

## High-performance innovation

Cross-portfolio enhancements and new solutions show that innovation continues at a rapid pace for IBM flash storage

IBM flash storage has a pedigree that stretches back to the 1970s and includes some of the first solid-state storage arrays.<sup>1</sup> Four decades later, IBM flash storage is being recognized as the most innovative in the marketplace.<sup>2</sup> The cadence of flash-related innovation at IBM hasn't slowed over the years.

---

### Highlights

- Brings NVMe performance to cost-efficient enterprise workloads
  - Further extends NVMe and NVMe-F capabilities across IBM Storage lines
  - Improves data economics with larger capacity flash drives
  - Improves the performance and efficiency of IBM FlashSystem 900
  - Accelerates the speed of IBM Storage solutions for mainframes
- 

Recently, IBM has announced significant enhancements, upgrades and new solutions across its entire flash portfolio, including the ongoing expansion of Non-Volatile Memory Express (NVMe) and NVMe over Fabrics (NVMe-F) technologies and capabilities, higher-capacity drives, ultra-fast links to mainframes, and a range of advances within the company's flagship IBM FlashCore technology. IBM flash storage is faster, more efficient, and more multicloud capable than ever before.

## Powerful new NVMe solution

Perhaps the biggest advance to come from IBM flash innovation recently is the introduction of an entirely new member of the IBM Storwize family. The new IBM Storwize V7000 is targeted at the cost-efficient enterprise and edge workload markets. It is designed to deliver flexible, cost-effective scaling and performance. The systems are NVMe-optimized, with support for NVMe-F for the highest end-to-end storage performance.

Storwize V7000 systems leverage the advantages of IBM FlashCore-enhanced 3D triple-layer cell (TLC) storage media that provides greater flash density and storage capacity than multi-level cell (MLC) solutions. Along with the move to 3D TLC flash, purpose-engineered IBM FlashCore modules (FCMs) utilize powerful inline, hardware-accelerated data compression technology that provides consistent, high-performance data compression across the full range of workloads. The IBM FCMs are designed to support Federal Information Processing Standard (FIPS) 140-2 Level 1 encryption<sup>3</sup> with IBM Security Key Lifecycle Manager centralized key management and full hot-swap capabilities.

You can choose IBM FCMs in multiple capacities, or you can opt for industry-standard NVMe-enabled flash drives, with the capability to support both drive types simultaneously within the array. This means that using the always-on inline high-performance data compression in the IBM FCMs or data reduction pool (DRP) technology with the industry-standard drives, effective capacities can range up to two petabytes in a single two-rack-unit (2U) enclosure, with the ability to cluster, scale out or scale up capacity and performance to many petabytes and millions of input/output operations per second (IOPS).

Storwize V7000 can lower both capital and operating expenditures (CapEx and OpEx) by extending its rich set of data services across existing heterogeneous external storage or by adding SAS disk expansion enclosures, thanks to the extensive artificial intelligence (AI)-based storage resource management, predictive analytics, automated support, and data placement provided by IBM Spectrum Virtualize. Once under IBM Spectrum Virtualize management, data in external storage systems becomes part of the Storwize solution and can be managed in the same way as data hosted on internal drives. External systems inherit all the IBM Spectrum Virtualize functional richness and ease-of-use features incorporated into the Storwize V7000 platform, including advanced replication, high-performance thin provisioning, encryption, compression, deduplication and IBM Easy Tier functionality, to improve administrator productivity and boost storage utilization while also enhancing and extending the value of existing storage investments.

DRPs within the Storwize V7000 solution help transform the economics of data storage. When applied to new or existing storage, they can significantly increase usable capacity while maintaining consistent application performance. This can help eliminate or drastically reduce costs for storage acquisition, rack space, power, and cooling, and can extend the useful life of existing storage assets. DRP capabilities include:

- Block deduplication that works across all the storage in a DRP to minimize the number of identical blocks
- Compression technology that provides consistent performance across application workload patterns
- SCSI UNMAP support that de-allocates physical storage when operating systems delete logical storage constructs such as files in a file system

IBM Spectrum Virtualize in Storwize V7000 enables the use of cloud storage for disaster recovery, dramatically speeds deployment of hybrid cloud configurations and helps slash storage costs. The new Storwize V7000 system comes in a standard all-flash configuration, then offers multiple options to extend and expand capacity and performance with flash or disk drives.

