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## IBM Power® Systems for SAS® Empowers Advanced Analytics

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### ABSTRACT

For over 40+ years of partnership between IBM and SAS®, clients have been benefiting **from the added value brought by IBM's infrastructure platforms to deploy SAS analytics, and now SAS Viya's evolution of modern analytics.**

IBM Power® Systems and IBM Storage empower SAS environments with infrastructure that does not make tradeoffs among performance, cost, and reliability. The unified solution stack, comprising server, storage, and services, reduces the compute time, controls costs, and maximizes resilience of SAS environment with ultra-high bandwidth and highest availability.

### INTRODUCTION

We will explore how to deploy SAS on IBM Power Systems platforms and unleash the full potential of the infrastructure, to reduce deployment risk, maximize flexibility and accelerate insights.

**We will start by reviewing IBM and SAS's technology relationship and the current state of SAS products on IBM Power Systems.**

Then we will look at some of the infrastructure options to deploy SAS 9.4 on IBM Power Systems and IBM Storage, while maximizing resiliency & throughput by leveraging best practices.

Next, we will look at SAS Viya, which introduces changes to the underlying infrastructure requirements while remaining able to be deployed alongside a traditional SAS 9.4 operation. **We'll explore the various deployment modes available.**

**Finally, we'll look at tuning practices and reference materials available for a deeper dive in deploying SAS on IBM platforms.**

### SAS: 40 YEARS OF PARTNERSHIP WITH IBM

IBM and SAS have been partners since the founding of SAS. It has been our joint goal to empower businesses to answer their most challenging analytics questions – quickly. IBM Power Systems has been a critical part of that partnership since the 1990s and it continues with the latest generation of Power Systems: IBM POWER9-based systems are designed from ground up to address the key needs of SAS workloads – massive I/O and memory bandwidth, accelerators for Machine Learning (ML)/Deep Learning (DL)/Artificial Intelligence (AI) training and inferencing, as well as the flexibility to run SAS workloads in the right cloud platforms.

IBM and SAS have offered SAS 9.4 and SAS Grid for AIX on IBM Power Systems for many **years and in November 2019 we GA'd SAS Viya on IBM Power Systems. SAS and IBM are** both fully focused helping our clients modernize their analytics environments as they begin to implement ML/DL and AI workloads across their company. We observe that analytics workloads are now mission-critical for our clients and require flexible capacity and cost

control – all differentiating attributes (#1 reliability, advanced virtualization, capacity on-demand) of IBM Power Systems.

As a key SAS executive shared<sup>1</sup> with the IBM team, the differentiation of IBM Power Systems comes down to physics. IBM Power Systems is engineered for SAS workloads because they require MASSIVE throughput and Power is the only system that can handle the amount of data that comes with a SAS workload. This has been, and continues to be, true regarding the SAS and AIX workloads and becomes even more impactful as we begin supporting the in-memory, ML/DL and AI capabilities of SAS Viya.

## OVERVIEW OF SAS SOFTWARE ON IBM POWER SYSTEMS

### REDUCING RISK WITH IBM POWER SYSTEMS

What's key about running SAS on IBM Power Systems is risk reduction: IBM Power Systems are the number one reliable servers for mission-critical analytics for the 10<sup>th</sup> straight year, **as noted in the ITIC reliability study titled "Global Server Hardware, Server OS Reliability Survey"**<sup>2</sup>.

In addition to that, risk reduction is obtained through the long-term partnership and expertise between IBM and SAS. IBM has proven expertise at high performance balanced systems and offers added value sold directly with the system or through separate services engagements.

Finally, IBM Power Systems provides additional flexibility thanks to its advanced virtualization and with capacity on demand, which gives clients the ability to scale on demand their SAS environment, including on-the-fly activations of dormant resources on enterprise models.

IBM differentiates itself when it comes to SAS workload thanks to the high throughput capability, and generally speaking, the ability to move data around (CPU to memory, CPU to GPU, memory to storage), which is one of the key characteristics needed for efficient SAS processes and optimal job execution.

### SAS 9.4 AND SAS GRID

**IBM has partnered with SAS around their "traditional" workloads: SAS 9.4 and SAS Grid.** SAS 9.4 is an advanced analytics, business intelligence, and data management solution and **SAS Grid is SAS' workload balancing product**, which is underpinned by IBM Spectrum LSF.

