White Paper

IBM FlashSystem 9100: Accelerate Data for the Multi-cloud Era

The NVMe-based Flash Array Core of a Modern Multi-cloud Data Center

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Introduction

Data is the heart of modern business, often determining a firm's competitiveness in an increasingly digital economy. As a result, multiple industries are embarking on a massive effort known as digital transformation. According to ESG's recent research on IT spending intentions, 86% of IT decision makers agree with the statement, "If we do not embrace digital transformation, we will be a less competitive and/or effective organization."[1]

As businesses work to improve their competitiveness, their data volumes increase enough to strain IT operations. Sixty-eight percent of IT decision makers surveyed by ESG reported that their IT environments are either more complex or significantly more complex than they were just two years ago, with 41% of those decision makers citing higher data volumes as a cause.[2]

In addition, new digital initiatives such as analytics or the development of cutting-edge applications not only add to the data challenges, but also may siphon resources away from infrastructure management and support. In summary, IT is essential to business competitiveness, but as demands increase, IT resources can be spread thinner.

To keep pace, IT organizations require a modern enterprise storage infrastructure, one that scales to meet the increased data demands while reducing the cost and complexity of infrastructure management. In other words, maximizing data's value requires an enterprise storage infrastructure designed to do more than simply store and protect. A modern data-centric storage infrastructure must be:

- Accelerated: The storage infrastructure must be able to serve data with enough speed to accelerate existing applications and simultaneously handle the massive increase in data-access and performance demands.
- Multi-cloud: The data center is not the only infrastructure option. IT organizations need a flexible, agile data storage architecture that is not restrained by the traditional boundaries of an array and that can easily integrate resources across the data center and the public cloud.

IBM, a leader in data center and cloud infrastructure services, recently announced the FlashSystem 9100, an NVMe (non-volatile memory express)-based all-flash array with integrated infrastructure virtualization capabilities. It is a system that delivers the performance required by the most data-demanding workloads, that integrates public cloud services as part of a larger multi-cloud infrastructure, and that in general, breathes new life into an existing IT infrastructure.

Building a Modern Storage Infrastructure with Flash, NVMe, and Storage-class Memory

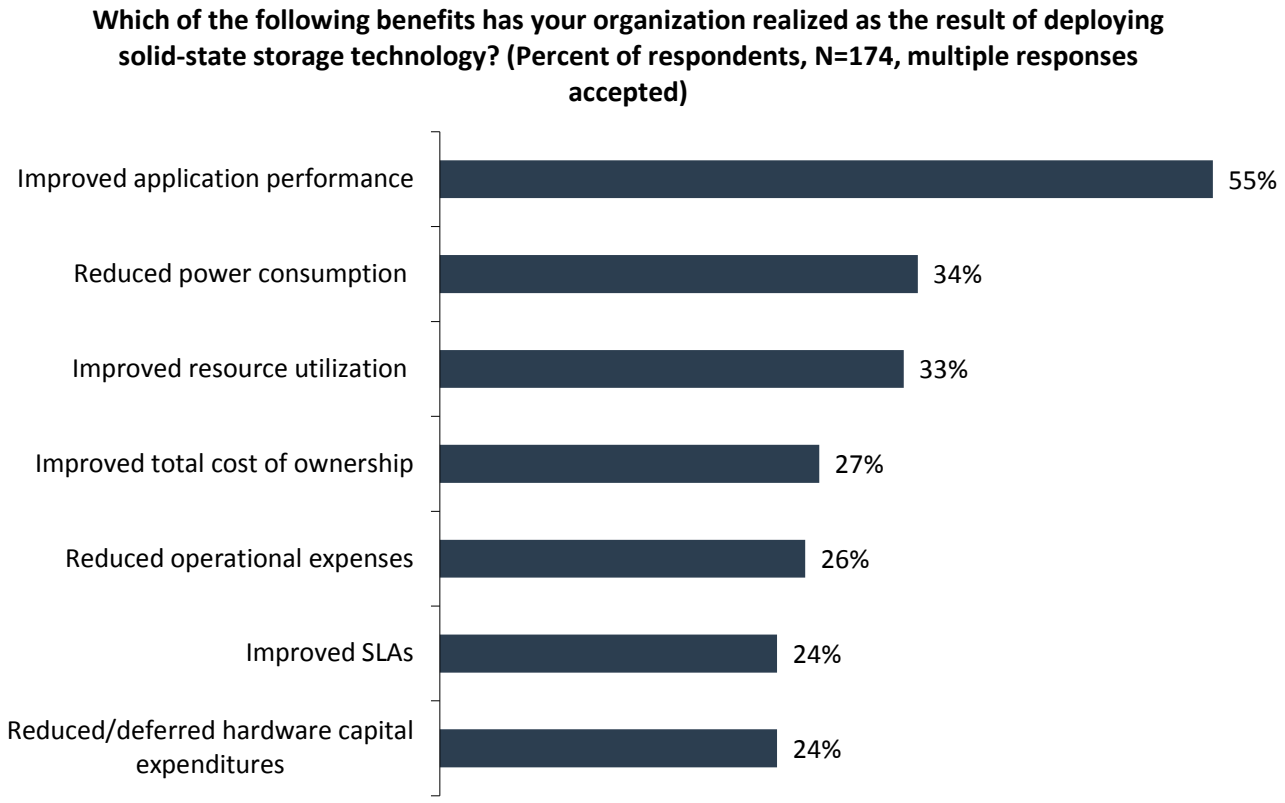
Flash storage has dramatically transformed data centers by significantly reducing data-access latencies. By transitioning away from mechanical spinning devices, organizations have seen a remarkable improvement in application performance. In an ESG survey on storage industry trends (see Figure 1), 55% of respondents identified improved application performance as one of the benefits that their organization has realized as a result of the use of flash storage, making it the most-cited response.[3]

