Built on over 50 years of Enterprise storage expertise, the IBM® DS8000® series is the flagship of disk storage systems within the IBM System Storage™ portfolio.

As of September 2019, the DS8900F is the latest addition and offers two new classes:

- **DS8910F: Flexibility Class all-flash**
  The flexibility class delivers significant performance improvements as compared to the previous IBM DS8880F generation.

- **DS8950F: Agility Class all-flash**
  The agility class is efficiently designed to consolidate all your mission-critical workloads for IBM Z®, IBM LinuxONE, IBM Power Systems, and distributed environments under a single all-flash storage solution.

This IBM Redbooks® Product Guide gives an overview of the features and functions that are available with the IBM DS8900F models running microcode Release 9.0 (Bundle 89.0 / Licensed Machine Code 7.9.0.xxx).

Figure 1 shows the front view of the DS8910F (model 994), and DS8950F (model 996) base frame. The height of the systems is 40U. The figure shows the standard doors (FC1105, left side). As an alternative, SpaceSaver doors (FC1106) are available (right side).
The DS8900F systems fit into a reduced-footprint, 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), which maximizes performance and throughput. These capabilities are further enhanced with the availability of the high-performance flash enclosures (HPFE Gen2).

All DS8000 models excel at supporting the IBM Z Enterprise server and IBM Power server environments, which offers many synergy features for these environments in particular.

Figure 2 shows a schematic diagram of the DS8910F rack-mounted model 993 (left) when installed (right) in an IBM z14® Model ZR1, or LinuxONE LR1. The IBM Z 3907 Business Class hosts feature an opening of up to 16U, which can incorporate that storage system.

![Figure 2 Installing the DS8910F Model 993 in an IBM z14 Model ZR1](image)

Did you know?

The IBM DS8900F family includes the following features:

- With three different possible 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 and performance.
- The DS8900F height is now a unique 40U, for all full-rack models. The footprint was further reduced, from a former depth of 144 cm (56.5 in, DS8880), to now only 117 cm (46.06 in) with the new SpaceSaver doors.
- All DS8900F models offer 3-phase and single-phase power support.
POWER9 features 8 billion transistors per core. This ability almost doubles what was available on the DS8880 models (IBM POWER8®), with the former 4.2 billion transistors per core.

The DS8910F model 993 is a modular rack-mountable enterprise all-flash storage system that can be integrated into 16U contiguous space of an IBM z14 Model ZR1, LinuxONE LR1, or other conforming 19-inch wide rack.

Transparent Cloud Tiering (TCT) enables a DS8900F to migrate and recall data in cloud storage. This functionality helps to reduce MIPS usage for Z clients during backup. 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).

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

IBM Easy Tier®, a well-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 (for DS8000 R9.0), 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 on the Nova-compute nodes can then use these storage resources.

Product highlights

The IBM DS8900F family includes the following highlights:

- The DS8900F offers next-level cybersecurity with Safeguarded Copy: Safeguarded Copy provides protection against data corruption or loss that is caused by malicious events, such as malware and ransomware, which delivers data stability and system resiliency for mission-critical workloads.

- The fastest application response time for IBM Z: Latency is the most important performance metric in storage. With shortest response times being as fast as 19 microseconds for mainframe (assuming zHyperLink) and 90 microseconds for distributed systems, the DS8900F family provides 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 was developed under the same microcode core as DS8880F. It inherited most of the advanced functions that were available in its predecessor.

- Performance improvements: As compared to the previous DS8880F generation, DS8910F can deliver a 60% increase in random IOPS and up to 150% increase in sequential throughput. DS8950F delivers up to 38% more random IOPS.

- Recovery options: The DS8000 models offer various disaster-recovery configurations with three- and four-site replication.

- A total of 32 GFC 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 GFC host adapters.
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 connected to an IBM z15™.

For more information, see IBM Fibre Channel Endpoint Security for 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 (NVDIMM) for write cache retention: Eliminates system battery requirements.

The DS8910F rack-mounted model 993 can be considered as a successor to smaller-capacity DS8870, DS8800, and DS8700 systems. Because of its compact size and flexibility, it targets a much wider market and is an attractive choice wherever a smaller capacity is needed in combination with the reliability and overall benefits of an IBM DS8900F.

It also is an ideal combination for IBM Z clients who have the Z Business Class models ZR1 or LR1 with the 16U of reserved space. The DS8910F is also well-suited for distributed environments with high-demanding IBM Power Systems or in any mainframe environment in which many hundreds of terabytes of capacity is not required.