On IBM Power Systems, these workloads are supported for the AIX operating system.

### SAS VIYA

SAS is positioning their next generation in-memory analytics framework, SAS Viya, as their **"Evolve Your Analytics Platform"**. This is an open and cloud-enabled, Machine Learning (ML)/Deep Learning (DL)/Artificial Intelligence (AI) workload. There are several products that take advantage of the SAS Viya framework; the most frequently used products are Visual Analytics, Visual Statistics, and Visual Data Mining, and Machine Learning.

**In addition to supporting SAS' proprietary SAS coding language, Viya users can also take advantage of open-source languages including Python, R, and Lua.** Viya is mainly a Linux-based workload.

On IBM Power Systems, SAS Viya is running specifically on Red Hat Enterprise Linux and can be deployed on any system equipped with POWER9 processors, whether as a

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<sup>1</sup> <https://www.youtube.com/watch?v=Jpxo8EsOwOw>

<sup>2</sup> <https://www.ibm.com/downloads/cas/DV0XZV6R>

standalone deployment or co-located with SAS 9.4, SAS Grid, or other mission-critical workloads and data sources.

## SAS PRODUCTS ON IBM POWER SYSTEMS

The “traditional” (pre-Viya) SAS portfolio is readily available on IBM Power Systems on the IBM AIX operating system.

Academic Analysis Suite	Data Mgt Cnbt Ext - World	Forecast Analyst WkbnchSvr	Merchandise Allocation	SAS/CONNECT
Affiliate Std Support Pkg	Data Mgt DataPack Tur Geocd	Forecast Server	Merchandise Assort Planning	SAS/EIS
All Standard SAS/ACCESS Eng	Data Mgt DataPack USA Addr	Forecast Server Procedures	Merchandise Solutions Base	SAS/ETS
Analytics Accel Teradata	Data Mgt DataPack USA AdVer	Gold Partner Program	Meta Bridge Big Data	SAS/FSP
Analytics Pro	Data Quality Accel Hadoop	Grid Manager Client	Metadata Server	SAS/Genetics
Analytics Server	Data Quality Accel Teradata	Hi-Perf Risk Server	Micr Anlt Svc Drvr Base	SAS/GIS
AntiMoneyLaund AlertGen Svr	Data Quality Server	High-Perf Data Mining	Model Manager Server	SAS/GRAPH
Authentication Server	Data Remediation	High-Perf Text Mining	New Product Forecasting	SAS/IML
Banking Analytics Arch	DataSurveyor for Oracle App	In-Database CdAcc Greenplum	Office Analytics	SAS/IntrNet
Base SAS	DataSurveyor for Salesforce	In-Database CdAcc Hadoop	OLAP Server	SAS/OR
BI Server	DataSurveyor for SAP	In-Database CdAcc Teradata	OpRisk VaR Server	SAS/QC
Bridge for Esri	DataSurveyor for Siebel	In-Database Tech Hadoop	Platform Suite for SAS	SAS/SHARE
Business Rules Manager	Decision Manager	Integration Technologies	Platinum Partner Program	SAS/STAT
Campaign Management Server	Decision Services	Inventory Opt Workbench	Portal Server Components	SAS/TOOLKIT
Cap Plan and Mgmt	Demand Signal Repository	Inventory Replenishment	Pred Model Wkbnch SAP HANA	SAS/Warehouse Administrator
Collaborat Plan Workbench	Education Analytical Suite	IT Resource Adapt SAP Svr	QKB Cont Info - World	Score Accelerator DB2
Compliance Solutions	Ent Case Mgmt Server	IT Resource Mgmt Server	QKB Cont Info English USA	Social Network Analysis Svr
Contextual Analysis	Enterpr Integration Tech	Japan Campus Program	QKB Prod Data Eng USA	STATPLUS
Cost Prof Mgmt DI and BI	Enterpr Model Mgmt Server	Job Monitor	QP Advanced Analytic Pkg	Strategy Management Server
Credit Scoring Addon Eminer	Enterprise BI Server	LASR Analytic Svr Dist	Real-Time Decision Mgr Svr	Suite Government Canada
Currency Trans Reporting	Enterprise Computing Europe	LASR Analytic Svr NonDist	RealTimeDecMgr RunTime Svr	Task Manager
Customer Due Diligence	Enterprise Miner Server	Marketing Automation Server	Rev Mgt Price Opt Analytics	Text Analytics
Data Governance Server	Federation Server	Marketing Optimization Svr	Risk Data AggregationReport	Text Miner Server
Data Integration Server	FedSvr Driver for Netezza	MDM Advanced	Risk Dimensions Svr	Vis Anlyt LASR Svr Distrib
Data Loader for Hadoop	FedSvr Driver for Teradata	MDM Data Quality Adv Svr	SAS LASR Analytic Acc Tools	Vis Anlyt LASR Svr Non-Dist
Data Management Advanced	Financial Crimes Mon Svr	MDM Data Quality Std Svr	SAS/ACCESS	Vis Process Orchestration
Data Management Standard	Financial Management Svr	MDM Standard	SAS/AF	Web Studio Server
	Financial Mgt Adapt SAP Svr	Merch Financial Planning	SAS/ASSIST	