The new generation of Storwize V7000 provides the foundation for implementing a cost-efficient storage infrastructure that also delivers extraordinary functionality and performance.

## Cross-portfolio NVMe

Along with introducing a new member of the Storwize family, IBM has continued its rapid implementation of NVMe across the storage portfolio. This extremely fast protocol helps AI and real-time applications more fully exploit the microsecond latency provided by all-flash arrays by reducing input/output (I/O) overhead between CPUs and storage, resulting in performance improvements compared to previous interfaces such as SCSI that were originally developed for use with far-slower hard disk drives.<sup>3</sup> Only a little more than a year ago, IBM announced<sup>4</sup> an NVMe strategy based on optimizing the entire storage system stack. Since then, IBM Storage has maintained a brisk pace of NVMe and NVMe-F implementation.

The innovation has included optimizing flash storage systems so that NVMe commands are transferred end-to-end without requiring translations in order to most effectively support the growing list of application workloads demanding ultra-low latencies. Users can configure new NVMe hosts and map volumes to these hosts using NVMe, or migrate existing workloads by reconfiguring hosts so that existing volumes are now accessed using NVMe. And the same IBM systems can simultaneously support both NVMe and SCSI, making data migrations simpler.

IBM has already incorporated NVMe technologies throughout the IBM FlashSystem platform, and now Storwize V7000 is NVMe enabled. With a simple nondisruptive software upgrade, NVMe-F for Fibre Channel can be added to systems that utilize IBM Spectrum Virtualize as foundational technology, such as IBM FlashSystem 9100 and IBM FlashSystem V9000, IBM Storwize V7000F, and IBM SAN Volume Controller (SVC). The new NVMe over Fibre Channel (NVMe-FC) functionality uses existing 16 Gb Fibre Channel adapters.

Today, InfiniBand is the preferred interconnect for leading AI and deep learning systems.<sup>5</sup> IBM was one of the founding members of the InfiniBand Trade Association (IBTA)<sup>6</sup> and IBM storage solutions such as IBM FlashSystem 900 all-flash arrays have offered InfiniBand interfaces for years.<sup>7</sup> For enterprises that want ultra-low storage network latency for application workloads and business use cases as varied as high-performance computing, supercomputing, intensive rendering, oil and gas exploration, genome sequencing and now AI, NVMe over an InfiniBand storage network fabric (NVMe-IB) makes an ideal choice. Recognizing this potential, last December at the AI Summit New York, IBM performed a technology preview and demonstration with the integration of IBM POWER9 Systems and IBM FlashSystem 900 using NVMe-IB. The demonstration confirmed that IBM FlashSystem arrays always have been NVMe-IB ready.

And the NVMe implementation continues. IBM has announced plans to enhance IBM Cloud Object Storage to support NVMe flash drives in software-defined configurations. Also, IBM is moving forward with incorporation of iSER, a network protocol that extends the iSCSI protocol to use Remote Direct Memory Access (RDMA), essentially the same type of technology as NVMe. Thanks to its RDMA foundation and its ability to reduce SCSI overhead, iSER can achieve ultra-low latencies across standard Ethernet—a great benefit for all the enterprises around the planet with substantial Ethernet investments.

## Higher-capacity flash

Though performance is crucial to data-driven enterprises these days, IBM engineering and innovation have been focused on more than speed; increasing storage capacity and efficiency have also been important objectives. To this end, IBM recently introduced a new 15.36 TB flash card that can almost double the storage density and raw capacity of IBM FlashSystem, Storwize and IBM DS8880 arrays. Larger storage capacities, such as those enabled by the new flash card, can offer multiple benefits. Not only do they enable more data to be stored in the same physical space—for example, IBM DS8888F systems can now reach nearly eight petabytes of effective capacity in a single array—they also allow the consolidation of multiple workloads, including big data analytics, technical computing, media streaming, Blockchain and machine learning. Thanks to the arrays that will leverage the new flash card, these benefits hold true for IBM Z, IBM LinuxONE, IBM Power Systems and distributed systems. And with AI-enhanced IBM Easy Tier functionality, data can be automatically moved between high-density and high-performance flash storage to maximize cost-efficiency or other policy-driven business and IT goals.

