IBM DS8880 Product Guide
(Release 8.51)

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Product Guide

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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.

The IBM DS8880 family includes the current models of the DS8000 series and offers business-critical, all-flash, and hybrid data systems that span a wide range of price points.

The all-flash family, machine type 533x includes the following models:

► DS8888F: Analytics Class all-flash
This model is the all-flash model 988 (533x all-flash machine type) for the highest performance demands. It offers up to two optional expansion frames 88E.

► DS8886F: Enterprise Class all-flash
These systems are the 533x all-flash machine type, model 985 (single-phase) and 986 (three-phase); They offer an optional associated expansion frames models 85E and 86E.

► DS8884F: Business Class all-flash
This system is the 533x all-flash machine type, model 984.

► DS8882F: Rack Mounted Model

The DS8882F model 983 is a modular DS8880 all-flash storage system with many of the same advanced functions as the other DS8880 systems. The DS8882F adds a modular rack-mountable enterprise storage system to the 533x all-flash machine type family. The modular system can be integrated into 16U contiguous space of an existing IBM z14™ Model ZR1 (z14 Model ZR1), IBM LinuxONE™ Rockhopper II (z14 Model LR1), or other standard 19-inch wide rack that conforms to EIA 310D specifications.

The hybrid family, machine type 283x includes:

► DS8886: Enterprise Class
These systems are the 238x hybrid machine type, model 985 (single-phase) and 986 (three-phase); they can both scale to the maximum number of five frames with their associated expansion frames models 85E and 86E.

► DS8884: Business Class
This system is the 238x hybrid machine type, model 984; It can scale to the maximum number of three frames with its associated expansion frames models 84E.

Each model represents the most recent in this series of high-performance, high-capacity, flexible, and resilient storage systems. For more information about the DS8880 families, refer to "DS8880 Families" on page 5.

This IBM Redbooks® Product Guide gives an overview of the features and functions that are available with the IBM DS8880 models running microcode Release 8.5 1(License Machine Code 7.8.51.xxx).

The IBM DS8880 architecture relies on powerful IBM POWER8® processor-based servers that manage the cache to streamline disk input/output (I/O), maximizing performance and

throughput. These capabilities are further enhanced with the availability of the *second generation* of high-performance flash enclosures (HPFE Gen2).

All DS8880 models excel at supporting the IBM Z® Enterprise server and IBM Power server environments, offering many synergy features.

Figure 1 shows front views of the DS8884 (left) and the DS8886 and DS8888F (right) base frames. As shown, the frame height for the IBM DS8886 and IBM DS8888F can be expanded from 40U to 46U. The DS8880 systems fit into a reduced footprint, 19-inch wide rack.

Figure 1   The IBM DS8884, IBM DS8886 and IBM DS8888 front views, base frame

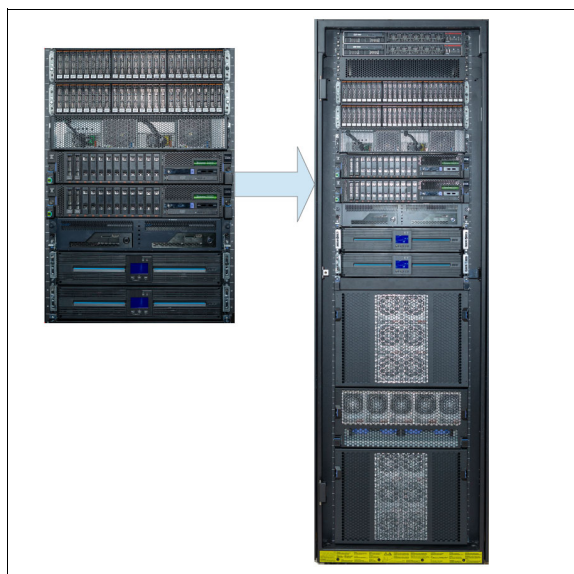Figure 2 shows the DS8882F front view (left) and then installed (right) in the IBM z14 Model ZR1.

Figure 2   DS8882F Front and installed in an IBM z14 Model ZR1

Did you know?

Here are some particular features of the IBM DS8880 family:

► With a frame width reduced from 33 inches to 19 inches, the DS8880 comes with a 42% narrower footprint than the previous DS8870 model.

► The DS8888 and DS8886 (986) models offer 3-phase power support. The DS8886 (985), the DS8884 and the DS8882F models offer single-phase power support.

► The first generation of DS8870 (IBM POWER7®) came with 1.2 billion transistors per core. The second DS8870 generation (IBM POWER7+™) came with 2.1 billion transistors per core. The DS8880 models (IBM POWER8) come with 4.2 billion transistors per core.

► The IBM DS8880 models feature the newer HPFE Gen2 for the current models (983, 984, 985, 986, and 988), which provides outstanding flash performance. The HPFE Gen2 is directly attached to the Peripheral Component Interconnect Express (PCIe) fabric by PCIe Gen3, using associated flash RAID adapters, enabling increased bandwidth and transaction processing capability.

► The DS8888F all-flash delivers up to 3 million I/O operations per second (IOPS) in distributed random I/O workload environments.

► The DS8882F is a modular rack-mountable enterprise all- flash storage system that can be integrated into 16U contiguous space of an existing IBM z14 Model ZR1 or other conforming 19-inch wide rack.

► The IBM Storage 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 Cinder (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.

► Transparent Cloud Tiering (TCT) enables a DS8880 model to migrate and recall data in cloud storage. This functionality helps to reduce MIPSe usage for Z clients during backup. It is used by DFSMShsm, the IBM TS7700, and other cloud service offerings, such as IBM Cloud™ Object Storage, and Amazon Web Services (AWS). Transparent Cloud Tiering provides the ability to use on-premises or public cloud storage for archiving data. Starting with microcode Release 8.5, data transmitted to this cloud network can be encrypted before leaving the DS8880. For more information about Transparent Cloud Tiering for DS8000 and DSHMShsm, refer to *IBM DS8880 and z/OS DFSMS: 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, refer to *IBM DS8000 Easy Tier (for DS8880 R8.5 or later)*, REDP-4667.

Product highlights

The DS8888F model 988 (with one or two 88E expansion frames) is the successor of the DS8888 982 model, which used the first-generation HPFE. The DS8886 models 985 and 986 (with 85E and 86E expansion frames) are the successors of the DS8886 981 model, which also used the first-generation HPFE. The DS8884 model 984 (with model 84E expansion frames) is the successor of the DS8884 980 model that used the first-generation HPFE.

The DS8882F rack-mounted model 983 can be considered as a successor to the IBM DS6000™, DS8100 and DS8300 systems and smaller capacity DS8700 and DS8800 systems. Given its very 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 DS8880. It is an ideal combination for IBM Z clients who have the new Z Business Classz14 Model ZR1 or LR1 with the 16U of reserved space, The DS8882F is well suited for distributed environments, with high-demanding IBM Power Systems™, or in any mainframe environment where there is not a requirement of many hundreds of terabytes of capacity.

> **Note:** For detailed information specific to the DS8882F, refer to *Introducing the IBM DS8882F Rack Mounted Storage System*, REDP-5505.

The high-end model in the DS8000 series, the DS8888F, supports 24-core processors with 1 TB system memory and 48-core processors with 2 TB, up to 128 host adapter ports, and up to 16 HPFE Gen2 pairs with up to 768 flash drives.

The DS8888F, DS8886F, DS8884F and DS8882F are all-flash models (HPFE Gen-2 flash drive enclosures only) of the 533x machine type family.

The DS8886 and DS8884 are hybrid models (a mix of standard and HPFE Gen-2 flash drive enclosures) of the 283x machine type family.

All DS8880 models support the HPFE Gen-2 flash enclosures.

All DS8880 models can be ordered with a one-year, two-year, three-year, or four-year support period.

Scalability and performance

The IBM DS8880 models feature POWER8 server technology to help support higher performance:

► The DS8880 family is available with different processor options. These options range from four sockets and 48 cores in the DS8888F to a single-socket, six-core system in the DS8882F to cover a wide-range of performance needs.

► The POWER8 simultaneous multithreading (SMT) technology allows analytic data processing clients to achieve up to 3 million IOPS in Database Open environments (70% read/30% write, 4 KB I/Os, 50% read cache hit) with 2 TB cache, 48-cores and a fully-configured HPFE Gen2 configuration.

► Memory configurations are available that range from 64 GB up to 2 TB system memory. System memory supports the operating system and functional code, disk storage cache, and disk non-volatile storage (NVS) for write data.

► The storage server architecture of the DS8880, with its powerful POWER8 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 POWER8 processors have enough processing power to implement sophisticated caching algorithms. These algorithms and the small cache segment size optimize cache hits, resulting in excellent I/O response times.

► The Adaptive Multi-stream Prefetching (AMP) caching algorithm can improve sequential performance dramatically, reducing 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 NVS until the data is destaged to hardened storage.

► Peripheral Component Interconnect Express (PCIe) Generation 3 improves sequential read/write throughput and IOPS. The I/O enclosures are directly connected to the DS8880 storage servers with point-to-point PCI Express Gen-3 cables.

► The HPFE Gen2 is populated with 2.5-inch encryption-capable flash drives on a dedicated architecture. Each HPFE Gen2 pair can contain up to 48 flash drives, with capacities ranging between 400 GB and 15.36 TB per flash drive.

► The DS8880 models are packaged in a 19-inch high-density frame.

  – The DS8888F all-flash model supports up to 768 flash drives.

  – The DS8886 (model 985) can support up to 1536 drives, plus 384 flash drives, in a small, high-density footprint (base frame and up to four expansion frames). This configuration helps to preserve valuable raised floor space in data center environments.

  – The DS8882F rack-mounted model supports up to 48 flash drives.

DS8880 Families

The DS8880 family encompasses a total of 11 models, in two machine types: The families are the All-Flash 533x machine type and the Hybrid 283x machine type. This section provides a summary the two machine types and associated models. For in-depth information about each of the models, go to "DS8880 Models" on page 26.

