

IBM Storage DS8900F Product Guide Release 9.3.2

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Storage

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This IBM® Redbooks Product Guide provides an overview of the features and functions that are available with the IBM Storage DS8900F models that run microcode Release 9.3.2 (Bundle 89.32 / Licensed Machine Code 7.9.32).

IBM Storage Rebranding: IBM has recently rebranded its Storage Portfolio. For more details see [Evolving the IBM Storage Portfolio Brand Identity and Strategy](#). With this new rebranding, “Storage” branding is added to all IBM DS8000 family of products (for example IBM DS8900F has become IBM Storage DS8900F). In this document IBM Storage DS8900F will be referred to as IBM DS8900F or simply DS8900F.

As of February 2023, the DS8900F with IBM DS8000 Release 9.3.2 is the latest addition to the DS8000 family. The DS8900F is an all-flash system exclusively, and it offers three classes:

- ▶ **DS8980F: Analytic Class**
The DS8980F Analytic Class offers best performance for organizations that want to expand their workload possibilities to artificial intelligence (AI), Business Intelligence, and Machine Learning.
- ▶ **DS8950F: Agility Class**
The agility class is efficiently designed to consolidate all your mission-critical workloads for IBM zSystems, IBM LinuxONE, IBM Power Systems, and distributed environments under a single all-flash storage solution.
- ▶ **DS8910F: Flexibility Class**
The flexibility class delivers significant performance for midrange organizations that are looking to meet storage challenges with advanced functionality delivered as a single rack solution.

Figure 1 shows the front view of the DS8910F (model 994), DS8950F (model 996), and DS8980F (model 998) base frame. The height of the systems is 40U. The figure shows the standard doors (Feature Code 1105, left side). As an alternative, SpaceSaver doors (Feature Code 1106) are available (right side).



Figure 1 IBM DS8900F base frame

The DS8900F systems fit into a 19-inch wide rack.

The IBM DS8900F architecture relies on powerful IBM POWER9 processor-based servers that manage the cache to streamline disk input/output (I/O), maximizing performance and throughput. These capabilities are further enhanced by using Generation-2 High-Performance Flash Enclosures (HPFEs).

All DS8000 models excel at supporting IBM zSystems and IBM Power System server environments. Both platforms offer many synergy features that are tailored for the DS8000.

Figure 2 shows a schematic diagram of the DS8910F rack-mounted model 993 when it is installed in an IBM z15 model T02 or IBM LinuxONE III model LT2. The 16U reserved space (Feature Code 0151) is available for integration of the IBM DS8910F Storage Model 993 only. Use of this space for any other purpose is not permitted.

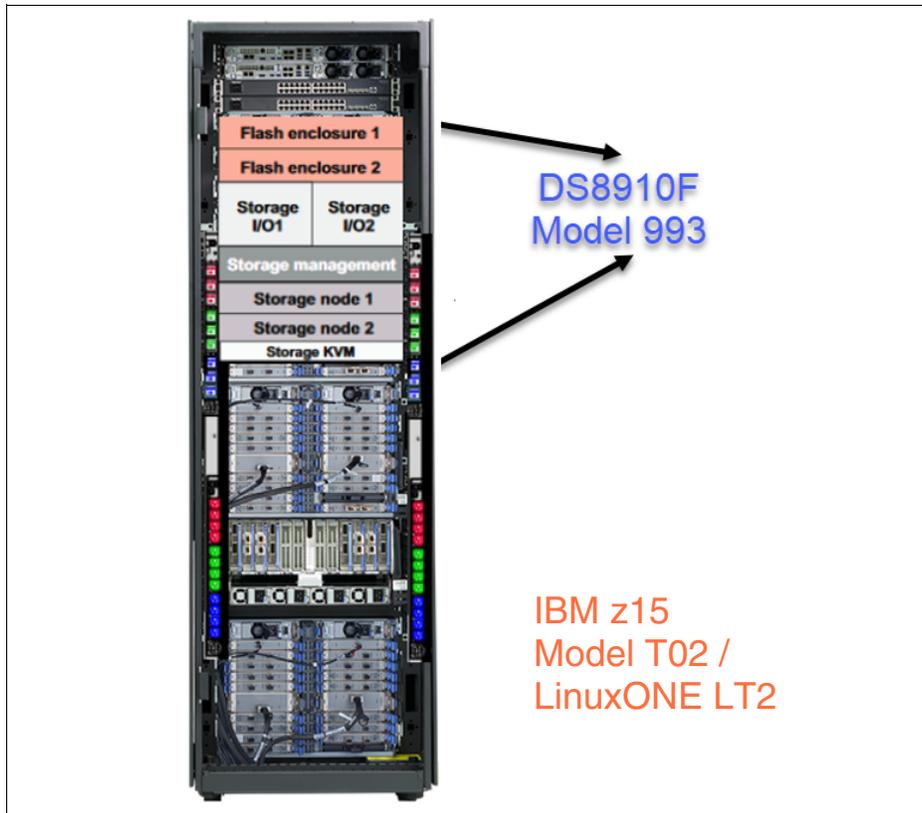


Figure 2 Installing the DS8910F Model 993 in an IBM z15

Did you know

The IBM DS8900F family includes the following features:

- ▶ With three different tiers of flash drives (performance-optimized and capacity-optimized), the DS8900F offers a wide range of flash choices for designing a configuration that is balanced in cost, capacity, and performance.
- ▶ The DS8900F height is 40U for all full-rack models.
- ▶ All DS8900F models offer three-phase and single-phase power support.
- ▶ POWER9 processor-based systems feature 8 billion transistors per core. This number almost doubles the 4.2 billion transistors per core available on the former DS8880 models (IBM POWER8® processor-based systems).
- ▶ The DS8910F model 993 is a modular rack-mountable enterprise all-flash storage system. The DS8910F model 993 can be integrated into the 16U contiguous space of an IBM z15 model T02, IBM z14 model ZR1, the LinuxONE models LT2 or LR1, or into any other conforming 19-inch wide rack.
- ▶ Transparent Cloud Tiering (TCT) enables a DS8900F to migrate and recall data in cloud storage. This function helps to reduce MIPS usage for IBM zSystems clients during migration and recall. TCT allows direct data offload to the IBM TS7700. It also features cloud service offerings, such as IBM Cloud® Object Storage and Amazon Web Services (AWS). Up to eight cloud targets can be defined.

TCT also enables the use of on-premises or public cloud storage for archiving data. Data that is transmitted to the cloud can be encrypted before it leaves the DS8000. For more

information about TCT, see *IBM DS8000 and Transparent Cloud Tiering*, SG24-8381. With a TS7700 that is configured as an object store, TCT data can be compressed on writing or can be encrypted while it is transferred to or from the data store (data-in-flight encryption).

- ▶ IBM Easy Tier, a proven feature of the DS8000 series, is available at no charge as part of the Base license package. Easy Tier dynamically optimizes performance for multi-tiered systems. It can also rebalance data within a single tier to help maintain optimal performance. For more information about Easy Tier, see *IBM DS8000 Easy Tier*, REDP-4667.
- ▶ The Cinder driver for OpenStack is a software component that integrates with the OpenStack cloud environment and enables the use of storage resources that are provided by supported IBM storage systems. After the driver is configured on the OpenStack Block Storage nodes, storage volumes can be allocated by the Cinder nodes to the Nova-compute nodes. Virtual machines (VMs) on the Nova-compute nodes can then use these storage resources.
- ▶ The OpenShift container platform and the IBM Container Storage Interface (CSI) driver for block storage are also supported by DS8000, including containerized applications that run on IBM zSystems.

Product highlights

The IBM DS8900F family includes the following highlights:

- ▶ The DS8900F enables cybersecurity with Safeguarded Copy: Safeguarded Copy provides protection against data corruption or loss that is caused by malicious events, such as malware and ransomware. Safeguarded Copy can be restored back to a Production copy by using incremental Global Copy rather than full Global Copy. Safeguarded Copy further improves data stability and system resiliency for mission-critical workloads.
- ▶ The fastest application response time for IBMzSystems: Latency is the most important performance metric in storage. The shortest response times are as fast as 18 microseconds for mainframe (assuming zHyperLink) and 80 microseconds for distributed systems. The fast response time enables the DS8900F family to provide ultra-low latency to help clients process huge volumes of transactions faster and deliver real-time insights to differentiate their products and gain a competitive advantage.
- ▶ The DS8900F family inherited most of the advanced functions that were available in its predecessor.

- ▶ Performance improvements: As compared to the previous DS8880F generation, lab measurements show that the DS8910F can deliver a 60% increase in random I/O operations per second (IOPS) and up to a 150% increase in sequential throughput. The DS8950F delivers up to 38% more random IOPS. The 44-core DS8980F further improves IOPS capability.
- ▶ Recovery options: The DS8900 models offer various disaster-recovery configurations with three- and four-site replication.
- ▶ 32 Gbps host adapters with authentication and line-rate encryption capability provide up to two times the bandwidth performance, higher IOPS, and lower latency compared to 16 Gbps host adapters used in prior models.
- ▶ Support for IBM Fibre Channel Endpoint Security: DS8900F host adapters include support for IBM Fibre Channel Endpoint Security as part of the cybersecurity solutions when they are connected to an IBM z16™ or z15.

For more information, see *IBM Fibre Channel Endpoint Security for IBM DS8900F and IBM Z*, SG24-8455.

- ▶ Simplified rack power distribution: Intelligent power distribution units (iPDUs) support single- or three-phase power in all models.
- ▶ Non-volatile dual in-line memory modules (NVDIMMs) for write cache retention: Eliminates system battery requirements.

The DS8910F rack-mounted model 993, with its compact size and flexibility, is an attractive choice wherever a smaller capacity is needed in combination with the reliability and overall benefits of an IBM DS8900F.