Note: For more information about the DS8910F Model 993, see Introducing the IBM DS8910F Model 993 Rack Mounted Storage System, REDP-5556.

All DS8900F models include a 533x machine type and support the HPFE Gen2 flash enclosures.

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

Scalability and performance

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

- The DS8900F family is available with different processor options. The DS8910F models support dual 8-core processors, and up to 512 GB system memory. The DS8950F supports dual 10-core, or dual 20-core processors, and up to 2 TB of system memory to cover a wide range of performance needs.

- Memory configurations are available in 192 GB - 2 TB system memory. System memory supports the operating system and functional code, flash drive storage cache, and non-volatile dual in-line memory modules (NVDIMM) for persistent write data.

- The storage server architecture of the DS8000, with its powerful POWER9 processors, make 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 PCI Express Gen-3 cables, with improved sequential read/write throughput and IOPS compared to DS8880 and 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 ranging between 800 GB and 15.36 TB per flash drive.

The DS8900F models are packaged in a 19-inch high-density frame. Consider the following points:
- The DS8950F all-flash model supports up to 384 flash drives.
- The DS8910F racked model supports up to 192 flash drives. When integrated in the 16U space of an IBM Z 3907 Business Class, 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 18.

**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 drive) or high-capacity (tier 1 and tier 2 flash drives). They provide the system with a balance between capacity and performance. Automated tiering is available to provide an optimized load distribution.
Figure 3 shows the DS8910F and DS8950F racked models. The DS8910F model 994 is a single-frame model. The DS8950F is one-frame (996) or can be extended with one extra expansion frame (E96).

Figure 3  DS8910F and DS8950F 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 Z model ZR1 (FC 0937), IBM LinuxONE Rockhopper II model LR1 (FC0938), or other standard 19-inch wide rack that conforms to EIA 310D specifications (FC0939). DS8910F model 993 includes all of the advanced features as DS8900F while limiting data center footprint and power infrastructure requirements.

The modular system contains two Power Server processor nodes, an I/O Enclosure pair, High-Performance Flash Enclosures, and a Management Enclosure (which includes the HMCs, Ethernet Switches, and RPCs). Figure 4 on page 7 shows two rack-mounted models 993. One is integrated into the ZR1/LR1.

The console is shared with ZR1/LR1 via the Z's KVM. 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.
In this section, the performance improvement functions and features are described.

**IBM Easy Tier**

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

Its capabilities include manual volume capacity rebalance, auto performance rebalancing in both homogeneous and hybrid pools, hot-spot management, rank depopulation, manual volume migration, and 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 subvolume or sub-LUN level) 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 your flash drives and the efficiency of all the tiers in your storage system.
You can use the features of Easy Tier between three tiers of storage within a DS8000. Use the capabilities of Easy Tier to support:

- **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**
    
    Hot data tier, which contains the most active data. This tier can also serve as the home tier for new data allocations.
  
  - **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.
  
  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 Easy Tier's 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 IBM 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 DSGUI.**

The 32 and 16 GFC FC/IBM FICON® host adapters in the DS8900F offer enhanced connectivity. They are available as 4-port only. The host adapters in the I/O enclosures are directly connected to the processor complexes.
The host adapters support FICON attachment to IBM Z servers. You can configure each port to operate as a Fibre Channel Protocol (FCP) port, or Fibre Channel connection (FICON) port.

**High-Performance FICON**

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 Z 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 Pre-fetch 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 Z central electronics complexes (CECs) 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.

**Parallel access volumes**

Traditional performance features for IBM Z system 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 Z 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 and multiplatform support, including IBM Z 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 GFC adapters can operate down to 8 Gbps
  - The 16 GFC 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.**
The DS8900F features Smart Rebuild, a function that is designed to help reduce the possibility of secondary failures and data loss in RAID arrays. In a RAID 6, while still online, a predicted failure starts a cloning of the affected drive, which is similar to a RAID 1 for this specific drive and eliminates a RAID rebuild. The cloning reduces the duration of the rebuild time. The procedure falls back to a classical rebuild when the flash drive is failing.

Dynamic Volume Expansion simplifies management by enabling easier, online volume expansion (for Open Systems and IBM Z) 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 functions, which are available for thin-provisioned volumes. Also, Copy Services Manager is preinstalled (although, not licensed) on the DS8000 Hardware Management Console (HMC).

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 with Copy Services Manager. For more information, see IBM DS8880 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) functionality. LDAP can simplify user management by allowing the IBM DS8000 to rely on a centralized LDAP directory rather than a local user repository. For more information, see IBM DS8880 Integrated Copy Services Manager and LDAP Client on the HMC, REDP-5356.

