS 9.4 with converged infrastructure file I/O, IBM POWER8 servers, and IBM Elastic Storage® Servers (Enterprise Storage Server) GL4 storage system with Mellanox network switch can configure the architecture as shown in Figure 2-3.

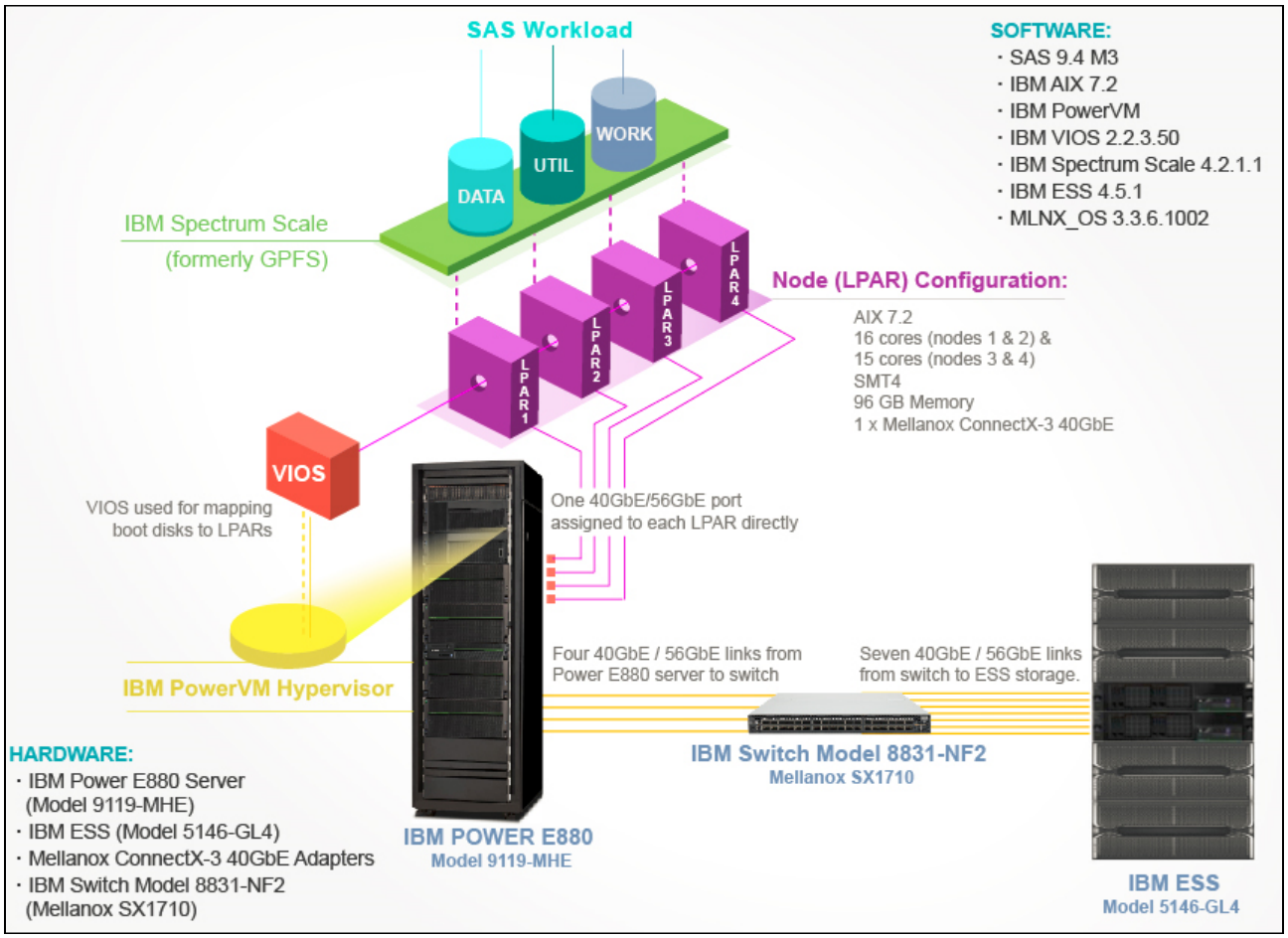

Figure 2-3 IBM Enterprise Storage Server GL4 Storage with Mellanox Switch

3

IBM POWER9 deployment options

This chapter describes SAS Viya 3.5 deployment options on IBM POWER9.

The IBM Power System portfolio of servers enables flexible deployment options for running SAS Viya 3.5. The IBM portfolio offers ultra-flexible systems with the highest reliability[1].

Also, the Enterprise and scale-out servers can run Linux in addition to IBM AIX and IBM i and allow for the consolidation of multiple workloads on a single system that can reduce data center footprint. An example of this workload consolidation is deploying multiple SAS workloads on the same system.

Customers can also take advantage of advanced virtualization features, such as capacity on-demand (CoD), to dynamically activate processor capacity and memory resources for ease scalability and flexibility in adapting to growing demands on your infrastructure.

This chapter includes the following topics:

[1] IITIC Global Server Hardware, Server OS Reliability Survey: https://www.ibm.com/downloads/cas/YGLRKEEK

3.1 IBM POWER9 deployment options

SAS Viya 3.5 can run in two modes: symmetric multiprocessing (SMP) and massively parallel processing (MPP).

The SMP mode uses multiple cores or processors on only one node or server. The SMP deployment option is suitable for proof-of-concept (PoC) or when the SAS Viya 3.5 workload requirements do not initially require a cluster. SMP mode deployments are also great options for programming-only environments and application development. Two SMP mode deployment options are available for IBM Power Systems, which are described in the next section.

The MPP mode uses a cluster of servers or partitions to run SAS Viya 3.5. In the MPP mode, SAS Cloud Analytics Services (CAS) Workers offload the analytics and spread the data to allow parallel loading of data and processing on multiple worker nodes. MPP offers a growth path and maximizes scaling.

3.1.1 SMP mode deployment options

Figure 3-1, Figure 3-2 on page 18, and Figure 3-3 on page 19 show the most straightforward options for deploying SAS Viya 3.5 on IBM Power Systems. These options are SMP mode deployments. A few variations use different types of IBM Power Systems.

Figure 3-1 shows a scale-out single-server deployment in which SAS Viya 3.5 and all its complementary software are installed on one IBM POWER9 server. An IBM Power System S922/L922 server model is shown as an example.

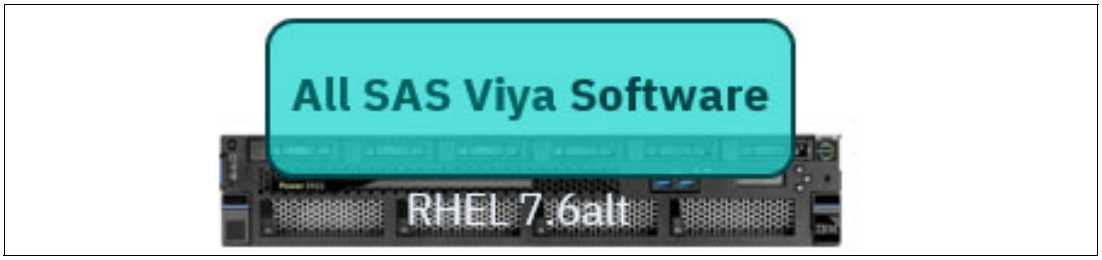

Figure 3-1 SMP mode: Scale-out single server on S922/L922

Figure 3-2 shows a scale-out single-server deployment where SAS Viya 3.5 and all its complementary software that is installed on one IBM POWER9 server.

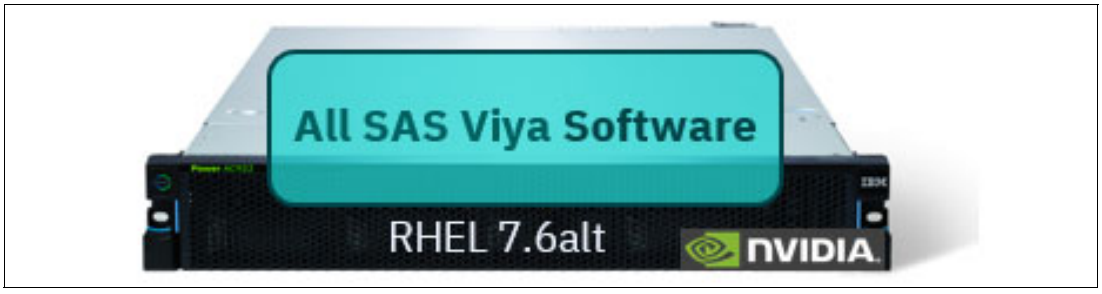

Figure 3-2 SMP mode: Scale-out single-server on AC922

An IBM Power System AC922 server model is shown as an example in Figure 3-2. The IBM Power System AC922 server is a powerful system that is built for analytics and can run CPU and GPU workloads. This server supports NVIDIA GPUs plus a NVIDIA technology that is called NVLink 2, which is unique to IBM POWER9 processor-based servers and is embedded within the NVIDIA GPUs.

NVLink 2 provides 5.6 times of data bandwidth acceleration when software switches between CPU and GPU. The most significant advantage of the use of an IBM Power System AC922 server is when the workload needs GPUs.

Figure 3-3 shows a scale-up single-partition deployment, where SAS Viya 3.5 (including CAS and all its complementary software) is installed on one IBM POWER9 partition (LPAR).

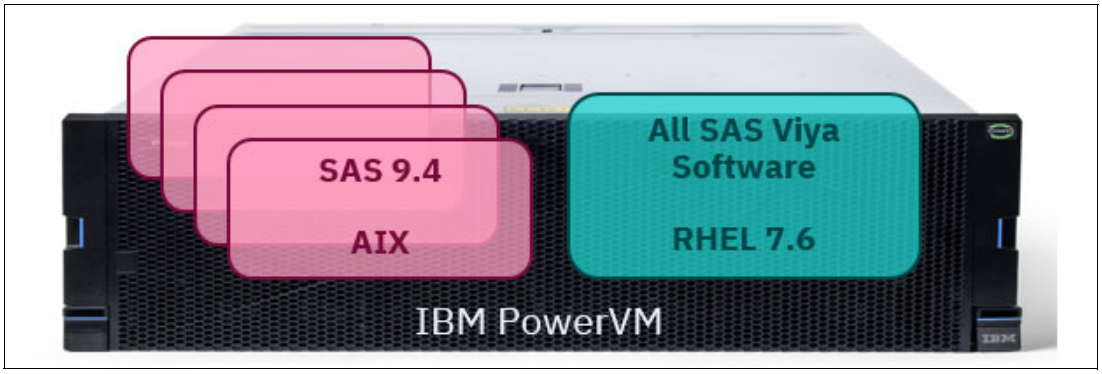

Figure 3-3 SMP mode: Scale-up single partition

The IBM POWER9 processor-based server family features several scale-up server models to choose from: the IBM Power System E950 or the IBM Power System E980. These enterprise-class servers are large and use IBM PowerVM virtualization to create separate single or many Linux logical partitions (LPARs) for installing SAS Viya 3.5. Because this SMP deployment option does not require the entire server, it is ideal for customers who run SAS 9.4 in an IBM AIX partition where they can use untapped resources (such as cores and memory) for deploying SAS Viya 3.5.

3.1.2 MPP mode deployment options

In MPP mode, CAS supports workers to help offload the analytics and spread the data to parallel processing on multiple workers. There are three MPP options.

Figure 3-4 shows a scale-out multi-server deployment. It is here that SAS Viya 3.5, including the CAS controller and CAS workers, and all its complementary software are installed across a cluster of IBM POWER9 scale-out servers.

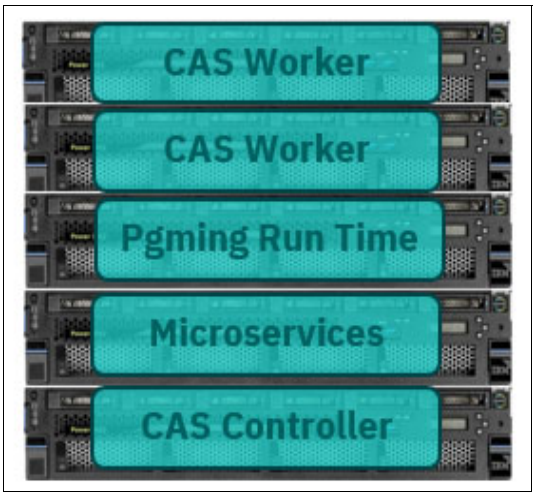

Figure 3-4 MPP mode: Scale-out multi-server

Figure 3-4 also shows a cluster of IBM Power Systems S922 servers. You can scale-out by adding servers to the cluster as demand grows. Add IBM Power System AC922 servers as worker nodes for workloads that can take advantage of GPUs.

Figure 3-5 shows another MPP mode deployment in which the analytics and data are spread out to allow for parallel processing on the multiple worker nodes.