**Figure 1. Extract of SAS products available on AIX on IBM Power Systems**

SAS Viya products are available on Linux on IBM Power Systems, which can be deployed alongside AIX, IBM i, on the same infrastructure. SAS Viya requires the latest generation of POWER processors: POWER9, or later.

The most commonly used SAS Viya products are readily available on IBM Power Systems and should be able to meet the needs of most deployments. Additional, less commonly used products can be made available as needed upon request to your SAS representative. The most current list of SAS Viya products supported with IBM Power Systems can be found at <https://sas.com/viyaonpower/>.

## CHOOSING AN INFRASTRUCTURE SOLUTION FOR SAS

### WHY POWER SYSTEMS FOR SAS

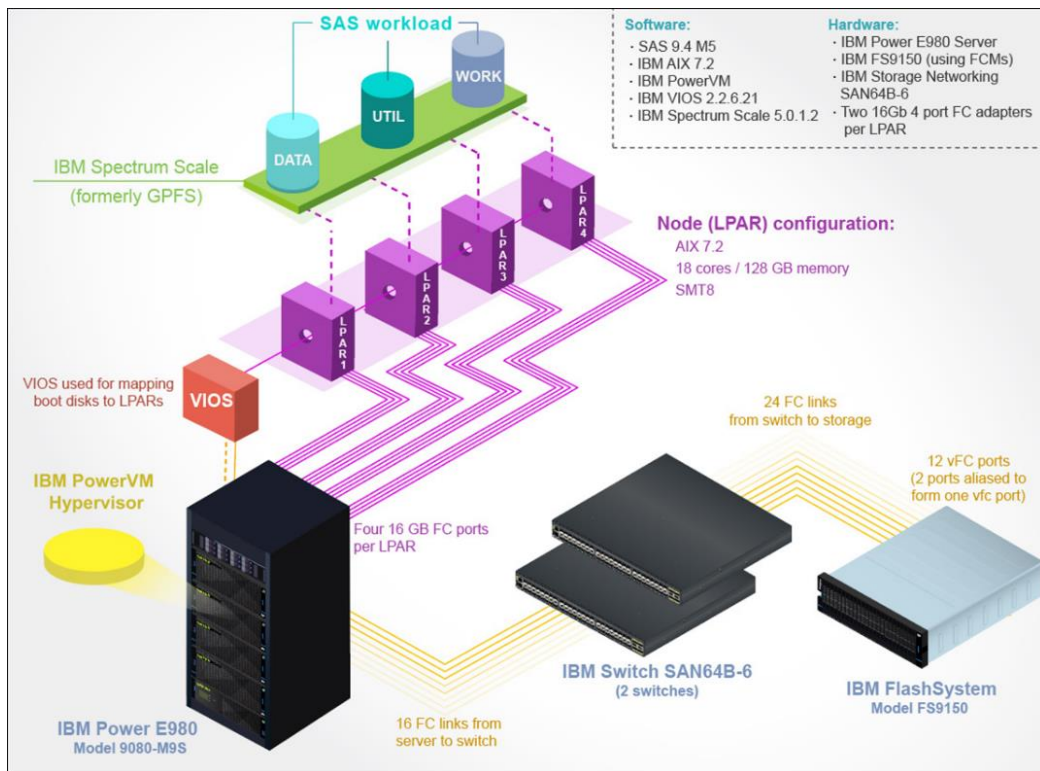
Besides reliability, flexibility, IBM differentiates itself when it comes to SAS workload thanks to the high throughput capability, and generally speaking, the ability to move data around (CPU to memory, CPU to GPU, memory to storage), which is one of the key characteristics needed for efficient SAS processes and optimal job execution.