The DS8910F rack-mounted model 993 is an ideal combination for IBM zSystems customers who have IBM z15 model T02 or IBM z14 model ZR1 with Feature Code 0937 and IBM LinuxONE III model LT2 or LinuxONE Rockhopper II model LR1 with Feature Code 0938 with the 16U of reserved space.

The DS8910F is also suited for distributed environments with high-demanding IBM Power Systems or in any mainframe environment in which many hundreds of terabytes of capacity are not required.

Note: For more information about the DS8910F Model 993, see *IBM DS8910F Model 993 Rack-Mounted Storage System*, REDP-5566.

All DS8900F models include a 5341 machine type and support the HPFE Gen2 flash enclosures.

All DS8900F models can be ordered with a one-year, two-year, three-year, four-year, or five-year support period.

Scalability and performance

The IBM DS8900F models feature POWER9™ server technology to help support higher performance. Consider the following points:

- ▶ The DS8980F supports dual 11-core processors per central processor complex (CPC), so a total of 44 cores, and up to 4.3 TB of system memory to cover a wide range of performance needs.

The DS8950F supports single or dual 10-core processors per CPC, so a total of 20 or 40 cores and up to 3.4 TB of system memory.

The DS8900F family is available with different processor options. The DS8910F models support dual 4-core processors per CPC, so a total of 16 cores and up to 512 GB system memory.

- ▶ Memory configurations are available in 192 GB - 4.3 TB system memory. System memory supports the operating system and functional code, flash drive storage cache, and NVDIMMs for persistent write data.
- ▶ The storage server architecture of the DS8000, with its powerful POWER9 processors, makes it possible to manage large caches with small cache segments of 4 KB, and thus large segment tables, without the need to partition the cache. The POWER9 processors feature enough processing power to implement sophisticated caching algorithms. These algorithms and the small cache segment size optimize cache hits result in excellent I/O response times.
- ▶ The Adaptive Multi-stream Prefetching (AMP) caching algorithm can improve sequential performance dramatically, which reduces times for backup, processing for business intelligence, and processing for streaming media. Sequential Adaptive Replacement Cache is a caching algorithm that allows you to run different workloads, such as sequential and random workloads, without negatively affecting each other.
- ▶ Write data is always protected by maintaining a copy of modified data in the NVDIMMs. This persistent-memory write cache eliminates the need for the large DC-UPS battery modules that equipped earlier DS8000 generations. Data is encrypted when it is written to NVDIMM flash.
- ▶ The POWER9-based servers that are used in the processor complexes feature Peripheral Component Interconnect® Express (PCIe) Generation 4. The I/O enclosures are directly connected to the DS8900F storage servers with point-to-point PCIe Gen3 cables, with improved sequential read/write throughput and IOPS as compared to earlier models.
- ▶ The HPFE Gen2 is populated with 2.5-inch encryption-capable flash drives on a dedicated architecture. Each HPFE pair can contain up to 48 flash drives, with capacities that range between 800 GB and 15.36 TB per flash drive.
- ▶ The DS8900F models are packaged in a 19-in. high-density frame. Consider the following points:
 - The DS8980F and DS8950F models support up to 384 flash drives.
 - The DS8910F model supports up to 192 flash drives. When integrated in the 16U space of an IBM zSystems single frame, up to 48 flash drives are supported.

DS8900F family

This section summarizes the associated DS8900F models. For more information about each model, see “DS8900F models” on page 20.

DS8900F all-flash models

An all-flash model means that the system can be provisioned only with flash drives that are installed in HPFE Gen-2 drive enclosures.

Flash drives are high-performance (Tier 0 flash drives) or high-capacity (Tier 1 and Tier 2 flash drives). They provide the system with a balance between capacity and performance. Automated tiering management provides an optimized load distribution.

Figure 3 shows the DS8910F, DS8950F, and DS8980F racked models. The DS8910F model 994 is a single-frame model. The DS8950F (996) and the DS8980F (998) can be extended with one expansion frame (E96).

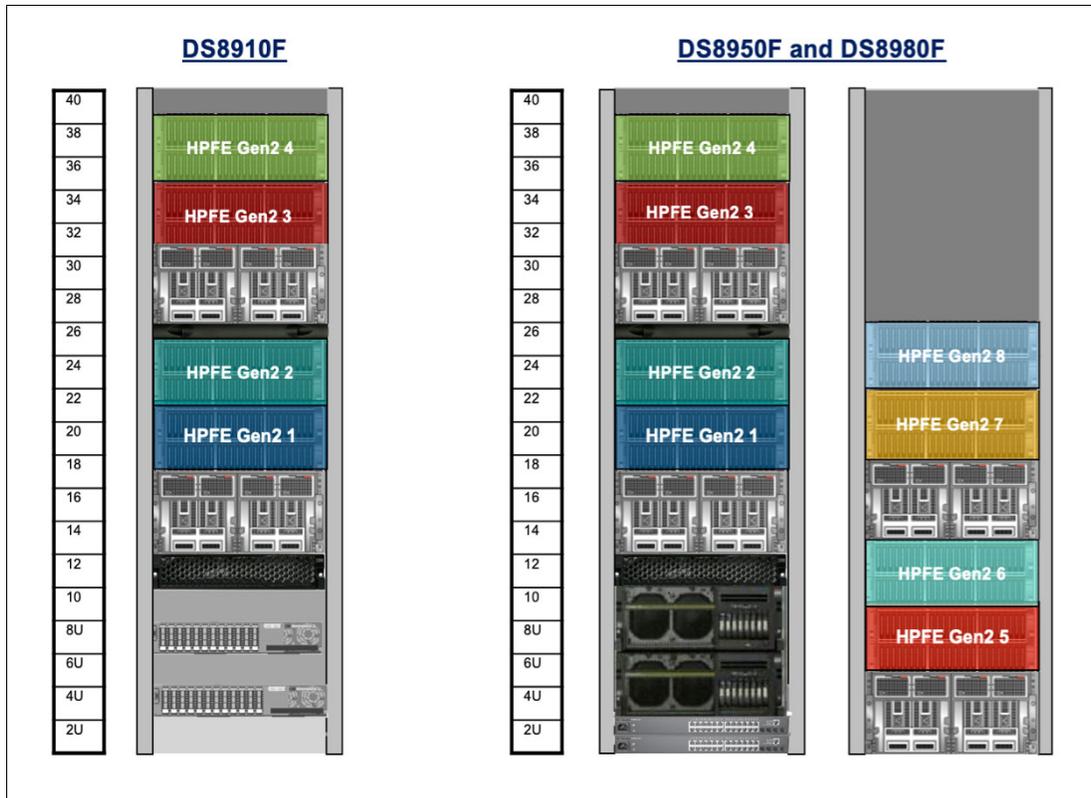


Figure 3 DS8910F, DS8950F, and DS8980F racked models

The DS8910F Flexibility Class model 993 provides a modular rack-mountable enterprise storage system.

The modular system can be integrated into an IBM z15 model T02 (Feature Code 0611/0937), IBM z14 model ZR1 (Feature Code 0610/0937), IBM LinuxONE III model LT2 (Feature Code 0621/0938), IBM LinuxONE Rockhopper II model LR1 (Feature Code 0620/0938), or other standard 19-inch wide rack that conforms to EIA 310D specifications (Feature Code 0939). The DS8910F model 993 includes all of the advanced DS8900F features, while it limits the data center footprint and power infrastructure requirements.

The modular system contains two Power Systems server processor nodes, an I/O Enclosure pair, HPFEs, and a Management Enclosure (which includes the Hardware Management Consoles (HMCs), Ethernet switches, and RPCs). Figure 4 on page 8 shows two rack-mounted models 993. One is integrated into an IBM z14.

When the model 993 is integrated into the IBM zSystems models ZR1/LR1, its console is shared with the KVM. When models T02/LT2 are integrated into the IBM zSystems models ZR1/LR1, the KVM unit is not shared. The other rack-mounted model 993 shown is the maximum configuration (two HPFE pairs) that can be integrated into a standard 19-inch wide rack.

The DS8910F model 993 supports single-phase and three-phase electrical power attachment.

