

IBM Storage FlashSystem 7300 Product Guide: Updated for IBM Storage Virtualize 8.7

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IBM Storage FlashSystem 7300 Family Product Guide

This IBM® Redpaper Product Guide describes the IBM Storage FlashSystem® 7300 (IBM FlashSystem 7300) solution, which is a next-generation IBM FlashSystem control enclosure. Leveraging IBM FlashCore technology and Non-Volatile Memory Express (NVMe) architecture, it delivers high performance, reliability, and data protection. Ideal for AI, big data analytics, and cloud environments, the 7300 helps enterprises overcome resource constraints and maximize existing investments.

IBM FlashSystem 7300 provides a rich set of software-defined storage (SDS) features that are delivered by IBM Storage Virtualize, including the following examples:

- ▶ Data reduction and deduplication
- ▶ Dynamic tiering
- ▶ Thin-provisioning
- ▶ Snapshots
- ▶ Cloning
- ▶ Cyber resilience
- ▶ Transparent Cloud Tiering (TCT)
- ▶ Policy-based replication
- ▶ Policy-based high availability
- ▶ Scale-out and scale-up configurations that further enhance capacity and throughput for better availability
- ▶ Inline Data Corruption Detection

Overview

The IBM FlashSystem 7300 leverages IBM FlashCore technology with enhanced compression to boost capacity up to 116 TB per drive.

The IBM FlashSystem 7300 system with IBM FCMs includes built-in hardware data compression, and this data reduction is always on. This compression is implemented in hardware by using field-programmable gate arrays (FPGAs) within each module and uses a modified dynamic GZIP algorithm. With this approach, the solution can deliver the level of performance that you expect without compression, with the added benefit of better use of the physical storage.

IBM FCMs implement hardware-based compression without any performance penalty, and performance scales linearly with the number of instances.

In addition, the IBM FlashSystem 7300 control enclosure supports data reduction pool (DRP) compression and deduplication that can increase the effective capacity of your flash memory up to 5x, which decreases the cost of storing data up to 80%. DRPs support active data, unlike other data reduction solutions.

The IBM FlashSystem 7300 control enclosure offers several features for DRP compression workloads. These features include two 10 Intel core processors with up to 768 TB of memory per node and a built-in compression accelerator for hardware-assisted compression. In addition, the IBM FlashSystem 7300 system with IBM FCMs NVMe-type drives applies compression to any data that is not already compressed.

Agile integration

The IBM FlashSystem 7300 system includes the following agile characteristics:

- ▶ Fully integrated system management.
- ▶ Application-aware data services.
- ▶ Advanced Encryption Standard (AES), data-at-rest encryption with all NVMe type drives, and IBM FCMs with FIPS 140-3.
- ▶ In-line hardware compression with IBM FCM.
- ▶ Tiering or mirroring to existing and public cloud storage.
- ▶ Mixed workload consolidation.
- ▶ Nondisruptive data migrations.
- ▶ Concurrent code load.

By accelerating physical and virtual applications, the IBM FlashSystem 7300 system can help organizations reduce costs, increase revenue, and improve customer satisfaction for all types of applications that include the following categories:

- ▶ Transactional
- ▶ Enterprise resource planning (ERP) and supply chain management
- ▶ Big data and analytics
- ▶ Server and desktop virtualization
- ▶ Cloud native
- ▶ Hybrid and multicloud

AI-empowered

The IBM FlashSystem 7300 system includes the following AI characteristics:

- ▶ AI-based data placement for optimal data center performance and zero-downtime data migration.
- ▶ IBM Storage Insights, which includes AI-empowered predictive analytics, storage resource management, and a support platform delivered over the cloud.

Multicloud enabled

IBM Storage Virtualize on-premises and IBM Storage Virtualize for Public Cloud together support mirroring between on-premises and cloud data centers or between cloud data centers. These functions can be used to perform the following tasks:

- ▶ Migrate data between on-premises and public cloud data centers or between public cloud data centers. Enjoy consistent data management between on-premises storage and the public cloud.
- ▶ Implement disaster recovery strategies between on-premises and public cloud data centers.
- ▶ Enable cloud-based DevOps to more easily replicate data from on-premises sources.
- ▶ Improve cyber resilience with copies on Amazon Web Services (AWS) by using air gap snapshots to S3 and IBM Safeguarded Snapshot on Microsoft Azure.

Customers can create hybrid multicloud solutions for their traditional block data and workloads by using built-in IP replication capabilities.

Deploy IBM Storage Virtualize for Public Cloud on AWS directly from AWS Marketplace through a predefined Cloud Formation Template that automatically and securely installs the software, and deploys a high availability two-node cluster on selected EC2 instances. Any Amazon EBS block storage can be attached.

On Azure, deploy directly from the Azure Apps Marketplace through predefined Azure Resource Manager templates that automatically and securely install the software, and deploy an HA two-node cluster on selected Azure VMs. Attach shared Azure Managed Disk solid-state drives (SSDs) to the cluster for HA.

On IBM Cloud®, automated installation scripts assist deployment of the software on bare metal servers. IBM Performance or Endurance block storage is supported behind the cluster. This setup enables clients to create clustered configurations, such as on-premises, and includes the optimization and virtualization capabilities of IBM Storage Virtualize to public cloud infrastructures.

IBM Storage Virtualize on-premises and IBM Storage Virtualize for Public Cloud together enable a hybrid multicloud deployment. The deployment provides a single data management layer between on-premises systems and the cloud across heterogeneous storage pools that might exist in the data center.

IBM Storage Virtualize provides the following functions:

- ▶ Storage pooling and automated allocation with thin provisioning
- ▶ IBM Easy Tier® automated tiering
- ▶ Deduplication and compression to reduce cloud storage costs
- ▶ IBM FlashCopy and remote mirror for local snapshots and remote replication

- ▶ IBM Safeguarded Snapshot for cyber resiliency
- ▶ Support for virtualized and containerized server environments:
 - VMware
 - Microsoft Hyper-V
 - IBM PowerVM®
 - Red Hat OpenShift
 - CRI-O
 - Kubernetes

For more information about IBM FlashSystem systems and Hybrid Multicloud, see [Embracing Hybrid Cloud: Storage Edition](#).

Data resilience

The IBM FlashSystem 7300 provides advanced capabilities that can help maximize data protection, security, and HA to significantly reduce the risk of disruption and financial losses because of user errors, malicious destruction, or ransomware attacks. The FlashSystem 7300 delivers the capability to enable this level of protection while also delivering high performance for applications.

With Safeguarded Snapshot, the IBM FlashSystem 7300 adds a line of defense against cyberthreats by protecting your valued data from cyberattacks with immutable and isolated copies that are hidden, nonaddressable, and cannot be altered. If an attack occurs, these copies can be restored quickly to support recovery.

Refer to IBM Redbooks *Data Resiliency Designs: A Deep Dive into IBM Storage Safeguarded Snapshots*, REDP-5737 and this [link](#) for more information.