**Energy efficiency**

The DS8900F models feature the following energy-efficient characteristics:
- Intelligent rack power distribution units (iPDUs) supply power to the storage system. Backup power modules (BPMs) provide power to the non-volatile dual in-line memory module (NVDIMM) 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 DS8950F expansion frame always includes two power cords.

The NVDIMM eliminates 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 nonvolatile (NVS) storage to the NAND flash on the NVDIMMs.

By no longer using the DC-UPS, 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 (HA), 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 Key Lifecycle Manager (SKLM) is mostly used as the encryption key management software. Support for OASIS Key Management Interoperability Protocol (KMIP) is available with the DS8000 with SKLM (version 3.0 required). The Gemalto SafeNet KeySecure is also supported as the external key server. For more information, see *IBM DS8000 Encryption for data at rest, Transparent Cloud Tiering, and Endpoint Security*, REDP-4500.

- Full disk encryption (FDE) can protect business-sensitive data by providing drive-based hardware encryption that is combined with sophisticated key management software. FDE is available for all drive types, including all flash drive types. Because encryption is done by the drive, it is not apparent to host systems and can be used in any environment, including z/OS.

- Data that is written to the NVDIMMs is encrypted.

- The 32 GFC 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*, REDP-8455.

- The Safeguarded Copy function takes cybersecurity to a new level.
Data that is transmitted to the Cloud can be encrypted, except when offloading to a TS7700 cloud when the Transparent Cloud Tiering feature is used. 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. For more information, see IBM DS8870 and NIST SP 800-131a Compliance, REDP-5069.

LDAP authentication support can simplify user management by allowing the DS8000 to rely on a centralized LDAP directory rather than a local user repository. LDAP support can be enabled through Copy Services Manager, which is packaged with the HMC code.

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.

For data-at-rest encryption, the following specific features of encryption key management help address Payment Card Industry Data Security Standard (PCI DSS) requirements:

– The encryption deadlock recovery key option enables you to restore access to an IBM DS8000 when the encryption key for the storage is unavailable because of an encryption deadlock scenario.

– 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 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 FDE feature can help clients satisfy PCI security standards.

Advanced functions

The DS8000 family includes the following advanced functions:

– The DS8900F provides DS Storage Manager (the graphical user interface [GUI]) and DS command-line interface (CLI) management interfaces to configure the system or query status information. The DS8900F DS GUI was redesigned with Release 9.0 and now has the same look and feel as the GUIs of other IBM storage products, which makes it easier for a storage administrator to work with different IBM storage products. The DSCLI and DS Service WUI are now embedded into the GUI to optionally allow quick CLI-based operations and remote access to the DS WUI.

– The user has the choice between two extent sizes for each Fixed Block extent pool:
  – Large 1 GiB extents as used in previous implementations, which remain a default.
  – Small 16 MiB extent sizes, which are often the recommended size now, unless 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 Fixed Block, the smaller extent size is advantageous when working with thinly provisioned volumes.

– Quick Initialization provides fast volume initialization for Open Systems logical unit numbers (LUNs) and CKD volumes. It allows the creation of devices, which makes them available when the command completes.
The following advanced Copy Services features are available in DS8000:

- 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, and restore critical customer data. Safeguarded Copy management is done with Copy Services Manager. For more information, see IBM DS8880 Safeguarded Copy, REDP-5506.

- The DS8900F models and 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 (PPRC) is used, even 4-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.

- Copy Services can be managed and automated by using IBM Copy Services Manager (CSM) that is preinstalled on the DS8900F HMC or the use of external CSM servers. 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.

- In cooperation with the z/OS Data Mover, another option is available for z/OS: Global Mirror for z/OS. Another important feature for z/OS Global Mirror (2-site) and z/OS Metro/Global Mirror (3-site) is Extended Distance FICON. This feature can help reduce the need for channel extender configurations by increasing the number of read commands in flight.

- Remote-Pair FlashCopy enables you to establish a FlashCopy relationship where the target is a remote mirror Metro Mirror primary volume, which keeps the pair in the full-duplex state.

- The Easy Tier Heat Map Transfer function is also integrated with IBM Copy Services Manager or with newer GDPS versions. All of the functions are available through the IBM Copy Services Manager.