## Improvements at the core

IBM FlashSystem 900 is the foundation of the IBM FlashSystem family of all-flash storage arrays. IBM FlashCore technology lies at the heart of all IBM FlashSystem arrays. The term refers to the IBM innovations that enable IBM FlashSystem storage to deliver extreme performance, ultra-low latency, enterprise-grade reliability, and a wide range of operational and cost efficiencies. These technologies and innovations are realized in the IBM FlashSystem hardware-accelerated architecture, the new small form-factor (SFF) IBM FCMs, and many other advanced flash management features and capabilities. IBM FlashCore technology truly defines IBM FlashSystem and differentiates it from competing all-flash systems. To maintain IBM FlashSystem 900 as one of the most powerful and efficient storage arrays available, IBM innovation has simply continued along the existing engineering trajectory. While competitors are fixing bugs in the first generations of their solutions, IBM engineers are adding cutting-edge features to a mature flash storage platform with years of successful deployments in the most mission-critical environments.

Increased capacity is one area of constant improvement for IBM FlashSystem 900, but in typical fashion, the most recent upgrades take an innovative approach—increasing the DRAM in the high-capacity module, which has the effect of dramatically raising its effective capacity to nearly 44 TB, depending on the compressibility of the stored data. The latest model has also been part of the IBM portfolio-wide NVMe implementation; it now offers a high-speed 16 Gb Fibre Channel NVMe SAN interface. The systems sport an updated user interface as well, plus faster rebuilds and improved capacity reporting, among a number of other improvements.

It's important to note that the IBM FlashSystem 900 engineering paradigm is to remove software from the data path to optimize performance and efficiency. But this doesn't mean that the systems compromise on functionality or capabilities. For example, both data compression and encryption are hardware-based and accomplished in line—with, remarkably, no performance penalties. In fact, depending on the workload, performance may actually increase, with latency falling to as low as 85 microseconds.

## More performance for mainframes

The IBM DS8880 family of data systems and their predecessors have been deployed to support business-critical environments for nearly two decades.<sup>8</sup> For years, DS8880 has been the number one family of storage systems supporting mainframe-based IT infrastructure.<sup>9</sup> DS8880 storage systems bring an enviable history of reliability and performance, but the systems would not have maintained a leadership position in a rapidly evolving IT marketplace without considerable ongoing evolution and innovation.

DS8880 family members, including the IBM DS8882F, IBM DS8884F, IBM DS8886F and analytics-grade IBM DS8888F models, all can leverage the increased density and cost-efficiency of the new 18 TB flash cards. Additionally, IBM has also upgraded its IBM zHyperLink technology, which can make DS8880 mainframe storage solutions even faster and more productive. zHyperLink is a short-distance mainframe attach link to IBM DS8880 data systems designed for up to 10 times lower latency than IBM High Performance FICON. It's the first new mainframe (I/O) channel link technology since IBM FICON.<sup>10</sup> The original zHyperLink implementation provided ultra-low latencies for reads, and now IBM has extended the benefits to writes as well. Low I/O latencies deliver value through improved mainframe workload elapsed times, faster transactional responses and lower scaling costs. The DS8880 implementation of zHyperLink delivers service times fast enough to enable a synchronous I/O model in high-performance IBM Z servers. zHyperLink accelerated writes dramatically speed IBM Db2 for IBM z/OS transaction processing and improve active log throughput. The zHyperLink write capability supports IBM Metro Mirror replication and IBM HyperSwap as well.

## Relentless innovation

The wide-ranging enhancements and new solutions recently introduced confirm that innovation within the IBM flash storage portfolio continues at a relentless pace. IBM has recently launched an entirely new Storwize V7000 platform that brings NVMe performance and IBM Spectrum Virtualize multicloud capabilities to cost-efficient enterprise and edge workloads. IBM has continued to expand NVMe and NVMe-F functionality across the storage portfolio. IBM FlashCore technology at the heart of IBM FlashSystem 900 has grown even more powerful and efficient over time. And now, IBM mainframe storage solutions are faster than ever.