DS8880 All-Flash models

There are five DS8880 All-Flash models belonging to the 533x machine type. An all-flash model means the system supports only flash drives installed in HPFE Gen-2 drive enclosures.

Flash drives are either high performance (tier 0 flash drive) or high capacity (tier 1 and tier 2 flash drives) and provide the system with a balance between capacity and performance.

Multiple tiers enable the systems to take advantage of the DS8880 advanced Easy Tier function.

Models include:

► DS8888F model 988 All-Flash Analytic Class
  – Up to 3 frames
  – Up to 16 HPFE Gen-2 flash drive enclosure pairs and 768 flash drives

Figure 3 shows the DS888F model 988 with 2 expansion enclosures
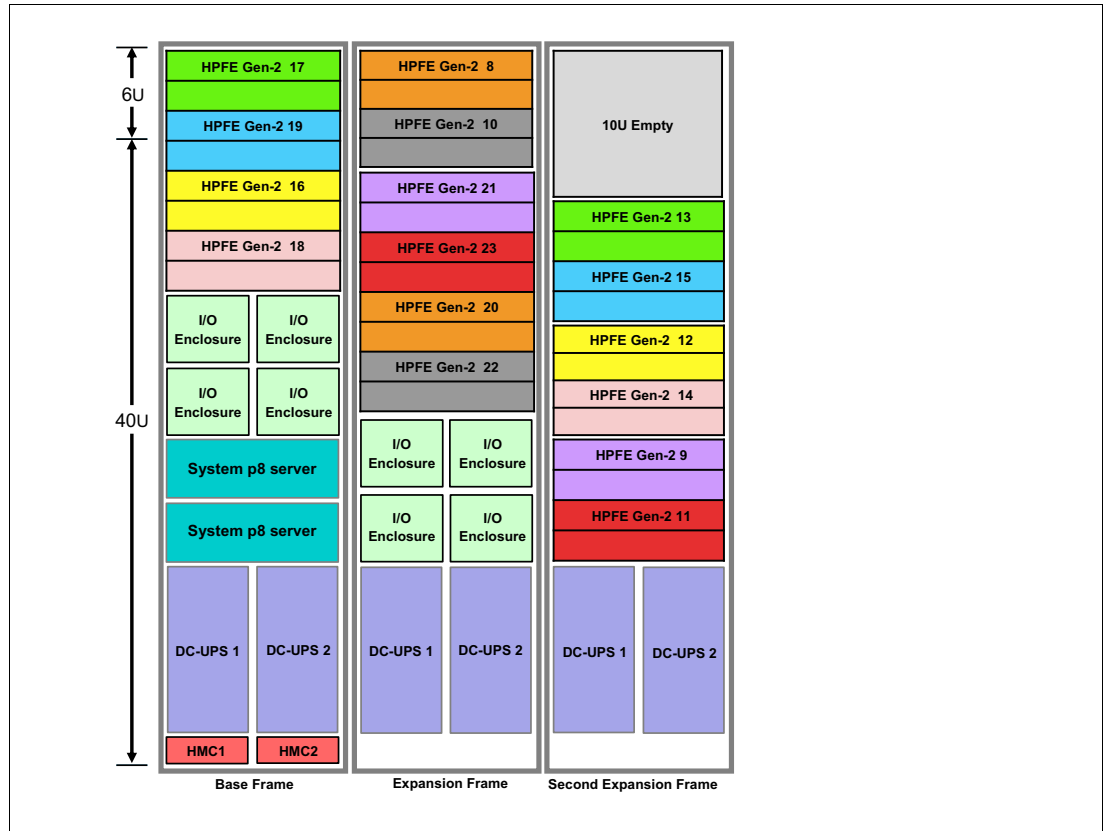

Figure 3   DS8888F model 988 with 3 frames

► DS8886F model 985 and 986 All-Flash Enterprise Class
  – DS8886 model 986 3 phase
  – DS8886 model 985 single phase
  – Up to 2 frames
  – Up to 8 HPFE Gen-2 flash drive enclosure pairs and 384 flash drives
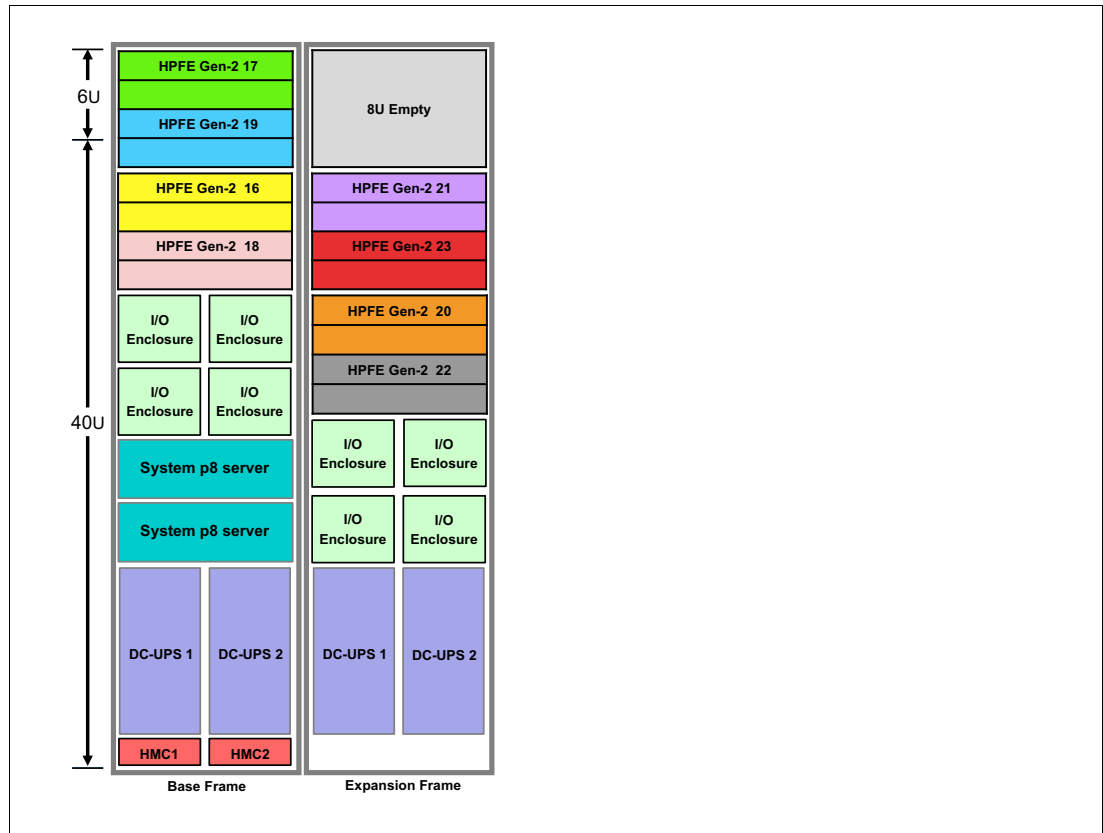
DS8886F model 986 is shown in Figure 4.

Figure 4   DS8886F Model 986 with 2 frames

► DS8884F model 984 All-Flash Business Class
   – A single base frame
   – Up to 8 HPFE Gen-2 flash drive enclosure pairs and 192 flash drives

Figure 5 shows the DS8884F model 984.

Figure 5   DS8884F model 984

► DS8882F model 983 All-Flash Rack Mounted
  – Eight 2U modules create a 16U modular DS8880 all-flash system
  – Can be integrated into IBM z14 Model ZR1 (z14 Model ZR1), IBM LinuxONE Rockhopper™ II (z14 Model LR1) with the 16U of reserved space
  – Can be integrated into any standard 19-inch wide rack that conforms to EIA 310D specifications
  – One HPFE Gen-2 flash drive enclosure pair and 48 flash drives

Refer to Figure 6.

Figure 6   DS8882F All-Flash Rack Mounted

DS8880 hybrid models

There are five DS8880 hybrid models belonging to the 283x machine type family. A hybrid model means the system supports both standard spinning drives and flash drives, providing the system with a higher total capacity and a balance between capacity and performance. Multiple tiers enable the systems to take advantage of the DS8880 advanced functions such as Easy Tier. Models include:

► DS8886 model 985 and 986 Enterprise Class
  – Up to 5 frames
  – Model 986 3 phase
  – Up to 32 standard drive enclosure pairs
  – Up to 1536 2.5 inch enterprise or 768 3.5 inch nearline drives
  – Model 985 single phase
  – Up to 30 standard drive enclosure pairs
  – Up to 1536 2.5 inch enterprise or 768 3.5 inch nearline drives
  – Both models can support up to 4 HPFE Gen-2 flash drive enclosure pairs and 192 2.5 inch flash drives

DS8886 model 986 is shown in Figure 7.