- The Resource Groups feature is a policy-based resource scope limiting function that enables the secure use of Copy Services 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 customers’ Copy Services requirements for any operating system that is supported by the DS8000 series.
The DS8000 models supports 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 2 TB), the Zeroing Blocks primitive and the UNMAP (Space Release) primitive is only supported with ESE volumes using 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 IBM 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.

Architecture and key components

This section gives 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, SG24-8456.

IBM POWER9 processor technology

A pair of POWER9-based servers, also known as central processor complexes (CPCs), are at the heart of the IBM DS8900F models. Between POWER8, what was the base for DS8880, and POWER9, the number of transistors for each chip almost doubled, from 4.2 bn to 8 bn.

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 any 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 20-core processors in a DS8950F Processor Complex. Among other innovations, the IBM POWER processor includes SMT modes, such as SMT4 or SMT8, which allow four or even eight instruction 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 the current PCI Express (PCIe) architecture to provide up to 16-lane (x16) high-speed connectivity to internal adapters.
- Up to four dual-port 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. The I/O enclosure features six PCIe x8 adapter slots and has four more PCIe x8 connectors that allow for attachment to the High-Performance Flash Enclosures and for the zHyperLink adapters.

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. A PCIe device is an I/O adapter or a processor node.

To improve I/O operations per second (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 Z systems-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 Z system central processing complexes (CPCs) directly to the zHyperLink ports of the I/O enclosure of a DS8000 system. In each I/O enclosure, two more ports are available for the new zHyperLink capability. For small-block reads, response times below 20 µs were achieved for I/Os qualifying for zHyperLink.

All DS8900F models allow zHyperLink attachment.

Flash RAID adapters

The flash RAID adapters have a PCIe eight-lane connection to 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 a logicalIO enclosure fails.

The DS8000 flash RAID adapter is designed for connectivity and management of the DS8900F HPFE Gen2.

The FC1604 is a pair of HPFE Gen2 adapters, which is installed directly into a PCIe3 x8 adapter slot in the I/O enclosure. One such HPFE Gen2 adapter pair is required for each HPFE Gen2 pair.
The FC1605 is then one HPFE Gen2 enclosure pair, for the R9 release of DS8000. Each HPFE pair can be populated with one, two, or three flash drive sets.

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

High-Performance Flash Enclosure Gen-2

The DS8900F models support the High-Performance Flash Enclosure Gen2. The High-Performance Flash Enclosure is a 2U storage enclosure that is installed in pairs.

The High-Performance Flash Enclosure 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 High-Performance Flash Enclosure 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 maintenance of flash drives, Expander Modules, and power supplies
- Two High-Performance Flash Enclosure 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 provides 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 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 (DS8910F only)
  - 7.68 TB
  - 15.36 TB

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

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

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**

All DS8900F models are available for single-phase or three-phase power attachment, which supports input voltages of 200 - 250 Vac. To account for the different worldwide geographical areas, the attachment options that are listed in Table 1 are available.

<table>
<thead>
<tr>
<th>Feature code</th>
<th>Power cord feature</th>
<th>Volts</th>
<th>Ampère</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1038</td>
<td>Single-phase</td>
<td>208 V</td>
<td>30 A</td>
<td>NEMA L6-30P 2P+G</td>
</tr>
<tr>
<td>1039</td>
<td>Single-phase</td>
<td>250 V</td>
<td>32 A</td>
<td>IEC 60309 P+N+G</td>
</tr>
<tr>
<td>1040</td>
<td>Three-phase</td>
<td>250 V</td>
<td>60 A</td>
<td>IEC 60309 3P+G (four-pin Delta)</td>
</tr>
<tr>
<td>1041</td>
<td>Three-phase</td>
<td>250 V</td>
<td>32 A</td>
<td>IEC 60309 3P+N+G (five-pin Wye)</td>
</tr>
<tr>
<td>1042</td>
<td>Single-phase</td>
<td>250 V</td>
<td>32 A</td>
<td>For use in Australia and New Zealand (not IEC 60309)</td>
</tr>
<tr>
<td>1043</td>
<td>Single-phase</td>
<td>250 V</td>
<td>30 A</td>
<td>For use in Korea</td>
</tr>
<tr>
<td>1044</td>
<td>Single-phase</td>
<td>250 V</td>
<td>32 A</td>
<td>IEC 60309 P+N+G (halogen free)</td>
</tr>
</tbody>
</table>

The former DC-UPS configuration that was used in earlier DS8000 models was replaced by a simplified rack power distribution. The new Intelligent power distribution units (iPDUs) replace the DC-UPSs. With the new NVDIMMs for write cache retention, they eliminate the need for bulky battery sets and significantly reduce the rack footprint. 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 a 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 this frame.