This improvement to data-access latencies also generates a cascade effect by improving efficiencies and reducing costs throughout the data center. For example, in this same study, 27% of storage decision makers identified reduced total cost of ownership (TCO) as a benefit of flash storage, 26% identified benefits to reduced operational expenditures, and 24%

[1] Source: ESG Master Survey Results, *2018 IT Spending Intentions Survey*, December 2017.
[2] ibid.
[3] Source: ESG Master Survey Results, *2017 General Storage Trends Survey*, November 2017. All ESG research references and charts in this white paper have been taken from this master survey results set, unless otherwise noted.

identified reduced or deferred capital expenditures. In total, 57% of participants identified a positive cost benefit from deploying flash storage.

Figure 1. Benefits Realized from Deploying Solid-state (Flash) Storage



Source: Enterprise Strategy Group

For some, that result may be surprising, as flash storage has a perception of being costlier than disk. ESG's research reveals, however, that a significant portion of flash users are receiving a net cost benefit.

Now, the introduction of NVMe technology is poised to further extend the benefits of flash storage. NVMe is a standard for communicating with flash storage. Its introduction is meant to further reduce latencies and improve the performance of flash. More traditional storage interconnect standards such as Serial-attached SCSI (SAS) or Serial ATA (SATA) were designed for spinning hard drives. In contrast, NVMe was designed to connect to faster memory-based storage such as flash, as well as the emergent storage class memory (SCM) technologies projected to be on the horizon.