Figure 7   DS8886 model 986 with 5 frames

- DS8884 model 984 Business Class
  - Up to 3 frames
  - Up to 16 standard drive enclosure pairs
  - Up to 768 2.5 inch enterprise or 384 3.5 inch nearline drives
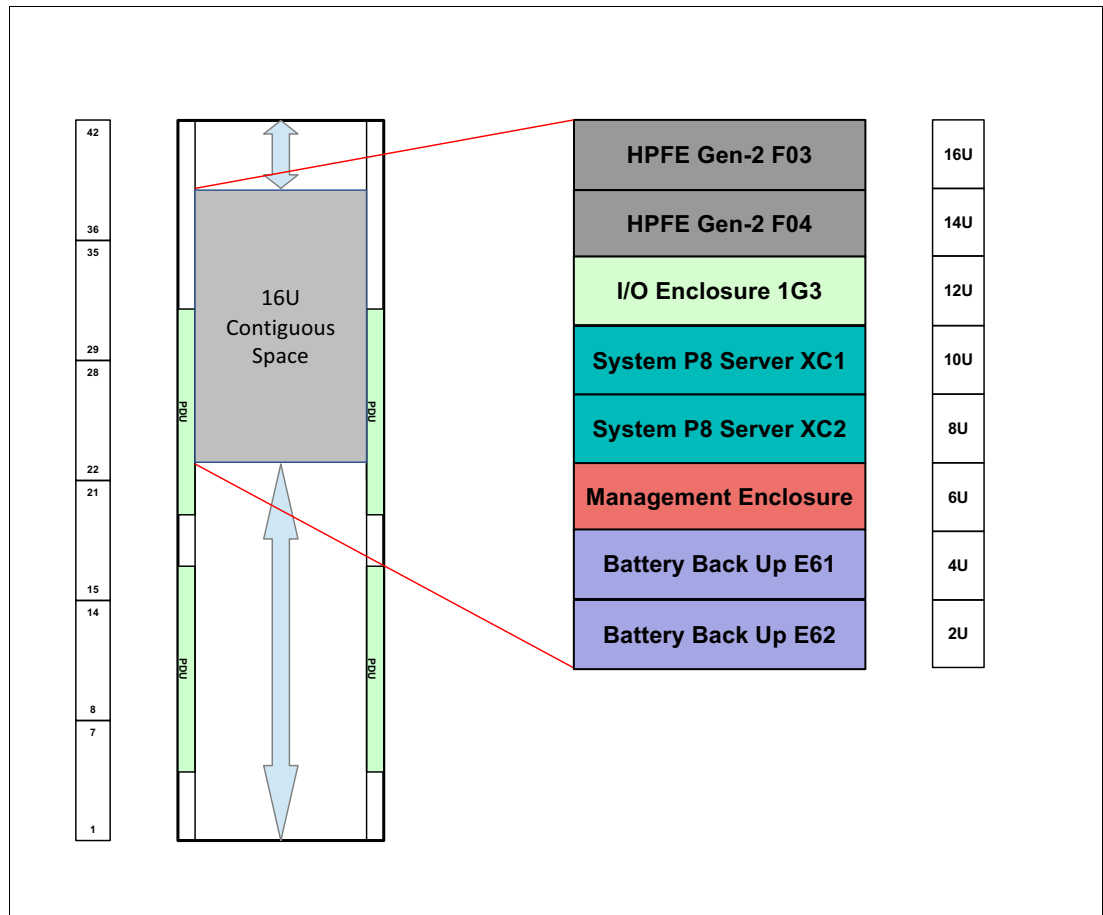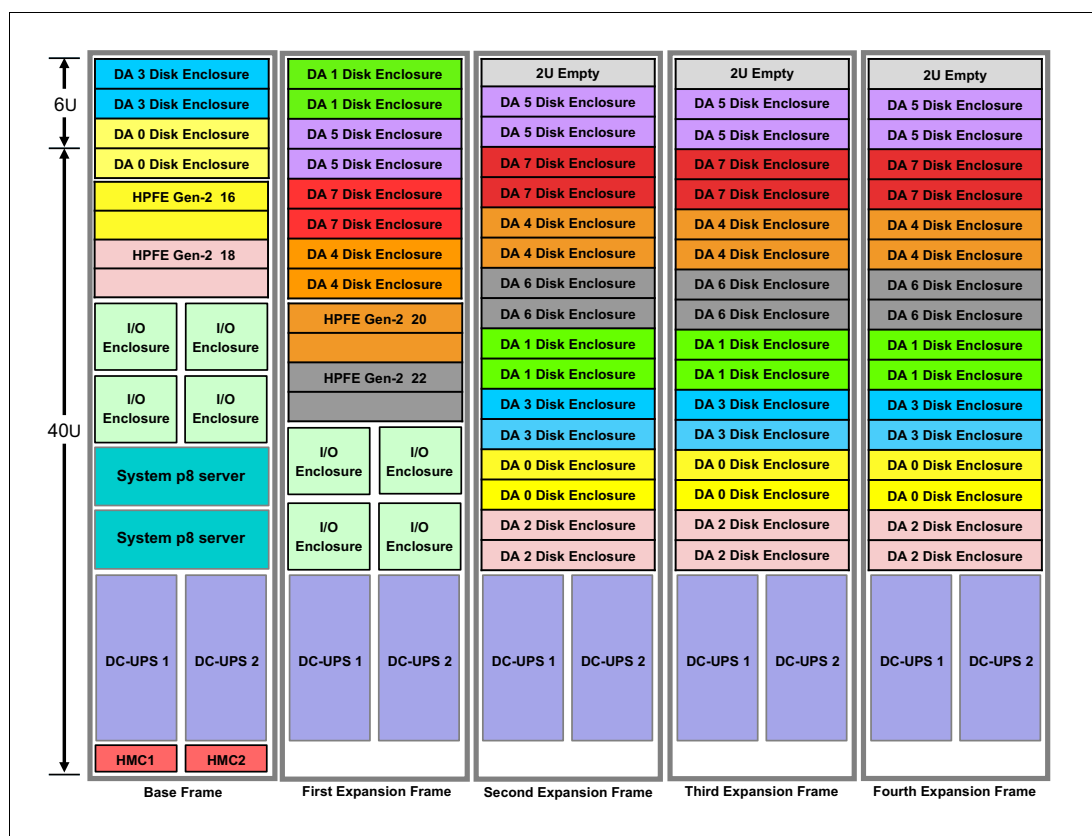 - Up to 2 HPFE Gen-2 flash drive enclosure pairs and 96 flash drives

DS8884 model 984 is shown in Figure 8.

Base Frame (40U)

| 3U Empty |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| DA 2 Disk Enclosure |
| HPFE Gen-2 18 |
| I/O Enclosure | I/O Enclosure |
| System p8 server |
| System p8 server |
| DC-UPS 1 | DC-UPS 2 |
| HMC1 | HMC2 |

First Expansion Frame

| 3U Empty |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| DA 3 Disk Enclosure |
| HPFE Gen-2 22 |
| I/O Enclosure | I/O Enclosure |
| DC-UPS 1 | DC-UPS 2 |

Second Expansion Frame

| 4U Empty |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 7 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DA 6 Disk Enclosure |
| DC-UPS 1 | DC-UPS 2 |

Figure 8   DS8884 model 984 with 3 frames

- First-generation DS8880 models
  - These models are the first-generation DS8880 models
  - The flash enclosures and drives supported in these models are the first-generation HPFE with the 1.8 inch flash drives
  - With Release 8.3 microcode, these models can support HPFE Gen-2 Flash Enclosures using the Dynamic Plug Order (DPO) support. For information about DPO see Appendix E in *IBM DS8880 Introduction and Planning Guide - Version 8 Release 5,* GC27-8525-16.
  - These models will not be discussed in detail in this product guide
  - DS8880 model 982 All-Flash
    - Up to 2 frames
    - 3 phase
    - Up to 16 HPFE flash enclosures
    - Up to 480 1.8 inch flash drives
  - DS8880 model 981 Hybrid
    - Up to 5 frames
    - 3 phase or single phase
    - Up to 32 standard drive enclosure pairs
    - Up to 1536 2.5 inch enterprise or 768 3.5 inch nearline drives
    - Up to 8 HPFE flash enclosures

- Up to 240 1.8 inch flash drives
  - DS8880 model 980 Hybrid
    - Up to 3 frames
    - Single phase
    - Up to 16standard drive enclosure pairs
    - Up to 768 2.5 inch enterprise or 384 3.5 inch nearline drives
    - Up to 4 HPFE flash enclosures
    - Up to 120 1.8 inch flash drives

Performance and IBM Z synergy

The following lists explains performance improvement function and features:

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 sub volume 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 DS8880. 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 five drive classes to create up to three tiers. The drives within a tier must be homogeneous. The following table lists the possible tier assignments for the drive classes.

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 classes.

- ► Tier 0

  - – Flash Tier 0 drives
    The highest performance drives, which provide high I/O throughput and low latency.
  - – Flash Tier 1 drives
    The first tier of high capacity drives.
  - – Flash Tier 2 drives
    The second tier of high capacity drives.

- ► Tier 1

  - – Enterprise drives
    SAS (10K or 15K RPM) disk drives.

- ► Tier 2

  - – Nearline drives
    Nearline (7.2-K RPM) disk drives, which provide large data capacity but lower performance.

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, disregarding 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 is able to provide 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 DS8880 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, as well as 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 drives (SSD), or a mix of Enterprise 15,000 and 10,000 RPM drives.

- – Starting with microcode release R8.3, Easy Tier reporting is fully integrated into the DSGUI. You can now offload the CSV files using both the DSGUI or DSCLI. Although the Storage Tier Advisor Tool (STAT) receives no further updates beyond the microcode Release 8.2, it can still be used to parse data from DS8880 systems running microcode Release 8.2 or earlier.

I/O Priority Manager

I/O Priority Manager is a feature that provides application-level quality of service (QoS) for workloads that share a storage pool. This feature provides a way to manage QoS for I/O operations that are associated with critical workloads, and gives them priority over other I/O operations that are associated with non-critical workloads. For IBM z/OS®, the I/O Priority Manager allows increased interaction with the host side.

8 Gbps FC/IBM FICON® host adapters in the DS8880 offer enhanced connectivity, with 4-port and 8-port host adapters in the I/O enclosures that are directly connected to the processor complexes. The 16 Gbps adapters are available as 4-port only. 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 comes with several generations of enhancements. Step-by-step, z/OS access methods have been converted to use the new I/O commands. zHPF is included in the DS8880 Z feature code package. The DS8880 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 interconnecting the IBM Z central electronics complexes (CECs) directly to the I/O bays of the DS8880.
Note that zHyperLink is only supported with 12 or more processor cores per DS8880 server (CEC), and a minimum of overall 256 GB processor memory. 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.

zHyperlink is not supported with the DS8882F

Parallel Access Volumes

Traditional performance features for IBM Z system environments include parallel access volumes (PAVs), HyperPAV, SuperPAV, Multiple Allegiance, I/O priority queuing, I/O Priority Manager, and zHPF. Available since Release 8.1, SuperPAV extends the previous HyperPAV capability by enabling alias devices to be used across multiple logical subsystems (LSSs).