For more information about the DS8900F power subsystem, see *DS8900F Architecture and Implementation*, SG24-8456.

**Hardware Management Console**

The mini-PC HMC is a Red Hat Linux-based server that enables users to interact with the DS8900F by using the HMC GUI (for service purposes) or DS Storage Manager/DS CLI (for storage administration or configuration).

A secondary management console is standard as a redundant management console to cater for environments with high-availability requirements.

With the introduction of the Mini HMC, the secondary HMC is installed in the DS8000 base frame, which eliminates the requirement for external rack space. Copy Services Manager 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 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 no external connections are 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.

**DS8900F 533x machine type models**

The DS8900F machine type models are described in this section.
DS8950F (machine type 533x models 996 and E96)

The DS8950F (machine type 533x models 996 with expansion frame E96) is a high-performance, high-efficiency, high-capacity storage system that is exclusively provisioned with High-Performance Flash Enclosures Gen2.

DS8950F storage systems are scalable with up to dual 20-core processors, 8 High-Performance Flash Enclosures 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 High-Performance Flash Enclosure Gen2 pairs in the base frame (model 996)
- Up to 4 High-Performance Flash Enclosure 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 DS8950F, depending on the number of processor cores and memory available.

### Table 2  Components for the DS8950F (machine type 533x models 996 and E96)

<table>
<thead>
<tr>
<th>Processors per Processor Complex</th>
<th>System memory (GB)</th>
<th>I/O enclosure pairs</th>
<th>FC/FICON Host adapters (4-Port)</th>
<th>HPFE Gen2 pairs</th>
<th>Expansion frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-core</td>
<td>512</td>
<td>1 - 2</td>
<td>2 - 16</td>
<td>1 - 4</td>
<td>0</td>
</tr>
<tr>
<td>20-core</td>
<td>1,024</td>
<td>1 - 4</td>
<td>2 - 32</td>
<td>1 - 8</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

### Table 3  Components for the DS8950F (machine type 533x models 996 and E96)

<table>
<thead>
<tr>
<th>Processors</th>
<th>System memory (GB)</th>
<th>zHyperLink adapters</th>
<th>Maximum flash drives</th>
<th>Maximum raw storage capacity ¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-core</td>
<td>512</td>
<td>0 - 4</td>
<td>192</td>
<td>2,949 TB</td>
</tr>
<tr>
<td>20-core</td>
<td>1,024</td>
<td>0 - 8 (Base frame)</td>
<td>384</td>
<td>5,898 TB</td>
</tr>
<tr>
<td></td>
<td>2,048</td>
<td>0 - 12 (incl. E96 frame)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Using 15.36 TB Flash Tier 2 drives

DS8910F (machine type 533x model 994)

The DS8910F is a high-density, high-performance, high-capacity racked storage system that includes only High-Performance Flash Enclosures Gen2.

The DS8910F storage system Processor Complexes feature 8-core processors and are scalable and 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 High-Performance Flash Enclosure Gen2 pair in a base frame (model 994).

Table 4 on page 20 and Table 5 on page 20 list the hardware components and maximum capacities that are supported for the DS8910F model 994.
Table 4  Components for the DS8910F (machine type 533x model 994)

<table>
<thead>
<tr>
<th>Processors per Processor Complex</th>
<th>System memory (GB)</th>
<th>I/O enclosure pairs</th>
<th>FC/FICON Host adapters (4-Port)</th>
<th>HPFE Gen2 pairs</th>
<th>Expansion frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-core</td>
<td>192 512</td>
<td>1 - 2</td>
<td>2 - 16</td>
<td>1 - 4</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 5  Components for the DS8910F (machine type 533x model 994)

<table>
<thead>
<tr>
<th>Processors</th>
<th>System memory (GB)</th>
<th>zHyperLink adapters</th>
<th>Maximum flash drives</th>
<th>Maximum raw storage capacity 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-core</td>
<td>192 512</td>
<td>0 - 4</td>
<td>192</td>
<td>2,949 TB</td>
</tr>
</tbody>
</table>

1. Using 15.36 TB Flash Tier 2 drives

DS8910F (machine type 533x model 993)

The DS8910F is an entry-level, rackless high-performance storage system that includes only High-Performance Flash Enclosures 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 High-Performance Flash Enclosure Gen2 pairs with up to 96 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. When mounting within the 16U sparing of an IBM Z/LinuxONE 3907 Business Class host, the number of flash drives is limited to 48 maximum.