Advanced data services

The IBM FlashSystem 7300 system provides the following advanced data services:

- ▶ Business continuity with replication services across up to three sites
- ▶ Data protection with IBM FlashCopy services
- ▶ High availability with the IBM policy-based HA function
- ▶ Higher storage efficiency with thin provisioning
- ▶ DRPs that provide compression with deduplication
- ▶ Data-at-rest AES-XTS 256 encryption
- ▶ IBM Easy Tier
- ▶ External virtualization
- ▶ Data migration
- ▶ IP quorum support
- ▶ N_Port ID virtualization (NPIV) support
- ▶ VMware vSphere Virtual Volume (VVOL) support and space-efficient copies
- ▶ Transparent Cloud Tiering (TCT)
- ▶ Data and cyber resiliency with IBM Safeguarded Snapshot
- ▶ Container support with the IBM block storage CSI driver
- ▶ Capacity and performance scaling through clustering

IBM FlashSystem 7300 enclosure overview

The IBM FlashSystem 7300 system includes the following types of enclosures:

- ▶ A *control enclosure* manages your storage systems, communicates with the host, and manages interfaces. It can also house up to 24 NVMe-capable flash drives. These drives can be industry-standard NVMe types or the exclusive IBM FCM NVMe-type and up to 12 optional Storage Class Memory (SCM) type class drives.
- ▶ An *expansion enclosure* increases the available capacity of an IBM FlashSystem 7300 cluster. It communicates with the control enclosure through a dual pair of 12 Gbps SAS connections. These expansion enclosures can house many flash (SSD) and hard-disk drive (HDD) serial-attached SCSI (SAS) drives, depending on which enclosure model is ordered. FCMs are not permitted in any of the SAS Expansion Enclosures.

Figure 1 shows the IBM FlashSystem 7300 control enclosure front view with an NVMe drive partially removed.



Figure 1 IBM FlashSystem 7300 control enclosure with one NVMe drive partially removed

Control enclosures

Each control enclosure can have multiple attached expansion enclosures, which expand the available capacity of the entire system. The IBM FlashSystem 7300 solution supports up to four control enclosures and up to two chains of SAS expansion enclosures per control enclosure.

The IBM FlashSystem 7300 control enclosure supports up to 24 NVMe-capable flash drives in a 2U high form factor and consists of one machine type: 4657. The 4657 is available in two models: 924 and U7D.

The 4657-U7D model is an IBM FlashSystem 7300 solution with a 1-year warranty, with optional Storage Expert Care service offerings, and is intended for the Storage Utility Offering space. This model is physically and functionally identical to the IBM FlashSystem 4657-924 model, except for target configurations and variable capacity billing. The variable capacity billing uses IBM Storage Control or IBM Storage Insights to monitor the system usage, which allows allocated storage use that is greater than a base subscription rate to be billed per terabyte per month. *Allocated storage* is identified as storage that is allocated to a specific host and unusable to other hosts, regardless of whether data is written. For thin-provisioning, the data that is written is considered used. For thick-provisioning, the total allocated volume space is considered used.

Expansion enclosures

The IBM FlashSystem 7300 expansion enclosures consist of one machine type, 4657, and three models, 12G, 24G, and 92G.

The new SAS-based small form factor (SFF) and large form factor (LFF) expansion enclosures support various flash and SSD MDisks in a storage pool, which can be used for IBM Easy Tier.

Consider the following points:

- ▶ IBM FlashSystem 7000 LFF Expansion Enclosure Model 12G offers drive options with SAS drives. Up to 144 drives in 12 SAS 12G expansions are supported per IBM FlashSystem 7300 control enclosure. The expansion enclosure is 2U high.
- ▶ IBM FlashSystem 7000 SFF Expansion Enclosure Model 24G offers drive options with SSD flash and SAS drives. Up to 288 drives in 12 SAS 24G expansions are supported per IBM FlashSystem 7300 control enclosure. The expansion enclosure is 2U high.
- ▶ IBM FlashSystem 7000 LFF Expansion Enclosure Model 92G offers drive options with SSD flash and SAS drives. Up to 368 drives in 4 SAS 92G expansions are supported per IBM FlashSystem 7300 control enclosure. The expansion enclosure is 5U high.

SAS chain maximums

Each SAS chain can have a maximum total *chain weight* of 5 or 6, depending on code version. Each 92G enclosure has a chain weight of 2.5; each 12G or 24G enclosure has a chain weight of 1.

For example, it is valid to have two 92G enclosures and one 24G enclosure (total chain weight of 6). Each control enclosure supports 2 SAS chains.

For more information, see [Enclosures](#).

Note: Attachment and intermixing of IBM Storwize® V7000 Expansion Enclosures Models 12F, 24F, and 92F with FlashSystem 7300 Expansion Enclosure Models 12G, 24G, and 92G is *not* supported.

The IBM FlashSystem 7300 control enclosure can be identified by the labeling “IBM FlashSystem 7300” on the left side of the bezel cover, which covers the rack-mounting screws.

Figure 2 shows the IBM FlashSystem 7300 bezel and NVMe drive.