SAN Fabric I/O Priority Management

SAN Fabric I/O Priority Management, starting with newer IBM Z system servers, extends QoS functions into the SAN fabric. As for the I/O Priority Manager with z/OS, there is cooperation between the IBM Z systems Workload Manager (WLM) and that SAN QoS function. The WLM can send the priority information of each I/O to the SAN fabric and to the DS8000, completing the management of the entire end-to-end flow of an I/O.

FICON Dynamic Routing

FICON Dynamic Routing (FIDR) is another performance-relevant function that is available with newer FICON cards, such as those provided by IBM z13® and later models. When considering the many paths in a SAN, for example with a larger number of 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 DS8880 family is designed and implemented with component redundancy to avoid potential single points of failure. The DS8880 models offer high availability and multiplatform support, including IBM Z and distributed systems:

► 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 16 Gbps adapters can operate down to 4 Gbps
- The 8 Gbps adapters can operate down to 2 Gbps

> **Note:** The DS8882F does not support 8 Gbps host adapters

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

► A nondisruptive upgrade path within each DS8880 model allows configuration upgrades for processors, memory, and storage capacity enhancement to be performed concurrently. Each DS8880 model supports a scalable upgrade path from the smallest to the largest processor configuration.

Upgrades between the DS8880 models are not possible.

Field model conversions from later DS8870 models to DS8886 are available to offer greater choices in price and performance and provide investment protection such as for recently acquired disk drives.

► The DS8880 family features Smart Rebuild, a function that is designed to help reduce the possibility of secondary failures and data loss in RAID arrays. The DS8000 series supports RAID 6 and RAID 10, as well as RAID 5 for drives smaller than 1 TB. RAID 6 is the default RAID type for most scenarios.

► 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, available for thin-provisioned volumes as well. Additionally, the Copy Services Manager (formerly known as IBM Tivoli® Productivity Center for Replication) is now preinstalled 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 has been identified as not being a valid reserve for a running server.

- Release 8.5 introduces SafeGuarded Copy. This function delivers the ability to create and retain hundreds of point-in-time copies to protect against logical data corruption or malicious destruction. 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. Refer to the IBM Redbooks publication, *IBM DS8880 SafeGuarded Copy*, REDP-5506 for details.

- 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 the deletion of 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 like 35 GB, 70 GB, 141 GB, 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.
- The DS8880 models are certified as meeting the requirements of the IPv6 Ready Logo program. This certification indicates its implementation of IPv6 mandatory core protocols and the ability to interoperate with other IPv6 implementations. They can be configured in native IPv6 environments.

  The logo program provides conformance and interoperability test specifications that are based on open standards to support IPv6 deployment globally. Furthermore, the US National Institute of Standards and Technology (NIST) tested IPv6 with the DS8000 series, thus granting it support for the USGv6 profile and testing program.

Energy efficiency

The DS8880 family has the following energy-efficient characteristics:

- The DS8880 models include a power architecture based on a direct current uninterruptible power supply (DC-UPS). DC-UPS converts incoming alternating current (AC) line voltage to rectified AC, and contains an integrated battery subsystem. DC-UPS allows the DS8880 to achieve the highest energy efficiency in the DS8000 series.

  > **Note:** DS8882F rack mounted uses two redundant battery backup modules to provide power to the system. For more detailed information about the DS8882F power system refer to *Introducing the IBM DS8882F Rack Mounted Storage System*, REDP-5505.

- Three-phase power is available for the DS8886, DS8886F (models 986), and DS8888F. Single-phase power, with smaller DC-UPS components, is available for DS8882F, DS8884, DS8884F, DS8886 and DS8886F (model 985).
- The DS8880 models are designed to comply with the ENERGY STAR specifications.
- High-density storage enclosures offer a considerable reduction in footprint and energy consumption.
- All DS8880 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 DS8880 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 DS8880 family provides a unique combination of high availability (HA), performance, and security.

To counteract the growing threat of security breaches, the DS8880 has self-encrypting drives as a standard feature. It also has security capabilities such as broad-based access-control and tamper-proof audit logging, and other security features needed to comply with regulatory authorities:

- Self-encrypted drives are a standard feature. IBM Security Key Lifecycle Manager (SKLM) is mostly used as the encryption key management software. Starting with Release 8.5, support for OASIS Key Management Interoperability Protocol (KMIP) is available with for 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 DS8880 Data-at-rest Encryption*, 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.

► With Release 8.5, you can also encrypt data transmitted to the Cloud when using the Transparent Cloud Tiering feature. For more information, see *IBM DS8880 Data-at-rest Encryption*, REDP-4500.

► Security improvements in the DS8880 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 made to the logical configuration can now be stored on separate syslog servers by using the rsyslog protocol.

► 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 DS8880 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 DS8880 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 DS8880 family has the following advanced functions:

► The DS8880 provides DS Storage Manager (the graphical user interface, or GUI) and DS command-line interface (CLI) management interfaces to configure the system or query status information. The DS8880 DS GUI has the same look and feel as the GUIs of other IBM storage products, making it easier for a storage administrator to work with different IBM storage products. The DSCLI and DS WUI have now been 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

► For Count Key Data (CKD) devices, two extent sizes are available: large extents based on 3390 Mod1 volumes with 1113 cylinders or small extents with 21 cylinders per extent. This includes volumes with thin provisioning.

- ► Quick Initialization provides fast volume initialization for Open Systems logical unit numbers (LUNs) and CKD volumes. It allows the creation of devices, making them available as soon as the command completes.
- ► The following list shows advanced Copy Services features 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, refer to *DS8000 Cascading FlashCopy Design and Scenarios*, REDP-5463. FlashCopy can be used to perform backup operations parallel to production or to create test systems.
  - – Release 8.5 introduces SafeGuarded Copy. This function delivers the ability to create and retain hundreds of point-in-time copies to protect against logical data corruption or malicious destruction. 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. Refer to the IBM Redbooks publication, *IBM DS8880 SafeGuarded Copy*, REDP-5506 for details.
  - – The DS8880 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. Asynchronous copy (Global Mirror) is supported for unlimited distances. Three-site options are available by combining Metro Mirror and Global Mirror. When using Multi-Target Peer-to-Peer Remote Copy (PPRC), which has been available since DS8870, with all involved storage systems required to be on a minimum R7.4 code level, 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 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) preinstalled on the DS8880 HMC with Release 8.1 or later or using existing 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 DS8880 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 are using the logical devices.
  - – In co-operation 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, keeping 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, and 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 DS8880 models provide support for 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, and the Zeroing Blocks primitive.

► The DS8880 models support VASA 2.0, and the RESTful API.

► The DS8880 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 DS8880 architecture.

> **Important:** The DS8882F Rack Mounted model has some architectural differences to the other DS8880 models described in this Product Guide. For more information about the DS8882F, see *Introducing the IBM DS8882F Rack Mounted,* REDP-5505.

IBM POWER8 processor technology

A pair of POWER8-based servers, also known as *central processor complexes* (CPCs), are at the heart of the IBM DS8880 models.

These two POWER8 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 POWER8 processors operate at cycle frequencies 3.52 - 3.89 GHz (Gigahertz) and can scale from 6-core processors (DS8882F, DS8884 and DS8884F) to 48-core processors (DS8888F). Among other innovations, the IBM POWER® processor includes SMT modes like 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 POWER8 multi-core architecture has been matched with a wide range of related technology innovations to deliver leading throughput, efficiency, scalability, and reliability.

Internal PCIe-based fabric

The DS8880 fabric has the following specifications:

► DS8880 POWER8 servers are based on PCI Express (PCIe) Gen3 architecture to provide up to 16-lane (x16) high-speed connectivity to the internal adapter cards.

► Up to four dual-port PCIe Gen3 adapters provide point-to-point connectivity to the IO enclosures. The IO enclosures provide connectivity between the IO adapters and the POWER8 processor complexes. The internal transfer rate to each IO enclosure is four times faster compared to the DS8870, which used PCIe Gen2.

► The IO enclosures provide PCIe Gen3 connectivity to all installed Host and Device Adapters. Release 8.2 introduced a newer I/O enclosure, which features six PCIe x8 adapter slots and has four additional 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 contains the following adapters.

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 connection using PCIe Gen3 with a maximum distance of 150 meters. It connects the IBM Z system central processing complexes (CPCs) directly to the zHyperLink ports of the I/O enclosure of a DS8880 system. In each I/O enclosure, there are two additional ports for the new zHyperLink capability. For small-block reads, response times below 20 μs have been achieved for I/Os qualifying for zHyperLink.

For a DS8880 to enable zHyperLink, it needs to have at least 12 processor cores per processor complex. The DS8884 and DS8884F models can be upgraded from a dual 6-core to a dual 12-core machine to provide this functionality.

The DS8882F model does not support zHyperLink.

Flash RAID adapters

The flash RAID adapters are PCIe adapters that are either installed in the DS8880 IO enclosures, or remotely connected to the IO enclosures through PCIe cables.

The flash RAID adapters have a PCIe Gen3 eight lane connection to the IO enclosures, which provide PCIe connectivity to the processor nodes of the DS8880.

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 has 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 IO enclosure pair. This 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 there is a flash RAID adapter or a logical IO enclosure failure.

The DS8880 flash RAID adapter is specifically designed for connectivity and management of the DS8880 HPFE Gen2.

The DS8880 flash RAID adapter is available in three different form factors, depending on the DS8880 model and location within that model. Internally, the three different form factors have the same core hardware and function.