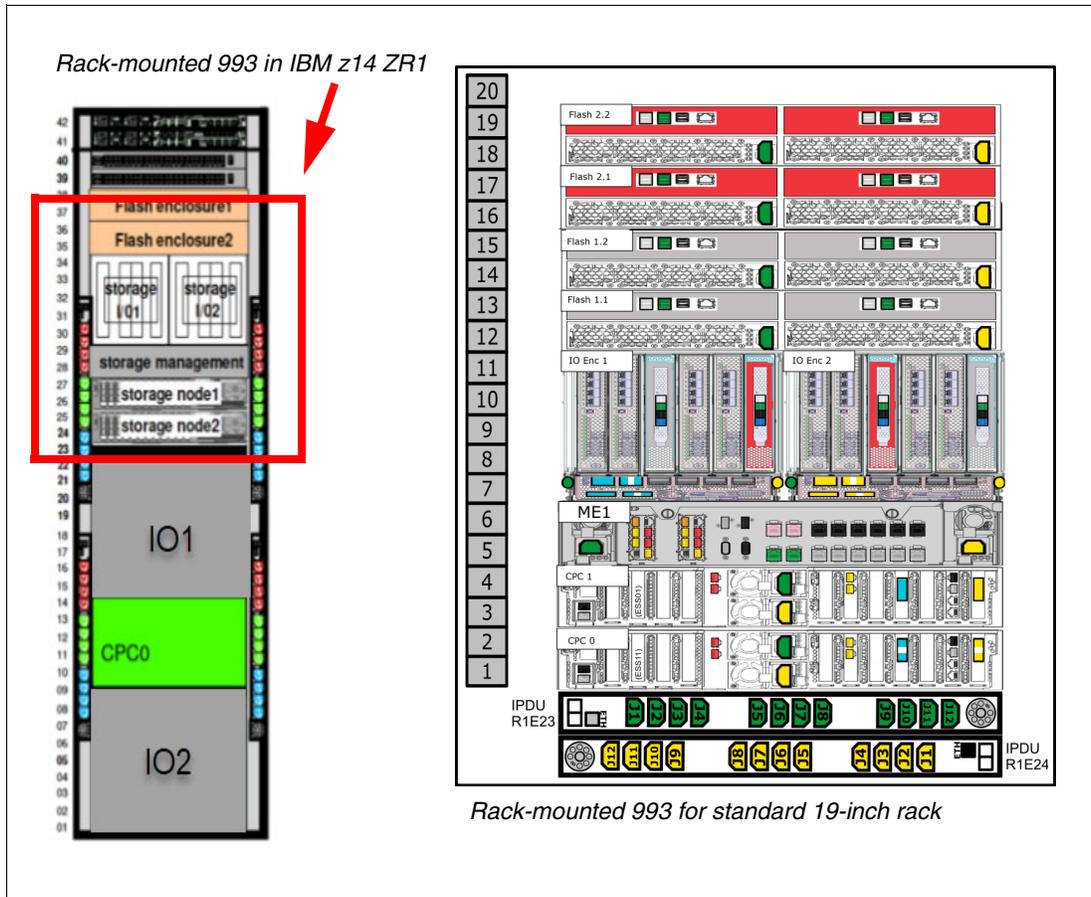


Figure 4 DS8910F all-flash rack-mounted model 993

Performance and IBM zSystems synergy

This section describes several performance improvement functions and features.

IBM Easy Tier

Easy Tier is a DS8000 series feature that is included at no cost. Easy Tier can greatly increase the performance of your system by ensuring that frequently accessed data is put on faster storage.

Easy Tier capabilities include the following items:

- ▶ Manual volume capacity rebalance
- ▶ Auto performance rebalancing in both homogeneous and hybrid pools
- ▶ Hot-spot management
- ▶ Rank depopulation
- ▶ Manual volume migration
- ▶ Thin provisioning support (ESE volumes only)

Easy Tier determines the appropriate tier of storage that is based on data access requirements and then automatically and non-disruptively moves data (at the sub-volume or sub-logical unit number level (LUN)) to the appropriate tier in the storage system.

Use Easy Tier to dynamically move your data to the appropriate drive tier in your storage system with its automatic performance monitoring algorithms. You can use this feature to increase the efficiency of flash drives in your storage system.

Easy Tier manages data placement across, and within, up to three storage tiers in DS8000:

► Three tiers

Using three tiers (each representing a separate drive class) and efficient algorithms improves system performance and cost effectiveness. You can select from various flash drive types to create up to three tiers. The drives within a tier must be homogeneous.

The tiers are listed according to the following values:

– Tier 0

Hot data tier, which contains the most active data. This tier can also serve as the home tier for new data allocations.

– Tier 1

Warm data tier, which is the workload that is not hot or cold and might be promoted or demoted.

– Tier 2

Cold data tier, which contains the least active data.

► Drive classes

The following drive classes are available, in order from highest to lowest performance. A pool can contain up to three drive tiers:

– Flash Tier 0 drives

The highest performance drives, which provide highest I/O throughput and lowest latency.

– Flash Tier 1 drives

The first tier of high-capacity drives.

– Flash Tier 2 drives

The second tier of high-capacity drives. Many standard loads already perform well while using this tier only.

Easy Tier also includes the following capabilities:

- Easy Tier Application enables clients to assign distinct application volumes to a particular tier in the Easy Tier pool, which disregards the Easy Tier advanced data migration function. This capability provides a flexible option for clients who want to ensure that certain applications remain on a particular tier to meet performance and cost requirements.
- Easy Tier Heat Map Transfer provides whatever the data placement algorithm is on the Metro Mirror/Global Copy/Global Mirror (MM/GC/GM) primary site. It can also reapply it on the MM/GC/GM secondary site through the Easy Tier Heat Map Transfer utility when failover occurs. With this capability, the DS8000 models can maintain application-level performance on the secondary site when they take over supporting a workload after a failover from the primary to secondary site.
- Easy Tier includes detailed reporting, such as workload skew curve, workload categorization, and a data movement daily report, and intra-tiering and micro-tiering support for storage tier with more than one drive technology. This combination can be a mix of high-performance and high-capacity flash drives (Flash Tier 0, 1, and 2).
- Easy Tier reporting is fully integrated into the DS graphical user interface (DSGUI).

Fibre Channel Host Adapters

The 32 (and 16) Gbps Fibre Channel Protocol (FCP) / Fibre Channel connection (IBM FICON) host adapters in the DS8900F offer enhanced connectivity. All host adapters in each I/O enclosure are connected to, and active in, both processor complexes.

Each of the four Fibre Channel ports in a host adapter can be configured to operate as either a Fibre Channel Protocol (FCP) port, or FICON port.

High-Performance FICON for IBM Z

High-Performance FICON for IBM Z (zHPF) is a z/OS® I/O architecture that includes several generations of enhancements. Step-by-step, z/OS access methods were converted to use the new I/O commands.

zHPF is included in the DS8000 IBM zSystems Feature Code package. The DS8900F family is at the most up-to-date support level for zHPF. Enhancements to zHPF include Extended Distance capability, zHPF List Prefetch support for IBM Db2® and utility operations, and zHPF support for sequential access methods. All of Db2 I/O is now zHPF-capable and supports the Db2 castout accelerator function, which allows the DS8000® to treat a castout as a single chain of I/Os.

IBM zHyperLink

zHyperLink is a short distance link technology that dramatically reduces latency by inter-connecting the IBM zSystems central processor complexes (CPCs) directly to the I/O bays of the DS8900F.

The current zHyperLink release supports read and write I/O. zHyperLink is intended to complement FICON technology to accelerate I/O requests that are typically used for transaction processing. Since Release 9.1, writes to primary volumes that are in a Global Mirror relationship are supported.

Parallel Access Volumes

Traditional performance features for IBM zSystems environments include Parallel Access Volumes (PAVs), HyperPAV, SuperPAV, Multiple Allegiance, I/O priority queuing, and zHPF. SuperPAV extends the previous HyperPAV capability by enabling alias devices to be used across multiple logical subsystems (LSSs).

FICON Dynamic Routing

FICON Dynamic Routing (FIDR) is another performance-relevant function that is available with newer FICON cards, such as those provided by recent IBM zSystems models. When considering the many paths in a SAN (for example, with many inter-switch links [ISLs]), the traditional static routing often led to unbalanced ISLs with not all available bandwidth being used. FIDR leads to an optimally balanced SAN, which means more efficient use of SAN ISL bandwidth.

Availability and serviceability

The DS8000 family is designed and implemented with component redundancy to avoid potential single points of failure. The DS8900F models offer high availability (HA) and multiplatform support, including IBM zSystems and distributed systems. Consider the following points:

- ▶ Up to 128 host adapter ports can be individually configured to operate as FC ports or FICON ports. The host adapters can auto-negotiate down by two speed factors:
 - The 32 Gbps adapters can operate down to 8 Gbps.
 - The 16 Gbps adapters can operate down to 4 Gbps.

Data transfers are full-duplex, over longwave or shortwave fiber links.

- ▶ A nondisruptive upgrade path within each DS8900F model allows configuration upgrades for processors, memory, and storage capacity enhancement to be performed concurrently. Each DS8900F model supports a scalable upgrade path from the smallest to the largest processor configuration.

Note: Upgrades between the DS8900F models are not possible.

- ▶ The DS8900F features Smart Rebuild, a function that is designed to reduce the possibility of secondary failures and data loss in RAID arrays. When a predicted failure occurs on one member of a RAID 5 or RAID 6 array, the affected drive is cloned to a spare drive, which allows it to participate in its own rebuild. The cloning process reduces the duration of the rebuild time. The process falls back to traditional rebuild when Smart Rebuild is unable to complete.
- ▶ Dynamic Volume Expansion simplifies management by enabling easier, online volume expansion (for Open Systems and IBM zSystems) to support application data growth. It also supports data center migration and consolidation to larger volumes to ease addressing constraints.
- ▶ For data protection and availability, the DS8000 series supports advanced disaster recovery (DR) and business continuity solutions, such as Copy Services (CS) functions. Also, IBM Copy Services Manager (CSM) is preinstalled (although not licensed) on the DS8000 HMCs.
- ▶ Resiliency highlights include the following capabilities:
 - IBM FlashCopy handling of volume reservations provides the detection of SCSI reserves for devices in a Metro Mirror or Global Mirror environments. It resets the reserve when creating a FlashCopy after it is identified as not being a valid reserve for a running server.
 - The Safeguarded Copy function delivers the ability to create and retain hundreds of point-in-time copies to protect against logical data corruption or malicious destruction. These copies can be used to verify customer data, analyze the nature of the corruption, and restore critical customer data. Safeguarded Copy management is done by using Copy Services Manager (CSM) or IBM GDPS®. For more information, see *IBM DS8000 Safeguarded Copy*, REDP-5506.
 - z/OS Soft Fence prevents any system from accessing data from the former remote mirror primary site when an unplanned IBM HyperSwap occurs.
- ▶ Active Volume Protection is a feature that prevents deleting volumes that are still in use.
- ▶ Support for T10 Data Integrity Field is standard. The Data Integrity Field standard of SCSI T10 enables end-to-end data protection, from the application or host HBA down to the storage drives.
- ▶ Support for IBM i variable LUNs adds flexibility for volume sizes and can increase capacity usage for IBM i environments. Before this advance, clients were limited to fixed LUN sizes, such as 35, 70, 141, or 282 GB.
- ▶ Lightweight Directory Access Protocol (LDAP) authentication support allows single sign-on (SSO) functions. LDAP can simplify user management by allowing the DS8000 to

rely on a centralized LDAP directory rather than a local user repository. For more information, see *LDAP Authentication for IBM DS8000 Systems*, REDP-5460.