SAS workloads bring a huge amount of data from many different sources (such as Online Transaction Processing (OLTP), flat files, databases, streaming data) and clients must deploy hardware that is able to keep up with the demands of the workload. Much of the work that a SAS programmer is performing is Extract, Transform, Load (ETL) with some amount of advanced analytics (statistical analytics and reports). The process of ETL can be very time and compute intensive and requires bandwidth in order to move data from the

source to the end target. Of all workloads running in your datacenter, SAS is one of the most demanding on its servers for the amount of bandwidth required in day-to-day operations. As a result, you need to be very aware of what your SAS programmers are using SAS for and choose and size hardware accordingly.

**If this isn't done, you're looking at a lot of challenges with your SAS workload** – the net is insufficient servers will result in long-running SAS jobs. This means that you will not get the data you need to make business decisions in an appropriate amount of time, potentially putting you behind the curve of your competition, of any fraud or risk activity.

Unlike commodity hardware which is typically underpowered and can result in I/O bottlenecks, slowing down your SAS workloads, IBM Power Systems is designed for massive analytics workloads. Designed from the ground up, IBM Power Systems has up to 5.6x faster I/O which can make bottlenecks a thing of the past. Couple this with the stability of an enterprise grade system and the ability to dynamically grow and shrink memory, CPU, and storage without any need for reconfiguration and you can see why IBM Power Systems is a great choice for your SAS workloads.



**Figure 2. SAS deployment using Enterprise Power Systems, IBM Flashsystem, and IBM Spectrum Scale**

### STORAGE OPTIONS FOR SAS

It is important not to compromise when it comes to choosing a storage solution because it can very quickly become a bottleneck that will hamper the compute power. First, IBM recommends the use of flash storage which is the only way to obtain the uncompromising throughput with low latency that is truly needed by SAS products.

There are several options to make flash storage available to a POWER9 server:

## Internal storage

The first option is to simply put NVMe flash drives inside the POWER9-based server itself. SAS data would be placed on PCIe-attached NVMe adapters (not in the M.2 built-in slots that are intended primarily for booting, VIOS images). This has the advantage to be fast and simple. The maximum bandwidth can be achieved through the PCIe bus. The disadvantage is that scaling is limited by the number of slots and the size of the drives available. So, **if you're talking a few 10s of terabytes** that's perfectly fine, if your client is going into 100s of terabytes or more, then we have to consider external storage options.

## FlashSystem

With external storage, the most common option, and usually the most cost effective one, would be to provide an IBM FlashSystem with NVMe drives, with IBM Spectrum Scale on top, to provide the file layer optimized for sequential IO and large blocks that SAS requires for optimal performance.

Spectrum Virtualize runs in all IBM FlashSystem block storage, typically attached over a Fibre Channel or high-performance Ethernet fabric. It also runs in the SAN Volume Controller (SVC).

FlashSystem is an end-to-end NVMe-accelerated multi-cloud solution that offers a transformation of performance and capacity density, built on Spectrum Virtualize, IBM Storage Insights and other members of the spectrum storage family.

FlashSystem 9200 delivers amazing throughput, with up to 34GB per second in just 2U, but it gets even better because it also delivers an amazing 3.75 million IOPS in that same 2U. Furthermore, SAS Viya can store up to 2PB in that same 2U and in many instances experience less than 100 microsecond latency response times. FlashSystem 9200 can deliver even greater performance, and reliability if you choose to scale up.

## Elastic Storage Server (ESS)

An alternative is to combine IBM Spectrum Scale, flash and NVMe into a single 2U drawer (that can scale out by adding additional drawers). This option is called the IBM Elastic Storage Server 3000. It is functionally equivalent and can be considered when scaling out without compromise is a requirement of the solution.