Figure 3-5 MPP mode: Scale-up multi-partition

This example is for a scale-up multi-partition deployment in which all of the same SAS Viya 3.5 software installs across a virtual cluster of IBM POWER9 partitions. Figure 3-8 on page 25 shows the set of IBM PowerVM partitions on an IBM Power System E980 server for running the SAS Viya 3.5 software (in green) adding these partitions to a server where other workloads are running.

Some workload examples can be SAS 9.4 on an AIX partition or SAP HANA in a Linux partition, or a partition that runs system backups. These new SAS Viya 3.5 partitions are separate and coexist with the other partitions.

The advantage of this scale-up environment is that you can grow without ordering more hardware. You can activate unused cores and memory, add resources to an LPAR, or add LPARs, such as worker nodes. You also benefit from a simplified network configuration between the nodes because all nodes are on the same server. This scale-up MPP deployment option applies to CPU-based workloads.

Figure 3-6 shows an MPP SAS Viya 3.5 deployment in a mixed environment.

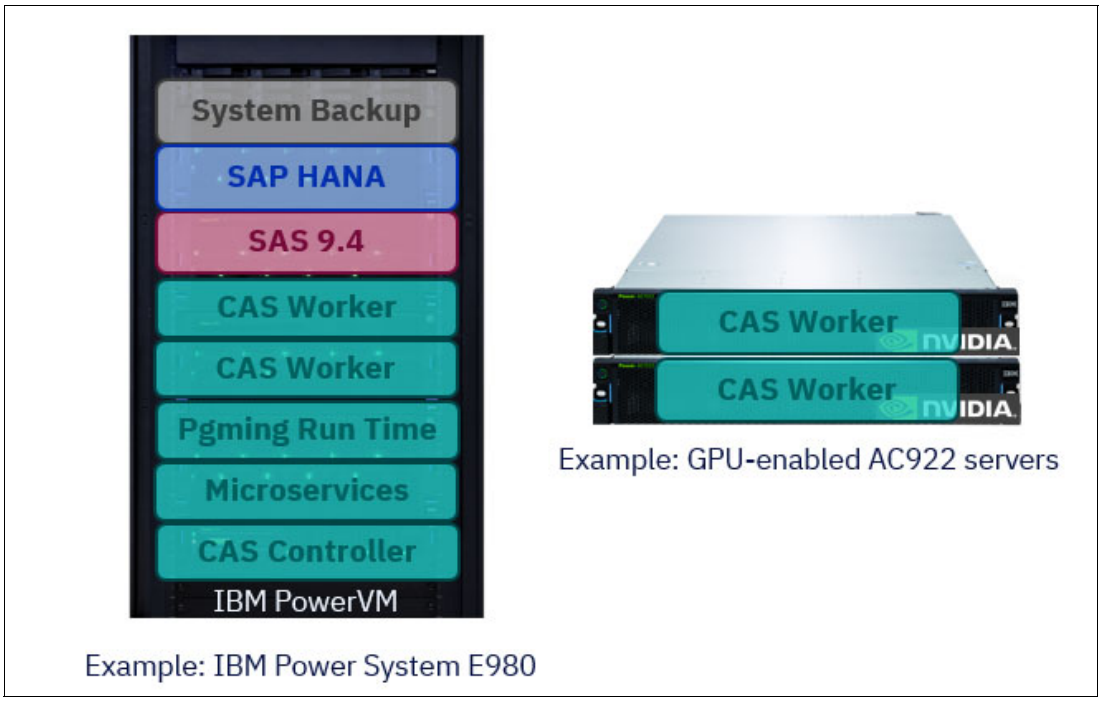

Figure 3-6 MPP mode: Mixed environment

SAS Viya 3.5 can be installed across a set of partitions on a scale-up server and one or more scale-out servers. In this case, the CAS controller and management type services run in the partitions on the left, and CAS worker nodes can run either on partitions (for non-GPU workloads) or on scale-out servers (for CPU or GPU workloads). Again, you can see the SAS Viya 3.5 components in green and non-Viya software in the other colors in Figure 3-6.

This environment provides a combined set of benefits:

- Scaling
- Parallel loading and processing data support
- Growth path
- Scaling by using unused resources (which allows adding partitions and resources to partitions or worker nodes)
- Simplified networking between LPAR nodes
- GPU-enabled workload support
- Performance benefits with NVLink 2.0 technology

Table 3-1 lists the different deployment options, an overview of the key differences, and the use cases that are good fits.

Table 3-1 Summary of IBM POWER9 deployment options for SAS Viya 3.5

IBM POWER9 deployment options	Description
Single-server	► This setup is ideal for PoCs, small workloads that do not require a cluster, or a few application developers that use a SAS Viya 3.5 programming-only environment. ► This setup provides options for bare metal, and servers with GPUs.
Single-partition on an IBM PowerVM-based server	► This setup is ideal for PoCs, small workloads that do not require a cluster, or a few application developers that use a SAS Viya 3.5 programming-only environment. ► This setup is ideal for clients that are running SAS 9.4 on AIX who want to integrate with SAS Viya 3.5 and take advantage of unused IBM POWER9 system resources. ► It supports PowerVM virtualization with no GPU option.
Multi-servers	► This setup is ideal for SAS Viya 3.5 full deployment environments of any size. ► It offers a growth path and maximizes scaling. ► It supports the parallel loading of data and processing. It also provides an option for a bare metal configuration with GPUs.
Multi-partitions on an IBM PowerVM-based server	► This setup is ideal for SAS Viya 3.5 full deployment environments. ► It offers a growth path and maximizes scaling by using available server resources. ► This setup is also ideal for clients who are running SAS 9.4 on AIX who want to integrate with SAS Viya 3.5. ► It features simplified networking between nodes. ► It supports the parallel loading of data and processing. ► It supports IBM PowerVM virtualization with no GPU option.
Mixed environment multi-servers with both IBM PowerVM-based and accelerated compute servers	► This setup is ideal for SAS Viya 3.5 full deployment environments of any size. ► It offers a growth path and maximizes scaling by using available server resources and adding servers as needed (for example, when GPU-enabled workloads are needed).

3.2 Network configuration options

The deployment options that are described is in 3.1, “IBM POWER9 deployment options” on page 18 can be configured by using internal storage devices or external storage solutions for the workload source data. In either case, the servers that are used for a SAS Viya 3.5 deployment must be networked.

Figure 3-7 on page 24, Figure 3-8 on page 25, Figure 3-9 on page 26, Figure 3-10 on page 27, Figure 3-11 on page 28, Figure 3-12 on page 29, Figure 3-13 on page 30, Figure 3-14 on page 31, and Figure 3-15 on page 32 show network configuration examples for each deployment option. They also how the servers and storage can be networked and connected.

Consider the following types of networks in your network design:

- Basic network: This network provides users access to the system and a path for administrators to perform systems management.
- Node network: This typically private network is used to provide high-speed, high-bandwidth, and low-latency communication between the cluster nodes. This connectivity must be a minimum of 10 Gb network.
- External data network: This network provides a separate connection for data transmission between the nodes and the external data source.

The network design is more straightforward with the single-server and single-partition deployments because it does not require internode connectivity. The internode connectivity is simplified with the multi-partition deployments because all partitions are on the same physical server.

Figure 3-7 shows an example of a single-server deployment with a bare metal IBM Power S922 server running Red Hat Enterprise Linux 7.6 ALT. Use solid-state drives (SSDs) or NVMe devices (shown in green in Figure 3-7) in the IBM POWER9 processor-based server for internal storage.

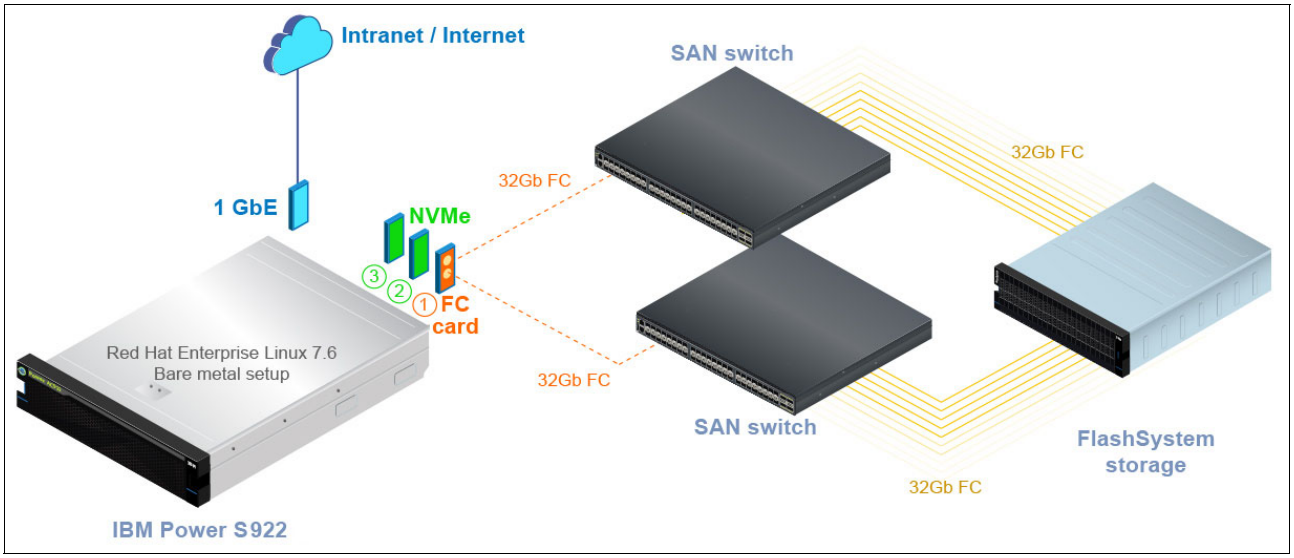

Figure 3-7 Single-server (internal and external storage)

Figure 3-7 also shows the use of a two-port 32 Gb Fibre Channel card (shown in orange) if workload source data is accessed from an external storage solution, such as IBM FlashSystem. Use the on-board 1 GbE Ethernet adapter for basic network access.

Figure 3-8 shows an example of a single-partition deployment that uses one Red Hat Enterprise Linux LPAR on an IBM Power System E980 server. Use SSDs or NVMe devices that can be used in the IBM POWER9 processor-based server for internal storage.

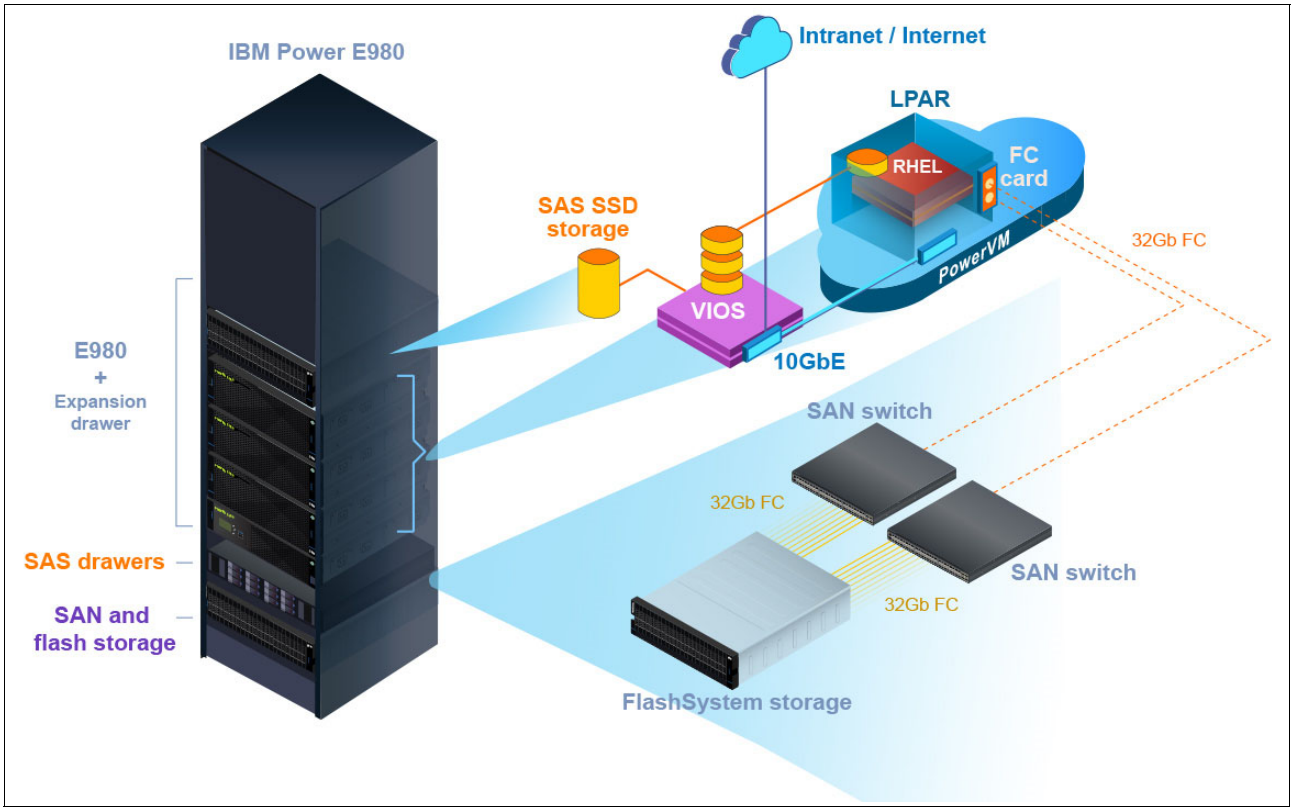

Figure 3-8 Single-partition (internal and external storage)

Figure 3-8 also shows the use of a two-port 32 Gb Fibre Channel card if workload source data is accessed from an external storage solution, such as IBM FlashSystem. This example uses VIOS for virtualized networks and internal storage. Use a 1 GbE or 10 GbE Ethernet adapter for basic network access.