Table 6 and Table 7 list the hardware components and maximum capacity that is supported for the DS8910F model 993.

Table 6  Components for the DS8910F (machine type 533x model 993)

<table>
<thead>
<tr>
<th>Rack mount option</th>
<th>Processors per Processor Complex</th>
<th>System memory (GB)</th>
<th>I/O enclosure pairs</th>
<th>FC/FICON Host adapters (4-Port)</th>
<th>HPFE Gen2 pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Z/LinuxONE BC</td>
<td>8-core</td>
<td>192 512</td>
<td>1</td>
<td>2 - 8</td>
<td>1</td>
</tr>
<tr>
<td>Client-provided standard rack</td>
<td>8-core</td>
<td>192 512</td>
<td>1</td>
<td>2 - 8</td>
<td>1 - 2</td>
</tr>
</tbody>
</table>

Table 7  Components for the DS8910F (machine type 533x model 993)

<table>
<thead>
<tr>
<th>Rack mount option</th>
<th>System memory (GB)</th>
<th>zHyperLink adapters</th>
<th>Maximum flash drives</th>
<th>Maximum raw storage capacity 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within Z/LinuxONE BC</td>
<td>192 512</td>
<td>0 - 4</td>
<td>48</td>
<td>737 TB</td>
</tr>
<tr>
<td>Client-provided standard rack</td>
<td>192 512</td>
<td>0 - 4</td>
<td>96</td>
<td>1,475 TB</td>
</tr>
</tbody>
</table>

1. Using 15.36 TB Flash Tier 2 drives
DS8900F weight specifications and dimensions

Table 8 lists the weight specifications and dimensions for the DS8910F and DS8950F and its expansion frame, including casters and covers.

**Table 8  DS8900F dimensions and weights**

<table>
<thead>
<tr>
<th>Model</th>
<th>Dimensions</th>
<th>Maximum weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS8900F Model 993</td>
<td>Height: 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)</td>
<td>246 kg (543 lb)</td>
</tr>
<tr>
<td>DS8900F Model 994</td>
<td>Height: 1927 mm (75.9 in) Width: With standard rack doors: 616 mm (24.3 in) With SpaceSaver doors: 600 mm (23.6 in) Depth: With standard rack doors: 1271 mm (50.0 in) With SpaceSaver doors: 1169 mm (46.0 in)</td>
<td>704 kg (1552 lb)</td>
</tr>
<tr>
<td>DS8900F Model 996</td>
<td>Height: 1927 mm (75.9 in) Width: With standard rack doors: 616 mm (24.3 in) With SpaceSaver doors: 600 mm (23.6 in) Depth: With standard rack doors: 1271 mm (50.0 in) With SpaceSaver doors: 1169 mm (46.0 in)</td>
<td>735 kg (1621 lb)</td>
</tr>
<tr>
<td>DS8900F Model E96</td>
<td>Height: 1927 mm (75.9 in) Width: With standard rack doors: 616 mm (24.3 in) With SpaceSaver doors: 600 mm (23.6 in) Depth: With standard rack doors: 1271 mm (50.0 in) With SpaceSaver doors: 1169 mm (46.0 in)</td>
<td>545 kg (1202 lb)</td>
</tr>
</tbody>
</table>

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

Table 9 lists power consumption and environmental information for DS8900F models.

**Table 9  Power consumption and environmental information (fully equipped frames)**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit of measure</th>
<th>Base frame</th>
<th>Expansion frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak electric power</td>
<td>Kilowatt (kW)</td>
<td>Model 993: 2.2</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model 994: 4.6</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model 996: 5.9</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model E96: 3.9</td>
<td></td>
</tr>
</tbody>
</table>
Other configuration features

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

- **Transparent Cloud Tiering**
  
  For IBM Z clients who want to use Transparent Cloud Tiering (TCT), a 10 Gbps Ethernet network adapter pair is available for all DS8900F models to increase the throughput for TCT. Feature code (FC) 3602 is used for the DS8910F, and FC 3603 for the DS8950F.

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

- **The Front and rear door lock kit (FC 1014)** enables locking your machine.

- **The Rack side cover pair feature (FC 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 (FC 1401)** includes a top-exit bracket for fiber cables.

- **The Shipping weight reduction option (FC 0200)** allows you to receive delivery of a DS8000 model in multiple shipments. If your site includes delivery weight constraints, IBM offers a shipping weight reduction option that ensures the maximum shipping weight of the initial model shipment does not exceed 909 kg (2000 lb). The model weight is reduced by removing selected components that are then shipped separately. The IBM service representative installs the components that were shipped separately during the storage unit installation.