Energy efficiency

The DS8900F models feature the following energy-efficient characteristics:

- ▶ Intelligent power distribution units (iPDUs) supply power to the storage system. Backup Power Modules (BPMs) provide power to the NVDIMMs when electrical power is down. Each iPDU includes its own dedicated input AC power cord.
- ▶ One iPDU pair (that is, two power cords) is installed by default. A second iPDU pair is required in the base frame when a second I/O enclosure pair or a second HPFE pair is added, which results in four power connections for this frame. The DS8980F expansion frame always includes two power cords.
- ▶ The NVDIMMs eliminate the need for DC-UPS (used in earlier DS8000 generations) and special stocking of batteries. If power is lost, the system shuts down completely in 20 ms, but the power is maintained to all of the NVDIMMs to write all data in non-volatile storage (NVS) to the NAND flash on the NVDIMMs.
- ▶ By eliminating the DC-UPSs, the DS8900F can significantly lower weight, height, floor space, and power consumption when compared to previous DS8000 generations.
- ▶ Three-phase and single-phase power attachments are available for all models.
- ▶ The DS8900F models are designed to comply with the ENERGY STAR specifications.
- ▶ High-density flash storage enclosures offer a considerable reduction in footprint and energy consumption.
- ▶ All DS8900F models are compatible with hot-aisle and cold-aisle data center layouts, which are designed to optimize airflow, reduce cooling costs, and increase energy efficiency.
- ▶ The DS8900F models are compliant with the current directives of the Restriction of Hazardous Substances (RoHS) standards.

Security and encryption

Combined with the world-class business resiliency and encryption features, the DS8000 family provides a unique combination of High Availability, performance, and security.

To counteract the growing threat of security breaches, the DS8900F includes self-encrypting drives as a standard feature. It also includes security capabilities, such as broad-based access-control and tamper-proof audit logging, and other security features that are needed to comply with regulatory authorities. Consider the following points:

- ▶ Self-encrypted drives are a standard feature. IBM Security® Guardium® Key Lifecycle Manager is mostly used as the encryption key management software. Support for the OASIS Key Management Interoperability Protocol (KMIP) is available for the DS8000 with Security Guardium Key Lifecycle Manager. Thales Vormetric Data Security Manager (DSM) and the Gemalto SafeNet KeySecure are also supported as external key servers.
- ▶ For data-at-rest encryption, the following specific features of encryption key management help to address Payment Card Industry Data Security Standard (PCI DSS) requirements:
 - The encryption deadlock recovery key option enables you to restore access to a DS8000 when the encryption key for the storage is unavailable because of an encryption deadlock situation.

- Dual-platform key server support is important if key servers on z/OS share keys with key servers on open systems. The DS8000 family requires one isolated key server, or local key management in encryption configurations. Dual-platform key server support allows two server platforms to host the key manager, with either platform operating in clear key or secure key mode.
- The recovery key Enabling/Disabling and Rekey data key options for the data-at-rest encryption feature can help clients satisfy PCI security standards.

Releases 9.2 and later also support the use of local key management. External key servers are not required. Local key management provides a DS8000 encryption solution that minimizes the risk of data exposure and can reduce operational costs. Local key management cannot be combined with isolated key servers. For more information, see *IBM DS8000 Encryption for Data at Rest, Transparent Cloud Tiering, and Endpoint Security*, REDP-4500.

- ▶ Data that is written to the NVDIMMs is encrypted.
- ▶ The 32 Gbps host adapters provide line-rate encryption capability. The DS8900F host adapters include support for IBM Fibre Channel Endpoint Security as part of the cybersecurity solutions that are offered by IBM. To take advantage of this capability, the platforms that are attached to the DS8900F must also have support for IBM Fibre Channel Endpoint Security. For more information, see *IBM Fibre Channel Endpoint Security for IBM DS8900F and IBM Z*, SG24-8455.
- ▶ Data that is transmitted to the Cloud can be encrypted. When offloading to a TS7700 cloud, data in flight can be encrypted. For more information, see *IBM DS8000 Encryption for Data at Rest, Transparent Cloud Tiering, and Endpoint Security*, REDP-4500.
- ▶ Security improvements in the DS8000 family enable customers to become compliant with the Special Publication (SP) number 800-131a, which is an NIST directive that provides guidance for protecting sensitive data by using cryptographic algorithms that have key strengths of 112 bits. Using this standard is a default. For more information, see *IBM DS8870 and NIST SP 800-131a Compliance*, REDP-5069.
- ▶ The Safeguarded Copy function takes cybersecurity to a new level.
- ▶ LDAP authentication support can simplify user management by allowing the DS8000 to rely on a centralized LDAP directory rather than a local user repository. Starting with DS8000 Release 9.1, the DS8900F HMC can connect proxy-free to the LDAP server.
- ▶ An audit log for access or modifications that are made to the logical configuration can now be stored on separate syslog servers by using the rsyslog protocol.
- ▶ Multifactor authentication (MFA) is a stronger method of authentication than just a password. It is typically used to protect sensitive data. MFA requires multiple proofs of identification to gain access.

Starting with DS8000 Release 9.3.2 MFA enables the DS8000 storage system user to configure remote authentication with RSA SecurID Authentication Manager or with direct LDAP+RSA SecurID Authentication Manager. It supports a PIN (something that the user knows) and a token (something the user has) as factors of authentication.

You can also configure IBM RACF® to use MFA by implementing *IBM Z® Multi-Factor Authentication* (IBM Z MFA).

- ▶ Starting with DS8000 Release 9.3.2, customers can use a customer-provided certificate for both Call Home and for Assist On-site (AOS). This enhancement applies only when a customer proxy is used.

Advanced functions

The DS8000 family includes the following advanced functions:

- ▶ The DS8900F provides DSGUI and DS command-line interface (DSCLI) management interfaces to configure the system or query status information. The DS8900F DSGUI was redesigned with Release 9 and now has the same appearance as the GUIs of other IBM storage products. The similar GUIs make it easier for a storage administrator to manage different IBM storage products. The DSCLI and Service web user interface (WUI) are now, in part, embedded into the GUI to optionally allow quick CLI-based operations and remote access to the Service WUI.
- ▶ The user has the choice between two extent sizes for each Fixed Block (FB) extent pool:
 - Large 1 GiB extents as used in previous implementations, which remain a default.
 - Small 16 MiB extent sizes, which are often recommended, unless you are working with total capacities in the petabyte range.
- ▶ For Count Key Data (CKD) devices, two extent sizes are available: large extents that are based on 3390 Mod1 volumes with 1113 cylinders or small extents with 21 cylinders per extent. As with FB, the smaller extent size is advantageous when working with thinly provisioned volumes.
- ▶ Quick Initialization provides fast volume initialization for Open Systems LUNs and CKD volumes. When creating volumes, Quick Initialization makes them available as soon as the command completes.
- ▶ The following advanced Copy Services features are available in DS8900F:
 - IBM FlashCopy is a feature that allows the creation of volume copies (and data set copies for z/OS) nearly instantaneously. Different options are available to create full copies, incremental copies, copy-on-write copies, and Cascaded FlashCopies. For more information about Cascaded FlashCopy, see *DS8000 Cascading FlashCopy Design and Scenarios*, REDP-5463. FlashCopy can be used to perform backup operations parallel to production or to create test systems.
 - The Safeguarded Copy function delivers the ability to create and retain hundreds of point-in-time copies to protect against logical data corruption or malicious destruction by ransomware. Those copies can be used to verify customer data, analyze the nature of the corruption (verification and analysis are not functions of Safeguarded Copy), and restore critical customer data. Safeguarded Copy management is done by using CSM. For more information, see *IBM DS8000 Safeguarded Copy*, REDP-5506.
 - The DS8900F models and functional code provide the same remote-mirroring options as previous models of the DS8000 family. Synchronous remote mirroring (Metro Mirror) is supported up to 300 km (186.4 miles). Asynchronous copy (Global Mirror) is supported for unlimited distances. Three-site options are available by combining Metro Mirror and Global Mirror. When Multi-Target Peer-to-Peer Remote Copy (MT-PPRC) is used, even four-site options are possible.
 - Metro Mirror, Global Copy, Global Mirror, Metro/Global Mirror, z/OS Global Mirror, and z/OS Metro/Global Mirror business continuity solutions are designed to provide the advanced functions and flexibility that is needed to tailor a business continuity environment for almost any recovery point or recovery time objective.
 - CS can be managed and automated by using external CSM servers, or CSM servers that are preinstalled on the DS8900F HMCs. For z/OS environments, IBM Geographically Dispersed Parallel Sysplex® (IBM GDPS) provides an automated DR solution.
 - With IBM AIX® operating systems, the DS8000 family supports Open IBM HyperSwap® replication. Open HyperSwap is a special Metro Mirror replication

method that is designed to automatically fail over I/O from the primary logical devices to the secondary logical devices during a primary storage system failure. The swap can be accomplished with minimal disruption to the applications that use the logical devices.