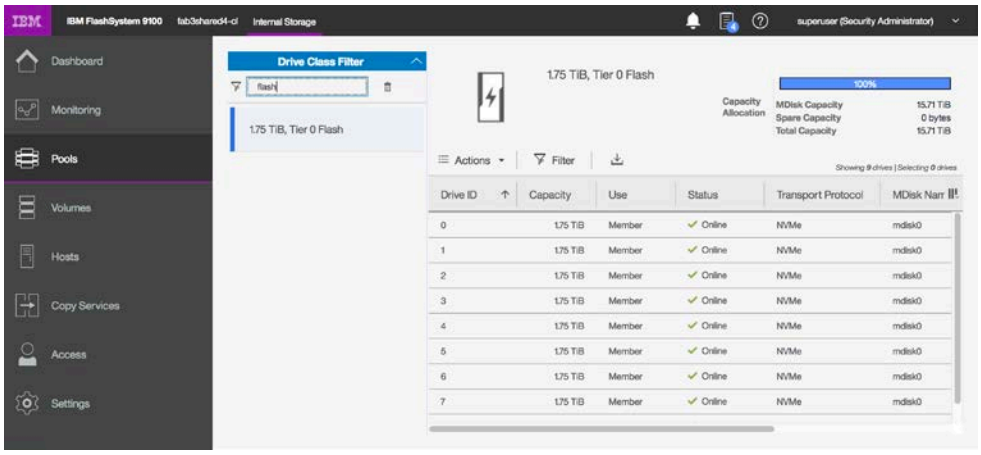
Despite NVMe-based storage technology being a relatively recent addition to the storage marketplace, storage decision makers are already bullish on the impact that it will have on the data center. In ESG's study on enterprise storage trends, 79% of storage decision makers familiar with NVMe technology expected NVMe-based flash storage to eventually replace traditional solid-state flash storage (i.e., SAS- or SATA-connected flash).

For IBM, however, NVMe is not new—this IT leader already has an established history with NVMe-based storage technology. IBM announced an NVMe strategy focused on optimizing the entire storage system stack more than a year ago. Shortly after that announcement, IBM exhibited FlashSystem 900 using NVMe over an InfiniBand fabric. For some IT vendors, NVMe is a future roadmap item. For IBM, it is already a reality, with real-world deployments.

IBM FlashSystem 9100

IBM is now extending its NVMe-based flash storage portfolio with the recently announced FlashSystem 9100. A single array is two rack units (2U) in height and features 24 dual-ported 2.5" NVMe flash bays. Two model options are available, FlashSystem 9110 and FlashSystem 9150. Both feature up to 1.5TB cache and up to six host adapters per control enclosure. The 9110 features four 8-core processors per control enclosure, while the 9150 offers four 14-core processors per controller. IBM has announced it will offer a non-disruptive upgrade capability between the two options.

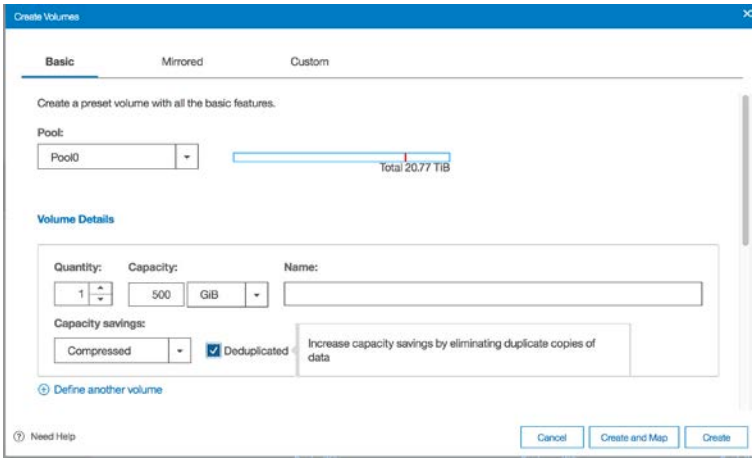
In addition to NVMe, IBM has integrated software-defined storage (SDS)-based infrastructure flexibility into the FlashSystem 9100 design by leveraging its IBM Spectrum Virtualize technology. As a result, the benefits of FlashSystem 9100 extend beyond the storage array to a larger data center ecosystem and even to a public cloud. Overall, the design is a marriage of NVMe data acceleration and SDS-based intelligent infrastructure flexibility.



NVMe drives on FlashSystem 9100

NVMe-based Data Acceleration

With NVMe, FlashSystem 9100 accelerates data access while future-proofing the system to be ready to harness future storage media options. IBM claims that the 9100 is storage class memory (SCM) enabled, with NVMe enabling that support. According to IBM, FlashSystem 9100 offers up to 2PB effective capacity and up to 2.5M IOPS in a single 2U array.



Configuring data reduction on FlashSystem 9100

The 9100 is also designed to leverage NVMe over Fabrics (NVMe-oF) and is expected to support end-to-end NVMe environments as the other components in the data path, such as storage fabric switches, adapters, multi-pathing, and support for NVMe-oF as well.