Figure 3-9 on page 26 shows an example of a multi-server deployment with a set of bare metal IBM Power System S922 servers. This example shows the use of two NVMe adapters (shown in green) in the IBM POWER9 processor-based server. Use a 10 GbE or 100 GbE two-port adapter on each server for internode communications. Use the on-board 1 GbE Ethernet adapters for basic network access.

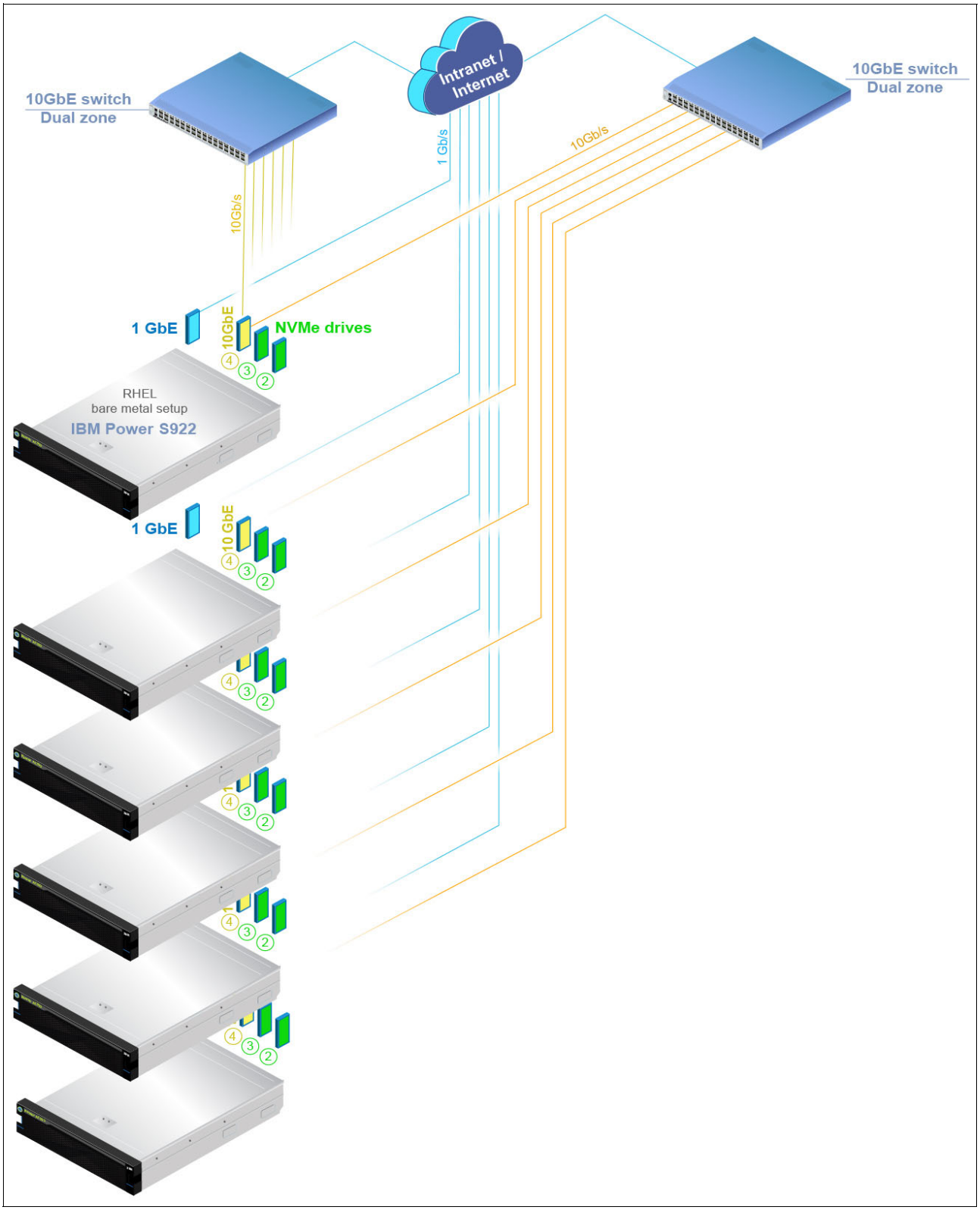

Figure 3-9 Multi-server with internal storage

Figure 3-10 shows you can add two-port 32 Gb Fibre Channel cards (shown in orange) if workload source data is accessed from an external storage solution, such as IBM FlashSystem.

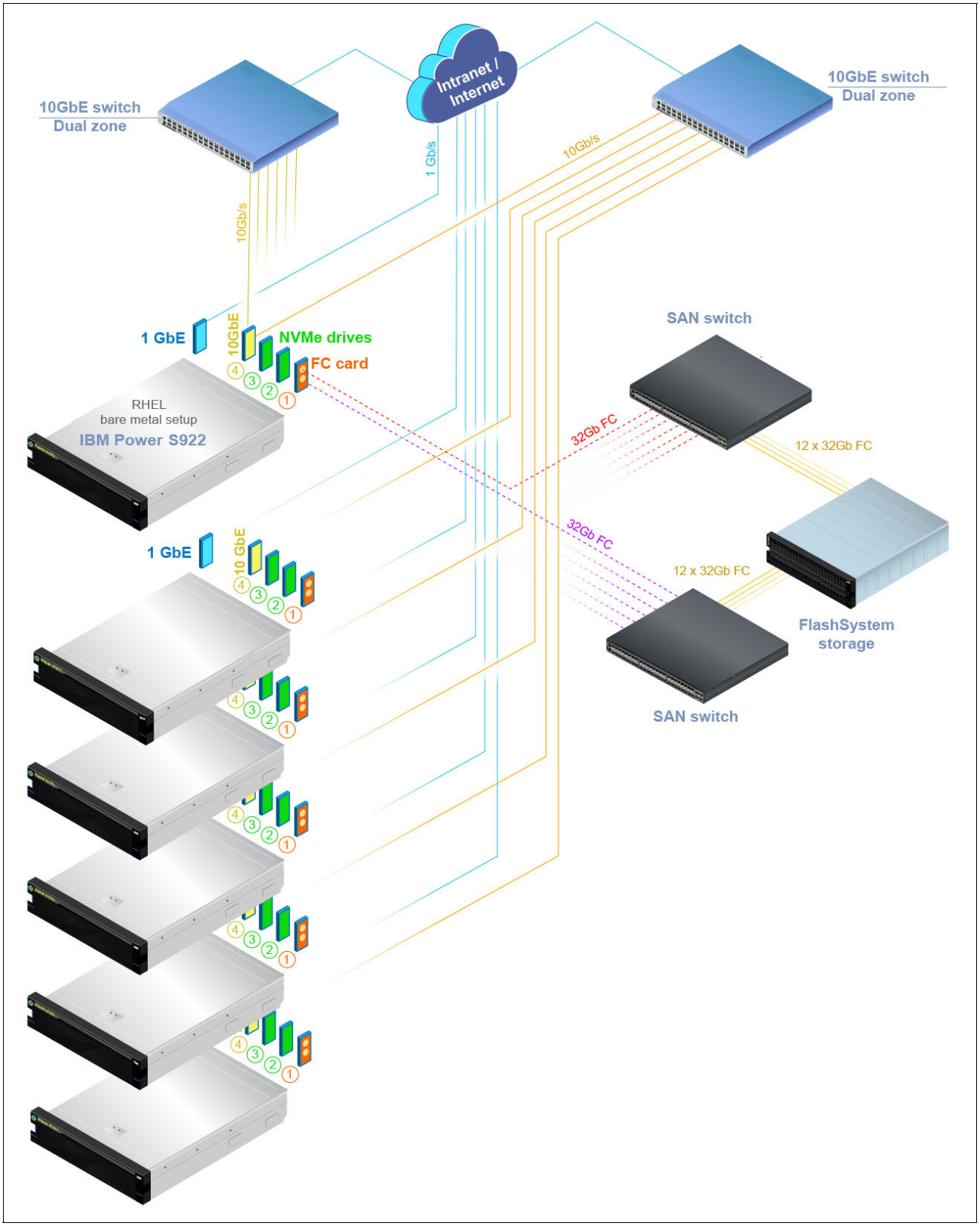

Figure 3-10 Multi-server with external storage

Figure 3-11 shows an example of a multi-partition deployment that uses a set of Red Hat Enterprise Linux LPARs on an IBM Power System E980 server. This example also shows the use of one NVMe adapter (shown in green) in each LPAR. Configure one 10 GbE or 100 GbE two-port adapter to each LPAR for internode communications. VIOS uses a virtualized network and internal storage. Use 10 GbE Ethernet adapters for basic network access.

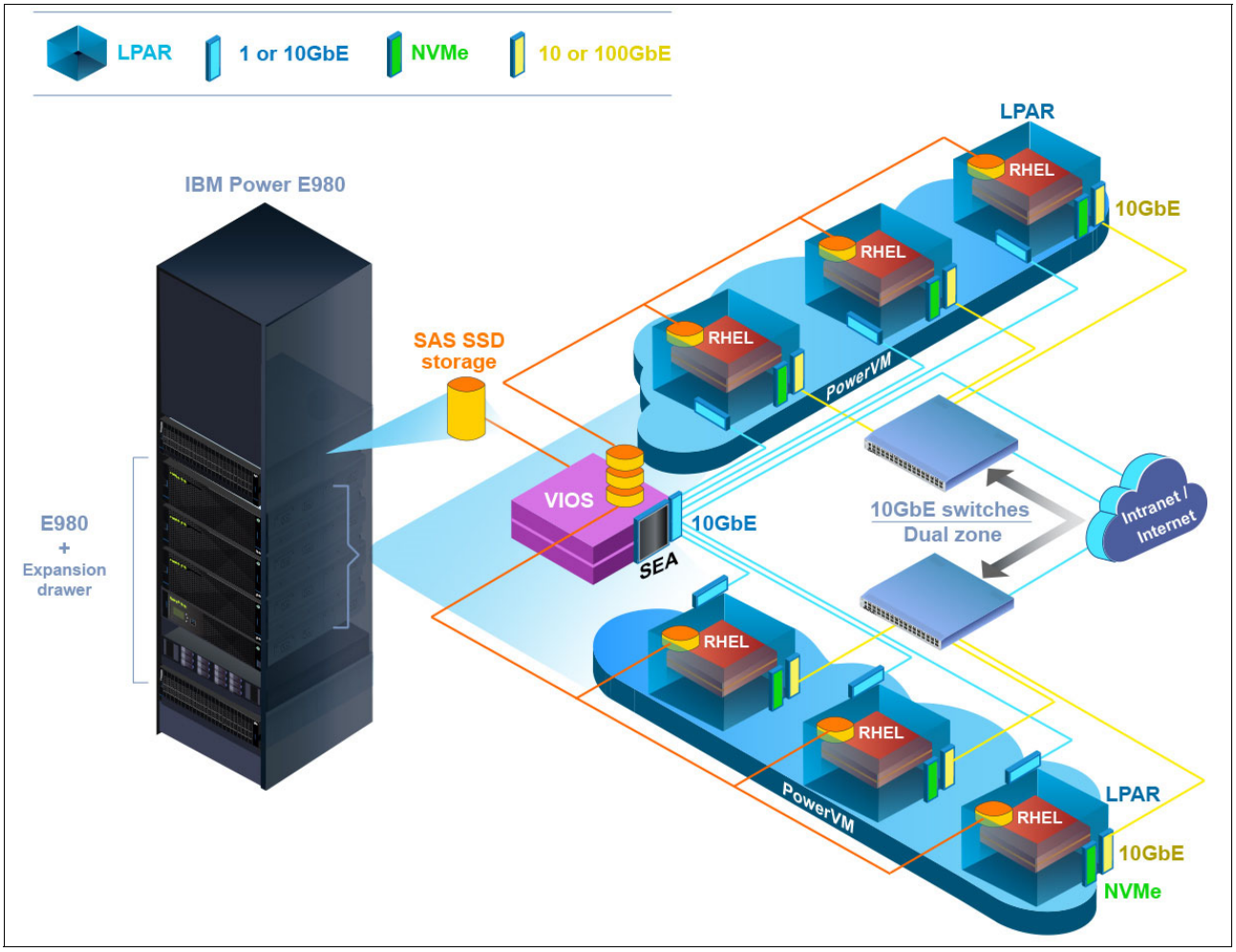

Figure 3-11 Multi-partition with internal storage

Figure 3-12 shows the use of a two-port 32 Gb Fibre Channel cards (shown in orange) if workload source data is accessed from an external storage solution, such as IBM FlashSystem.