IBM Storage based on Spectrum Scale, such as the ESS3000, is deliver high-throughput file and object serving. Spectrum Scale can also be deployed without ESS, on top of a block solution like Spectrum Virtualize. In the ESS storage solution, Spectrum Scale is built-in and does not need to be installed separately.



**Figure 3. Elastic Storage Server scales out by adding 2U drawers**

### Third-party storage

Finally, ensure you understand that 3<sup>rd</sup>-party flash storage solutions are fully supported and can be put in production in SAS on POWER9 server environment. Again, the inclusion of IBM Spectrum Scale for the file layer is recommended because it is a perfect match for the I/O pattern of SAS software.

### THE BENEFITS OF NVMe FLASH STORAGE

Figure 4 shows the results of a test using SAS 9.4 with an IBM Power Systems server with an all-flash storage array, compared to a non-flash storage array.

Three tests were as follows: one with POWER8 and a non-flash array, one with POWER9 with non-flash array, and one with POWER9 with an all-flash array. What we observe is that all key performance indicators are significantly better with the all-flash array including throughputs, and the very important real-time performance indicator, which is the total elapsed runtime for the SAS jobs (obviously, lower is better). What we see here is that real-time total went from 4.06 minutes to 2.31 minutes going simply from non-flash to all-flash using this exact same POWER9 server.

The bottom line: by using modern flash storage technology, we can reduce the real-time total almost by half.

The flash array was a FlashSystem 9200 (formerly known as 9150), which achieved an impressive read throughput of about 24GB/sec (6GB x 4 LPARs), which is in line with the specifications of the array.

- POWER8+non-flash to POWER9+non-flash -32% (real time) 13% (read max) 9% (write max)
- POWER9+non-flash to POWER9+FS9200 -43% (real time) 47% (read max) 27% (write max)
- POWER8+non-flash to POWER9+FS9200 -61% (real time) 67% (read max) 37% (write max)