To differentiate between the three form factors, the unique naming and features. They are as follows:

► Microbay flash RAID adapter

   – Remotely connected to the IO enclosures by a PCIe3 x8 cable to a stand-alone enclosure
   – Connects to HPFE Gen2 pairs in models 984, 985, 986 and the first eight HPFE Gen2 pairs for model 988
   – The microbay enclosure has its own power supplies and integrated cooling
   – Feature code 1600 is a pair of HPFE Gen2 storage enclosures, and a pair of Microbay flash RAID adapters and all associated cabling

► SAS flash RAID adapter

   – Installed directly into a PCIe3 x8 adapter slot in the IO enclosure
   – Connects to HPFE Gen2 pairs nine to sixteen in model 988
   – Feature code 1602 is a pair of HPFE Gen2 storage enclosures (no flash RAID adapters)
   – Feature code 1604 is a pair SAS flash RAID adapters and associated cabling

► Base IO expander with flash RAID adapter

   – Is a PCIe3 x8 adapter that is physically embedded into the base PCIe IO expander, which is installed in the DS8882F 2U IO enclosure
   – Exclusively available only in the DS8882F model 983

Switched Fibre Channel arbitrated loop and device adapters

The DS8880 Device Adapters (DA) are configured for high performance and availability:

► The standard drive enclosures connect to the processor complexes through four-port FC-AL DAs. These adapters are optimized for Flash Drive (SSD) technology and designed for long-term scalability.

► The DS8880 uses a switched Fibre Channel Arbitrated Loop (FC-AL) topology to connect the DAs to the standard drive enclosures. Switched FC-AL uses the FC-AL protocol, but the physical topology is that of a switched FC SAN fabric, with each drive connection acting as an independent FC-AL loop. Switched FC-AL topology includes the following key features:

   – Standard FC-AL communication protocol from DA to drives
   – Point-to-point connections established between DA and drives
   – Isolation capabilities during drive failures, providing easy problem determination
   – Predictive failure statistics
   – Simplified expansion, where no cable rerouting is required when another storage enclosure is added

► The DS8880 architecture uses dual-redundant, switched FC-AL connections to each of the storage enclosures. This configuration features the following key benefits:

   – Two independent switched FC-AL networks provide high-performance connections to drives

- – Four access paths are available to each drive
- – Each DA port operates independently
- – The configuration provides double the bandwidth of traditional FC-AL loop implementations

Host adapters

The DS8880 offers 16 Gbps Host Adapters (HAs) with four ports, and 8 Gbps HAs with either four or eight ports. Each HA port can be individually configured for FC or FICON connectivity. The 8 Gbps adapters also support FC-AL connections. Configuring multiple host connections across multiple HAs in multiple I/O enclosures provides the best combination of throughput and fault tolerance.

Storage enclosures

The DS8880 supports two types of storage enclosures:

- ► High-performance flash enclosure Gen 2 (HPFE Gen2)
  - – Support high performance or high capacity flash drives

- ► Standard drive enclosures

  - – Support flash drives (SSDs) or spinning drives

High-Performance Flash Enclosure Gen-2

The High-Performance Flash Enclosure Gen2 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 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 connected to the four SAS Expander Modules providing fully-redundant access from each RAID adapter to both 2U enclosures
  - – Integrated cooling

Figure 9 shows the HPFE Gen2.

Figure 9   Front and rear view of the HPFE

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

  – 400 GB
  – 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

  – 7.68 TB
  – 15.36 TB

Note: Intermix of high performance (flash tier 0) and high capacity (Flash Tier 1, 2) drives in same HPFE Gen2 pair is not supported

For more information about the HPFE Gen2, associated flash RAID adapters and flash drives, refer to the *IBM DS8880 High-Performance Flash Enclosure Gen2*, REDP-5422.

Standard drive enclosures

The standard drive enclosure is a 2U storage enclosure that is installed in pairs.

Each standard drive enclosure contains the following hardware components:

► Up to 24 small form factor (SFF), 2.5-inch SAS drives, or
► Up to 12 large-form factor (LFF), 3.5-inch drive enclosures
► Two power supplies with integrated cooling fans
► Two Fibre Channel interconnect cards that connect four Fibre Channel 8 Gbps interfaces to a pair of device adapters or another standard drive enclosure
► One back plane for plugging components

Standard drive enclosure drives

The 2.5-inch disk drives and flash drives (SSDs) are available in sets of 16 drives. Figure 10 shows the standard drive enclosures (SFF and LFF configuration).
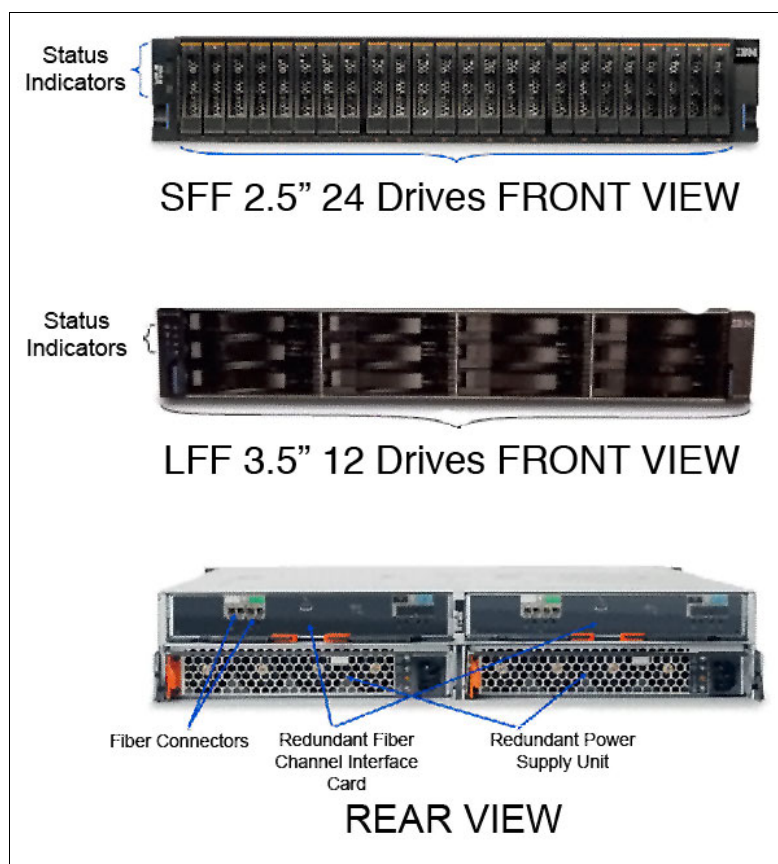

Figure 10   The standard drive enclosures (SFF and LFF configuration)

The following 2.5 inch disk drives and flash drives (SSDs) are available:

► 2.5-inch flash drives (SSDs) with FDE

   – 400 GB
   – 800 GB
   – 1.6 TB

► 2.5-inch disk drives with FDE

   – 300 GB, 15K RPM
   – 600 GB, 15K RPM
   – 600 GB, 10K RPM
   – 1.2 TB, 10K RPM
   – 1.8 TB, 10K RPM

Note: Intermix of disk drives and flash drives (SSDs) in the same enclosure pair is not supported

The 3.5-inch SAS disk drives are available in half-drive sets of eight drives.

The following 3.5 inch disk drives are available:

► 6 TB, 7.2K RPM, 3.5-inch disk drives with FDE

Power subsystem

The DS8884F, DS8884 (models 984), DS8886F and DS8886 (models 985), use single-phase power, and support input voltages of 200–240 Vac.

The DS8886F, DS8886 (models 986) and DS8880F, use three-phase power, and support input voltages of 200–240 Vac or 380-415 Vac.

The DS8880 power subsystem has the following characteristics:

► The DS8880 power subsystem is based on DC-UPS with integrated battery sets. The single-phase DC-UPS has been made a lot more compact than on earlier DS8000 models, using just 8U of space. The three-phase DC-UPS uses 12U of space.

► DC-UPS delivers greater levels of efficiency over the primary power supplies (PPSs) used in previous generations of the DS8000 series. The power subsystem in the DS8880 complies with the current directives for the RoHS, and is engineered to comply with US Energy Star guidelines.

► Each frame contains two DC-UPS power supplies in a redundant active-active configuration. Each frame has two input power cords, each feeding a single DC-UPS. If input AC is not present on one power cord, the associated DC-UPS continues to operate by using rectified AC from the partner DC-UPS, with no reduction of system power redundancy. If neither AC input is active, the DC-UPSs switch to battery power.

Each DC-UPS has its own battery-backup functions. Therefore, the battery system also provides 2N redundancy. The battery of a single DC-UPS is able to preserve NVS in a complete power outage. The battery module is called a battery service module (BSM).

The BSM helps protect data during a loss of external power. During a complete loss of AC input power, the batteries are used to maintain power to the processor complexes and I/O enclosures long enough to allow the contents of NVS memory (modified data that is not yet destaged from cache to drives) to be written to the internal hard disk drives in the processor complexes. After power has been restored, the preserved modified data will be destaged to the processor complex hard disk drives.

Other key elements of the power subsystem include the following components:

► The rack power control (RPC) cards manage the power subsystem, providing functions of control, monitor, and reporting. There are two RPC cards for redundancy.

► The power control network (PCN) provides power control and monitoring for the installed I/O enclosures.

The standard power feature of all DS8884, DS8886 and DS8888 models offers a 4-second full-rack battery backup for power line disturbance (PLD) ride through. An extended power line disturbance (ePLD) feature is available, bringing this duration to 40 seconds.

Hardware Management Console

The mini PC HMC is a Linux-based server that enables users to interact with the DS8880 by using the HMC GUI (for service purposes) or DS Storage Manager/DS CLI (for storage administration or configuration).

A *secondary management console* is available as an optional feature and as a redundant management console for environments with high-availability requirements (mandatory for DS8882F, or with the Copy Services license).

With the introduction of the Mini HMC, the secondary HMC is installed in the DS8880 base frame, eliminating the requirement for external rack space. If Copy Services are being used, a redundant management console configuration is required. In addition, Copy Services Manager (formerly known as Tivoli Productivity Center for Replication) is now 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 DS8880 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 DS8880 base frame has 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 DS8880 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 DS8880 private network only.
> No client network connection should ever be made directly to these internal switches.