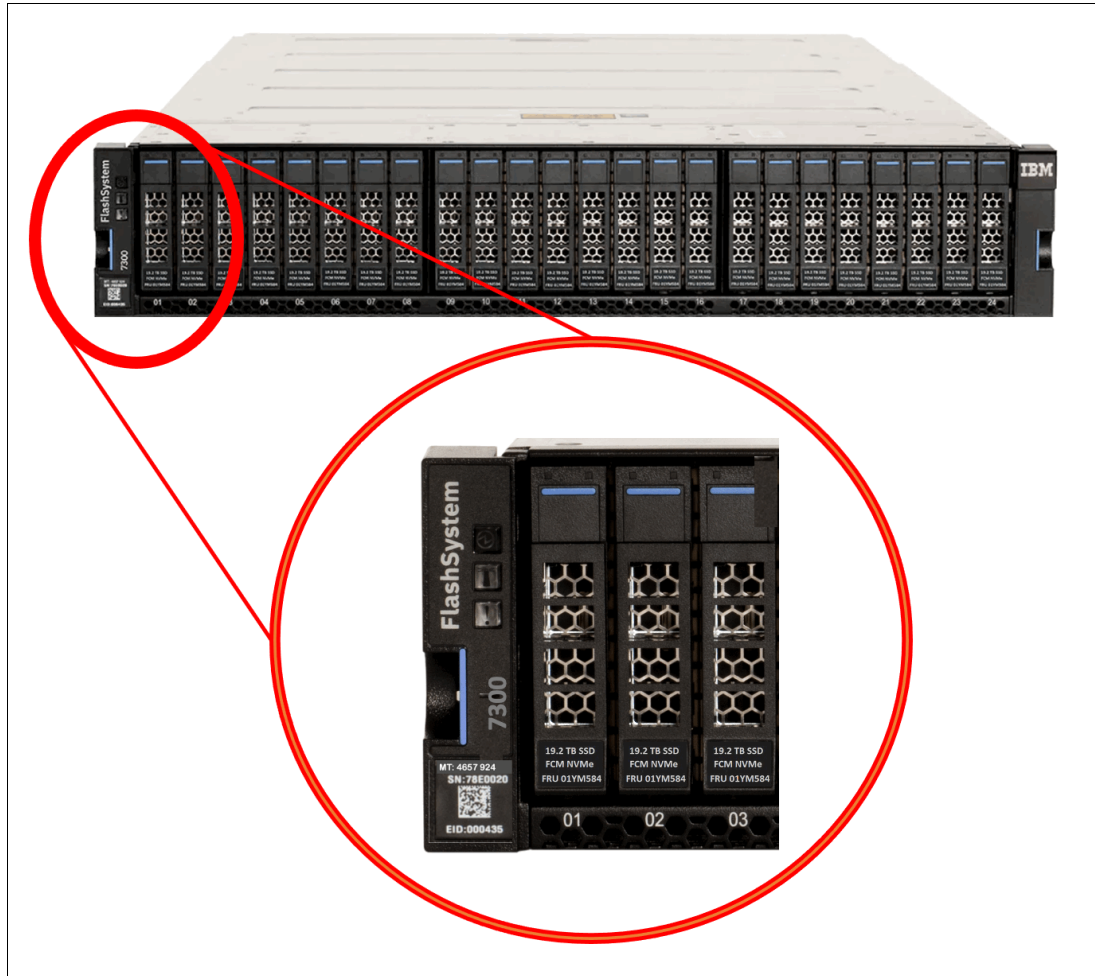


Figure 2 IBM FlashSystem 7300 bezel and IBM FCM description

Labeling on the NVMe drive provides the drive type, capacity, type of drive, and FRU number. The example that is shown in Figure 2 is the IBM FCM NVMe 19.2 TB.

Placing your IBM FlashSystem 7300 in your infrastructure

Various use cases exist for the IBM FlashSystem 7300, all of which can address many technical and business requirements. In addition, the IBM FlashSystem 7300 can be used to simplify the overall storage architecture.

The IBM FlashSystem 7300 can be used in the following scenarios:

- ▶ First tier storage repository for production data.
- ▶ Primary or target system for data replication or disaster recovery (DR).
- ▶ HA storage within a policy-based high availability configuration where two IBM FlashSystem 7300s are in a synchronous replication relationship.
- ▶ Externally virtualizing IBM or non-IBM storage by using IBM Storage Virtualize, which extends advanced functions such as data reduction, encryption, and replication to those storage subsystems.

- ▶ Data migration from IBM or non-IBM storage with IBM Storage Virtualize.
- ▶ Hybrid cloud storage by:
 - Enabling communication between an on-premises deployment of IBM Storage Virtualize and IBM Storage Virtualize for Public Cloud.
 - Deploying the Container Storage Interface (CSI) driver for Red Hat OpenShift Container Platform to provide persistent storage for on-premises or cloud-based containerized applications.
 - Using TCT to convert data into an object store for back up to specific available cloud instances.
- ▶ Support and interoperability within the IBM Storage Software Suite, which include:
 - IBM Storage Scale where the IBM FlashSystem 7300 can be used as the back-end storage repository for metadata, primary data or in initial microprogram load (IML) processing.
 - IBM Storage Protect and IBM Storage Protect Plus where the IBM FlashSystem 7300 can be used as a cache or data repository.
 - IBM Copy Data Management where the IBM FlashSystem 7300 can be used as a cache or as a copy services target.

Figure 3 shows an IBM FlashSystem 7300 that is fully deployed in a hybrid multicloud environment where it is also externally virtualizing various on-premises storage subsystems.

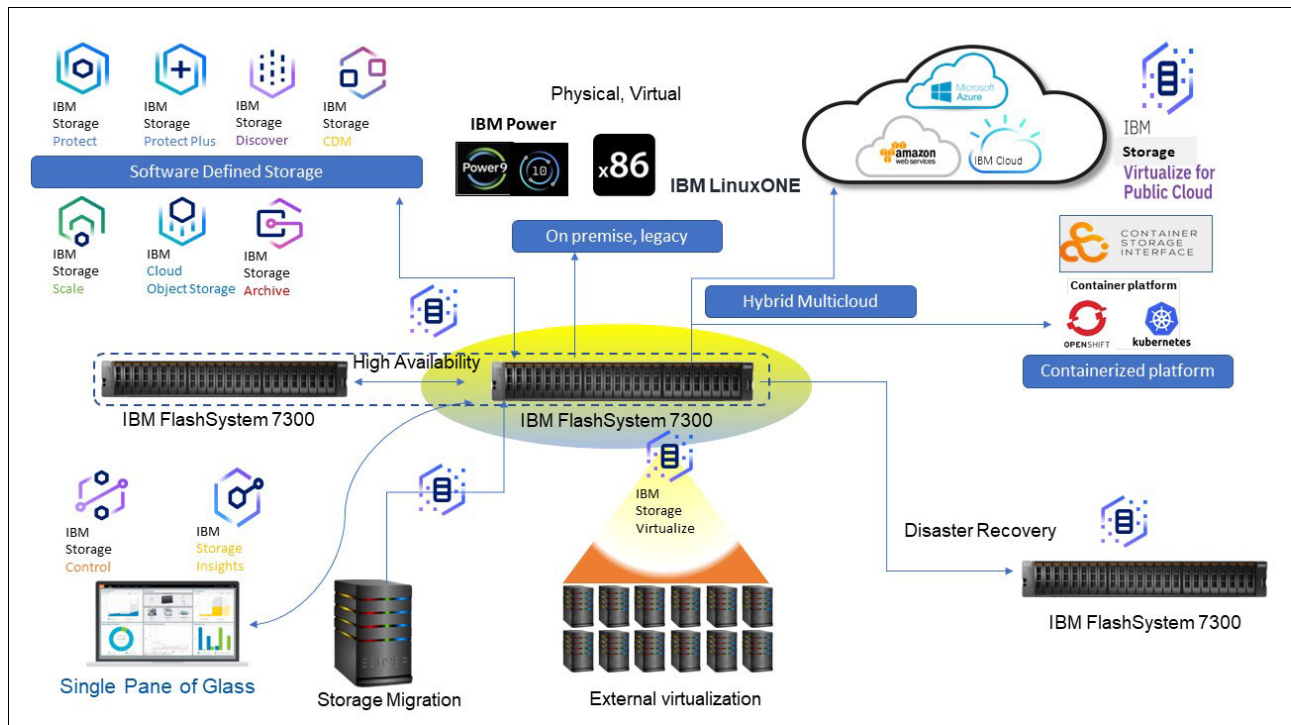


Figure 3 Fully deployed IBM FlashSystem 7300 sample scenario

The IBM FlashSystem 7300 can support multiple Open System hosts and interoperability with all the software from the IBM Storage Suite of products.