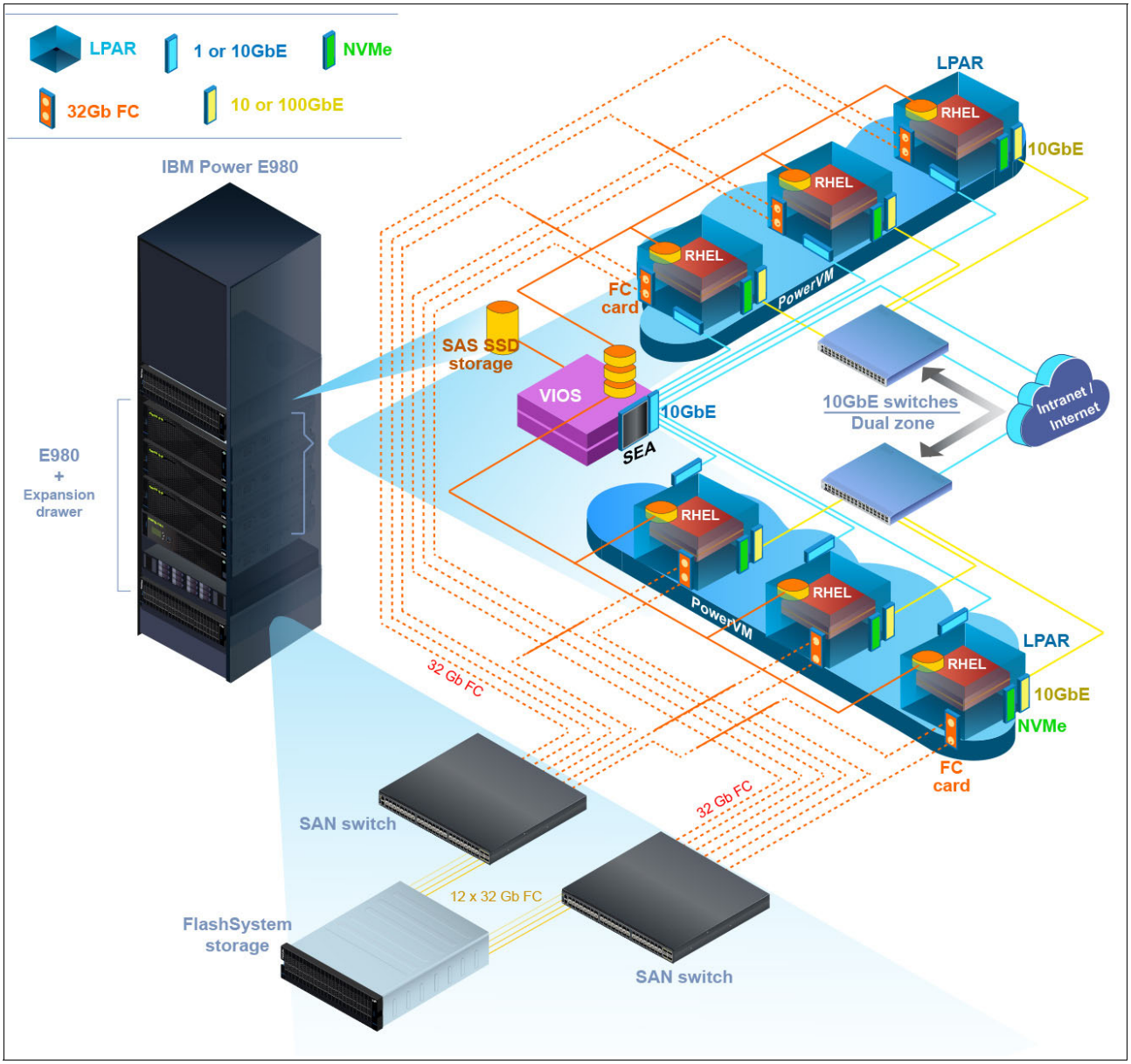

Figure 3-12 Multi-partition with external storage

Figure 3-13 shows an example of a mixed server deployment that uses a set of Red Hat Enterprise Linux LPARs on an IBM Power System E980 server and a set of bare metal IBM Power System AC922 servers. Each LPAR and server uses one or more NVMe adapters (shown in green) for internal storage. You configure one 10 GbE two-port adapter to each LPAR and each server for internode communications. VIOS uses a virtualized network and internal storage on the IBM Power System E980 server. Use 1 GbE or 10 GbE Ethernet adapters for basic network access.

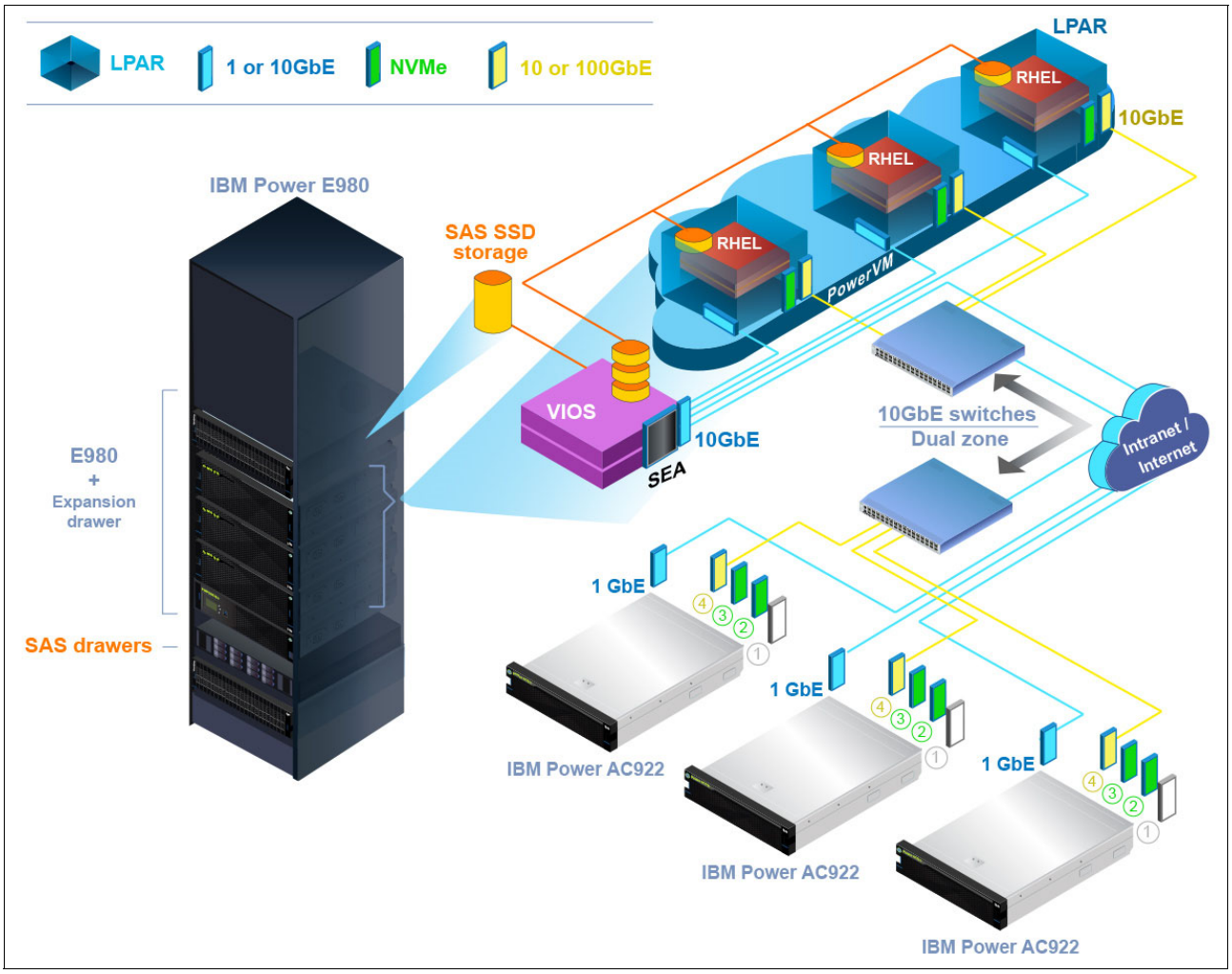

Figure 3-13 Mixed-environment with internal storage

Figure 3-14 shows the use of two-port 32 Gb Fibre Channel cards (shown in orange) if workload source data is accessed from an external storage solution, such as IBM FlashSystem.

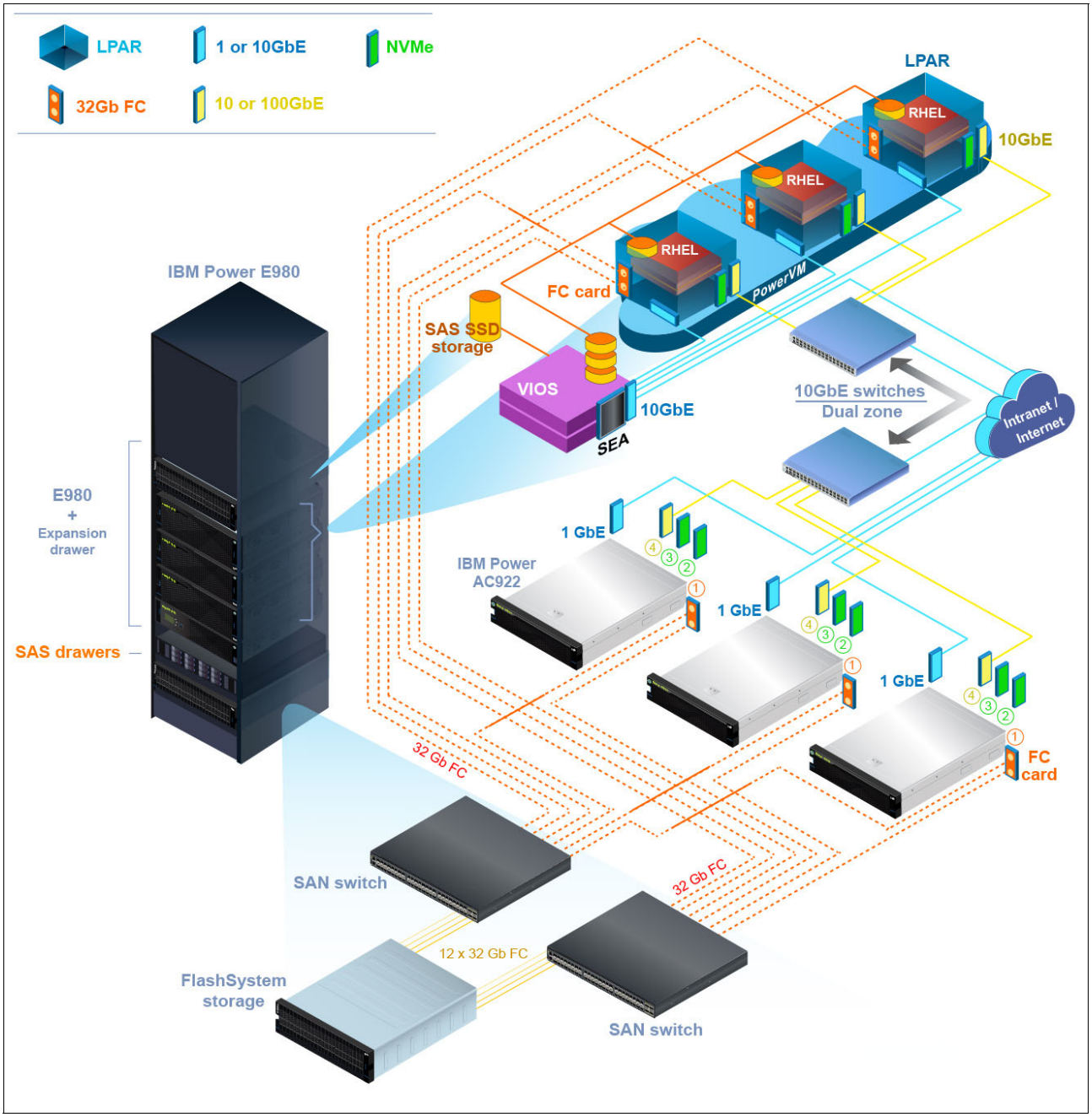

Figure 3-14 Mixed-environment with external storage

Figure 3-15 shows the use of two-port 10 GbE or 100 GbE Ethernet adapters (shown in orange) if workload source data is accessed from an external storage solution, such as IBM Elastic Storage System (ESS) 3000.