DS8880 Models

The DS8880 delivers extensive scalability. The DS8880 is composed of two machine type families:

► The all flash 533x machine type

– An all-flash model means the system supports only high performance and high capacity flash drives installed in HPFE Gen-2 drive enclosures

► The Hybrid 283x machine type

– A hybrid model means the system supports spinning drives and flash drives (SSDs) installed in standard drive enclosures and high performance and high capacity flash drives installed in HPFE Gen-2 drive enclosures

DS8880 all flash 533x machine type models

DS8888F (machine type 533x models 988 and 88E)

The DS8888F (machine type 533x models 988 and 88E) is a high-performance, high-efficiency, high-capacity storage system that includes only High-Performance Flash Enclosures Gen2.

DS8888F storage systems (machine type 533x models 988 and 88E) are scalable with up to 48-core processors, 16 High-Performance Flash Enclosures Gen2 pairs, and up to 768 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. They are optimized and configured for cost. The frame is 19 inches wide with a 46U capacity. They support the following storage enclosures:

► Up to 4 High-Performance Flash Enclosure Gen2 pairs in the base frame (model 988)
► Up to 6 High-Performance Flash Enclosure Gen2 pairs each in the first expansion frame (model 88E)
► Up to 6 High-Performance Flash Enclosure Gen2 pairs each in the second expansion frame

The following tables list the hardware components and maximum capacities that are supported for the DS8888F (models 988 and 88E), depending on the amount of memory that is available.

Table 1   Components for the DS8888F (machine type 533x models 988 and 88E)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	HPFE Gen2 pairs	Expansions frames
24-core	1024	2	2 - 16	1 - 4	0
48-core	2048	4	2 - 32	1 - 16	0 - 2

Table 2   Components for the DS8888F (machine type 533x models 988 and 88E)

Processors	System memory (GBs)	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity [1]	Maximum total drives
24-core	1,024	192	2,949 TB	192
48-core	2,048	768	11,796 TB	768
1. Using 15.36TB flash tier 2 drives				

DS8886F (machine type 533x models 985 and 85E or 986 and 86E)

The DS8886F (machine type 533x models 985/85E and 986/86E) is a high-density, high-performance, high-capacity storage system that includes High-Performance Flash Enclosures Gen2.

The DS8886F models 985 and 85E support single-phase power. The DS8886F models 986 and 86E support three-phase power.

DS8886F (machine type 533x models) storage systems are scalable with up to 24-core processors, and up to 384 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives. They are optimized and configured for performance and throughput by maximizing the number of paths to the storage enclosures.

The frame is 19 inches wide and 46U high. They support the following storage enclosures:

- ▶ Up to 4 High-Performance Flash Enclosure Gen2 pairs in a base frame (model 985 or 986)
- ▶ Up to 4 High-Performance Flash Enclosure Gen2 pairs in an expansion frame (model 85E or 86E)

The following tables list the hardware components and maximum capacities that are supported for the DS8886F (machine type 533x models 985/85E and 986/86E), depending on the amount of memory that is available.

Table 3   Components for the DS8886F (machine type 533x models 985/85E and 986/86E)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	HPFE Gen2 pairs	Expansions frames
8-core	128	2	2 - 16	1 - 4	0
8-core	256	2	2 - 16	1 - 4	0
16-core	256	4	2 - 32	1 - 8	0 - 1
16-core	512	4	2 - 32	1 - 8	0 - 1
24-core	1024	4	2 - 32	1 - 8	0 - 1
24-core	2048	4	2 - 32	1 - 8	0 - 1

Table 4   Maximum capacity for the DS8886F (machine type 533x models 985/85E and 986/86E)

Processors	System memory (GBs)	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity [1]	Maximum total drives
8-core	128	192	2949 TB	192
8-core	256	192	2949 TB	192
16-core	256	384	5898 TB	384
16-core	512	384	5898 TB	384
24-core	1024	384	5898 TB	384
24-core	2048	384	5898 TB	384
1. Using 15.36 TB flash tier 2 drives				

DS8884F (machine type 533x model 984)

The DS8884F is an entry-level, high-performance, high-capacity storage system that includes only High-Performance Flash Enclosures Gen2.

The DS8884F storage systems feature 6-core (12-core with zHyperLink support) 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 DS8884F supports up to four High-Performance Flash Enclosure Gen2 pair in a base frame (model 984). The DS8884F supports single-phase power.

The following tables list the hardware components and maximum capacities that are supported for the DS8884F, depending on the amount of memory that is available.

Table 5   Components for the DS8884F (machine type 533x model 984)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	HPFE Gen2 pairs	Expansions frames
6-core	64	1	2 - 8	1	N/A
	128	1 - 2	2 - 16	1 - 4	
	256				
12-core[1]	256				
1. 12-core processors are supported only with zHyperLink					

Table 6   Maximum capacity for the DS8884F (machine type 533x model 984)

Processors	System memory (GBs)	Maximum flash tier 0, 1,or 2 drives	Maximum storage capacity [1]	Maximum total drives
6-core	64	96	1475 TB	96
	128	192	2949 TB	192
	256			
12-core[2]	256			
1. Using 15.36 GB flash tier 2 drives 2. 12-core processors are supported only with zHyperLink				

DS8882F (machine type 533x model 983)

The DS8882F is an entry-level, high-performance storage system that includes only High-Performance Flash Enclosures Gen2. It is based on the same architecture as the rest of the DS8880F family.

The DS8882F storage system features 6-core processors and supports one High-Performance Flash Enclosure Gen2 pair with up to 48 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives.

The following tables list the hardware components and maximum capacity that is supported for the DS8882F.

Table 7   Components for the DS8882F (machine type 533x model 983)

Processors	System memory (GBs)	IO enclosure	Host adapters (4 Port)	HPFE Gen2 pairs
6-core	64	1	2 or 4	1
	128			
	256			

Table 8   Maximum capacity for the DS8882F (machine type 533x model 983)

Processors	System memory (GBs)	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity [1]	Maximum total drives
6-core	64	48	737 TB	48
	128			
	256			
1. Using 15.36 TB flash tier 2 drives				

DS8880 hybrid 283x machine type models

DS8886 (machine type 283x models 986 and 86E)

The DS8886 (machine type 283x models 986 and 86E) is a high-density, high-performance, high-capacity storage system that includes standard disk enclosures and High-Performance Flash Enclosures Gen2, and supports single-phase power.

DS8886 (machine type 283x models 986 and 86E) storage systems are scalable with up to 24-core processors, up to 192 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives, and up to 1,440 standard drives. They are optimized and configured for performance and throughput, by maximizing the number of device adapters and paths to the storage enclosures. The frame is 19 inches wide and expandable from 40U - 46U. They support the following storage enclosures:

► Up to 2 standard drive enclosure pairs and up to 2 High-Performance Flash Enclosure Gen2 pairs in a base frame (model 986)
► Up to 4 standard drive enclosure pairs and up to 2 High-Performance Flash Enclosure Gen2 pairs in a first expansion frame (model 86E)
► Up to 9 standard drive enclosure pairs in a second expansion frame
► Up to 9 standard drive enclosure pairs in a third expansion frame
► Up to 9 standard drive enclosure pairs in a fourth expansion frame.

The following tables list the hardware components and maximum capacities that are supported for the DS8886 (models 986 and 86E), depending on the amount of memory that is available.

Table 9   Components for the DS8886 (machine type 283x models 986 and 86E)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	Device adapter pairs	Standard drive enclosure pairs[1]	HPFE Gen2 pairs[1]	Expansion frames
8-core	128	2	2 - 16	0 - 3	0 - 2	0 - 2	0
	256						
16-core	256	4	2 - 32	0 - 8	0 - 30	0 - 4	0 - 4
	512						
24-core	1024						
	2048						

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	Device adapter pairs	Standard drive enclosure pairs[1]	HPFE Gen2 pairs[1]	Expansion frames
1. This configuration of the DS8880 must be populated with either one standard drive enclosure pair or one High-Performance Flash Enclosure Gen2 pair							

Table 10   Maximum capacity for the DS8886 (machine type 283x models 986 and 86E)

Processors	System memory	Maximum 2.5-in standard disk drives	Maximum storage capacity 2.5-in standard disk drives[1]	Maximum 3.5-in standard disk drives	Maximum storage capacity 3.5-in standard disk drives[2]	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity flash tier 0, 1, or 2 drives[3]	Maximum total drives[4]
8-core	128	96	173 TB	48	288 TB	96	1475 TB	192
	256							
16-core	256	1440	2.59 PB	720	4.32 PB	192	2949 TB	1632
	512							
24-core	1024							
	2048							
1. Using 1.8TB 2.5-in standard disk drive 2. Using 6TB 3.5-in standard disk drive 3. Using 15.36TB flash tier 2 drives 4. Combined total of 2.5-in. disk drives and 2.5-in. Flash Tier 0, 1 or 2 drives								

DS8886 (machine type 283x models 985 and 85E)

The DS8886 (machine type 283x models 985 and 85E) is a high-density, high-performance, high-capacity storage system that includes standard disk enclosures and High-Performance Flash Enclosures Gen2, and supports single-phase power.

DS8886 (machine type 283x models 985 and 85E) storage systems are scalable with up to 24-core processors, up to 192 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives, and up to 1,536 standard drives. They are optimized and configured for performance and throughput, by maximizing the number of device adapters and paths to the storage enclosures. The frame is 19 inches wide and expandable from 40U - 46U. They support the following storage enclosures:

► Up to 3 standard drive enclosure pairs and up to 2 High-Performance Flash Enclosure Gen2 pairs in a base frame (model 985)
► Up to 5 standard drive enclosure pairs and up to 2 High-Performance Flash Enclosure Gen2 pairs in a first expansion frame (model 85E)
► Up to 9 standard drive enclosure pairs in a second expansion frame
► Up to 9 standard drive enclosure pairs in a third expansion frame
► Up to 6 standard drive enclosure pairs in a fourth expansion frame.