In this scenario, the IBM FlashSystem 7300 provides the following benefits:

- ▶ Investment protection of older storage by using IBM Storage Virtualize to enable migration from older storage and external virtualization of heterogeneous storage.
- ▶ A hybrid multicloud architecture by connecting to IBM Storage Virtualize for Public Cloud, which is available in AWS, Azure, and IBM public cloud.
- ▶ Data protection by extending HA and DR to externally virtualized heterogeneous storage.
- ▶ Support for containerized workloads by interfacing with Red Hat OpenShift and Kubernetes in on-premises and off-premises infrastructures.
- ▶ Ease of management and seamless integration with the IBM Storage Insights and all the products in the IBM Storage Software Suite.

Features of IBM FlashSystem 7300

IBM FlashSystem 7300 runs on IBM Storage Virtualize V8.7 Licensed Machine Code, which provides the following features:

- ▶ Control enclosure support for SSDs, including up to 24 industry 2.5-inch Small Form Factor (SFF) standard NVMe drives and IBM FCMs and up to 12 SCM drives.

The following NVMe drives are supported:

- 2.5-inch SFF 4.8 TB, 9.6 TB, 19.2 TB, or 38.4 TB IBM FCMs
 - 1.92 TB, 3.84 TB, 7.68 TB, 15.36 TB, or 30.72 TB industry-standard NVMe drives
 - A mixture of both
 - 1.6 TB SCM drives
- ▶ Autonomic tiering through Easy Tier, which enables workload data to be placed on the most suitable storage media:
 - various classes of NVMe drives for the control enclosure
 - HDDs and commodity SSDs for the expansion enclosures and externally virtualized storage
 - ▶ Hardware-based data reduction and encryption from IBM FCMs with negligible effect on system performance.
 - ▶ Scale out capacity options with the 12 Gbps SAS-attached model 12G, 24G, and 92G expansion enclosures.
 - ▶ Software-based AES-256 data-at-rest encryption and key management through IBM Security Guardium® Key Lifecycle Manager or USB key encryption. Up to four Security Guardium Key Lifecycle Manager key servers are supported.
 - ▶ Remote Support Assistance (RSA), which enables IBM support personnel to access the system to complete troubleshooting tasks.
 - ▶ Multiple data-protection solutions such as FlashCopy (point-in-time-copy), Metro Mirror (synchronous replication), and Global Mirror (asynchronous replication).
 - ▶ Cyber resiliency with Safeguarded Snapshot, which provides rapid ransomware recovery by using immutable, untouchable snapshots that are based on FlashCopy technology.
 - ▶ Multiple management modes by using a graphical user interface (GUI) or a Linux-based command-line interface (CLI).
 - ▶ Performance throttling that allows control of used resources when the system is processing host I/O, advanced functions, or copy services.

- ▶ TCT, which enables a FlashCopy volume that can be backed up to an S3 object store, such as AWS or IBM Cloud.
- ▶ Support for 32 Gbps FC and 10/25 GBE or 100 Gbps Ethernet iSCSI and NVMe RDMA connectivity. The ability to intermix these port options is also supported.
- ▶ Simplified connectivity by using portsets, which enable host connectivity ports to be grouped for more effective zoning and management.
- ▶ Compatibility with IBM Storage Insights, which offers advanced performance monitoring for one or more IBM FlashSystem 7300s.
- ▶ Extra access security through multi-factor authentication.

In addition to the base warranty, the IBM FlashSystem 7300 offers IBM Storage Expert Care with three levels of support options. For more information, see “IBM Storage Expert Care” on page 15.

Current release functions

This section describes several new functions and features that are available in the current IBM FlashSystem 7300 release.

New in IBM FlashSystem 7300 Software V8.7.0

- ▶ Policy-based high availability:
 - Define host location
 - Local-site I/O access to avoid cross-ISL traffic

The High Availability (HA) solution uses storage partitions, a configuration object that is the single point of management for HA objects. These partitions contain volumes, volume groups, hosts, and host-to-volume mappings.

Within a partition:

- All volumes are in volume groups.
 - Mappings can be created only between volumes and hosts in the same partition.
 - HA replication policies are associated with storage partitions to define the paired systems providing high availability. Partition membership automatically configures objects across both systems, enabling host access from either system. Hosts can prioritize the local system for data access. Before creating partitions, partnerships, linked pools, replication policies, and IP quorum must be established. Multiple HA partitions are supported, each with a preferred and active management system that can fail over. All partition elements are highly available with management and I/O failover. Partitions can be expanded with additional volumes, volume groups, hosts, and mappings. IP Quorum prevents split-brain scenarios by designating an active management system.
- ▶ TLS connection to send syslog notifications and messages.
 - The syslog protocol is a standard protocol for forwarding log messages from a sender to a receiver on an IP network. The system can send syslog messages that notify personnel about an event. You can set up syslog event notifications with either the management GUI or the command-line interface (CLI).
 - ▶ New Flash Grid

- You can scale out a storage system by using a Flash Grid, which combines multiple independent systems into a federated cluster. Unlike traditional scale-out systems based on I/O groups, Flash Grid supports up to eight systems, delivering linear increases in performance, capacity, volumes, hosts, and snapshots. Each system within a Flash Grid can be updated independently, allowing for hardware diversity and upgrades. Storage Partitions can be seamlessly migrated across systems within a Flash Grid using non-disruptive Storage Partition Migration.

Systems in a Flash Grid have the following requirements

- The system supports a maximum of a single I/O group and the compatibility mode for multiple I/O groups must be disabled.
 - The system topology must be standard.
 - The system layer must be replication.
- Systems in a Flash Grid exchange certificates to enable secure communication between members. System-signed certificates are the default, however a CA-signed certificate can be used instead providing it meets the requirements. For more information, see [Requesting and installing an externally signed certificate](#). A Flash Grid is supported on the following systems:
 - IBM Storage FlashSystem 5200
 - IBM Storage FlashSystem 5300
 - IBM Storage FlashSystem 7200
 - IBM Storage FlashSystem 7300
 - IBM Storage FlashSystem 9100
 - IBM Storage FlashSystem 9200
 - IBM Storage FlashSystem 9500
 - SAN Volume Controller
- ▶ Automatic download of compatible security patches to the system.
 - Under some scenarios, IBM releases a patch that fixes or updates a part of the product. Patch installation does not cause any interruption to the IO processing. Patches are made available on FixCentral with the help of direct download link (for more information, see [Obtaining packages](#)) or as part of a general collection of available patches.
 - ▶ An increase in the number of short-distance partnerships over RDMA.
 - ▶ To convert thin-clone volume to clone volume.
 - ▶ Fast path Ethernet and VLAN for Management IP addresses.
 - ▶ Non-disruptive storage partition migration from one FlashSystem to another using IBM Storage Insights.
 - ▶ Ability to view volume group snapshot restore timestamp details.
 - ▶ Ability for policy-based replication to be used on a different partnership for different volume groups while policy-based high availability is configured.
 - ▶ Snapshot population for non-high availability partitions.
 - ▶ RESTful APIs to provide system performance statistics.
 - The IBM Storage Virtualize REST model API offers Common Information Model (CIM) and ways to extract general performance statistics from a Storage Virtualize system for new users Application programmers, who are migrating away from CIM to REST API,

and new REST API users can complete the following tasks to extract system performance statistics:

- Understand the now decommissioned CIM-based performance statistics for the IBM Storage Virtualize systems.
 - Discover and connect to the REST API to list and download performance data files.
 - Retrieve and extract metrics and apply calculations that were previously applied by the CIM agent.
- CIM, a DMTF standard for system management, is increasingly being replaced by RESTful APIs due to their performance, scalability, and widespread adoption. IBM Storage Virtualize offers a high-performance REST API. To optimize system management and reduce script complexity, it is recommended to migrate from CIM to REST. This document provides guidance on the migration process, CIM agent calculations, and REST API code examples.
- ▶ Ransomware threat detection:
 - File-system awareness for ransomware threat detection.
 - Storage Insights Pro entitlement information.
 - ▶ Automatic update of candidate FlashCore Modules (FCM).
 - ▶ Policy-based high availability and policy-based replication for the IBM FlashSystem 5045.
 - ▶ User-configurable default grain size for new snapshots and FlashCopy mappings.

Highlights

The IBM FlashSystem 7300 (machine type 4657) is a high-performance, hybrid cloud-enabled storage system featuring NVMe technology, IBM FlashCore modules, and storage-class memory. Backed by IBM Storage Expert Care and IBM Storage Insights, it delivers industry-leading performance and low latency. This 2U, 24-NVMe system utilizes Intel Cascade Lake processors and offers a variable capacity utility model (U7D) with a base subscription and pay-per-use overage.

IBM FlashCore technology

At the heart of the IBM FlashSystem 7300 system is IBM FlashCore technology, if the IBM FCMs are ordered, which consists of the following key elements:

- ▶ Hardware-accelerated architecture that is engineered for flash, with a hardware-only data path.
- ▶ The IBM FlashSystem data compression and decompression algorithm is a modified dynamic GZIP algorithm. Because it is implemented completely in hardware, no processor intervention is required.
- ▶ IBM FCMs, which are designed for low latency, density, and reliability.
- ▶ IBM Advanced Flash Management, which improves flash endurance over standard implementations without sacrificing latency.

Figure 4 shows IBM FlashCore technology.

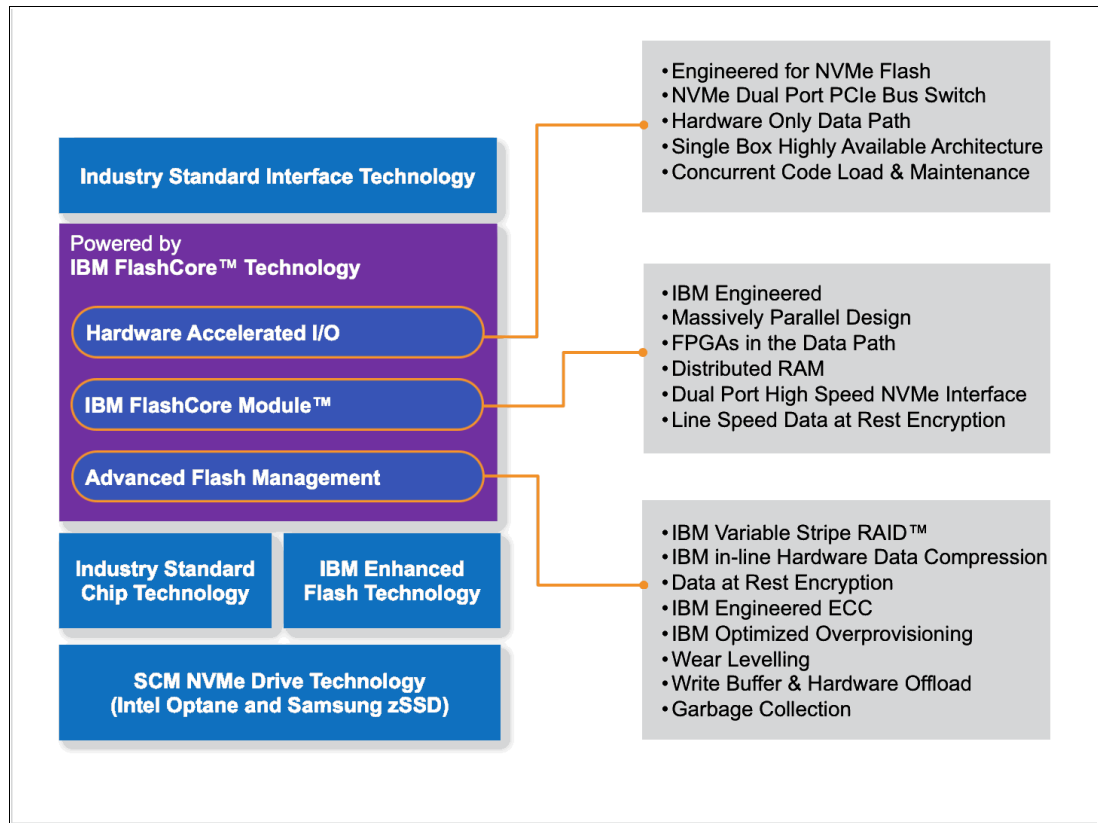


Figure 4 IBM FlashCore technology

For more information about IBM FlashCore technology, see [What is flash storage?](#) or the IBM Redpaper *IBM FlashCore Module (FCM) Product Guide: Features the newly available FCM4 with AI-powered ransomware detection*, [REDP-5725](#).

Storage Class Memory

Storage Class Memory (SCM) is an industry-wide statement for nonvolatile memory devices that perform faster (~10 μ s) than traditional NAND SSDs (100 μ s) but slower than DRAM (100 ns).

The technology pricing sits between dynamic random access memory (DRAM) and traditional NAND. Price is significantly more expensive than traditional NAND drives.

The IBM FlashSystem 7300 system supports the new low-latency, high-speed SCM drives in any of the slots of the control enclosure. The control enclosure can contain up to 12 SCM drives.

Note: SCM and other NVMe drive types can be installed in any drive slot. However, the highest capacity drives must be installed in the lowest available drive slots.

SCM with Easy Tier

SCM with Easy Tier is designed to decrease latency and sometimes, improve IOPS. If you want to realize the full benefit of SCM across all of your capacity, Easy Tier continually and automatically moves the hottest data onto the SCM tier and leaves the rest of the data on the

lower tiers. This autonomic tiering can also benefit DRPs where the metadata is moved to the SCM drives.

If you have a specific workload that requires the best performance and lowest latency, and it fits in the limited SCM capacity available, use SCM as a separate pool and decide which workloads use that pool. Because of their faster speed, SCM drives are placed in a new top tier of Easy Tier. This new tier is ranked higher than the existing tier0_flash that is used for NVMe NAND drives that are supported today.