At this rate of IBM flash storage innovation, the biggest question for the marketplace may be how competitors can keep up.

1 “RamSan flash cram: IBM snaps up Texas Memory Systems,” *The Register*, August 16, 2012. [https://www.theregister.co.uk/2012/08/16/ibm\\_buys\\_tms/](https://www.theregister.co.uk/2012/08/16/ibm_buys_tms/)

2 “Flash Memory Summit Award: Most Innovative Flash Memory Technology — IBM FlashSystem 9100,” *IBM IT Infrastructure Blog*, August 2018. <https://www.ibm.com/blogs/systems/flash-memory-summit-award-innovative-flash-memory-technology/>

3 “NVMe over Fibre Channel for Dummies” (Brocade special edition), *Wiley Brand*, 2017.

4 “IBM Supports New Faster Protocols for Flash Storage” *IBM Press Release*, May 7, 2017. <https://www-03.ibm.com/press/us/en/pressrelease/52280.wss>

5 “InfiniBand Leads the TOP500 List, is Preferred Fabric of Leading AI and Deep Learning Systems,” *InfiniBand Trade Association*, December, 2017. <http://blog.infinibandta.org/2017/12/07/infiniband-leads-the-top500-list-is-preferred-fabric-of-leading-ai-and-deep-learning-systems/>

6 “About the IBTA,” *InfiniBand Trade Association*. [http://www.infinibandta.org/content/pages.php?pg=about\\_us\\_overview](http://www.infinibandta.org/content/pages.php?pg=about_us_overview)

7 “IBM Technology Preview with NVMe-over-Fabrics,” *IBM developerWorks*, December 2017. <https://developer.ibm.com/storage/2017/12/07/ibm-technology-preview-nvme-fabrics/>

8 “Power You Can Count On—Some History,” *IBM Systems Magazine*, April 2010. [http://ibmsystemsmag.com/power/infrastructure/storage/system\\_storage\\_ds8700/some-history/](http://ibmsystemsmag.com/power/infrastructure/storage/system_storage_ds8700/some-history/)

9 Calculations based on data from IDC WW Quarterly Enterprise Storage Systems Tracker file, March 2017

10 “IBM DS8880 zHyperLinks gives low latency access to storage,” *IBM developerWorks*, April 2017. <https://developer.ibm.com/storage/2017/04/15/ibm-ds8880-zhyperlinks-gives-low-latency-access-storage/>

## Why IBM?

Storage solutions from IBM leverage market-leading innovation and multicloud capabilities to help data-driven enterprises gain greater value from data assets and maintain competitive advantage. No matter the workload—from traditional databases and transactional processing, to next-generation mobile, social, real-time analytics and AI applications—IBM Storage offers the features and functionality needed to help lower costs, improve data security and accelerate business performance.

## For more information

To learn more about IBM Storwize V7000 and other all-flash storage innovations from IBM, please contact your IBM representative or IBM Business Partner, or visit: [ibm.com/it-infrastructure/storage/flash](https://www.ibm.com/it-infrastructure/storage/flash)

Additionally, IBM Global Financing provides numerous payment options to help you acquire the technology you need to grow your business. We provide full lifecycle management of IT products and services, from acquisition to disposition. For more information, visit: [ibm.com/financing](https://www.ibm.com/financing)



---

© Copyright IBM Corporation 2018.

IBM, the IBM logo, and [ibm.com](https://www.ibm.com) are trademarks of International Business Machines Corp., registered in many jurisdictions worldwide. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the Web at <https://www.ibm.com/legal/us/en/copytrade.shtml>, and select third party trademarks that might be referenced in this document is available at [https://www.ibm.com/legal/us/en/copytrade.shtml#section\\_4](https://www.ibm.com/legal/us/en/copytrade.shtml#section_4).

This document contains information pertaining to the following IBM products which are registered trademarks of IBM Corporation:  
IBM® FlashCore®, IBM FlashSystem®, IBM LinuxONE™, IBM Power Systems™, IBM Spectrum Virtualize™, IBM Z®, Db2®, Easy Tier®, FICON®, HyperSwap®, Power9™, Storwize®, z/OS®

All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

---