The following tables list the hardware components and maximum capacities that are supported for the DS8886 (models 985 and 85E), depending on the amount of memory that is available.

Table 11   Components for the DS8886 (machine type 283x models 985 and 85E)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	Device adapter pairs	Standard drive enclosure pairs[1]	HPFE Gen2 pairs[1]	Expansion frames
8-core	128	2	2 - 16	0 - 3	0 - 3	0 - 2	0
	256						
16-core	256	4	2 - 32	0 - 8	0 - 32	0 - 4	0 - 4
	512						
24-core	1024						
	2048						

► This configuration of the DS8880 must be populated with either one standard drive enclosure pair or one High-Performance Flash Enclosure Gen2 pair

Table 12   Maximum capacity for the DS8886 (machine type 283x models 985 and 85E)

Processors	System memory	Maximum 2.5-in standard disk drives	Maximum storage capacity 2.5-in standard disk drives[1]	Maximum 3.5-in standard disk drives	Maximum storage capacity 3.5-in standard disk drives[2]	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity flash tier 0, 1, or 2 drives[3]	Maximum total drives[4]
8-core	128	144	259 TB	72	432 TB	96	1475 TB	240
	256							
16-core	256	1536	2.76 PB	768	4.61 PB	192	2949 TB	1728
	512							
24-core	1024							
	2048							

1. Using 1.8 TB 2.5-in standard disk drive
2. Using 6 TB 3.5-in standard disk drive
3. Using 15.36 TB flash tier 2 drives
4. Combined total of 2.5-in. disk drives and 2.5-in. Flash Tier 0, 1, or 2 drives

DS8884 (machine type 283x models 984 and 84E)

The DS8884 is an entry-level, high-performance, high-capacity storage system that includes standard disk enclosures and High-Performance Flash Enclosures Gen2.

The DS8884 storage systems feature 6-core (12-core with zHyperLink support) processors and are scalable and support up to 96 Flash Tier 0, Flash Tier 1, or Flash Tier 2 drives, and up to 768 standard drives. They are optimized and configured for cost, by minimizing the number of device adapters and maximizing the number of storage enclosures that are attached to each storage system. The frame is 19 inches wide and 40U high. The DS8884 supports single-phase power.

The DS8884 model 984 supports the following storage enclosures:

- ► Up to 4 standard drive enclosure pairs and up to 1 High-Performance Flash Enclosure Gen2 pair in a base frame (model 984)
- ► Up to 5 standard drive enclosure pairs and up to 1 High-Performance Flash Enclosure Gen2 pair in a first expansion frame (model 84E)
- ► Up to 7 standard drive enclosure pairs in a second expansion frame (model 84E)

The following tables list the hardware components and maximum capacities that are supported for the DS8884 (models 984 and 84E), depending on the amount of memory that is available.

Table 13   Components for the DS8884 (machine type 283x models 984 and 84E)

Processors	System memory (GBs)	IO enclosure pairs	Host adapters (4 or 8 Port)	Device adapter pairs	Standard drive enclosure pairs[1]	HPFE Gen2 pairs[1]	Expansion frames
6-core	64	1	1	0 - 1	0 - 4	0 - 1	0
	128	2	2	0 - 4	0 - 16	0 - 2	0 - 2
	256						
12-core[2]	256						

1. This configuration of the DS8880 must be populated with either one standard drive enclosure pair or one High Performance Flash Enclosure Gen2 pair
2. 12-core processors are supported only with zHyperLink

Table 14   Maximum capacity for the DS8884 (machine type 283x models 984 and 84E)

Processors	System memory	Maximum 2.5-in standard disk drives	Maximum storage capacity 2.5-in standard disk drives[1]	Maximum 3.5-in standard disk drives	Maximum storage capacity 3.5-in standard disk drives[2]	Maximum flash tier 0, 1, or 2 drives	Maximum storage capacity flash tier 0, 1, or 2 drives[3]	Maximum total drives[4]
6-core	64	192	346 TB	96	576 TB	48	737 TB	240
	128	768	1.38 PB	384	2.3 PB	96	1475 TB	864
	256							
12-core[5]	256							

1. Using 1.8 TB 2.5-in standard disk drive
2. Using 6 TB 3.5-in standard disk drive
3. Using 15.36 TB flash tier 2 drives
4. Combined total of 2.5-in. disk drives and 2.5-in. Flash Tier 0, 1, or 2 drives
5. 12-core processors are supported only with zHyperLink

DS8880 weight specifications and dimensions

Table 15 summarizes the weight specifications and dimensions for the DS8884, DS8886, and DS8888 base and expansion frames, including casters and covers.

Table 15   DS8880 dimensions and weights. Base frame and first expansion frame shown

Model	Dimensions	Maximum weight
DS8884 Model 984	Height 193 cm (76 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	976 kg (2151 lb)
DS8886 Model 985	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	1144 kg (2520 lb)
DS8886 Model 986	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	1099 kg (2421 lb)
DS8880 Model 988	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	1080 kg (2380 lb)
DS8880 Model 84E (first expansion frame)	Height 193 cm (76 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	1040 kg (2290 lb)
DS8880 Model 85E (first expansion frame)	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	1116 kg (2460 lb)
DS8880 Model 86E (first expansion frame)	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	953 kg (2100 lb)
DS8880 Model 88E (first expansion frame)	Height (without top expansion) 193 cm (76 in.) Height (with top expansion) 220 cm (86.5 in.) Width 64 cm (25 in.) Depth 144 cm (56.5 in.)	908 kg (2000 lb)

Table 16 summarizes the weight specifications and dimensions for the DS8882F rack-mounted system.

Table 16   DS8882F Dimensions and weight

Dimensions		Maximum Weight
Height without optional keyboard and display	71.1 cm (28 in.)	242.7 kg (535 lb)
Height with optional keyboard and display	75.6 cm (29.8 in.)	
Distance between rack front and rear EIA rails	70.1 - 78 cm (27.6 - 30.7 in.)	
Minimum distance from cabinet rear rail to rear door	20.3 cm (8 in.)	
Minimum distance from cabinet front rail to front door	5 cm (2 in.)	

DS8880 systems are designed to operate in a temperature range of 16–32 °C.

Table 17 shows power consumption figures and environmental information for DS8880 models

Table 17   Power consumption and environmental information (fully equipped frames)

Measurement	Unit of measure	Base frame Model	Expansion frame Model
Peak electric power	Kilovolt-amperes (kVA)	983: 3.0 (single-phase) 984: 4.9 (single-phase) 985: 6.7 (single-phase) 986: 6.2 (three-phase) 988: 8.1 (three-phase)	N/A 84E: 4.3 (single-phase) 85E: 6.7 (single-phase) 86E: 6.4 (three-phase) 88E: 4.4 (three-phase)
Thermal load	British thermal units (BTU) per hour	983:10236 (Single phase) 984:16595 (single-phase) 985:22886 (single-phase) 986:21020 (three-phase) 988:27715 (three-phase)	N/A 84E: 14795 (single-phase) 85E: 22971 (single-phase) 86E: 21743 (three-phase) 88E: 15062 (three-phase)
Capacity of exhaust	Cubic meters per min. (cubic feet per minute (CFM))	983:22.7 (800) 984/5/6/8:44.2 (1500)	N/A 984/5/6/8:51.8 (1800)
Ground leakage current	milliamperes (mA)	983:11 984/5/6/8:43	N/A 984/5/6/8:43
Startup current	amperes (A or amp)	983: ≤ 100 984/5/6/8: ≤ 100	N/A 984/5/6/8: ≤ 100
Startup current duration	microseconds (μs or μsec)	983:<200 984/5/6/8:<200	N/A 984/5/6/8:<200

For more information about DS8880 power and environmentals, see the *IBM DS8880 Introduction and Planning Guide*, GC27-8525. For more information about the DS8882F power and environmentals, see *IBM DS8882F storage system Introduction and Planning Guide,* GC27-9259.

Other configuration features

This section highlights the main features, upgrades, and options that can be requested with new DS8880 orders or installed later.

► A secondary HMC can be ordered as a redundant HMC to provide continuous availability to the HMC functions. The use of a second HMC can be useful in storage environments where encryption capability, and required if Copy Services functions have been activated.

► 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 DS8880 models to increase the throughput for TCT. This is feature code 3600 for the DS8882F, DS8884F and the DS8884, and feature 3601 for the DS8886, DS8886F and the DS8888F. For more information about Transparent Cloud Tiering (TCT), refer to *IBM DS8880 and z/OS DFSMS: Transparent Cloud Tiering*, SG24-8381.

► Microcode Releases 8.3 and higher allow HPFE Gen2 storage enclosure pairs to be added to existing installed 980, 981 and 982 systems using the field upgrade process.

> **Note:** The first-generation DS8880, model 980, 981 and 982, are not discussed in detail in this product guide. More information about installing HPFE Gen-2 flash enclosures in these models is described in appendix E of the *IBM DS8880 Introduction and Planning Guide - Version 8 Release 5,* GC27-8525.

► The extended power line disturbance (ePLD) option is designed to protect your storage unit for 40 seconds, rather than only 4 seconds, from a power line disturbance.

> **Note:** The DS8882F model does not have a DC-UPS power system. For details about the DS8882F power system, see *Introducing the IBM DS8882F Rack Mounted Storage System*, REDP-5505.

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

► An optional overhead cabling feature is available. The overhead cabling option includes a top-exit bracket for fiber cables.

► The shipping weight reduction option allows you to receive delivery of a DS8880 model in multiple shipments. If your site has 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 is an optional seismic kit for stabilizing the storage unit rack so that the rack complies with IBM earthquake resistance standards.