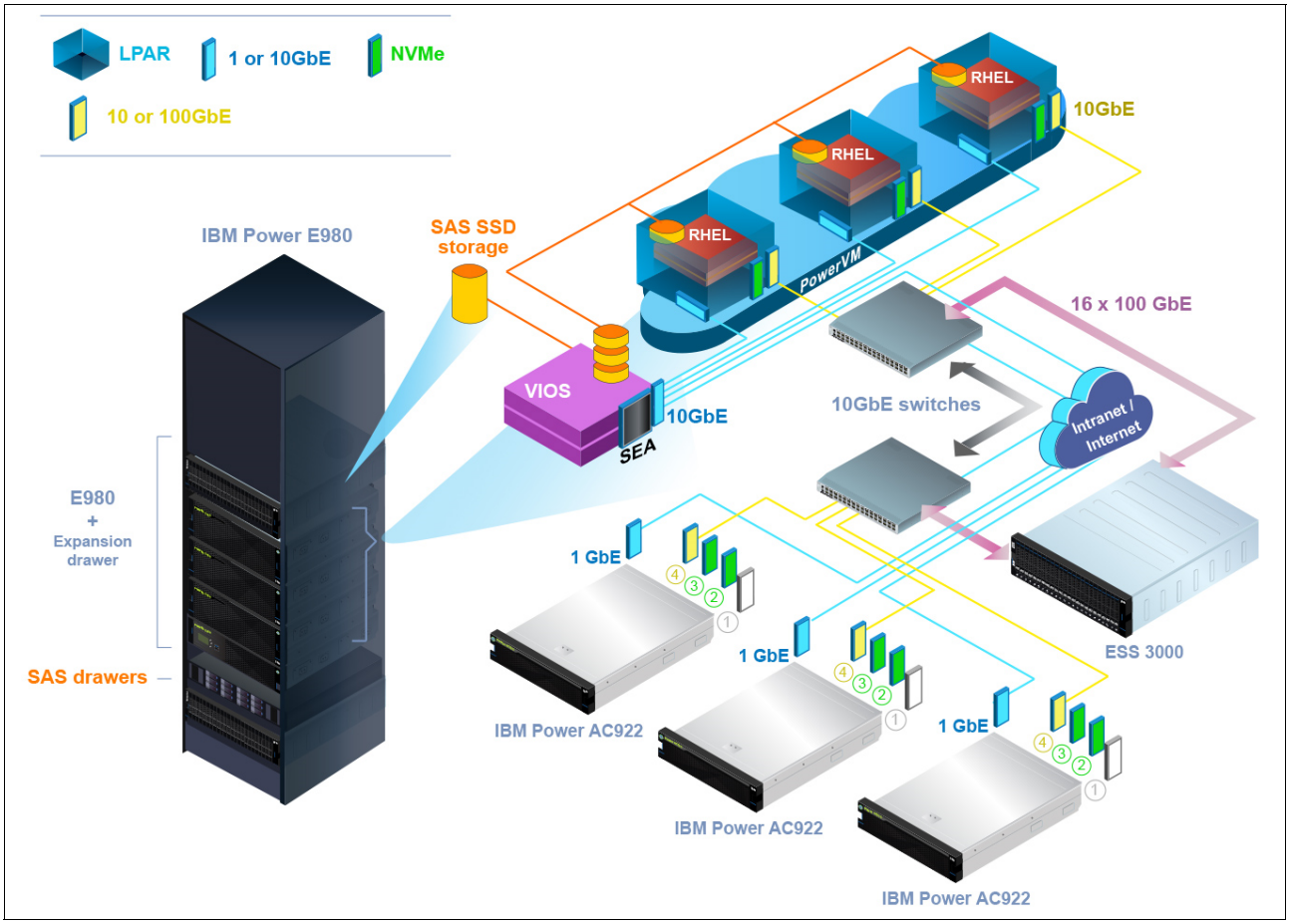

Figure 3-15 Mixed-environment with network-attached storage appliance

3.3 IBM POWER9 hardware minimum configuration options

This section describes the minimum hardware configurations for the various deployment options. When ordering IBM POWER9 servers for a SAS Viya 3.5 deployment, the SAS section in the IBM POWER eConfigurator tool reflects the minimum configuration options that are described here.

Three types of storage are required. The SAS Viya 3.5 management services (non-worker node functions) need two drives and solid-state drives (SSDs) are sufficient. The CAS_Disk_Cache (CDC) requires internal temporary storage. The workload source data requires permanent storage, and it is best to have at least two drives for striping the data.

For a configuration that allows for growth, consider a larger number of cores per processor, and more memory. IBM Power System S922 and L922 servers are suitable options, and add AC922 when GPU is required.

With the IBM Power System AC922 (8335-GTH) type and model, you can order a maximum of two CPUs (with up to 20 cores each) and up to four GPUs if the client's SAS Viya 3.5 workloads can make use of GPUs. If one server needs six GPUs, the server must be the water-cooled model. SAS Viya 3.5 cannot use more than four GPUs.

For more information about storage, see 3.4, "Storage considerations" on page 38. For more information about networking options, see 3.2, "Network configuration options" on page 23.

3.3.1 Single-server hardware configurations

Table 3-2 lists the minimum configuration for an IBM Power System S922 and L922 servers that are used in a single-server deployment. The minimum configuration is dictated by combining the hardware configuration of the server components and the SAS Viya 3.5 software needs. For IBM Power System S922, L922 and E980 servers, memory must be at least 32 GB per core, unless more is needed to load the data into memory. For intensive workloads operation on large files, consider at least 64 GB per core.

Table 3-2 Use cases: PoCs, small projects, programming-only, application development

IBM Power Systems Server	Minimum configuration	Growth configuration	Notes
IBM POWER9 server: Type-Model	IBM Power System S922	IBM Power System S922	N/A
Processors, cores per processor	Two, 8-cores	Two, 11-cores	N/A
Memory	512 GB	Up to 4 TB	64 GB per core for production environments
Storage: ► Permanent space: Management services (internal) ► Temporary space: CAS disk cache (internal) ► Permanent space: Workload data (internal or external)	► Two SSDs ► One SSD or NVMe ► Two SSD or NVMe	► Two SSDs ► One SSD or NVMe ► Two SSD or NVMe	Min: 100 - 125 MBps per physical CPU core Use striped logical volumes
Network adapter: ► Basic access ► External data (optional)	► One 1 GbE ► One 32 Gb HBA or 100 GbE NIC card	► One 1 GbE ► Up to two 32 Gb HBA or 100 GbE NIC cards	NIC card bandwidth is important

Table 3-3 lists an optional single-server hardware configuration is provided for GPU enabled workloads that use IBM Power System AC922 servers. For IBM Power System AC922 servers, memory must be at least 16 GB per core, unless more is needed to load the data into memory.

Table 3-3 Use cases: PoCs, small projects, programming-only, application development with GPUs

IBM Power Systems Server	Minimum configuration	Growth configuration	Notes
IBM POWER9 server: Type-model	IBM Power System AC922: 8335-GTH, Air-cooled	IBM Power System AC922: 8335-GTH, Air-cooled	N/A
Processors, cores per processor	Two, 16-cores	Two, 20-cores	N/A
GPUs: NVIDIA Tesla V100 GPU accelerators with NVLink	Two	Four	Six GPUs require water-cooling GTH model. SAS Viya 3.5 cannot use more than 4 GPUs.
GPU cache	16 GB	32 GB	N/A

3.3.2 Single-partition hardware configurations

Table 3-4 lists the minimum configuration for an enterprise-class server that is used in a single-partition deployment. This configuration requires the use of IBM PowerVM to create the partition where SAS Viya 3.5 is deployed. The minimum number of required cores by SAS Viya 3.5 is 16. The enterprise-class server models offer large configuration sizes (for cores and memory) that allow for growth and room for other workloads in other partitions on the same server.

Table 3-4 Use cases: PoCs, small projects, programming-only, application development

IBM POWER9 enterprise-class server	Minimum configuration	Growth configuration.
Processors, cores per processor	Two, 8-cores	Up to two, 96-cores
Memory	512 GB	Up to 64 TB
Storage: ► Permanent space: Management services (internal) ► Temporary space: CAS disk cache (internal) ► Permanent space: Workload data (internal or external)	► Two SSDs ► One SSD or NVMe ► Two SSD or NVMe	► Two SSDs ► Up to 16 NVMe cards
Network adapter: ► Basic access ► External data (optional)	► One 1 GbE ► One 32 Gb HBA or 100 GbE NIC card	► One 1 GbE ► One 32 Gb HBA or 100 GbE NIC card
Virtualization hypervisor	IBM PowerVM	IBM PowerVM

3.3.3 Multi-server minimum hardware configuration

Table 3-5 lists the minimum configuration for a cluster of IBM Power System S922 servers. The first row lists the different types of SAS Viya 3.5 nodes. The three management type nodes require less memory than the worker nodes and need internal drives for storage management-related data. Three different types of worker nodes are available. You must designate one worker node as a secondary CAS controller. One type of worker node supports CPU-based workloads.

Table 3-5 Use cases: CPU-enabled workloads

SAS Viya 3.5 node type	CAS controller (primary)	Viya microservices and other processes	SAS Programming Runtime	CAS worker workloads: CPU-enabled + CAS controller (secondary)	CAS worker workloads: CPU-enabled
POWER9 server: Type-model	IBM Power System S922	IBM Power System S922	IBM Power System S922	IBM Power System S922	IBM Power System S922
Minimum quantity	1	1	1	1	1
Processor, cores per processor	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores
Memory	512 GB	512 GB	512 GB	512 GB	512 GB
Storage ► Permanent: Management services (internal)[a].	Two SSD.	Two SSD.	Two SSD.	N/A	N/A
Storage: ► Temporary: CAS disk cache (internal) ► Permanent: Workload data (internal or external)	► One SSD or NVMe ► Two SSD or NVMe	N/A	N/A	► One SSD or NVMe ► Two SSD or NVMe	► One SSD or NVMe ► Two SSD or NVMe
Network adapter: ► Basic access ► Node inter-connectivity ► External data (optional)	One 1 GbE One 10 GbE	One 1 GbE One 10 GbE	One 1 GbE One 10 GbE	► One 1 GbE ► One 10 GbE ► One 32 Gb HBA or 100 GbE NIC card	► One 1 GbE ► One 10 GbE ► One 32 Gb HBA or 100 GbE NIC card

a. The storage is assumed to be internal storage for permanent purposes unless otherwise noted.

Table 3-6 on page 36 lists the minimum configuration for a cluster of IBM Power System S922 servers. The first row shows the different types of SAS Viya 3.5 nodes. The three management type nodes require less memory than the worker nodes and need internal drives for storage management-related data. Three different types of worker nodes are available: one worker node must be designated as a secondary CAS controller, one type of worker node supports CPU-based workloads, and the third type supports GPU-based workloads, such as Visual Data Mining and Machine Learning (VDMML). The GPU-based worker nodes are optional and are used only if VDMML is used.

Table 3-6 Use cases: Visual analytics [CPU-enabled, VDMML (GPU-enabled)]

SAS Viya 3.5 node type	CAS controller (primary)	Viya microservices and other processes	SAS Programming Runtime	CAS worker workloads: CPU-enabled + CAS controller (secondary)	CAS worker workloads: CPU-enabled	Workload: VDMML/ GPU-enabled
IBM POWER9 server: Type-model	IBM Power System S922	IBM Power System S922	IBM Power System S922	IBM Power System S922	IBM Power System S922	IBM Power System AC922: 8335-GTH
Minimum quantity	1	1	1	1	1	0
Processor, cores per processor	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 16-cores
Memory	512 GB	512 GB	512 GB	512 GB	512 GB	512 GB
Storage: Permanent: Management services (internal)[a]	Two SSD	Two SSD	Two SSD	N/A	N/A	N/A
Storage: ► Temporary space: CAS disk cache (internal) ► Permanent space: Workload data (internal or external)	► One SSD or NVMe ► Two SSD or NVMe	N/A	N/A	► One SSD or NVMe ► Two SSD or NVMe	► One SSD or NVMe ► Two SSD or NVMe	► One SSD or NVMe ► Two SSD or NVMe
Network adapter: ► Basic access ► Node inter-connectivity ► External data (optional)	► One 1 GbE ► One 10 GbE	► One 1 GbE ► One 10 GbE	► One 1 GbE ► One 10 GbE	► One 1 GbE ► One 10 GbE ► One 32 Gb HBA or 100 GbE NIC card	► One 1 GbE ► One 10 GbE ► One 32 Gb HBA or 100 GbE NIC card	► One 1 GbE ► One 10 GbE ► One 32 Gb HBA or 100 GbE NIC card
GPUs: NVIDIA Tesla V100 GPUs with NVLink	N/A	N/A	N/A	N/A	N/A	Two
GPU cache	N/A	N/A	N/A	N/A	N/A	16 GB

a. The storage is assumed to be internal storage for permanent purposes unless otherwise noted.