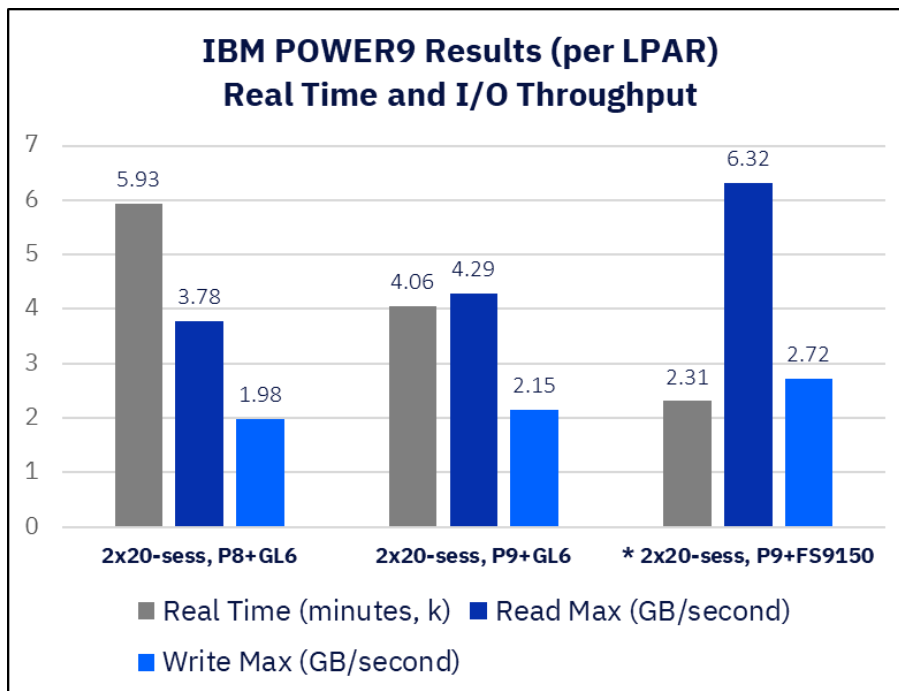


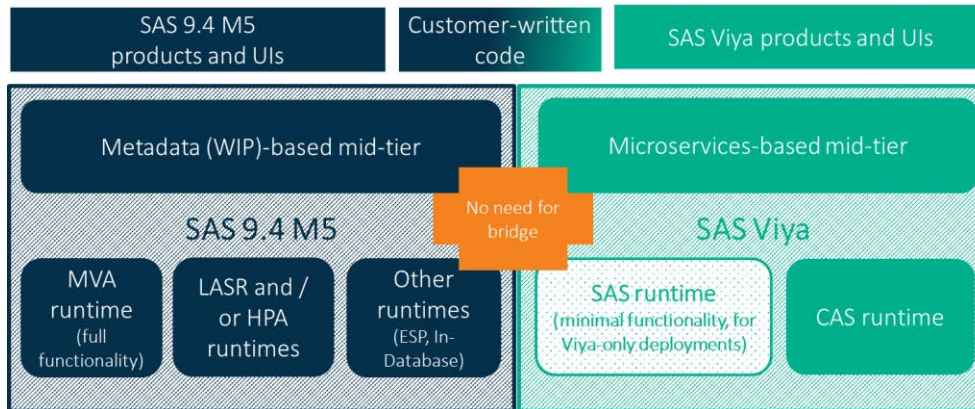
Figure 4. Results of tests comparing POWER8 & POWER9, All-flash vs. traditional disk

## SAS VIYA ON IBM POWER SYSTEMS

### OVERVIEW OF SAS VIYA

SAS Viya (Viya) is the modernization of the SAS platform focused on performance (in-memory analytics), democratization of analytics (ability to use open source languages, user friendly interface allowing citizen data scientists to use the tools), cloud ready (containerized, available on public cloud), Artificial Intelligence (AI)/Machine Learning (ML)/Deep Learning (DL) workloads beginning to take advantage of GPU.

SAS will continue to support and invest in their SAS 9.4 platform. SAS Viya can be seen as a workload to augment traditional SAS 9.4 and Grid deployments. SAS code and models can be executed in SAS Viya and SAS Viya results can be fed into existing SAS 9.4 deployments.



**Figure 5. SAS Viya alongside SAS 9.4**

## SAS VIYA – WHY GET EXCITED?

Viya gives clients the ability to parallelize, speeding the time it takes to garner valuable insights from their data. Cloud-ready, Viya enables clients to consider different deployment options for their environments, whether it be on-premises, hybrid cloud, or public cloud.

Today, Viya can take advantage of GPUs for some of its workloads; for example, through Visual Data Mining and Machine Learning (VDMML). These Artificial Intelligence (AI), Machine Learning (ML)/Deep Learning (DL) questions allow you to have new insights into **your data that wasn't possible before. Finally, Viya democratizes SAS analytics** – it opens the ability to use open source tools like Python, R, and Lua, while providing robust **visualization tools for the citizen data scientist. At IBM we're excited to partner with SAS to bring this awesome and groundbreaking software to market for our joint clients.**

SAS Viya is the new computing architecture centered on the Cloud Analytics Server (CAS), which has the following characteristics:

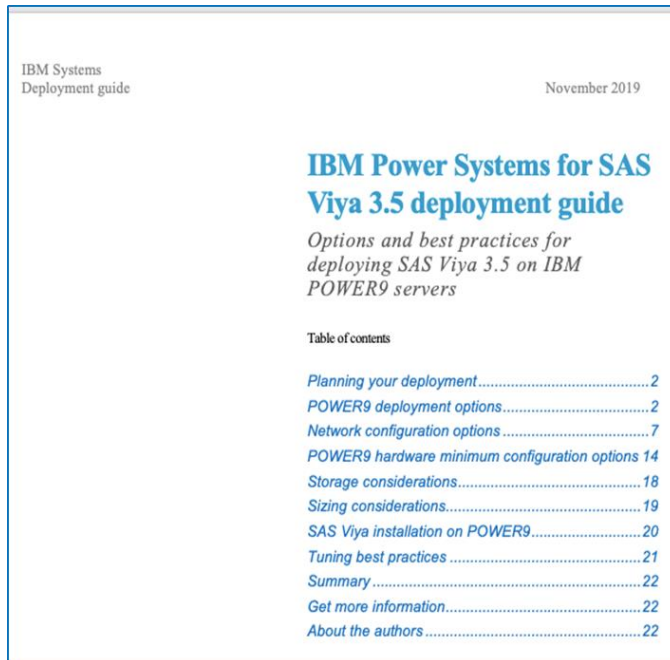
- Holds as much data as possible in memory
- All actions are inherently parallel and can operate across multiple nodes
- Reduced transaction time
- Visual tools that empower people, democratizing analytics to people who are not data scientists
- Opens the platform to Python, R, Lua open source tool to allow developers with these **skills to utilize whichever tool they're most comfortable with**
- Allows open source developers to collaborate with SAS programmers