To further extend the benefits of NVMe-based flash, IBM offers optional IBM FlashCore modules for the FlashSystem 9100. IBM's FlashCore modules come in 4.8TB, 9.6TB, and 19.2TB raw capacity options with up to 5:1 compression and support FIPS 140 certification.

These IBM flash modules may offer some notable advantages over their more traditional counterparts. For example, IBM designed them with hardware compression and data encryption built in. According to IBM, the design makes the addition of those services performance-neutral to the system; in other words, there is a negligible impact to performance from running both compression and encryption. IBM also designed its flash modules with a specific error-

correcting code (ECC) algorithm to correct high bit-rate errors efficiently, and it designed the chip placement to provide endurance without creating a latency penalty.

IBM states that the result is a flash module that can simultaneously increase the effective capacity and reduce the cost of flash, while also integrating increasingly important encryption capabilities. IBM's FlashCore modules are an important part of how FlashSystem 9100 can, according to IBM, offer six times the data and three times the performance in the same rack footprint as its predecessor.

Intelligent and Flexible SDS-based Design

With IBM Spectrum Virtualize as part of the FlashSystem 9100 architecture, IBM also integrates the infrastructure flexibility IT organizations expect from SDS-based storage solutions. In an ESG research study focused on SDS industry trends, storage decision makers that had deployed or were interested in SDS technologies indicated a desire for hardware flexibility. For example, one-third (33%) of participants were driven to SDS technologies to achieve greater agility to adjust hardware to evolving requirements, and nearly one-third (30%) were driven to SDS to support multiple hardware generations to eliminate data migrations.[4]

There is an intelligent and cloud-like quality to the functionality expected from SDS, where the storage software offers abstraction from the underlying hardware, making it simpler to move workloads and stay up to date with the latest hardware technology.

Infrastructure Virtualization

With Spectrum Virtualize, FlashSystem 9100 offers a variety of benefits often associated with SDS and multi-cloud environments, such as:

- A single management point for a heterogenous storage environment: Spectrum Virtualize, and by extension the FlashSystem 9100, offers a single user interface to manage multiple storage systems regardless of vendor. Currently, IBM Spectrum Virtualize supports more than 440 external storage system models, enabling cloud-like manageability for existing infrastructure assets, whether they were procured from IBM or not.

- Extension of the useful life of existing investments: Spectrum Virtualize can also apply enterprise storage functionality across existing heterogenous infrastructure, prolonging the life and extending the value of existing investments. Enterprise functionality that the FlashSystem 9100 can extend includes compression, deduplication, replication, tiering, high availability, migration, and encryption.

- Transparent data movement. With Spectrum Virtualize, the FlashSystem 9100 can move data transparently between different storage systems. This capability can dramatically simplify IT operations by enabling workloads to easily and freely move across different infrastructure components. In addition, IT organizations can retire existing heterogeneous assets on their preferred timetable, thereby reducing the cost, complexity, and risk associated with data migrations.

- Multi-cloud and hybrid cloud infrastructure: With the inclusion of cloud-enabling IBM Spectrum Software, FlashSystem 9100 is ready for deployment in popular hybrid cloud use cases including data reuse, modern data protection, business continuity, as well as private cloud deployments. Specifically, each FlashSystem 9100 includes 5TB each of IBM Spectrum Protect Plus, IBM Spectrum Copy Data Management, and IBM Spectrum Virtualize for Public Cloud. With IBM Spectrum Virtualize for Public Cloud, FlashSystem 9100 can extend its infrastructure virtualization and data movement capabilities to public cloud infrastructure services, making it easier to leverage the

[4] Source: ESG Research Report, *Software-defined Storage (SDS) Market Trends*, February 2017.

cloud to augment IT capabilities such as disaster recovery. Also included is IBM's Spectrum Connect, which drives persistent storage for container environments, such as Docker and Kubernetes configurations.