The following Easy tier levels are available:

- ▶ **SCM**
This tier exists when the pool contains drives that use persistent memory technologies that improve endurance and speed of current flash storage device technologies.
- ▶ **Tier 0 flash**
This tier exists when the pool contains high-performance flash drives.
- ▶ **Tier 1 flash**
This tier exists when the pool contains tier 1 flash drives. Tier 1 flash drives typically offer larger capacities, but slightly slower performance and lower write endurance.
- ▶ **Enterprise tier**
This tier exists when the pool contains enterprise-class MDisks, which are disk drives that are optimized for performance.
- ▶ **Nearline tier**
This tier exists when the pool contains nearline-class MDisks, which are disk drives that are optimized for capacity.

Hot data is placed in the SCM tier when Easy Tier is enabled. DRP and VG extent allocation was tuned to use SCM drives, especially for metadata such as directory volume lookups. This use case is one of the main use cases for SCM drives with an IBM FlashSystem 7300 system.

SCM and RAID configurations

SCM drives feature the following rules about RAID supported configurations:

- ▶ Distributed DRAID 1 with two drives or more (including distributed spare capacity) and is the best practice configuration.
- ▶ Distributed DRAID 5 with four drives or more (including distributed spare capacity) is supported. DRAID 5 is available as an RPQ only.
- ▶ Distributed DRAID 6 with six drives or more (including distributed spare capacity) is supported.
- ▶ Traditional TRAIID 1 and 10 with two drives is supported; however, no spare is available, and performance might be limited.
- ▶ SCM drives have their own SCM technology type and drive class.
- ▶ SCM and Standard NVMe or SAS cannot intermix in the same array.
- ▶ Easy Tier tier_scm arrays can take lower tech types as spare drives when no tier_scm drives are available.
- ▶ Lower-tier arrays can accept tier_scm drives as superior drives.

SCM drive formatting and UNMAPS

Because of its media technology, SCM drive formats take longer to format than a typical NVMe drive. Formatting a drive can take 15 minutes until the process completes.

SCM drive formats occur when one of the following conditions exists:

- ▶ A drive is replaced
- ▶ An enclosure is managed
- ▶ An array or MDisk is removed

Note: Intel Optane drives do not support UNMAPs because it is not beneficial for these drives. Instead, the system writes zeros to deallocate drive sectors.

IBM Storage Expert Care

IBM FlashSystem 7300 is a client-installed product and is being released with a one-year warranty and the ability to include IBM Storage Expert Care Basic, Advanced, or Premium.

Figure 5 shows IBM Storage Expert Care levels.

	Warranty	Basic 5200, 7200, 7300	Advanced 5200, 7200, 7300, 9200, 9500	Premium 7200, 7300, 9200, 9500
IBM Spectrum Virtualize fixes, updates and new releases	1 year	Yes	Yes	Yes
Guidance on installation, usage and configuration		Yes	Yes	Yes
Automated ticket management and alerting		Yes	Yes	Yes
Use of Storage Insights for collaborative problem resolution		Yes	Yes	Yes
Predictive issue alerting			Yes	Yes
Storage Insights Pro entitlement				Yes
IBM Installation	Standard with 9500	Additional paid service	Additional paid service	Additional paid service for 7300
Remote code upgrades (2x year) ***				Yes
Dedicated Technical Account Manager (TAM)				Yes
30 minutes Severity 1/2 response				Yes
Hardware service / parts replacement	9x5 NBD* or 24x7 Same day**	9x5 NBD, IBM on-site	24x7 Same day, IBM on-site	24x7 Same day, IBM on-site

* Next business day, parts only for FS5200, FS 7200 and FS7300 ** Same day, IBM on-site for FS 9200 and FS9500 *** On-site available as additional paid service

Figure 5 IBM Storage Expert Care levels

IBM Storage Expert Care BASIC

The IBM Storage Expert Care BASIC option includes the following support features:

- ▶ Duration: 1–5 years.
- ▶ IBM On-Site repair, which coverage includes 9–5 and Next Business Day Support that is based on the duration that you choose.
- ▶ Licensed Machine Code subscription and support.
- ▶ IBM Storage Expert Care services:
 - Installation, usage, and configuration support line. Physical installation is chargeable.

- Predictive alerting.
- Automated ticket management.

IBM Storage Expert Care ADVANCED

The IBM Storage Expert Care ADVANCED option includes the following support features:

- ▶ Duration: 1–5 years.
- ▶ IBM On-site Repair coverage includes 24x7, Same Day Support that is based on the duration that you choose.
- ▶ Licensed Machine Code subscription and support.
- ▶ IBM Storage Expert Care services:
 - Installation, usage, and configuration support line. Physical installation is chargeable.
 - Proactive issue resolution.
 - Predictive alerting.
 - Automated ticket management.

IBM Storage Expert Care PREMIUM

The IBM Storage Expert Care PREMIUM option includes the following support features:

- ▶ Duration: 1–5 years.
- ▶ IBM On-Site Repair coverage includes 24x7 Same Day Support that is based on the duration that you choose.
- ▶ Enhanced response time for defect support:
 - Response time is defined as the elapsed time between technical support receipt of the client problem submission and the acknowledgment of the submission.
 - 30-minute targeted response time objectives for Severity 1 and Severity 2 problem reports.
- ▶ Licensed Machine Code subscription and support.
- ▶ IBM Storage Expert Care services:
 - Installation, usage, and configuration support line. Physical installation is chargeable.
 - Proactive issue resolution.
 - Predictive alerting.
- ▶ Automated ticket management.
- ▶ IBM Storage Insights Pro with more detailed reports and planning.
- ▶ Remote Code Load including code upgrades that are provided by IBM remote support representatives up to twice per year to keep your systems updated.
- ▶ Onsite code load services that are available by ordering feature code #AHY2 - Remote code load exception when required.
- ▶ Dedicated Technical Account Manager.

Note: The Technical Account Manager serves as the key client interface for in-scope hardware and software. It delivers partnership and consultancy, and direct engagement on high-priority support cases.

Storage Assurance

IBM Storage Assurance Perpetual offers a subscription model for IBM FlashSystem that ensures consistent modernization, budget predictability, and premium support. This option includes full-system refreshes, eliminating lifecycle challenges like terminal code levels, end-of-support concerns, disruptive migrations, and procurement hurdles. Available as a 4 or 8-year contract, it simplifies storage management and reduces costs.

For more information see [IBM Storage Assurance](#).

Table 1 Overview of the available IBM Storage Assurance features. Valid for all FlashSystem models

Years	Upfront	Annual	Quarterly	Monthly
1	ALF0	ALF8	ALFG	ALFO
2	ALF1	ALF9	ALFH	ALFP
3	ALF2	ALFA	ALFI	ALFQ
4	ALF3	ALFB	ALFJ	ALFR
5	ALF4	ALFC	ALFK	ALFS
6	ALF5	ALFD	ALFL	ALFT
7	ALF6	ALFE	ALFM	ALFU
8	ALF7	ALFF	ALFN	ALFV

Note: Availability may vary depending on country offering.