Most Cloud Analytics Server (CAS) actions are parallelizable, but sometimes the data or action is more optimally run serially (to avoid unnecessary distribution of small amounts of data).

SAS 9.4M5, the SAS MVA Cloud Analytics Server (CAS) client connectivity capabilities are included; programs in 9.4m5 can access CAS directly eliminating the extra step of using SAS/CONNECT. Customer-written code can now be a blend of traditional SAS 9.4 code and new CAS enabled code

## DEPLOYING SAS VIYA ON IBM POWER SYSTEMS

IBM provides comprehensive information and advice to ensure our clients make correct choices when deploying SAS Viya. Our reference document is our deployment guide<sup>3</sup>, which is updated on a quarterly basis with latest best practices.



IBM Systems  
Deployment guide

November 2019

**IBM Power Systems for SAS  
Viya 3.5 deployment guide**

*Options and best practices for  
deploying SAS Viya 3.5 on IBM  
POWER9 servers*

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**Figure 6. Deployment Guide for SAS Viya on IBM Power Systems**

## SAS VIYA DEPLOYMENT MODES ON IBM POWER SYSTEMS

IBM's Power System portfolio of servers enables flexible deployment options for running SAS Viya. SAS Viya can run in two modes:

SMP mode is Symmetric multiprocessing which leverages multiple cores or processors on just one node or server. SMP deployment options are appropriate when investing in a cluster is not yet needed. We have 2 deployment options for IBM Power Systems.

### SMP-mode deployments

#### **Single server**

We support single-server deployment, where SAS Viya and all its complementary software are installed on one POWER9 server. Figure 7 shows a server model AC922.

<sup>3</sup> <https://www.ibm.com/downloads/cas/JZ738LM1>



## Single server

- Select AC922 for GPU-enabled workloads (acceleration with NVLink 2.0)
- Select IC922 for other workloads

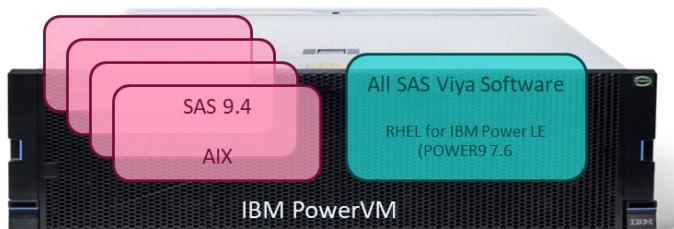


### Figure 7. Single-server deployment

The AC922 server supports NVidia GPUs plus an NVidia technology called NVLink 2 which is unique to IBM POWER9 servers and its embedded Nvidia GPUs. NVLink 2 provides 5.6x data bandwidth acceleration when software switches between CPU and GPU.

### Scale-up

We also support Scale-up Single Partition deployment, where SAS Viya including Cloud Analytic Services (CAS) and all its complementary software are installed on one POWER9 partition. **In the POWER9 server family picture you see examples of IBM's scale-up servers, the E950 being one of them. An E980 could also be used.** These enterprise-class servers are large; you can use IBM PowerVM virtualization to create a separate Linux partition (or LPAR) for installing SAS Viya. This SMP deployment option does not require the entire large server, so it is ideal for customers that currently run SAS 9.4 in an AIX partition where they can use untapped resources (cores, memory).



### Figure 8. Scale-up Single Partition

These SMP-mode deployments are great options for proof-of-concepts, for getting started with Viya, for small projects, or for Programming Only environments.