Intelligent Insights

In addition to Spectrum Virtualize, FlashSystem 9100 works with IBM Storage Insights, an AI-based predictive analytics, storage resource management, and support platform delivered over the cloud. With Storage Insights, IT organizations receive IT infrastructure support and management benefits such as:

IBM Storage Insights

- Artificial intelligence (AI)-based telemetry information, storage metrics, and insight into storage system health.
- Automatic insight based on IBM's knowledge base of best practices, call-home alerts, known issues, and support feedback to ease the support process while expediting resolution.
- Analytics to identify configurations outside of IBM best practices and potential impending issues.
- Proactive notifications of system status and potential issues, helping to reduce the risk of unforeseen complications impacting production workloads.

By consolidating these insights into a single cloud-based management console, administrators can view and plan workload and capacity needs across their storage infrastructure, helping to better tailor the infrastructure to their specific application demands. The result is a more efficient and less costly infrastructure designed to avoid unplanned expenses.

Pay-per-use with IBM Storage Utility

IBM Storage Insights also plays a key role enabling IBM's Storage Utility offering, a pay-per-use program for the FlashSystem 9100. Leveraging AI-based predictability and forward planning, FlashSystem owners can pay for their storage infrastructure monthly based on actual usage, rather than an estimated or projected amount. A measure of available capacity remains on-premises, ready to expedite capacity deployments when demands scale, but owners only pay for what they use. IBM also offers the ability to increase and decrease spend as capacity changes, allowing IT organizations to reduce costs when demands decrease.

Foundation for a Modern Multi-cloud Architecture

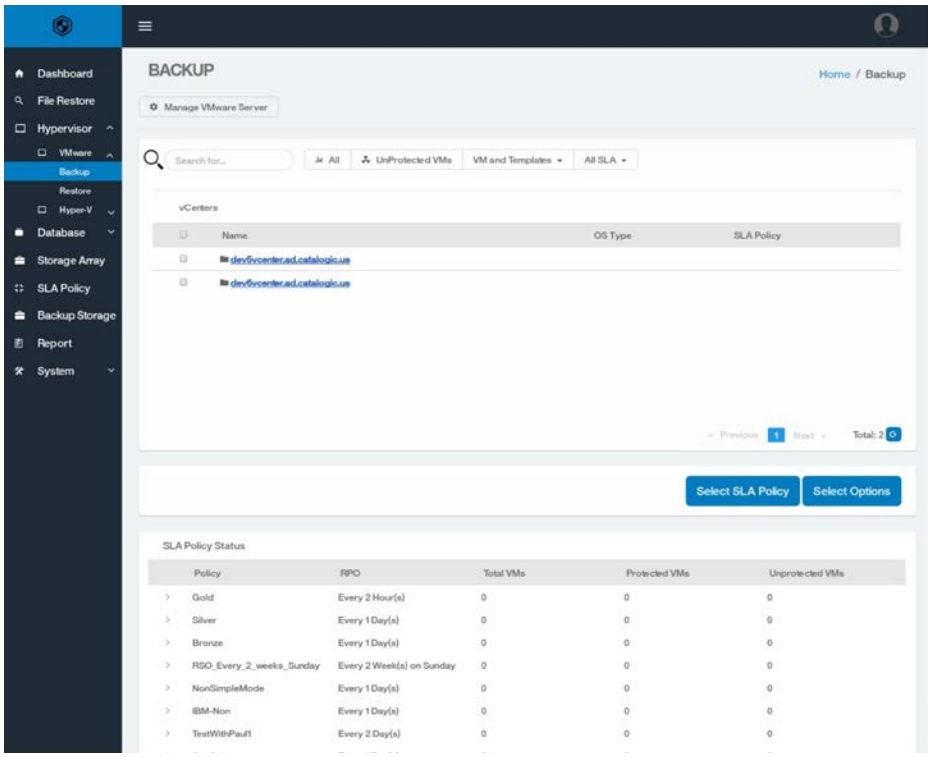
By combining NVMe-based acceleration and SDS-level flexibility, FlashSystem 9100 aspires to be more than a performant storage silo. IBM foresees FlashSystem 9100 as a foundation for a multi-cloud architecture. As such, IBM has developed three fit-for-purpose multi-cloud software options that leverage a set of Blueprint guides to help its customers design and deploy end-to-end IT solutions around the FlashSystem.