The Perpetual Model offers transparent, flat-rate pricing for budget predictability. It ensures access to cutting-edge technology, boosting operational agility. With a future-proof all-flash platform, continuous innovation is unlocked. Enjoy flexible payment options (upfront, annual, quarterly, or monthly) on 4 or 8-year contracts, backed by premium ExpertCare support, comprehensive software licensing, and automatic hardware refreshes aligned with SLAs:

- ▶ Refresh if the system is not meeting your performance¹ or energy efficiency needs.
- ▶ Refresh if your system is no longer compatible with the latest SW release or if your system has reached its end-of-support (EOS) date.
- ▶ Refresh if your system cannot add more capacity.
- ▶ Refresh at least once during an 8-year contract.

IBM Storage Assurance Perpetual delivers continuous innovation, budget predictability, and simplified management for IBM FlashSystem. Enjoy AI-powered data management, ransomware protection, and seamless upgrades while optimizing storage efficiency, performance, and resilience across hybrid cloud environments

IBM Storage Assurance – Perpetual model feature overview

Software upgrades get full access to all-inclusive array and monitoring features at the time of purchase and in the future as they become available Hardware upgrades experience all-inclusive full-system hardware refreshes if your current device cannot upgrade to the latest software, cannot add more capacity, is end of support, or does not meet your performance needs.

Premium Support Premium-level ExpertCare

Predictive analytics support, capacity planning, monitoring and reporting with IBM Storage Insights Pro entitlement. The following guarantees are offered:

- ▶ Non-disruptive system-to-system migrations guarantee.
- ▶ Price protection guarantee.
- ▶ Workload performance guarantee.
- ▶ End of service guarantee.
- ▶ Energy efficiency guarantee.
- ▶ Eight-year contract full-system guarantee.
- ▶ Terminal code level guarantee.
- ▶ Capacity upgrade eligibility guarantee.

Considerations:

- ▶ Performance guarantee only after year 3.
- ▶ Optional feature, priced separately.
- ▶ For high-level contract term details and country availability, see this [link](#).

IBM FlashWatch overview

IBM FlashWatch is an offering from IBM to complement the purchase of the IBM FlashSystem 7300. It features these main focus areas:

Cyber recovery

Once configured by IBM Expert Labs, the FlashSystem Cyber Recovery Guarantee states that immutable snapshots from Safeguarded Snapshot can be recovered in just 60 seconds. This offering includes FlashSystem implementation, Safeguarded Snapshot configuration and recovery validation. The scope of work also enhances security options such as Two Person Integrity and Multi-Factor authentication. This also brings capabilities such as our new ransomware threat detection capabilities as part of the tools to detect an attack.

See this [link](#) for more information.

3:1 data reduction

IBM offers a 3:1 self-certified data reduction guarantee to give organizations peace of mind when they acquire a specific amount of raw capacity for their workloads. Organizations will benefit from the hardware assisted data reduction technology on IBM FlashCore Modules (FCMs). FCMs are a unique computational storage platform that due to advanced hardware assistance delivers a great compression ratio on the business's workloads without any performance impact

100% data availability

For critical workloads, IBM offers a high availability commitment through its policy-based HA configuration. This approach aims to minimize downtime during a failure by automatically switching operations to a secondary FlashSystem. Policy-based high availability is available on systems that can support multiple I/O groups or machines.

Storage Expert Care

All IBM FlashSystems come with 1-year limited warranty for all the components. See "IBM Storage Expert Care" on page 15.

Sustainability

IBM FlashSystems are the first primary block storage vendor to offer an energy efficiency / sustainability guarantee on client-owned devices. The IBM FlashSystem Sustainability IBM FlashSystem with FlashCore Modules can deliver up to 1.7 W/TB energy efficiency on selected configurations. Additionally, it offers a lower footprint, greater storage capacity per watt, and 10x more IOPs per watt compared to leading competitors. IBM prioritizes sustainability throughout its supply chain, products, and ongoing efforts. Learn more in [IBM Sustainability in Business](#).

IBM Storage Insights

IBM Storage Insights is an IBM Cloud Software as a Service offering that can help you monitor and optimize the storage resources in the system and across your data center.

IBM strongly recommends that all customers install and use this no-charge, cloud-based application because it provides a single dashboard that gives you a clear view of all your IBM block storage. You can make better decisions by seeing trends in performance and capacity.

With storage of health information, you can focus on areas that need attention, and when IBM support is needed. IBM Storage Insights simplifies uploading logs, speeds resolution with online configuration data, and provides an overview of open tickets all in one place.

IBM Storage Insights includes the following features:

- ▶ A unified view of IBM systems:
 - Provides a single view to see all your system's characteristics.
 - Displays all of your IBM storage inventory.
 - Provides a live event feed so that you know in near real-time the status of your storage.
- ▶ IBM Storage Insights collects telemetry data and Call Home data and provides real-time system reporting of capacity and performance. Overall storage monitoring, which provides the following information:
 - The overall health of the system.
 - Monitoring of the configuration to see whether it meets preferred practices.
 - System resource management to determine which system is overtaxed and provides proactive recommendations to fix it.
- ▶ IBM Storage Insights provides advanced customer service with an event filter that you can use to accomplish the following tasks:
 - You and IBM Support can view, open, and close support tickets, and track trends.
 - You can use the autolog collection capability to collect the logs and send them to IBM before IBM Support looks into the problem. This capability can save as much as 50% of the time to resolve the case.

In addition to the no-charge version of IBM Storage Insights, IBM offers IBM Storage Insights Pro, which is a subscription service that provides longer historical views of data, more reporting and optimization options, and supports IBM file and block storage with EMC VNX and VMAX.

Customer dashboard

Figure 6 shows a view of the IBM Storage Insights main dashboard and the systems that it monitors.