- Remote-Pair FlashCopy enables you to establish a FlashCopy relationship where the target is a remote Metro Mirror primary volume, which keeps the pair in the full-duplex state.
 - The IBM Easy Tier® Heat Map Transfer function is also integrated with CSM or with newer GDPS versions. Heat Map Transfer ensures that the data placement on remote site DS8000 systems is consistent with the usage patterns at the primary site.
 - The Resource Groups feature is a policy-based resource scope-limiting function that enables the secure use of CS functions by multiple users on a DS8000 series storage system. Resource Groups are used to define an aggregation of resources and policies for configuration and management of those resources. The scope of the aggregated resources can be tailored to meet each hosted customer's CS requirements for any operating system that is supported by the DS8000 series.
- ▶ The DS8000 models support VMware vStorage application programming interfaces (APIs) for Array Integration (VAAI). VAAI enables certain storage tasks to be offloaded from the server hardware to the storage array. Support is included for the Atomic Test and Set (ATS) primitive, the Cloning Blocks primitive (not supported for ESE volumes or volumes larger than 4 TB), the Zeroing Blocks primitive, and the UNMAP (Space Release) primitive. Thin provisioning and UNMAP require the ESE volumes that use 16 MiB small extents.
 - ▶ The DS8900F models support VASA 2.0, and the RESTful API.
 - ▶ The DS8900F models also support the IBM Storage Management Console for VMware vCenter. The IBM Storage Management Console for VMware vCenter is a software plug-in that integrates into the VMware vCenter server platform. It enables VMware administrators to independently and centrally manage their storage resources on IBM storage systems. In addition to being a virtualization-related solution, the IBM Storage Management Console is a powerful management solution for VMware administrators who want to control storage resources primarily from the VMware vSphere Client GUI.
 - ▶ DS8000 Storage Replication Adapter (SRA) is a software add-on that integrates with VMware vCenter Site Recovery Manager (SRM) solution and enables SRM to perform failovers together with DS8000 storage systems. The DS8000 SRA extends SRM capabilities and allows it to employ DS8000 replication and mirroring as part of the SRM comprehensive Disaster Recovery Planning (DRP) solution.
 - ▶ DS8900F supports the Container Storage Interface (CSI) specification. IBM released an open source CSI driver for IBM storage that allows dynamic provisioning of storage volumes for containers on Kubernetes and Red Hat OpenShift Container Platform (OCP)/ OpenShift Data Foundation.

Architecture and key components

This section provides a high-level description of the main elements of the DS8900F architecture.

Important: For more information about the DS8900F architecture, see *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456.

IBM POWER9 processor technology

A pair of POWER9-based servers, also known as CPCs, are at the heart of the IBM DS8900F models. Compared to POWER8, which is used in DS8880, POWER9 almost doubles the number of transistors for each chip, from 4.2 billion to 8 billion.

These two IBM POWER® servers share the load of receiving and moving data between the attached hosts and the storage arrays. However, they are also redundant, so that if either server fails, the system operations fail over to the remaining server and continue to run without host interruption.

The POWER9 processors operate at cycle frequencies 3.4 - 3.9 GHz and can scale from the 8-core processors in a DS8910F Processor Complex to 22-core processors in a DS8980F Processor Complex. Among other innovations, the IBM POWER processor includes simultaneous multithreading (SMT) modes, such as SMT4, which allow four threads to be run simultaneously in each processor core.

The POWER processor also features Intelligent Threads that can vary based on the workload demand. The POWER9 multi-core architecture was matched with a wide range of related technology innovations to deliver leading throughput, efficiency, scalability, and reliability.

Internal PCIe-based fabric

The DS8900F fabric includes the following specifications:

- ▶ DS8900F POWER9 servers are based on current PCIe Gen4 architecture to provide up to 16-lane (x16) high-speed connectivity to internal adapters.
- ▶ PCIe adapters provide point-to-point connectivity to the IO enclosures. The I/O enclosures provide connectivity between the IO adapters and the POWER9 processor complexes.
- ▶ The I/O enclosures provide PCIe Gen3 connectivity to all installed host and device adapters. Each I/O enclosure features six PCIe x8 adapter slots and two additional PCIe x8 connectors for attachment to zHyperLink optical transceivers.

I/O enclosures

The I/O enclosure provides connectivity between the adapters and the processor complex.

The I/O enclosure uses PCIe interfaces to connect I/O adapters in the I/O enclosure to both processor nodes.

To improve IOPS and sequential read/write throughput, the I/O enclosure is connected to each processor node with a point-to-point connection.

The I/O enclosure can contain the adapters that are described next.

zHyperLink

zHyperLink is a short-distance IBM zSystems attached link that is designed for up to 10x lower latency than High-Performance FICON®. It is a point-to-point optical cabling connection with a maximum distance of 150 meters (492 feet). It connects the IBM zSystems central processor complexes (CPCs) directly to the zHyperLink ports of the I/O enclosure of a DS8000 system. In each I/O enclosure, two ports are available for the zHyperLink capability. For small-block reads, response times below 20 µs were achieved for I/Os qualifying for zHyperLink.

All DS8900F models support zHyperLink attachment.

Flash RAID adapters

The DS8000 flash RAID adapter is designed for connectivity and management of the DS8900F HPFE Gen2 storage. The flash RAID adapters are installed into PCIe slots in the I/O enclosures.

The main processor is a RAID engine that provides RAID and sparing management to the flash drives in the HPFE Gen2 flash enclosures. Each flash RAID adapter features four SAS ports, which provide connectivity from the flash RAID adapters to the HPFE Gen2 enclosures.

The flash RAID adapters are installed as a pair, one in each of an I/O enclosure pair. This configuration is known as a “device adapter pair” (DA pair). Logical configuration should be balanced across the DA pair for load balancing and the highest throughput. The redundant DA pair ensures continued availability if a flash RAID adapter or IO enclosure fails.

Host adapters

The DS8900F offers 32 Gbps and 16 Gbps host adapters with four ports. Each host adapter port can be individually configured for FC or FICON connectivity. Configuring multiple host connections across multiple host adapters in multiple I/O enclosures provides the best combination of throughput and fault tolerance.

High-Performance Flash Enclosure Gen-2

All DS8900F models support 2U HPFE Gen2 storage enclosures, which are installed in pairs.

The HPFE Gen2 pair provides two 2U storage enclosures with associated RAID controllers and cabling. This combination of components forms a high-performance, fully redundant flash storage array.

The HPFE Gen2 pair contains the following hardware components:

- ▶ Two 2U 24-slot SAS flash drive enclosures. Each of the two enclosures contains the following components:
 - Two power supplies with integrated cooling fans
 - Two SAS Expander Modules with two SAS ports each
 - One midplane or backplane for plugging components that provides connectivity for flash drives, Expander Modules, and power supplies
 - Up to 24 2.5-inch Flash drives, installed in sets of 16, split across the enclosure pair.
- ▶ Two HPFE Gen2 flash RAID adapters that are configured for redundant access to the 2U flash enclosures. Each RAID adapter supports concurrent maintenance and includes the following components:
 - High-Performance ASIC RAID engine
 - Four SAS ports and cables that are connected to the four SAS Expander Modules, which provide fully redundant access from each RAID adapter to both 2U enclosures
 - Integrated cooling

Figure 5 shows the HPFE Gen2.



Figure 5 HPFE Gen2 front (top) and rear (bottom)

HPFE Gen2 Flash drives

The following drives are available for the HPFE Gen2:

- ▶ 2.5-inch Flash Tier 0 high-performance flash drives with Full Disk Encryption (FDE):
 - 800 GB
 - 1.6 TB
 - 3.2 TB
- ▶ 2.5-inch Flash Tier 1 high-capacity flash drives with FDE:
 - 3.84 TB
- ▶ 2.5-inch Flash Tier 2 high-capacity flash drives with FDE:
 - 1.92 TB
 - 7.68 TB
 - 15.36 TB

Flash Tier 2 and Flash Tier 0 can be combined for a 2-tier system. Depending on load characteristics and subject to an exact sizing exercise, many standard loads perform well even when they solely use a Flash Tier 2 single-tier storage system.

On special request, an intermix of different high-performance flash capacities within one HPFE pair can be allowed. Contact your account representative for more information.

Note: Intermixing high-performance (Flash Tier 0) and high-capacity (Flash Tier 1 and 2) drives in the same HPFE Gen2 pair is not supported.

For more information about the HPFE Gen2, associated flash RAID adapters, and flash drives, see *IBM DS8000 High-Performance Flash Enclosure Gen2*, REDP-5422.

Power subsystem

The use of NVDIMMs for write cache retention allows DS8900F to greatly simplify rack power distribution. Bulky DC-UPS battery-backup systems are replaced by compact intelligent power distribution units (iPDUs) that significantly reduce the rack footprint and weight.

All DS8900F models are available for single-phase or three-phase power attachment. Table 1 lists the power attachment feature codes available to support the various worldwide power standards.

Table 1 Power options

Feature Code	Power cord feature	Volts	Ampère	Description
1038	Single-phase	208 V	30 A	NEMA L6-30P 2P+G
1039	Single-phase	250 V	30/32 A	IEC 60309 P+N+G
1041	Three-phase	220 - 240 V (Line-to-neutral) 380 - 415 V (Line-to-line)	32 A	IEC 60309 3P+N+G (five-pin Wye)
1042	Single-phase	250 V	32 A	For use in Australia and New Zealand (not IEC 60309)
1043	Single-phase	250 V	30 A	For use in Korea
1044	Single-phase	230 V	30/32 A	IEC 60309 P+N+G (halogen free)
1045	Three-phase	200 - 240 V	60/63 A	IEC 60309 3P+G (four-pin Delta)

Each iPDU has one AC power connector and uses its own AC inline power cord.

The iPDU supports SNMP/Telnet/Web Interface and is firmware upgradeable. The HMCs are responsible for the whole system power state and monitoring by communicating to the network interfaces of the iPDUs. By default, each DS8900F frame includes one pair of iPDUs. If the second HPFE Gen2 storage enclosure pair or the second I/O enclosure pair is added to the base frame of the racked models, a second iPDU pair is required for the base frame.