- **The Earthquake Resistance Kit (FC 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 FC 1341 with the expansion frame for the required cabling.

- **The BSMI certificate for Taiwan option (FC 0400)** provides the required Bureau of Standards, Metrology, and Inspection (BSMI) ISO 9001 certification documents for storage system shipments to Taiwan.

---

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Unit of measure</th>
<th>Base frame</th>
<th>Expansion frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal load</td>
<td>British thermal units (BTU) per hour</td>
<td>Model 993: 7464</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model 994: 15682</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Model 996: 20199</td>
<td>Model E96: 13320</td>
</tr>
<tr>
<td>Capacity of exhaust</td>
<td>Cubic meters per minute (cubic feet per minute, CFM)</td>
<td>44.2 (1500)</td>
<td>51.8 (1800)</td>
</tr>
<tr>
<td>Ground leakage current</td>
<td>milliamperes (mA)</td>
<td>&lt; 21</td>
<td>&lt; 21</td>
</tr>
<tr>
<td>Startup current</td>
<td>amperes (A or amp)</td>
<td>≤ 100</td>
<td>≤ 100</td>
</tr>
<tr>
<td>Startup current duration</td>
<td>microseconds (µs or µsec)</td>
<td>&lt; 200</td>
<td>&lt; 200</td>
</tr>
</tbody>
</table>

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

DS8900F offers the Enterprise Choice warranty of 1, 2, 3, or 4 years on the hardware and the advanced function software with the following options:

- 4 years on 5334 all-flash models
- 3 years on 5333 all-flash models
- 2 years on 5332 all-flash models
- 1 year on 5331 all-flash models

Model conversion

Although DS8950F and DS8910F share many 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 2 TB of system memory.

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

Licensed functions

The licensed functions are now bundled into the groups that are listed in Table 10.

<table>
<thead>
<tr>
<th>Licensed function for DS8000 with Enterprise Choice warranty</th>
<th>License scope</th>
<th>IBM 904y-FF8 indicator feature code numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Function (BF)</td>
<td>ALL</td>
<td>8151 - 8160</td>
</tr>
<tr>
<td>Copy Services (CS)</td>
<td>ALL, FB, or CKD</td>
<td>8250 - 8260</td>
</tr>
<tr>
<td>z-synergy Services (zsS)</td>
<td>CKD</td>
<td>8350 - 8360</td>
</tr>
</tbody>
</table>

The grouping of licensed functions facilitates ordering, which differs from earlier DS8000 models for which licensed functions were more granular and were ordered specifically.
The license bundles contain the following functions:

- **Base Function license (BF):**
  - Operating Environment License (OEL)
  - Logical Configuration support for Fixed Block (FB) (open systems)
  - Thin Provisioning
  - Easy Tier
  - Encryption Authorization

- **Copy Services license (CS):**
  - FlashCopy
  - Safeguarded Copy
  - Metro Mirror
  - Global Mirror
  - Metro/Global Mirror
  - z/Global Mirror
  - z/Global Mirror Resync
  - Multi-Target Peer-to-Peer Remote Copy (MT-PPRC)

- **z-synergy Services license (zsS):**
  - Fibre Channel connection (FICON) attachment
  - Parallel Access Volumes (PAV)
  - HyperPAV (including SuperPAV)
  - High-Performance FICON for IBM Z systems (zHPF)
  - IBM z/OS Distributed Data Backup
  - zHyperLink
  - Transparent Cloud Tiering

The licensed functions are enabled through a 533\text{x} (x=1...4) licensed function indicator feature, plus a 904\text{y}-FF8 (y=6...9) licensed function authorization feature number. Consider the following points:

- The DS8000 provides Enterprise Choice warranty options that are associated with a specific machine type. The \text{x} in 533\text{x} designates the machine type according to its warranty period, where \text{x} can be 1, 2, 3, or 4. For example, a 5334-996 machine type designates a DS8950F storage system with a four-year warranty period.

- The \text{y} in 904\text{y} can be 6, 7, 8, or 9, according to the associated 5331/5332/5333/5334 base unit model. For example, a 9048-FF8 designates a DS8000 Licensed Function Authorization for a 5333 machine with a three-year warranty period.

- 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 904\text{y}-FF8 (y=6 - 9) licensed function authorization feature numbers establish the extent of authorization for that function on the 533\text{x}-99\text{z} (x=1...4, z=3...6) 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 zsS licenses are only available with the CKD (z/FICON) scope.