3.3.4 Multi-partition minimum hardware configuration

Table 3-7 shows the minimum configuration for a cluster of enterprise-class server partitions. Because of partition configuration's flexibility, the number of cores and amount of memory can be smaller to match the minimum that is required by the SAS Viya 3.5 software. Because GPUs are not available on enterprise-class servers, no GPU-based worker node type is available. VDMML workloads can still run on enterprise-class servers that use CPUs for processing.

Table 3-7 Use cases: Visual analytics, VDMML

IBM POWER9 enterprise-class server	**CAS controller (primary)**	**Viya microservices and other processes**	**SAS Programming Runtime**	**CAS worker workload: CPU-enabled + CAS controller (secondary)**	**CAS worker workload: CPU-enabled**
Minimum quantity of partitions.	1	1	1	1	1
Processors, cores per processor.	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores	Two, 8-cores
Memory	512 GB	512 GB	512 GB	512 GB	512 GB
Storage ► Perm space: mgmt services (internal)[a]	Two SSD	Two SSD	Two SSD	N/A	N/A
Storage: ► Temp space: CAS disk cache (internal) ► Perm space: workload data (internal or ext)	N/A	N/A	N/A	► One SSD or NVMe ► Two SSD or NVMe	► One SSD or NVMe ► Two SSD or NVMe
Network adapter: ► Basic access ► Node interconnectivity ► External data (optional)	One 1 GbE One 10 GbE	One 1 GbE One 10 GbE	One 1 GbE One 10 GbE	One 1 GbE One 10 GbE One 32 Gb HBA or 100 GbE NIC card	One 1 GbE One 10 GbE One 32 Gb HBA or 100 GbE NIC card
Virtualization hypervisor.	IBM PowerVM	IBM PowerVM	IBM PowerVM	IBM PowerVM	IBM PowerVM

a. The storage is assumed to be internal storage for permanent purposes unless otherwise noted.

Use Table 3-5 on page 35, Table 3-6 on page 36 and Table 3-7 for configuration guidance for mixed environment deployments where the management nodes are installed on a set of enterprise-class server partitions and worker nodes are deployed on enterprise-class server partitions and IBM Power System S922 or IBM Power System AC922 (GPU-enabled).

3.4 Storage considerations

SAS Viya 3.5 requires storage for proper functioning. It allows some flexibility with the type and location of the storage drives or devices, at the same time recommending internal drives for some specific elements. SAS describes several key storage considerations in the CAS storage performance consideration document[2], focusing on making the best storage choice to ensure optimal Viya performance. It is important to read and apply those recommendations.

IBM Power Systems offers various SSD and NVMe devices in SAS Viya 3.5 deployments. The device sizes vary depending on the specific server type and model. They also provide the performance and capacity that is required by SAS Viya 3.5.

Three primary types of SAS Viya 3.5 data-related storage entities are available as listed in the following tables:

- Table 3-2 on page 33
- Table 3-3 on page 34
- Table 3-4 on page 34,
- Table 3-5 on page 35
- Table 3-6 on page 36
- Table 3-7 on page 37

For more information, see 3.3, “IBM POWER9 hardware minimum configuration options” on page 32.

Data and software that is associated with SAS Viya 3.5-related management services, such as CAS controller and microservices, must be installed on the internal storage (that is, front-facing devices). Generally, two or more write-intensive, high-performance SSDs are sufficient.

The CDC is an on-device extension of memory-mapped files, and acts as a backing store for memory-mapped file segments. The CDC requires high bandwidth and low latency. It is best provisioned as multiple write-intensive, high-performance SSDs or NVMe devices. These devices can consider Enterprise-class storage devices with the most massive drive writes per day (DWPD) metric. The number and architecture of the devices (file system, parity, and striping choices) must be guided by the SAS Infrastructure Assessment activities to fit the EEC sizing or hardware estimate workload guidelines.

The SAS Programming Run-time (SPRE) node needs persistent storage for files that must persist between runs. The SPRE node needs a SAS WORK file system, similar to SAS 9.4.

Persistent storage is where all SAS Viya 3.5 workload source and result data persistently is stored. Although storage this can be internal (collocated), it often uses external storage because of the data volume. A high-performance Fibre Channel or Ethernet attached storage solution can be used for CASLIB PATH serial or distributed NFS (DNFS) parallel access to CAS nodes for processing.

Note: IBM Spectrum Scale can support HDFS by way of the Hadoop Connector.

[2] Engineering CAS Performance Hardware Network and Storage Considerations for CAS servers: https://www.sas.com/content/dam/SAS/support/en/sas-global-forum-proceedings/2019/3351-2019.pdf

IBM offers several storage solutions that are great choices for SAS Viya environments. The IBM FlashSystem family is an excellent choice for Fibre Channel attached storage with high bandwidth and low latency. See example network configurations for a SAS Viya 3.5 deployment that uses IBM POWER9 server and IBM FlashSystem 9200 in the 3.2, “Network configuration options” on page 23 of this document.

3.4.1 IBM FlashSystem family

The IBM FlashSystem family combines the performance of flash and end-to-end Non-Volatile Memory Express (NVMe) with the following benefits for SAS Viya 3.5 environments:

- Reliability and innovation of IBM FlashCore® technology
- Ultra-low latency of Storage Class Memory (SCM)
- Rich features of IBM Spectrum Virtualize
- AI predictive storage management
- Proactive support from Storage Insights

Built in a powerful 2U enterprise-class, blazing-fast storage all-flash array, the IBM FlashSystem 9200 enclosure is shown in Figure 3-16. Providing intensive data-driven multi-cloud storage capacity, FlashSystems helps you to easily add multi-cloud solutions that best support your most critical demands.

Figure 3-16 IBM FlashSystem 9200 control enclosure

3.4.2 NVMe protocol

NVMe is an optimized, high-performance scalable host controller interface that addresses the needs of systems that use PCI Express-based SSDs. The NVMe protocol is an interface specification for communicating with storage devices. It is functionally analogous to other protocols, such as SAS. However, the NVMe interface was designed for fast storage media, such as flash-based SSDs and low-latency non-volatile storage technologies.

NVMe storage devices are typically directly attached to a host system over a PCI Express (PCIe) bus. The NVMe controller is contained in the storage device, which alleviates the need for another I/O controller between the CPU and the storage device. The architecture results in lower latency, throughput scalability, and simpler system designs. NVMe protocol supports multiple I/O queues, versus traditional SAS and SATA protocols that use only a single queue.

However, the PCIe bus presents specific challenges for storage systems at scale. Practical challenges limit the number of NVMe drives that are attached to a host over PCIe to a few tens of devices. NVMe over Fabrics (NVMe-oF) overcomes the PCIe bus' limitation by extending the benefits of low latency and high efficiency of the NVMe technology across network fabrics to support sharing of NVMe storage at a large scale (100s or 1000s of devices) and over distance (see Figure 3-17).

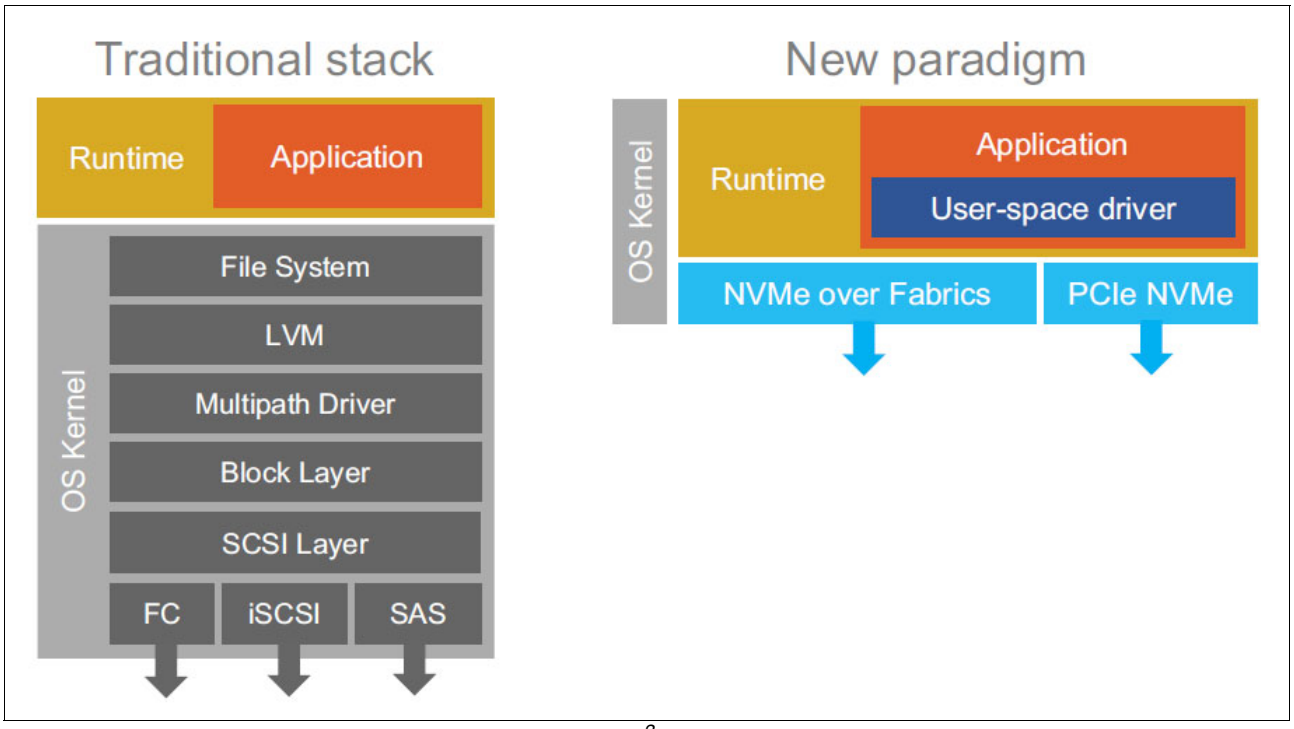

Figure 3-17 The traditional I/O stack and the new paradigm[3]

According to the Fibre Channel Industry Association (FCIA) publications[4], the simplicity, parallelism, and efficiency of NVMe deliver significant performance gains versus SCSI protocol.

3.4.3 IBM Spectrum Virtualize for Public Cloud

As available in IBM Cloud and AWS, IBM Spectrum Virtualize is the leading software-defined storage. This technology has been proven for years in IBM SAN Volume Controller and FlashSystem families of storage systems with more than 180,000 systems running IBM Spectrum Virtualize and managing more than 11 exabytes of data. IBM Spectrum Virtualize for Public Cloud provides the following features:

- Migrates SAS Viya 3.5 data between on-premises and public cloud data centers or between public cloud data centers.
- Implements disaster recovery strategies between on-premises and public cloud data centers.
- Enables cloud-based DevOps with easy replication of data from on-premises sources.
- Improves cyber resiliency with SAS Viya 3.5 data backups on AWS by using air gap snapshots to S3.

[3] Storage and the NVM Express Revolution: http://www.redbooks.ibm.com/abstracts/redp5437.html?Open
[4] Shared Storage with NVMe: https://fibrechannel.org/shared-storage-with-nvme/

These all-flash systems include IBM Spectrum Virtualize software and introduce the following remarkable new features in comparison to the predecessor models:

- End-to-end NVMe support

  NVMe is a logical device interface standard from 2011 for accessing non-volatile storage media that is attached by way of a PCI Express bus.

- Lower latencies through RDMA

  Direct memory access from a node's memory into that of another without involving either one's operating system.

- Data reduction pools (DRP)

  DRPs represent a significant enhancement to the storage pool concept. With the introduction of data reduction technology, compression, and deduplication, it became more of a requirement to have an uncomplicated way to stay thin.

- FlashCore Modules (FCMs) or industry-standard NVMe drives

  These components can be used for the IBM FlashSystems. If the FCM option is chosen, the user can take advantage of the built-in hardware compression, which automatically attempts to compress the stored data when written to the drives.

- Thin-provisioned IBM FlashCopy®

  This feature uses disk space only when the source or target data are updated, and not for the entire capacity of a volume copy.

- IBM HyperSwap® capability

  This feature enables each volume to be presented by two IBM FlashSystems. This high-availability configuration tolerates combinations of node and site failures by using host multipathing drivers that are based on the one that is available for the regular IBM FlashSystem.