Warranty information and upgrades

DS8880 offers the Enterprise Choice warranty of 1, 2, 3, or 4 years on both the hardware and the advanced function software, with the following options:

- ► 4 years on type 2834 models and on 5334 all-flash models
- ► 3 years on type 2833 models and on 5333 all-flash models
- ► 2 years on type 2832 models and on 5332 all-flash models
- ► 1 year on type 2831 models and on 5331 all-flash models

Model conversion

It is possible to convert an existing DS8870 (models 961 and 96E) to a high-performance DS8886 (machine type 283x models 985 and 85E or 986 and 86E). This conversion uses existing storage enclosures, drives, host adapters, and device adapters. IBM provides new frames, including the management console(s), processor enclosures, power supplies, and I/O enclosures. The first expansion frame includes power supplies and I/O enclosures. The second, third, and fourth expansion frames include power supplies.

The conversion process can only be performed by an IBM service representative.

The model conversion consists of the following phases:

1. Planning
2. Verification of prerequisites
3. Physical model conversion
4. Post conversion operations

The IBM service representative will not begin mechanical conversion until all prerequisites are complete.

Conversion between DS8880 models is not supported.

Scalable upgrades

The DS8880 series supports concurrent upgrades within the same model and machine type.

Types of available upgrades include:

- ► Processor and system memory
- ► IO enclosures, host adapters and device adapters
- ► Storage enclosures and drive sets
- ► Expansion frames

As an example, with the DS8884 model, you can start with a single-frame 6-core configuration with storage enclosures for 48 DDMs, and grow to a full-scale, 768-drive, 96 Flash-drive, three-frame configuration.

With the DS8886 model 985, you can start with a single-frame 8-core configuration, and grow to a 1536-drive, 192 Flash-drive, five-frame 24-core configuration.

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

Licensed functions

The licensed functions are now bundled into the groups listed in Table 18.

Table 18   DS8000 licensed functions

Licensed function for DS8000 with Enterprise Choice warranty	License scope	IBM 283*y*-LF8 indicator feature code numbers
Base Function (BF)	ALL	8151 - 8160
Copy Services (CS)	ALL, FB, or CKD	8250 - 8260
z-synergy Services (zsS)	CKD	8350 - 8360

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
  – I/O Priority Manager
  – Database Protection
  – 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 (now 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 283*x* (*x*=1...4) licensed function indicator feature, plus a 283*y*-LF8 (*y*=6...9) licensed function authorization feature number. The 533*x* (*x*=1...4) all-flash models come with a 904*y* (*y*=6...9) advanced function authorization:

► The DS8000 provides Enterprise Choice warranty options that are associated with a specific machine type. The *x* in 283*x* and 533*x* designates the machine type according to its warranty period, where *x* can be 1, 2, 3, or 4.

  For example, a 2834-986 machine type designates a hybrid DS8886 (three-phase power) storage system with a four-year warranty period.

- The *y* in 283*y* can be 6, 7, 8, or 9, according to the associated 2831/2832/2833/2834 base unit model. The 2836 function authorizations apply to 2831 base units, 2837 to 2832, and so on.

  For example, 2839-LF8 designates a DS8000 Licensed Function Authorization for a 2834 machine with a four-year warranty period.

- The licensed function indicator feature numbers enable the technical activation of the function, subject to a feature activation code that is made available by IBM and applied by the client. The 283*y*-LF8 (*y*=6...9) (or, 904*y*) licensed function authorization feature numbers establish the extent of authorization for that function on the 283*x*-98*z* (*x*=1...4, *z*=0...8) (or, 533*x*) 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 that the function can be used with. 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 both mainframe and open systems, which is a scope of ALL. Also, to configure CKD volumes, the activation of Feature Code 8300 is required.

  With CS, if these services are only used for either mainframe or open systems, the restriction to either FB or CKD is possible. However, most clients will want to configure CS for scope ALL.

For each group of licensed functions, specific feature code numbers indicate the licensed capacity, as shown in Table 19.

Table 19   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 (from 100.1 TB to 250 TB capacity)
8153	8253	8353	25 TB (from 250.1 TB to 500 TB capacity)
8154	8254	8354	75 TB (from 500.1 to 1,250 TB capacity)
8155	8255	8355	175 TB (from 1,250.1 TB to 3,000 TB capacity)
8156	8256	8356	300 TB (from 3,000.1 TB to 6,000 TB capacity)
8160	8260	8360	500 TB (from 6,000.1 TB to 12,000 TB capacity)

Remote code load

For the DS8880 models, IBM is adopting Remote Code Load (RCL) as the default delivery and installation of microcode upgrades.

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 DS8880 code upgrades

Remote Code Load (RCL) 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 Remote Code Load process is concurrent, it can be run without interruptions in the business operations. This process consists of the following steps, also illustrated in:

1. IBM Remote Support will work with IBM Technical Advisors for the planning of the microcode update. This will ensure 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 will initiate a session with the target HMC

3. During the agreed upon window, IBM will direct the HMC to acquire the code images from the FixCentral repository and prepare for code activation

4. During the customer maintenance window, IBM will initiate the activation request, moving the HMC(s) and DS8000 to the new target microcode level
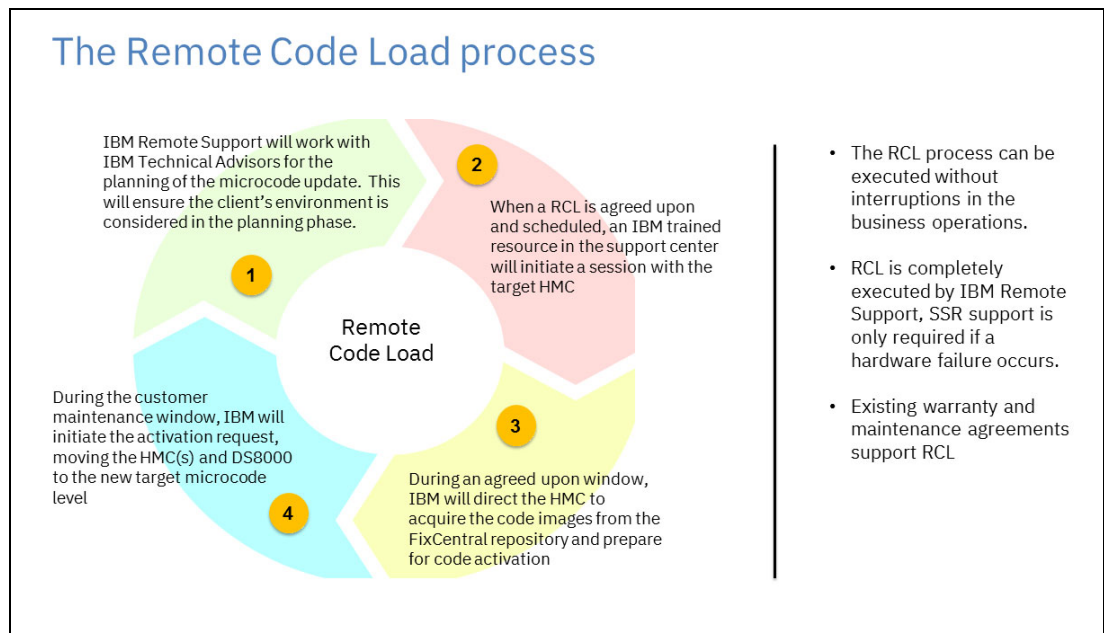

Figure 11   Remote Code Load process

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 has been enhanced to include more information about logical volume and logical subsystem (LSS) configuration.

On the DS8880, the call-home function is no longer offered through a modem, and is only implemented 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 *IBM DS8880 Architecture and Implementation (Release 8.3)*, SG24-8323.

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 DS8000 supports over 90 platforms. For the most current list of supported platforms, see the DS8000 System Storage Interoperation Center (SSIC) at this website:

http://www.ibm.com/systems/support/storage/config/ssic/

There are also papers for special attachments available, such as *IBM DS8880 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 DS8880 storage capacity among the attached environments, can help support storage consolidation requirements and dynamic environments.

Disk Magic

Disk Magic is a Windows-based performance modeling tool that is used by IBM and IBM Business Partners to model storage system performance. It supports storage systems from multiple vendors and offers detailed support for IBM storage systems.

> **Important:** IBM Disk Magic for Windows is a product of IntelliMagic, which is licensed to IBM and IBM Business Partners to model disk and flash storage system performance. Contact your IBM Representative or IBM Business Partner to discuss a Disk Magic study.

Related information

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

IBM Redbooks

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

- ► *IBM DS8880 Architecture and Implementation (Release 8.3)*, SG24-8323
- ► *Introducing the IBM DS8882F Rack Mounted,* REDP-5505
- ► *IBM DS8880 Introduction and Planning Guide*, GC27-8525
- ► *IBM DS8882F storage system Introduction and Planning Guide,* GC27-9259
- ► *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 DS8880 R8.5 or later)*, REDP-4667
- ► *DS8870 Easy Tier Application*, REDP-5014
- ► *IBM DS8870 Easy Tier Heat Map Transfer*, REDP-5015
- ► *DS8000 I/O Priority Manager*, REDP-4760
- ► *IBM DS8000 Series Command-Line Interface User's Guide*, SC27-8526
- ► *IBM Assist On-site for Storage Overview*, REDP-4889
- ► *IBM DS8880 Data-at-rest Encryption*, REDP-4500
- ► *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
- ► *DS8880 SafeGuarded Copy,* REDP-5506
- ► *IBM DS8880 and z/OS DFSMS: Transparent Cloud Tiering*, SG24-8381

Online resources

These websites are also relevant as further information sources:

- ► IBM Knowledge Center:

  http://www.ibm.com/support/knowledgecenter/
- ► IBM Assist On-site:

  http://www.ibm.com/support/assistonsite/
- ► IBM System Storage Interoperation Center (SSIC):

  https://www.ibm.com/systems/support/storage/ssic/
- ► IBM data storage feature activation (DSFA):

  http://www.ibm.com/storage/dsfa

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