The base functions are mandatory. The base functions must always be configured for mainframe and open systems, which is a scope of ALL. Also, the activation of Feature Code 8300 is required to configure CKD volumes.

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 11.

Table 11: License feature codes

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

Remote code load

IBM is adopting Remote Code Load (RCL) as the default delivery and installation of microcode upgrades for the DS8900F models.

With Remote Code Load (RCL), IBM provides an efficient and secure method to update the DS8000 systems microcode in a concurrent way without interrupting business operations.

Important: IBM is adopting RCL as the default delivery for DS8900F code upgrades.

RCL (FC 0991) is the trusted process of having IBM support personnel securely connect to a DS8000 system, enable the remote acquisition, perform the distribution and activation of License Internal Code (LIC) bundles, and Install Corrective Service (ICS) images.

The RCL process is concurrent and it can be run without interruptions in the business operations. This process consists of the following steps, as shown in Figure 6 on page 26:

1. IBM Remote Support works with IBM Technical Advisors 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, IBM direct 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.
On special request, clients can decide to opt out of RCL on the initial order (FC 0990).

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 logical subsystem (LSS) configuration.

On the DS8900, the Call Home function is no longer offered through a modem. Instead, it is implemented only through an Internet SSL-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 DS8900F Architecture and Implementation, SG24-8456.

Supported environments

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

The DS8900F supports over 40 platforms. For the most current list of supported platforms, see the DS8000 System Storage Interoperation Center (SSIC) at this website.
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, or IntelliMagic Disk Magic, 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.

**Author**

This Product Guide was written by:

**Peter Kimmel** is an IT Specialist and ATS team lead of the Enterprise Storage Solutions team at the EMEA Storage Competence Center (ESCC) in Kelsterbach, Germany. He joined IBM Storage in 1999, and since then has worked with all the various IBM Enterprise Storage Server® and System Storage DS8000 generations, with a focus on architecture and performance. He was involved in the Early Shipment Programs (ESPs) of these early installations, and co-authored several DS8000 IBM publications. Peter holds a Diploma (MSc) degree in Physics from the University of Kaiserslautern.

**Related information**

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

**IBM Redbooks publications**

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

- *DS8900F Architecture and Implementation*, SG24-8456
- *IBM DS8910F Model 993 Rack-Mounted Storage System*, REDP-5566
- *IBM DS8000 High-Performance Flash Enclosure Gen2*, REDP-5422
- *DS8000 Copy Services*, SG24-8367
- *IBM System Storage DS8000 Performance Monitoring and Tuning*, SG24-8318
- *IBM DS8880 Thin Provisioning (Updated for Release 8.5)*, REDP-5343
- *IBM DS8000 Easy Tier (for DS8000 R9.0)*, REDP-4667
- *DS8870 Easy Tier Application*, REDP-5014
- *IBM DS8870 Easy Tier Heat Map Transfer*, REDP-5015
IBM Assist On-site for Storage Overview, REDP-4889
IBM DS8000 Encryption for data at rest, Transparent Cloud Tiering, and Endpoint Security, REDP-4500
IBM Fibre Channel Endpoint Security for IBM DS8900F and IBM Z, SG24-8455
IBM DS8870 and VMware Synergy, REDP-4915
DS8870 Data Migration Techniques, SG24-8257
IBM DS8870 Multiple Target Peer-to-Peer Remote Copy, REDP-5151
IBM System Storage DS8000 Copy Services Scope Management and Resource Groups, REDP-4758
IBM DS8880 Integrated Copy Services Manager and LDAP Client on the HMC, REDP-5356
Using IBM DS8000 in an OpenStack Environment, REDP-5220
IBM System Storage DS8000: Host Attachment and Interoperability, SG24-8887
DS8000 Cascading FlashCopy Design and Scenarios, REDP-5463
IBM DS8880 Safeguarded Copy, REDP-5506
IBM DS8000 Transparent Cloud Tiering, SG24-8381

Online resources

The following websites are also relevant as further information sources:

- IBM DS8900F Introduction and Planning Guide:
- IBM Knowledge Center:
  https://www.ibm.com/support/knowledgecenter/SSHGBU
- IBM Assist On-site:
  https://www.ibm.com/support/home/pages/assist-on-site/
- IBM System Storage Interoperation Center (SSIC):
  https://www.ibm.com/systems/support/storage/ssic/
- IBM data storage feature activation (DSFA):
  https://www.ibm.com/storage/dsfa/

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