- The IBM FlashSystem 9200

  This feature supports the new low latency, high-speed Storage Class Memory (SCM). SCM is a non-volatile memory device that performs faster (~10µs) than traditional NAND SSDs(100µs), but slower than DRAM (100 ns).

- IBM Storage Insights

  This feature is another part of the IBM FlashSystem 9200 system's monitoring capacity and supplements the GUI's views.

For more information about the IBM FlashSystem family, see this IBM data sheet.

3.4.4 IBM SAN Volume Controller

Built with IBM Spectrum Virtualize software, IBM SAN Volume Controller is a hardware and software storage virtualization solution through which various storage devices can be grouped into a common pool that is available to the SAN. IBM SAN Volume Controller also assists SAS Viya 3.5 customers who want to simplify storage management and reduce storage costs with SAN installations.

IBM SAN Volume Controller offers the following highlights:

- Transparent migration of back-end storage for performance tuning and disk migration without needing to stop or modify the application.
- A 25 Gbps iSCSI server attachment that supports high performance at a lower cost.

- Controls storage and retains all information, which helps to speed and simplify implementation in addition to minimizing the need for more storage.
- When combined with IBM Spectrum Control, allows the user to tune storage and improve performance and usage.
- Provides information about the amount of available storage, the amount of storage being used at which location, the hosts that are attached to which storage, and potential or outages, performance reporting, and trending.
- Scales from small configurations (1 TB) to large enterprises (500 TB and larger). New IBM SAN Volume Controller engines deliver dramatically better throughput, which supports larger and more I/O intensive environments.
- IBM SAN Volume Controller supports more than 500 flash, hybrid, and disk storage systems from IBM and other storage vendors[5].

IBM SAN Volume Controller provides in-band storage virtualization by creating a pool of managed disks from attached back-end disk storage systems. These managed disks are then mapped to a set of virtual disks for use by various host computer systems. IBM SAN Volume Controller is flexible and can manage all host storage requirements. It also offers an alternative for FlashCopy, VolumeCopy, and Enhanced Remote Mirroring for disaster recovery, maintenance, and high availability (HA).

Disk storage systems with a lower internal cache feature performance value that is based on the amount of cache they can offer. Introducing IBM SAN Volume Controller in front of these storage systems improves the overall performance. The cache also reduces the latency of writing commands by completing them without sending the write blocks to disks.

As shown in Figure 3-18, IBM SAN Volume Controller consists of two nodes for HA. All write blocks are stored in both nodes. If a disk failure occurs, written blocks are stored in a cache. The blocks are then marked as a pinned memory block. All IBM SAN Volume Controller memory is available for reading cache, without the pinned blocks if they exist.

Figure 3-18 IBM SAN Volume Controller nodes

[5] IBM SVC data sheet: https://www.ibm.com/downloads/cas/JOWZXNMW

3.4.5 More information

For more information about IBM SAN Volume Controller, see the following resources:

- *Implementing the IBM SAN Volume Controller with IBM Spectrum Virtualize V8.3.1*, SG24-8465
- IBM Documentation

IBM ESS 3000 is a network storage appliance and includes high-performance IBM Spectrum Scale software. An example network configuration for a SAS Viya 3.5 deployment that uses IBM POWER9 server and IBM ESS 3000 is shown Figure 3-15 on page 32.

SAS Viya 3.5 can be used with various file systems. For example, on Red Hat Enterprise Linux V7, XFS is a high performance, scalable file system and is the default system (ext4 is also supported). Both options feature extent-based allocation schemes that help in overall file system throughput.

When deploying CAS on an MPP system with a secondary CAS controller, a shared file system is needed. It is also needed when a Direct Network File System (DNFS) type of data source (introduced for accessing data from conventional storage solutions) is used where CAS nodes include concurrent access to the same data to support parallel loading.

IBM Spectrum Scale clustered file system is a great choice for this purpose. It uses FS2, if feasible.

When a Hadoop cluster and SASHDAT (SAS proprietary file format) files are used with SAS Viya 3.5, Hadoop Distributed File System (HDFS) is a natural choice, especially when Hadoop data nodes are colocated with the SAS Viya CAS nodes.

With the CAS_disk_cache, only local file systems, such as XFS or ext4, are supported. Cluster file systems are *not* supported.

For more information about file system requirements, see the SAS Viya 3.5 Deployment Guide, which is available at this web page.

3.5 Sizing considerations

The client requirements for analytics workloads and usage influence how the IBM POWER9 deployment option and hardware configuration is best to deploy. The sizing process is critical for assessing the requirements and making that determination. The sizing process involves experts within SAS and IBM. Key inputs are needed from the client to start the sizing process.

Table 3-8 lists the input types that must be gathered before starting the sizing process. After the key inputs are known, work with your SAS account team to submit a sizing request to the SAS EEC Sizing team.

Table 3-8 Examples of sizing input needed

Required input	Description	Influenced server specifications
Workload type	Type of applications, analytics CPU or GPU-enabled	► Server model ► Number of servers ► Number of GPUs
SAS products to be installed	Type of workloads allowed to be processed	► Server model ► Number of servers
Number of users/ concurrent users	Estimated number of authorized SAS users by workload type, if known	► Number of servers ► Overall size of the server
Data set size	GB, TB, PBs of data to be ingested and analyzed	► Amount of memory ► Type of storage (for example, internal versus external) ► Speed of storage (for example, HDD, SSD, NVMe)
Data set the growth rate in 1 - 3 years	It helps select the correct initial configuration that enables easy scaling and growth	► Number of servers ► Amount of memory ► Type of storage (for example, internal versus external)
Location of data	Where workload is saved	► Type and number of adapters ► Type of storage (for example, internal versus external)
Interested in using available space on an existing enterprise server	Helps determine whether available resources are sufficient for planned usage	Server model

3.6 High availability considerations

It is important to read and understand the HA options for SAS Viya 3.5 deployments that are documented by SAS Institute. The following important HA documents were written by SAS experts:

- *Proper Planning Prevents Possible Problems: SAS Viya 3.5 High-Availability Considerations*
- *SAS Viya 3.5: Architect for High Availability Now and Users Will Thank You Later*
- *Optimize SAS Viya 3.5: Dividing Load through the Use of Multiple SAS Cloud Analytic Services Servers*

HA of SAS Viya 3.5 is achieved through the load balancing of system components. If you plan to use HA, you must understand your options and decide how and when to set it up. The SAS Viya 3.5 components to be load balanced are divided into the following categories or components:

- SAS Cloud Analytic Services (CAS)
- SAS Viya 3.5 Programming Run-Time Servers
- Microservices
- Infrastructure servers, which often run on the same server as Microservices

HA is accomplished by having a secondary or backup server for each of these components. For each of these components, HA is achieved through automatic failover by the SAS component and other components achieved through manual failover.

When implementing HA for SAS Viya 3.5 in an IBM POWER environment that uses only POWER9 accelerated servers (for example, IBM Power System AC922 and IBM Power System IC922 servers), the HA techniques and their methods remain the same as for other platforms. You add a second server for each component. \

When implementing HA in a SAS Viya 3.5 environment that is installed across IBM PowerVM LPARs on an IBM POWER9 enterprise server, a second IBM POWER9 enterprise server must install each of the secondary or backup SAS Viya 3.5 components, each in their own separate LPAR. These second enterprise server LPARs can be configured by using shared resources.

Most cores and memory are allocated to those secondary LPARs only when the primary enterprise server or any of its LPARs become unusable and HA is activated. This configuration allows the hardware resources on the second enterprise server to be primarily used by other mission-critical solutions that are running in other LPARs on that same server. For more information about configuring shared resources with IBM PowerVM, see this web page.

Alternatively, HA can also be achieved by using front-end load-balancing across multiple SAS Viya 3.5 environments. For more information, see *High Availability with SAS Viya 3.4: Front-end Load-Balancing Considerations*.

3.7 Disaster recovery considerations

For mission-critical business operations that use SAS Viya 3.5 software, it is important to consider a deployment architecture that provides continued operations and sufficient recovery if a disaster occurs.

You must consider common disaster recovery (DR) methods that are based on specific SAS Viya 3.5 SLA and usage requirements.

Instead of splitting a cluster of SAS Viya 3.5 services across multiple sites, the preferred approach that is recommended by SAS Institute is to deploy separate, independent instances of the SAS solution at each site. By using this approach implementation, the challenges become how to keep the SAS sites in synchronization and determine when the DR site must become operational. Synchronization necessitates a process that regularly copies updates from the primary site over to the DR site.

For more information, see this web page.

4

SAS Viya 3.5 on IBM POWER9

This chapter discusses SAS Viya 3.5 deployment guidelines and tuning suggested practices on IBM POWER9.

This chapter includes the following topics:

4.1 Installing SAS Viya 3.5 on IBM POWER9

SAS Viya 3.5 must be installed by following the instructions that are described in the SAS Viya 3.5 for Linux Deployment Guide.

The steps are identical for installing it on an IBM POWER9 processor-based system that is running Red Hat Enterprise Linux. If SAS Viya 3.5 is in one or more IBM PowerVM partitions, those partitions must create before the SAS Viya 3.5 software installation process.

SAS Viya 3.5 supports Red Hat Enterprise Linux for IBM Power Systems LE 7.6 (sometimes referred to as the Red Hat Enterprise Linux 7.6 ALT edition specific to IBM POWER9) as only a supportive operating system at the time of this writing.

4.2 Tuning suggested practices

In this section, we describe several recommendations for running SAS Viya 3.5 on IBM POWER9 servers.

4.2.1 Best frequency for performance-critical workload

On a bare metal server, the operating system controls the CPU energy governor by setting the CPUfreq governor to performance mode for the best performance. Use the **cpupower** command to verify the performance policy and sets the CPUfreq governor:

```
cpupower -c all frequency-info
cpupower -c all frequency-set -g performance
```

On an IBM PowerVM server, the controls for all power saver modes are available on the Advanced System Management Interface (ASMI) and can be dynamically modified, as shown in Figure 4-1 on page 49. The default performance mode depends on the IBM POWER9 processor-based server model. Enable Maximum Performance is the default mode for IBM Power System E980 systems.

For more information about IBM POWER9 power and performance management, see is section 2.1.10 of IBM Power System E980 Technical Overview and Introduction, REDP-5510.

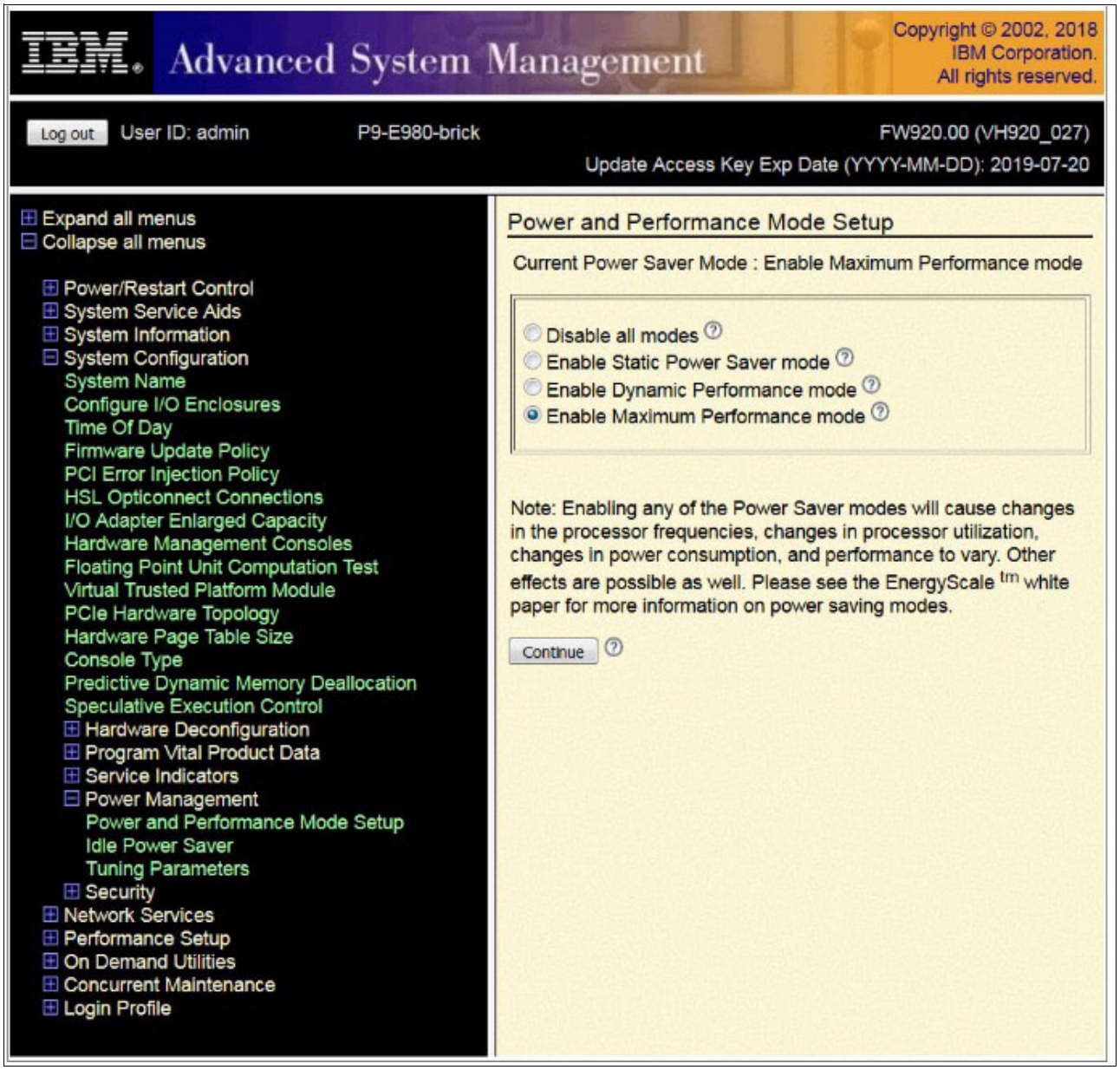

Figure 4-1 Advanced System Management Interface: Power and Performance Mode setup

4.2.2 Simultaneous multithreading

Simultaneous multithreading (SMT) enables a single physical processor core to dispatch instructions simultaneously from more than one hardware thread context. With SMT, each IBM POWER9 core can present up to eight hardware threads. Because multiple hardware threads are available per physical processor core, more instructions can run simultaneously.