IBM Blueprints are solution design guides that provide detailed instructions and best practices on how to architect and deploy a multi-component IT solution. These guides help reduce the complexity of modern IT infrastructure, while still allowing administrators enough flexibility to adjust the design to their specific IT environments. As a result, IT administrators can better modernize their infrastructures and transform their IT capabilities to enable their businesses to better compete in a digital economy. For FlashSystem 9100, IBM has developed several Blueprint solutions, three of which are discussed below.

IBM FlashSystem 9100 Solution for Data Reuse, Protection, and Efficiency

This FlashSystem 9100 multi-cloud solution offering is orderable as a licensed software package with the FlashSystem 9100 array. The solution is sold by either 1TB or 10TB increments, where every 1TB of capacity protects up to 10 Virtual Machines. The software contained in this offering includes both IBM Spectrum Protect Plus and IBM Spectrum Copy Data Management. Accompanying this offering is a Blueprint that shows clients how to leverage IBM data protection and snapshots with IBM Spectrum Protect Plus and IBM Spectrum Copy Data Management. The guide describes how to deploy IBM's software to replicate data copies to a target device either on-premises or in the public cloud (IBM Public Cloud). That data can then be used as a backup. The guide also walks users through best practices for leveraging that backup data, or snapshots of that data, to support initiatives such as DevOps, analytics, or disaster recovery. Specifically, the Blueprint simplifies a number of critical steps by showing IT administrators how to:

1. Operate IBM Spectrum Protect Plus for both VM and physical environments with the FlashSystem 9100.
2. Use IBM Spectrum Copy Data Management to create and manage snapshots.
3. Implement offsite data protection with IBM Public Cloud.



IBM Spectrum Protect Plus

The resulting solution offers several business benefits, including the abilities to:

- Efficiently leverage data copies/snapshots in the cloud or on-premises.
- Maximize the value of data by better enabling business initiatives such as DevOps and analytics.
- Reduce the cost, time, and complexity of configuring offsite backup and/or disaster recovery, freeing up cycles of IT personnel.
- Reduce the configuration risk associated with deploying a hybrid cloud architecture.

IBM FlashSystem 9100 Solution for Business Continuity and Data Reuse

This FlashSystem 9100 multi-cloud solution offering is also orderable as a licensed software package with the FlashSystem 9100 array. Similarly, this solution is also sold by either 1TB or 10TB increments, where the capacity can be used for an instance of Spectrum Virtualize to manage capacity on the public cloud, and for Copy Data Management to create snapshots or orchestration of copies. The software contained in this offering includes both IBM Spectrum Virtualize for Public Cloud and IBM Spectrum Copy Data Management. Accompanying this offering is another FlashSystem 9100 Blueprint that offers detailed instructions on deploying a business continuity solution to enable failover to a recovery site in the event of a site failure. The process leverages IBM Spectrum Virtualize for Public Cloud and Spectrum Copy Data Management. This Blueprint simplifies a number of important steps by showing IT administrators how to:

1. Configure Spectrum Virtualize for Public Cloud on IBM Cloud IaaS.
2. Set up secure networking between the data center and the public cloud.
3. Set up IP-based remote copy processes with IBM's Global Mirror and Change Volumes technology.
4. Set up VMware SRM for business continuity.
5. Recover a primary site after a failover has been completed.
6. Leverage IBM Spectrum Copy Data Management on the disaster recovery site in the cloud for additional business initiatives such as DevOps or analytics-based workloads.

The resulting solution offers several business benefits, including the abilities to:

- Take the guesswork and the subsequent risk out of setting up secure networking between the data center and the cloud.
- Reduce the complexity, the time, and the cost associated with deploying a disaster recovery solution and migrating workloads to the cloud.
- Protect production workload performance from the constraints of replication bandwidth when maintaining an offsite disaster recovery solution.
- Leverage cloud disaster recovery copies for other business initiatives such as DevOps or analytics-based workloads.
- Recover applications with near-zero RTO/RPO, according to IBM.