SMP mode deployments are great options for proof-of-concepts, for getting started with Viya, for small projects, or for Programming Only environments.

### MPP-mode deployments

**MPP is SAS's term for massive parallel processing;** which is essentially a cluster of servers. In MPP mode, Cloud Analytic Services (CAS) supports workers to help offload the analytics and spread the data out to allow for parallel processing on the multiple workers. There are 3 options:

#### SCALE-OUT

A Scale-out Multi-Server deployment is where SAS Viya including the CAS Controller and CAS workers, and all its complementary software are installed across a cluster of POWER9 scale-out servers. Figure 9 shows a cluster of AC922 servers. As growth is experienced, you can scale out by adding more servers to the cluster.



Example: Rack of IBM Power System AC922 servers

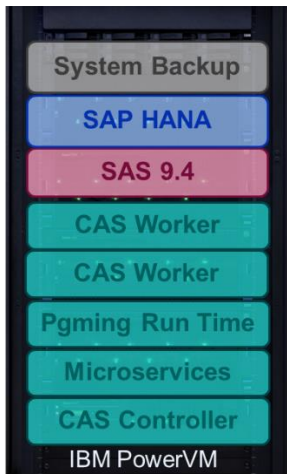
**Figure 9. Scale-out Multi-Server deployment**

**SCALE-UP**

This example is for a Scale-Up Multi Partition deployment, where all the same SAS Viya software is installed across a virtual cluster of POWER9 partitions.

In Figure 10, you can see the set of PowerVM partitions on a POWER9 E980 server running the SAS Viya software, in red. These partitions can be added to an existing server where other workloads have already been running. Some workload examples may be SAP HANA, or SAS 9.4 in an AIX partition, or a partition that runs system backups. These new Viya partitions are separate and coexist with the other partitions.

The advantage of this scale-up environment is that you can grow without necessarily having to order more hardware. You can activate unused cores and memory, and either add more resources to an existing LPAR or add more LPARS, such as additional worker nodes. You also benefit from a simplified network configuration between the nodes because all nodes are on the same server.



Example: IBM Power System E980

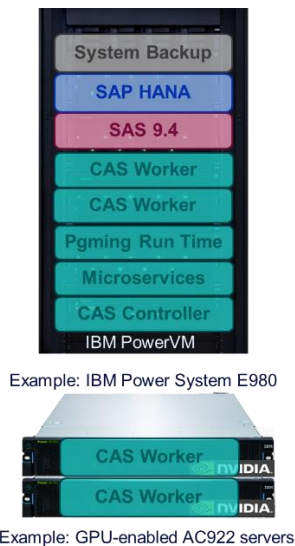
**Figure 10. Scale-up Single-Server deployment**

**MIXED ENVIRONMENTS**

In this last example (Figure 11) of a Massive Parallel Processing (MPP)-mode deployment, you are looking at a mixed environment. SAS Viya and its software are installed across a set of partitions on a scale-up server and one or more scale-out servers. In this case, the Cloud Analytic Services (CAS) Controller and management type services would run in partitions, and CAS workers nodes could run either on partitions (for non-GPU workloads) or on scale-out servers (for GPU workloads). Again, you can see the SAS Viya components in red and other non Viya software in the other colors.

In this environment you gain a combined set of the benefits for scaling, supporting parallel loading and processing of data, a growth path, scaling by using unused resources which

allow adding more partitions or resources to the partitions, or add more worker nodes, simplified networking between LPAR nodes, supporting GPU-enabled workloads as they are added, and performance with NVLink 2.0 technology.



**Figure 11. Mixed MPP deployment**

## CONCLUSION

IBM and SAS are uniquely architected to tackle the most complex SAS workloads, with reliable, flexible deployment options with IBM Power Systems and IBM storage to gain maximum efficiency and performance.

SAS and IBM are both fully focused helping our clients modernize their analytics environments as they begin to implement Machine Learning (ML)/Deep Learning (DL) and AI workloads across their company.

IBM Power Systems is engineered for SAS workloads because they require throughput and Power is the only system that can handle the amount of data that comes with a SAS workload. This has been, and continues to be, true regarding the SAS and AIX workloads and becomes even more impactful as we begin supporting the in-memory, ML/DL and AI capabilities of SAS Viya.

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