SMT8 is the default for IBM Power System E980, and SMT4 is the default for the IBM Power System AC922. IBM POWER9 processor-based servers offer up to eight threads per core, whereas Intel processor-based servers provide only two threads per core.

However, SAS Viya 3.5 automatically determines parallelization that is based on the number of available hardware threads, and the application can over-parallelize to have more than 1,000 threads running concurrently.

In specific workloads, large numbers of runnable threads can cause a locking contention (see Example 4-2 on page 50) and longer runtime. The locking contention is most prominent when the NUMA assignment is not optimal for the LPARs. In such situations, reducing SMT to four or two can alleviate the locking contention and improve runtime. Use the **ppc64_cpu** command to set the SMT mode to 4 or 2, as shown in Example 4-1.

Example 4-1 vmstat command shows a high number of runnable threads in the first column

```
ppc64_cpu --smt=4
ppc64_cpu --smt=2

procs         -----------memory---------- ---swap--    -----io----     -system-- ------cpu-----
r     b   swpd      free   buff     cache   si   so      bi     bo     in     cs us sy id wa st
1303  2      0 131319808    512 248346368    0    0 1890659     57 106992 136739 83 17  0  0  0
1180  1      0 127116992    512 258590144    0    0 1944883    258 104255 143950 88 12  0  0  0
1073  4      0 118337728    512 266641664    0    0 1553706 319264 101604 105751 79 21  0  0  0
1506  5      0 107629248    512 275541312    0    0 1631779 182636 119852 192827 78 21  1  0  0
```

Example 4-2 shows the output of the perf tool with lock contention.

Example 4-2 Profile from the perf tool showing lock contention at the top of the list

```
# Overhead  Command      Shared Object       Symbol
# ........  .............  ........... .........................................
#
    39.16%  cas              [kernel.kallsyms]        [k] _raw_spin_lock
     5.93%  cas              airlev.so                [.] IPRA.$GetClasVals
     5.58%  cas              libessl.so.1             [.] datb17v
     5.24%  cas              airlev.so                [.] IPRA.$MakeOneEffectXBuf
```

4.2.3 Minimize NUMA effects in multi-partition configuration with IBM PowerVM

Most multi-socket servers experience Non-Uniform Memory Access (NUMA) effects that can affect performance. The most optimal partition assignment is to stay within a single NUMA node on a single socket. If the required core count exceeds one available NUMA node, try to contain the partition in two NUMA nodes within the same Central Electronics Complex for memory affinity.

When a partition is created or deployed, the IBM PowerVM hypervisor chooses the physical resources to assign to a specific partition (LPAR). The hypervisor inline memory modules (DIMMs), processor sockets, I/O devices, and so on, and uses this location information to optimize the resources that are assigned to partitions. But over time, when multiple partitions are defined on a server, especially with Dynamic LPAR (DLPAR), the assignment of resources is no longer optimal.

It is a good practice to use the **numactl** Linux command to check the NUMA nodes assignment in each partition to ensure optimal memory assignment:

```
numactl --hardware
```

In the situation where a partition is assigned across multiple NUMA nodes by the IBM PowerVM hypervisor, a reconfiguration of memory assignment can improve the partition's performance.

In a non-production development environment in which a power off on the server is possible, the following steps can be taken to reconfigure the memory assignment to all the partitions on the server for the most optimal assignment:

1. Make any profile updates that you need to make to the partitions.
2. Power off all the defined partitions.
3. Start all of the partitions that are specified in the configuration with the necessary attributes. Set the partition at least the SMS prompt as you activate.
4. After all partitions are simultaneously activated with the updated profile, start powering off all the partitions.
5. Power off the server.
6. Start the server.
7. Activate the partitions from the management console. The order of activation is not important.

Other workloads and users often are running on the same server in a production environment, which makes a server power off not possible. The Dynamic Platform Optimizer (DPO) is a function that is provided as part of IBM PowerVM. It allows for the dynamic optimization of the resources that are assigned to active and inactive partitions to minimize these NUMA effects without interrupting the availability of the workloads.

One way to determine (must start a DPO operation) is to use the **`lsmemopt`** command in the Hardware Management Console (HMC) command-line interface (CLI) command. Its output score represents how close a partition or the server is to the optimal assignment of resources.

The **`optmem`** HMC CLI command starts a DPO operation on the server. Partitions exclusion parameters and partition ordering parameters also are available for these commands. For more information, see this web page.

4.2.4 Network tuning in an MPP environment

When significant internode networking activities exist in an MPP environment, increasing the maximum transmission unit (MTU) size from 1500 (default) to 9000 (JumboFrames) can reduce the RX error count and improve network performance. Enabling MTU per port on the network switch can be required.

To change the MTU size, use the **`/usr/sbin/ifconfig`** command on each node:

```
ifconfig <Interface> mtu 9000 up
```

For example:

```
ifconfig enp1s0f0 mtu 9000 up
```

Test MTU JumboFrames support between the nodes in the internode network:

```
ping -M do -s 8972 <destination IP>
```

If MTU is supported and enabled in client and destination, the ping output is similar to the following example:

```
PING xxx.xxx.xxx.xxx (xxx.xxx.xxx.xxx): 8184 data bytes
8192 bytes from xxx.xxx.xxx.xxx: icmp_seq=0 ttl=128 time=0.714 ms
```

For more information about MTU testing, see this web page.

4.2.5 Large memory capacity and high data bandwidth

The IBM POWER9 processor features an exceptional cache, memory capacity, and interconnect bandwidths. These features make it a perfect environment for SAS Viya 3.5 in-memory analytics.

The IBM Power System E980 server includes up to 64 TB memory capacity, and the IBM Power System AC922 server has up to 2 TB memory capacity. When equipped with a large memory capacity, it can support a much more massive in-memory database than other platforms that are limited by memory capacity.

By using enhanced cache hierarchy, the IBM POWER9 processor has a total of 120 MB of L3 caches with 12 20-way associative regions and advanced placement policies. A 7 TBps on-chip bandwidth feeds the L3 caches. Along with its peak I/O bandwidth of 80 GBps, as powered by PCIe Gen4 (with Gen3 compatibility), IBM POWER9 provides a high data bandwidth environment.

4.2.6 Fast storage devices for optimal performance

The recommendation for optimal performance is to use fast storage options, such as SSDs and NVMe devices, that provide a faster I/O speed that matches the IBM POWER9 processor-based servers' computing power. Installing multiple SSDs or NVMe devices allows multiple storage devices to be accessed concurrently, which increases total I/O write and read throughput.

Creating a striped logical volume is a good method for balancing I/O across multiple SSDs or NVMe devices by using the following Linux command examples:

- Linux command to create LVM physical volumes:

  ```
  pvcreate /dev/nvme0n1 /dev/nvme1n1
  ```

- Linux command to create volume group:

  ```
  vgcreate <striped_vol_group> /dev/nvme0n1 /dev/nvme1n1
  ```

- Linux command to create striped logical volume:

  ```
  lvcreate -i2 -L<volume size> -n <striped_logical_volume> <striped_vol_group>
  ```

For more information about striped logical volume implementation, see this Red Hat documentation.

4.3 SAS data access

SAS/Access provides seamless and transparent read, write, and update rights to more than 60 data sources, including relational and non-relational databases, PC files, Hadoop, Amazon Redshift, and data warehouse appliances. Technical users who want more control can interact directly with the data source by using native interfaces, such as SQL.

The software passes database queries, joins, and other functions to the target data source, which reduces network traffic and speeding data processing times. Native bulk-load utilities enable even faster load times.

Currently, SAS Viya 3.5 supports the following licensed Data Access products on IBM POWER9:

- PC files
- PostgreSQL
- ODBC

SAS Viya 3.5 provides a data access component that is called *SAS Data Connector*, which provides data access capabilities between SAS Cloud Analytic Services (CAS) on a SAS Viya 3.5 platform and various data sources. Most SAS Access Interface products include a Data Connector component that does not need to be licensed separately.

4.3.1 SAS/Access Interface to PC files

SAS/Access allows you to access formats, such as `.jmp`, `.spss`, `.stata`, `.xlsx`, or `.xls` (Microsoft Excel). The IMPORT procedure is part of the SAS software. You can use these procedures without a license for SAS/ACCESS Interface to PC files.

For more information, see this SAS Help Center web page.

4.3.2 SAS/Access Interface to PostgreSQL

This includes SAS Data Connector to PostgreSQL and enables the reading and writing of PostgreSQL data into and from CAS.

SAS/Access allows access to PostgreSQL by using the Libname Engine and SAS CAS. PostgreSQL can access by specifying the source type as PostgresSQL in the LIBNAME statement or the CAS code. Although it can be accessed by way of the generic ODBC interface, the PostgreSQL interface is more efficient and optimized.

For more information about the configuration, see Configure SAS/ACCESS Interface to PostgreSQL.

For more information about how to Verify Access Interface to PostgreSQL, see Verify SAS/ACCESS Interface to PostgreSQL.

4.3.3 SAS/Access Interface to ODBC

An ODBC driver uses the Open Database Connectivity (ODBC) interface by Microsoft that allows applications to access data in database management systems (DBMS) by using SQL as a standard for accessing the data.

ODBC permits maximum interoperability, which means a single application can access different DBMS. Application users can then add ODBC database drivers to link the application to their choice of DBMS.

To connect to a supported database, it is recommended to install the suitable ODBC driver manager and database driver. Some popular open source driver managers are unixODBC and iODBC, both of which are available for Linux on IBM Power Systems.

For more information about ODBC configurations for SAS, see Configure SAS/ACCESS Interface to ODBC.

Note: For Relational DBMS (such as Hive) that currently do not provide an open-sourced driver for IBM Power Systems, third-party vendors provide the same driver. One example is Progress Software Inc., which provides DataDirect ODBC drivers for Linux on IBM Power Systems to connect to various databases. Suitable ODBC configuration entries (`.ini` files) must be made and environment variables set correctly to establish connectivity to SAS.

Related publications

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

IBM Redbooks

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

- *IBM Power System AC922 Introduction and Technical Overview*, REDP-5472
- *IBM Power System E980: Technical Overview and Introduction*, REDP-5510
- *IBM Power System E950: Technical Overview and Introduction*, REDP-5509
- *IBM FlashSystem 9200 and 9100 Best Practices and Performance Guidelines, SG24-8448*
- *Introduction Guide to the IBM Elastic Storage System, REDP-5253*

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

ibm.com/redbooks

Online resources

The following websites are also relevant as further information sources:

- SAS Viya Deployment Guides:

  https://support.sas.com/en/documentation/install-center/viya/deployment-guides.html

- SAS Viya on IBM Power Systems:

  https://www.ibm.com/it-infrastructure/power/capabilities/sas-viya

- IBM Redbooks highlighting POWER9 processor-based technology:

  http://www.redbooks.ibm.com/Redbooks.nsf/pages/power9?Open

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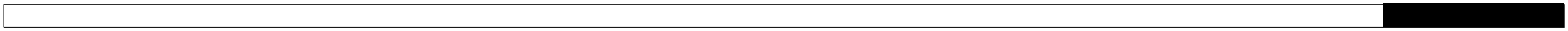

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