For more information about the DS8900F power subsystem, see *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456.

Hardware Management Console

The mini-PC hardware management console (HMC) is a Red Hat Linux-based server that enables users to interact with the DS8900F by using the Service WUI for service purposes, or by using DS GUI or DSCLI for storage administration or configuration.

A *secondary management console* is standard as a redundant management console to cater for environments with high-availability requirements. The secondary HMC is installed in the DS8000 base frame management enclosure, which eliminates the requirement for external rack space.

Copy Services Manager (CSM) is included with the HMC software. For more information, see *IBM DS8880 Integrated Copy Services Manager and LDAP Client on the HMC*, REDP-5356.

Important: The DS8900F HMC supports IPv6, the next generation of the Internet Protocol. The HMC continues to support the IPv4 standard and mixed IPv4 and IPv6 environments.

Ethernet switches

The DS8900F base frame management enclosure includes two internal private Ethernet switches. Two switches are supplied to allow the creation of a fully redundant private management network. Each processor complex includes connections to each switch to allow

each server to access both private networks. These networks cannot be accessed externally, and external connections are not allowed.

External client network connection to a DS8900F system is through a dedicated connection to each HMC. The switches receive power from the power junction assemblies (PJAs), and do not require separate power outlets.

Important: The internal Ethernet switches are for the DS8000 private network only. No client network connection should ever be made directly to these internal switches.

DS8900F models

The DS8900F delivers extensive scalability. As an all-flash model, the system supports only high-performance and high-capacity flash drives installed in HPFE Gen2 drive enclosures.

Starting with release 9.3 new builds, IBM changed the DS8900F product family to only machine type 5341. The former warranty and service options are now offered as part of Expert Care. Options range from one-year base warranty, to five-year Expert Care Advanced or Premium.

DS8980F (machine type 5341 models 998 and E96)

The DS8980F is a high-performance, high-efficiency, high-capacity storage system that is exclusively provisioned with HPFEs Gen2.

DS8980F storage systems feature dual 22-core processors, 8 HPFE Gen2 pairs, and up to 384 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. The frame is 19 inches wide with a 40U capacity. They support the following storage enclosure pairs:

- ▶ Up to 4 HPFE Gen2 pairs in the base frame (model 998)
- ▶ Up to 4 HPFE Gen2 pairs each in the expansion frame (model E96)

Table 2 and Table 3 list the hardware components and maximum capacities that are supported for the DS8980F.

Table 2 Components for the DS8980F (machine type 5341 models 998 and E96)

Processors per processor complex	System memory (GB)	I/O enclosure pairs	FC / FICON Host adapters (4-Port)	HPFE Gen2 pairs	Expansion frames
22-core	4352	1 - 4	2 - 32	1 - 8	0 - 1

Table 3 Components for the DS8980F (machine type 5341 model 998 and E96)

Processors per processor complex	System memory (GB)	zHyperLink adapters	Maximum flash drives	Maximum raw storage capacity ^a
22-core	4352	0 - 8 (Base frame) 0 - 12 (includes the E96 frame)	384	5,898 TB

a. Using 15.36 TB Flash Tier 2 drives.

DS8950F (machine type 5341 models 996 and E96)

The DS8950F is a high-performance, high-efficiency, high-capacity storage system that is exclusively provisioned with HPFEs Gen2.

DS8950F storage systems are scalable with up to dual 20-core processors, 8 HPFE Gen2 pairs, and up to 384 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. They are optimized and configured for cost and performance. The frame is 19 inches wide with a 40U capacity. They support the following storage enclosure pairs:

- ▶ Up to 4 HPFE Gen2 pairs in the base frame (model 996)
- ▶ Up to 4 HPFE Gen2 pairs each in the expansion frame (model E96)

Table 4 and Table 5 list the hardware components and maximum capacities that are supported for the DS8950F, depending on the number of processor cores and memory available.

Table 4 Components for the DS8950F (machine type 5341 models 996 and E96)

Processors per processor complex	System memory (GB)	I/O enclosure pairs	FC / FICON Host adapters (4-Port)	HPFE Gen2 pairs	Expansion frames
10-core	512	1 - 2	2 - 16	1 - 4	0
20-core	1,024 2,048 3,456	1 - 4	2 - 32	1 - 8	0 - 1

Table 5 Components for the DS8950F (machine type 5341 models 996 and E96)

Processors per processor complex	System memory (GB)	zHyperLink adapters	Maximum flash drives	Maximum raw storage capacity ^a
10-core	512	0 - 6	192	2,949 TB
20-core	1,024 2,048 3,456	0 - 8 (Base frame) 0 - 12 (includes the E96 frame) 0 - 12 (includes the E96 frame)	384	5,898 TB

a. Using 15.36 TB Flash Tier 2 drives.

DS8910F (machine type 5341 model 994)

The DS8910F is a high-density, high-performance, high-capacity racked storage system that includes only HPFEs Gen2.

The DS8910F storage system Processor Complexes feature 8-core processors and are scalable to support up to 192 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. The frame is 19 inches wide and 40U high.

The DS8910F supports up to four HPFE Gen2 pair in a base frame (model 994).

Table 6 and Table 7 list the hardware components and maximum capacities that are supported for the DS8910F model 994.

Table 6 Components for the DS8910F (machine type 5341 model 994)

Processors per processor complex	System memory (GB)	I/O enclosure pairs	FC / FICON Host adapters (4-Port)	HPFE Gen2 pairs	Expansion frames
8-core	192 512	1 - 2	2 - 16	1 - 4	0

Table 7 Components for the DS8910F (machine type 5341 model 994)

Processors per processor complex	System memory (GB)	zHyperLink adapters	Maximum flash drives	Maximum raw storage capacity ^a
8-core	192 512	0 - 4	192	2,949 TB

a. Using 15.36 TB Flash Tier 2 drives.

DS8910F (machine type 5341 model 993)

The DS8910F model 993 is an entry-level, rackless high-performance storage system that includes only HPFEs Gen2. It is based on the same architecture as the rest of the DS8900F family.

The DS8910F storage system Processor Complexes feature 8-core processors and supports one or two HPFE Gen2 pairs with up to 96 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. When mounting within the 16U spacing of an IBM zSystems or LinuxONE 8562 / 3907, the number of flash drives is limited to 48 maximum.

Table 8 and Table 9 on page 22 list the hardware components and maximum capacity that is supported for the DS8910F model 993.

Table 8 Components for the DS8910F (machine type 5341 model 993)

Rack mount option	Processors per processor complex	System memory (GB)	I/O enclosure pairs	FC / FICON Host adapters (4-Port)	HPFE Gen2 pairs
Within IBM zSystems/LinuxONE	8-core	192 512	1	2 - 8	1
Client-provided standard rack	8-core	192 512	1	2 - 8	1 - 2

Table 9 Components for the DS8910F (machine type 5341 model 993)

Rack mount option	System memory (GB)	zHyperLink adapters	Maximum flash drives	Maximum raw storage capacity ^a
Within IBM zSystems/LinuxONE	192 512	0 - 4	48	737 TB
Client-provided standard rack	192 512	0 - 4	96	1,475 TB

a. Using 15.36 TB Flash Tier 2 drives

DS8900F weight specifications and dimensions

Table 10 lists the weight specifications and dimensions for the DS8900F models and their expansion frame, including casters and covers.

Table 10 DS8900F dimensions and weights

Model	Dimensions	Maximum weight
DS8900F Model 993	Height: <ul style="list-style-type: none"> ▶ 15U or 667 mm (26.3 in) ▶ 16U or 711 mm (28.0 in) ▶ 20U or 889 mm (35.0 in) Width: 465 mm (18.3 in) Depth: 700 mm - 780 mm (27.6 in - 30.7 in)	246 kg (543 lb)
DS8900F Model 994	Height: 1927 mm (75.9 in) Width: <ul style="list-style-type: none"> ▶ With standard rack doors: 616 mm (24.3 in) ▶ With SpaceSaver doors: 600 mm (23.6 in) Depth: <ul style="list-style-type: none"> ▶ With standard rack doors: 1271 mm (50.0 in) ▶ With SpaceSaver doors: 1169 mm (46.0 in) 	704 kg (1552 lb)
DS8900F Model 996 and DS8900F Model 998	Height: 1927 mm (75.9 in) Width: <ul style="list-style-type: none"> ▶ With standard rack doors: 616 mm (24.3 in) ▶ With SpaceSaver doors: 600 mm (23.6 in) Depth: <ul style="list-style-type: none"> ▶ With standard rack doors: 1271 mm (50.0 in) ▶ With SpaceSaver doors: 1169 mm (46.0 in) 	735 kg (1621 lb)
DS8900F Model E96	Height: 1927 mm (75.9 in) Width: <ul style="list-style-type: none"> ▶ With standard rack doors: 616 mm (24.3 in) ▶ With SpaceSaver doors: 600 mm (23.6 in) Depth: <ul style="list-style-type: none"> ▶ With standard rack doors: 1271 mm (50.0 in) ▶ With SpaceSaver doors: 1169 mm (46.0 in) 	545 kg (1202 lb)

DS8000 systems are designed to operate in a temperature range of 16 - 32 °C (61 - 99 °F).

Table 11 lists power consumption and environmental information for DS8900F models.