IBM FlashSystem 9100 Solution for Private Cloud Flexibility and Data Protection

For cloud-like IT efficiency and flexibility benefits on-premises, IBM offers this licensed software package that enhances the IBM Cloud Private solution with data protection and data reuse. There is a Blueprint guide called Spectrum Access that describes how to build a private cloud environment around the FlashSystem 9100. This process leverages IBM Spectrum Connect, IBM Spectrum Copy Data Management, and IBM Cloud Private to help IT organizations modernize their data centers to better facilitate traditional applications while also enabling the deployment of containerized cloud-native workloads. The Blueprint shows IT administrators how to:

1. Configure IBM Spectrum Connect for automation and orchestration of FlashSystem 9100 in containerized (such as with Docker), VMware, and Microsoft PowerShell environments.
2. Configure IBM Spectrum Access for IBM Cloud Private for policy-based automation across compute, storage, and network resources for traditional application, virtualized, or container environments.
3. Configure volume-level data protection with IBM Copy Data Management for backup and restore of data leveraged by IBM Cloud Private.
4. Create and then restore backups with IBM Spectrum Copy Data Management.
5. Reuse backup and other data copies on-premises for DevOps, reporting with virtualized and Linux on bare metal.

The resulting solution offers several key business benefits, including the abilities to:

- Simplify storage infrastructure deployment with a pretested and pre-validated IBM Cloud Private and FlashSystem 9100 solution.
- Reduce the cost and complexity of infrastructure management by automating storage provisioning, monitoring, and data protection.
- Automate infrastructure to support mixed traditional workload and containerized cloud-native workload environments.
- Reuse data copies and backup for DevOps, analytics, and backups within virtualized environments and Linux on bare metal.

The IT complexity that stems from data growth is typically not isolated to one device, one software application, or one system. Complexity emerges when combining multiple disparate systems together to solve a business need. An end-to-end data center environment requires multiple technologies, often from different vendors, to work in concert. These FlashSystem 9100 multi-cloud solution offerings with accompanying Blueprint guides from IBM address the complexity by offering IT leaders insight into complex solutions across multiple systems (such as securing data movement to public cloud infrastructure), thus reducing the workload burden placed upon valuable IT personnel. Simplification also reduces risk. Misconfigurations can open security concerns or cause delays in infrastructure deployment, impacting product workloads. Simple one-stop-shop ordering, fulfillment, and support, accompanied by IBM Blueprints, addresses the real needs of managing a modern, multifaceted IT ecosystem.

The Bigger Truth

With FlashSystem 9100, IBM could have easily just added NVMe capabilities, released the new product, and considered it a success. The potential for cost-effective data acceleration, especially with IBM FlashCore modules, helps address a critical IT need by multiple industries for faster data access and increased performance. IBM did not stop there, however. The integration of Spectrum Virtualize and Storage Insight adds cloud-like infrastructure flexibility, management, and an optional pay-per-use monthly payment plan.

IBM even extends the value of FlashSystem 9100 by including it in IBM's Peace of Mind Data Initiative. This guarantee program offers a variety of additional benefits for FlashSystem 9100 users, reducing the risk of managing enterprise storage infrastructure. For example, IBM offers both a data reduction guarantee, up to a 5:1 after a data analysis and when following best practices, a 100% data availability guarantee, a controller upgrade program, and seven years of system

support. IBM FlashCore modules are also covered for read/write endurance while the system is under warranty or maintenance. When you deploy a new FlashSystem 9100, IBM offers 45 days to migrate the data at no extra charge.

Modern IT organizations face a variety of demands, all seemingly increasing and coming at them from different angles. Data is generated faster and accessed more frequently than before. Not only are traditional workloads demanding more resources, but newer containerized cloud-native workloads are demanding data resources as well. Adding further strain to infrastructure and personnel resources, new initiatives, such as DevOps and analytics, further increase data access demands, while often consuming budget. NVMe is a powerful step forward in improving application performance, but performance alone is often not enough. Modern IT leaders need solutions, like the FlashSystem 9100, that can address the cost and complexities of managing a larger multi-cloud ecosystem, while delivering peace of mind that your storage infrastructure is prepared to serve your business's demands well into the future.