Table 11 Power consumption and environmental information (fully equipped frames)

Measurement	Unit of measure	Base frame	Expansion frame
Peak electric power	Kilowatt (kW)	Model 993: 2.2 Model 994: 4.6 Model 996: 6.2 Model 998: 5.3	N/A N/A Model E96: 3.9
Thermal load	British thermal units (BTU) per hour	Model 993: 7464 Model 994: 15682 Model 996: 20984 Model 998: 21489	N/A N/A Model E96: 13320
Capacity of exhaust	Cubic meters per minute (cubic feet per minute, CFM)	44.2 (1500)	51.8 (1800)

Measurement	Unit of measure	Base frame	Expansion frame
Ground leakage current	Milliamperes (mA)	< 21	< 21
Startup current	Amperes (A or amp)	≤ 100	≤ 100
Startup current duration	Microseconds (μs or μsec)	< 200	< 200

For more information about DS8900F power and measurements, see the *IBM DS8900F Introduction and Planning Guide*, SC27-9560.

Other configuration features

The following main features, upgrades, and options can be requested with new DS8900F orders or installed later:

▶ TCT

For IBM zSystems clients who want to use TCT, a 10 Gbps Ethernet network adapter pair is available for all DS8900F models to increase the throughput for TCT. Feature Code 3602 is used for the DS8910F, and Feature Code 3603 for the DS8950F and DS8980F.

For more information about TCT, see *IBM DS8000 and Transparent Cloud Tiering*, SG24-8381.

- ▶ The Front and rear door lock kit (Feature Code 1014) enables locking your machine.
- ▶ The Rack side cover pair feature (Feature Code 1107) provides two 40U high-end rack side covers. These covers are decorative and are not mandatory.
- ▶ An optional overhead cabling top-exit bracket feature (Feature Code 1401) includes a top-exit bracket for fiber cables.
- ▶ The Earthquake Resistance Kit (Feature Code 1907) is an optional seismic kit for stabilizing the storage unit rack so that the rack complies with AC156 earthquake resistance standards.
- ▶ The DS8950F expansion frame can stand up to 20 m (65.6 feet) apart from the base frame. When this option is used, select Feature Code 1341 with the expansion frame for the required cabling.
- ▶ The BSMI certificate for Taiwan option (Feature Code 0400) provides the required Bureau of Standards, Metrology, and Inspection (BSMI) ISO 9001 certification documents for storage system shipments to Taiwan.

Warranty information and upgrades

Beginning with release 9.3, DS8000 systems have only machine type 5341. The former warranty and service options are now offered as part of Expert Care. Options range from one-year base warranty, to five-year Expert Care Advanced or Premium, and can be chosen when ordering a new system, or upgraded as requirements change.

Table 12 describes the available Expert Care options.

Table 12 Expert Care 1–5 year options

Expert Care Services	Base Warranty 5341	Advanced 5131 (A01-A05)	Premium 5131 (P01-P05)
Hardware Maintenance (IOR = IBM On-site Repair)	1-Year 24x7 same day	24x7 same day	24x7 same day
Support Line (24x7 remote technical support)		✓	✓
Predictive Support		✓	✓
Storage Insights		✓	✓ (Pro)
Technical Account Manager (TAM)			✓
Enhanced Response Time (30 min for Severity 1 & 2)			✓
Remote Code Load (up to 2x per year)		Optional add-on	✓
Outside the bundle			
On-site Code Load (optional add-on via Feature Code)		Optional add-on	Optional add-on
Media Retention (optional add-on via Service Pac)		Optional add-on	Optional add-on

Expert Care Feature Codes

The Machine Type / Models for Expert Care are 5131-A0x for Advanced and 5131-P0x for Premium, where x indicates the number of years of support. The indicator for the Expert Care Premium software program number is 577x-ECP.

You can select from two levels of support:

- ▶ Premium: Hardware maintenance with same-business-day onsite response, 24 hours a day, seven days a week, Support Line, predictive support, enhanced response time for defect support, hardware remote code load, and access to a dedicated Technical Account Manager.
- ▶ Advanced: Hardware maintenance with same-business-day onsite response, 24 hours a day, seven days a week, predictive support, and Support Line.

Table 13 shows the feature codes for each of the available options.

Table 13 Expert Care feature codes

Description	Expert Care Advanced 5131 (A01 - A05)	Expert Care Premium 5131 (P01 - P05)
Expert Care Indicator	ALH0	ALH0
1 year	ALK1	ALL1
2 years	ALK2	ALL2
3 years	ALK3	ALL3
4 years	ALK4	ALL4
5 years	ALK5	ALL5
On-Site Code Load	AHY3	AHY2

Description	Expert Care Advanced 5131 (A01 - A05)	Expert Care Premium 5131 (P01 - P05)
Remote Code Load	AHY4	Included

Specific options are also available regarding contact and resolution times, including 1-hour committed contact, 4-hour committed on-site, or 4-, 6-, 8-, 12-, 24-, 48-, and 72-hour committed fix time, each with a corresponding feature code. Contact your IBM Sales Representative if any of these options are required.

Options might differ from region to region. For a full listing, refer to the relevant IBM Hardware Announcement for your region.

For additional information, see Chapter 7.4 in *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456.

Model conversion

Although DS8980F, DS8950F, and DS8910F share several common parts, conversion between these models or upgrades from earlier DS8000 generations are not offered.

Scalable upgrades

The DS8000 series supports concurrent upgrades within the same model and machine type.

The following types of upgrades are available:

- ▶ Processor and system memory
- ▶ I/O enclosures, host adapters, and device adapters
- ▶ High-Performance Flash Enclosures and flash drive sets
- ▶ Expansion frame

For example, with the DS8950F model, you can start with a single-frame dual 10-core configuration with flash enclosures for 48 drives, 512 GB of system memory, and grow to a full-scale, 384-drive, 2-frame configuration, dual 20-core with 3.4 TB of system memory.

All frame, capacity, cache, and processor upgrades are concurrent, regardless of configuration type.

Licensed functions

DS8900F licensed functions are bundled into groups, as shown in Table 14. The grouping of licensed functions facilitates ordering.

Table 14 DS8900F licensed functions

Licensed function	License scope	5341 or 9031-FF8 Feature Code numbers
Base Function (BF)	ALL	8151 - 8160
Copy Services	ALL, FB, or CKD	8250 - 8260

Licensed function	License scope	5341 or 9031-FF8 Feature Code numbers
z-synergy Services (zsS)	CKD	8350 - 8360
Copy Services Manager on HMC ^a	N/A	8451

a. The license for CSM on the HMC server must be purchased as a separate software license.

CSM provides an advanced GUI to more efficiently manage CS. CSM is available on the DS8000 HMC, which eliminates the need to maintain a separate server for CS functions. For that reason, and in addition to the other license bundles that are shown in Table 14, the CSM for HMC license can be configured along with the bundles and enabled by using a Data Storage Feature Activation (DSFA) activation key. CSM-enablement files are activated on the HMC when the key is applied.

The license bundles contain the following functions:

- ▶ Base Function license:
 - Operating Environment License (OEL)
 - Logical Configuration support for FB (open systems)
 - Thin Provisioning
 - Easy Tier
 - Encryption Authorization
- ▶ Copy Services license:
 - FlashCopy®
 - Safeguarded Copy
 - Metro Mirror
 - Global Mirror
 - Metro/Global Mirror
 - z/Global Mirror
 - z/Global Mirror Resync
 - MT-PPRC
- ▶ z-synergy Services license:
 - FICON attachment
 - PAVs
 - HyperPAV (including SuperPAV)
 - zHPF
 - IBM z/OS Distributed Data Backup
 - zHyperLink
 - TCT
- ▶ CSM on the HMC license

CSM facilitates the use and management of CS functions, such as the remote mirror and copy functions (Metro Mirror and Global Mirror), point-in-time function (FlashCopy), and Safeguarded Copy. CSM is available on the HMC, which eliminates the need to maintain a separate server for CS functions.
- ▶ IBM authorization for licensed functions is purchased as 5341 or 9031 machine function authorizations. However, the license functions are storage models. For example, the Base Function license is listed as a 5341, or 9031 model FF8. The 5341 or 9031 machine function authorization features are for billing purposes only.
- ▶ Support for extended functions is coupled with the Expert Care terms chosen.
- ▶ The licensed function indicator feature numbers enable the technical activation of the function, which is subject to a feature activation code that is made available by IBM and

applied by the client. The 5341 or 9031 licensed function authorization feature numbers establish the extent of authorization for that function on the 5341-9xx machine for which it was acquired.

- ▶ Licensed functions are activated and enforced with a defined license scope. *License scope* refers to the type of storage and the type of servers with which the function can be used. For instance, the z/s licenses are only available with the CKD (z/FICON) scope.
- ▶ The BFs are mandatory. The BFs must always be configured for mainframe and open systems, which have a scope of ALL. Also, BF licensing is based on the total unformatted capacity of the installed flash drives.
- ▶ With CS, if these services are used only for mainframe or open systems, the restriction to FB or CKD is possible. However, most clients likely want to configure CS for scope ALL.

For each group of licensed functions, specific Feature Code numbers indicate the licensed capacity, as listed in Table 15.

Table 15 License Feature Codes

Feature Code			Feature Code granularity for licensed function indicator
BF	CS	zsS	
8151	8251	8351	10 TB (up to 100 TB capacity)
8152	8252	8352	15 TB (100.1 - 250 TB capacity)
8153	8253	8353	25 TB (250.1 - 500 TB capacity)
8154	8254	8354	75 TB (500.1 - 1,250 TB capacity)
8155	8255	8355	175 TB (1,250.1 - 3,000 TB capacity)
8156	8256	8356	300 TB (3,000.1 - 6,000 TB capacity)
8160	8260	8360	500 TB (6,000.1 - 12,000 TB capacity)

Copy Services Manager on the Hardware Management Console license

CSM provides an advanced GUI to easily and efficiently manage CS. CSM is available on the DS8000 HMC, which eliminates the need to maintain a separate server for CS functions.

For that reason, and in addition to the three grouped license bundles that are listed in Table 14 on page 26, the CSM for HMC license can be configured along with the licenses and enabled by using a DSFA activation key. CSM enablement files are activated on the HMC when the key is applied. The license for CSM on the HMC server must be purchased as a separate software license.

Microcode Updates

For Release 9.3 systems, IBM provides three options for microcode updates:

- ▶ “Customer Code Load”
- ▶ “Remote Code Load”
- ▶ “Onsite SSR Code Load”

Customer Code Load

For customers who choose Expert Care Advanced or the base warranty service, Customer Code Load is the default method for performing concurrent microcode updates.

- ▶ Microcode bundles are downloaded and activated by the customer, using the standard DS Storage Manager GUI.
- ▶ Download defaults to the current recommended bundle, or an alternate compatible bundle can be chosen.
- ▶ Health checks are run before download, and again before activation, to ensure that the system is in good health.
- ▶ If a problem is encountered anywhere in the process, a ticket is automatically opened with IBM support, and the ticket number is provided in the GUI for reference.
- ▶ When the problem is corrected, code load can be restarted, and automatically resumes after the last successful step.

For more information about Customer Code Load, see Chapter 11.2 of *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456.

Remote Code Load

Remote Code Load (RCL) is the default for delivery and installation of microcode upgrades for systems that are covered under Expert Care Premium. However, customers who want to perform their own code loads can do so.

Customers who are covered under Expert Care Advanced can optionally acquire entitlement for Remote Code Load (RCL) with the chargeable feature code number AHY4.

With RCL, IBM provides an efficient and secure method to update the DS8000 systems microcode concurrently, without interrupting business operations.

RCL is the trusted process of having IBM support personnel securely connect to a DS8000 system, enable the remote acquisition, and perform the distribution and activation of Licensed Internal Code (LIC) bundles and Install Corrective Service (ICS) images.

The RCL process is concurrent and can be run without interruptions in the business operations. This process consists of the following steps, as shown in Figure 6:

1. IBM Remote Support works with IBM Technical Account Managers and client teams for the planning of the microcode update. This planning ensures the client's environment is considered in the planning phase.
2. When a remote code load is agreed upon and scheduled, an IBM trained resource in the support center starts a session with the target HMC.
3. During the agreed upon window, the IBM representative directs the HMC to acquire the code images from the Fix Central repository and prepares for code activation.
4. During the customer maintenance window, IBM starts the activation request, moving the HMCs and DS8000 to the new target microcode level.

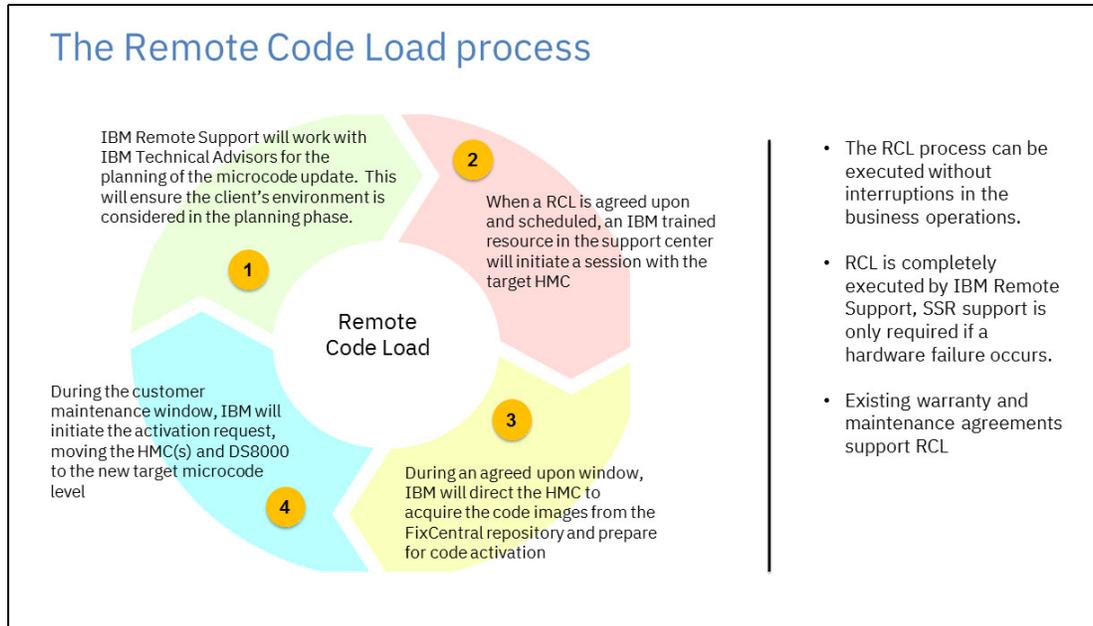


Figure 6 Remote Code Load process

Onsite SSR Code Load

Customers who want to have an IBM SSR perform Onsite Code Load, can purchase Feature code #AHY2 along with Expert Care Premium, or #AHY3 along with Expert Care Advanced.

Call Home and remote support

Call Home is the capability of the HMC to contact IBM support services to report a problem, which is referred to as *call home for service*. The HMC also communicates machine-reported product data (MRPD) to IBM by the Call Home facility. MRPD data was enhanced to include more information about logical volume and LSS configuration. Call Home is implemented by using Internet SSL.

Remote support is offered through the Assist On-site connection or Remote Support Center (RSC).

For more information about remote support operations with IBM Assist On-site, see *IBM Assist On-site for Storage Overview*, REDP-4889.

For a brief overview of the embedded RSC, see *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456.

Supported environments

The DS8000 offers connectivity support across a broad range of server environments, including Power Systems, IBM zSystems, servers from HPE and Oracle, non-IBM AMD-based, and Intel-based servers.

At the time of writing, the DS8900F supports over 60 platforms. For the list of supported platforms, see the [DS8000 System Storage Interoperation Center \(SSIC\)](#).

IBM Redpaper publications also are available for special attachments, such as *IBM DS8000 and IBM Z Synergy*, REDP-5186, or *IBM DS8870 and VMware Synergy*, REDP-4915.

This rich support of heterogeneous environments and attachments, along with the flexibility to easily partition the DS8000 storage capacity among the attached environments, can help support storage consolidation requirements and dynamic environments.

Performance modeling and sizing

IBM has tools available, such as the IBM Storage Modeller, to model the expected performance of your storage system in advance, depending on target configuration and your specific workload profiles.

Important: Contact your IBM representative or IBM Business Partner to discuss a performance modeling and sizing study.

Related information

The publications that are listed in this section are considered suitable for a more detailed description of the topics that are covered in this paper.

IBM Redbooks publications

The following publications provide more information about topics in this document:

- ▶ *DS8000 Cascading FlashCopy Design and Scenarios*, REDP-5463
- ▶ *DS8000 Copy Services*, SG24-8367
- ▶ *DS8870 Data Migration Techniques*, SG24-8257
- ▶ *DS8870 Easy Tier Application*, REDP-5014
- ▶ *Getting Started with IBM Z Cyber Vault*, SG24-8511
- ▶ *IBM Assist On-site for Storage Overview*, REDP-4889
- ▶ *IBM DS8000 and IBM Z Synergy*, REDP-5186
- ▶ *IBM DS8000 Easy Tier*, REDP-4667
- ▶ *IBM DS8000 Encryption for Data at Rest, Transparent Cloud Tiering, and Endpoint Security*, REDP-4500
- ▶ *IBM DS8000 High-Performance Flash Enclosure Gen2*, REDP-5422
- ▶ *IBM DS8000 Safeguarded Copy*, REDP-5506
- ▶ *IBM DS8000 Series Command-Line Interface User's Guide*, SC27-8526
- ▶ *IBM DS8000 and Transparent Cloud Tiering*, SG24-8381
- ▶ *IBM DS8870 Easy Tier Heat Map Transfer*, REDP-5015
- ▶ *IBM DS8870 Multiple Target Peer-to-Peer Remote Copy*, REDP-5151
- ▶ *IBM DS8870 and VMware Synergy*, REDP-4915
- ▶ *IBM DS8880 Integrated Copy Services Manager and LDAP Client on the HMC*, REDP-5356
- ▶ *IBM DS8000 Thin Provisioning*, REDP-5343

- ▶ *IBM DS8900F Architecture and Implementation: Updated for Release 9.3*, SG24-8456
- ▶ *IBM DS8900F Performance Best Practices and Monitoring*, SG24-8501
- ▶ *IBM DS8910F Model 993 Rack-Mounted Storage System*, REDP-5566
- ▶ *IBM Fibre Channel Endpoint Security for IBM DS8900F and IBM Z*, SG24-8455
- ▶ *IBM System Storage DS8000 Copy Services Scope Management and Resource Groups*, REDP-4758
- ▶ *IBM System Storage DS8000: Host Attachment and Interoperability*, SG24-8887
- ▶ *LDAP Authentication for IBM DS8000 Systems*, REDP-5460
- ▶ *Using IBM DS8000 in an OpenStack Environment*, REDP-5220

Online resources

The following websites are also relevant as further information sources:

- ▶ IBM Assist On-site:
<https://www.ibm.com/support/home/pages/assist-on-site/>
- ▶ IBM Data Storage Feature Activation (DSFA):
<https://www.ibm.com/storage/dsfa/>
- ▶ IBM DS8900F Introduction and Planning Guide:
<https://www.ibm.com/support/pages/ibm-ds8900f-introduction-and-planning-guide-93>
- ▶ IBM Documentation:
<https://www.ibm.com/docs/en/ds8900>
- ▶ IBM System Storage Interoperation Center (SSIC):
<https://www.ibm.com/systems/support/storage/ssic/>

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