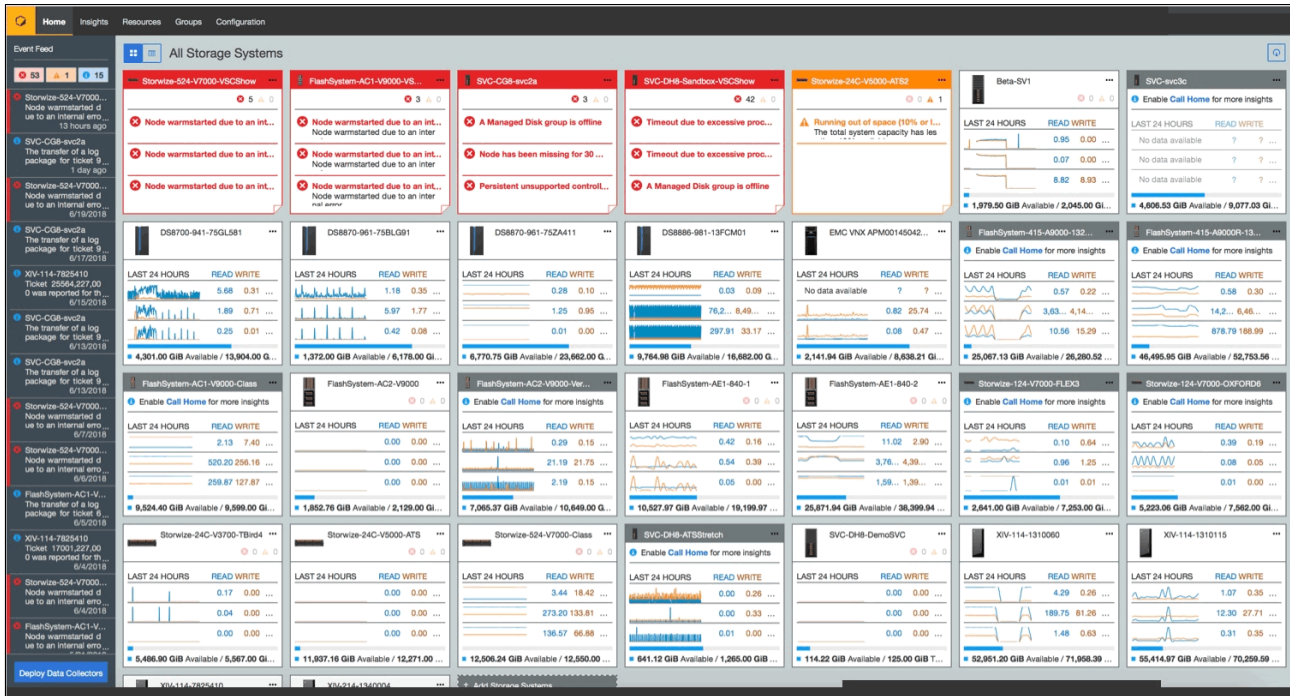


Figure 6 IBM Storage Insights dashboard

For more information about dashboard displays, see “IBM Storage Insights: Information and registration” on page 20.

For more information about the architecture and design overview of IBM Storage Insights, see IBM Redbooks *Unleash the Power of Flash: Getting Started with IBM Storage Virtualize Version 8.7 on IBM Storage FlashSystem and IBM SAN Volume Controller*, [SG24-8561](#).

IBM Storage Insights: Information and registration

For more information about IBM Storage Insights, see the following resources:

- ▶ [IBM Storage Insights Fact Sheet](#)
- ▶ [Product demonstration](#) (log in required)
- ▶ [IBM Storage Insights Security Guide](#), [SC27-8774](#)
- ▶ [IBM Storage Insights](#)

To register for free service, see [Sign Up for Storage Insights](#).

IBM Storage Connect

IBM FlashSystem 7300 Software supports integrating VASA and VAAI by using IBM Spectrum® Connect V3.11.0 or later. For more information about this feature, see [IBM Storage Connect](#).

IBM Storage Control

IBM Storage Control consolidates a range of IBM storage provisioning, virtualization, cloud, automation, and monitoring solutions through a unified server platform. IBM Storage Control provides insight and awareness about the configuration capabilities, storage health, and events of a storage system regarding VMware and vSphere. With this capability, VMware

administrators can independently and centrally manage their storage resources on IBM storage systems. For more information, see [IBM Storage Control](#).

IBM FlashSystem 7300 GUI

Multiple IBM FlashSystem 7300 control enclosures can be connected to form a system, which is sometimes called a cluster. A single management interface is used for the connected IBM FlashSystem 7300 control enclosures. Each IBM FlashSystem 7300 node canister is an individual server in an IBM FlashSystem 7300 clustered system, on which the IBM FlashSystem 7300 software runs.

The IBM FlashSystem 7300 system includes an easy-to-use management GUI that runs on the IBM FlashSystem 7300 control enclosure to help you monitor, manage, and configure your system. You can access the GUI by opening any supported web browser and entering the management IP addresses.

You can connect from any workstation that can communicate with the IBM FlashSystem 7300 system. The IBM FlashSystem 7300 control enclosure is delivered in a 2U 19 inch rack-mount enclosure.

Figure 7 on page 21 shows the IBM FlashSystem 7300 GUI dashboard.

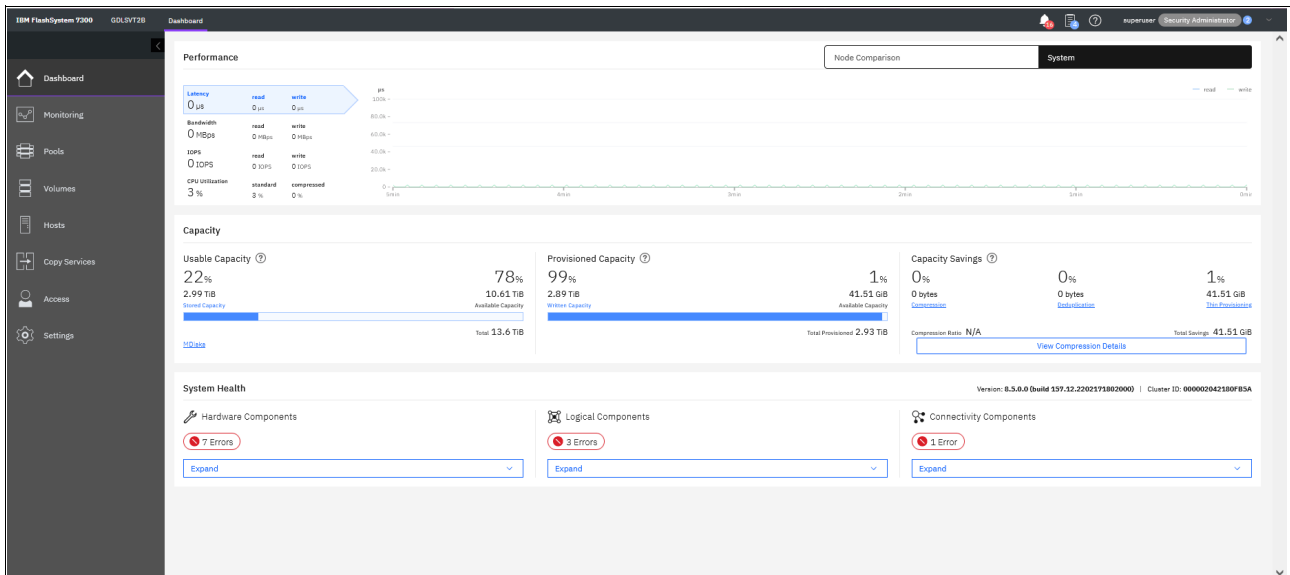


Figure 7 IBM FlashSystem 7300 GUI showing the dashboard

Figure 8 shows the control enclosure window. You can open this window by selecting **Monitoring** → **System Hardware** from the left side menu.

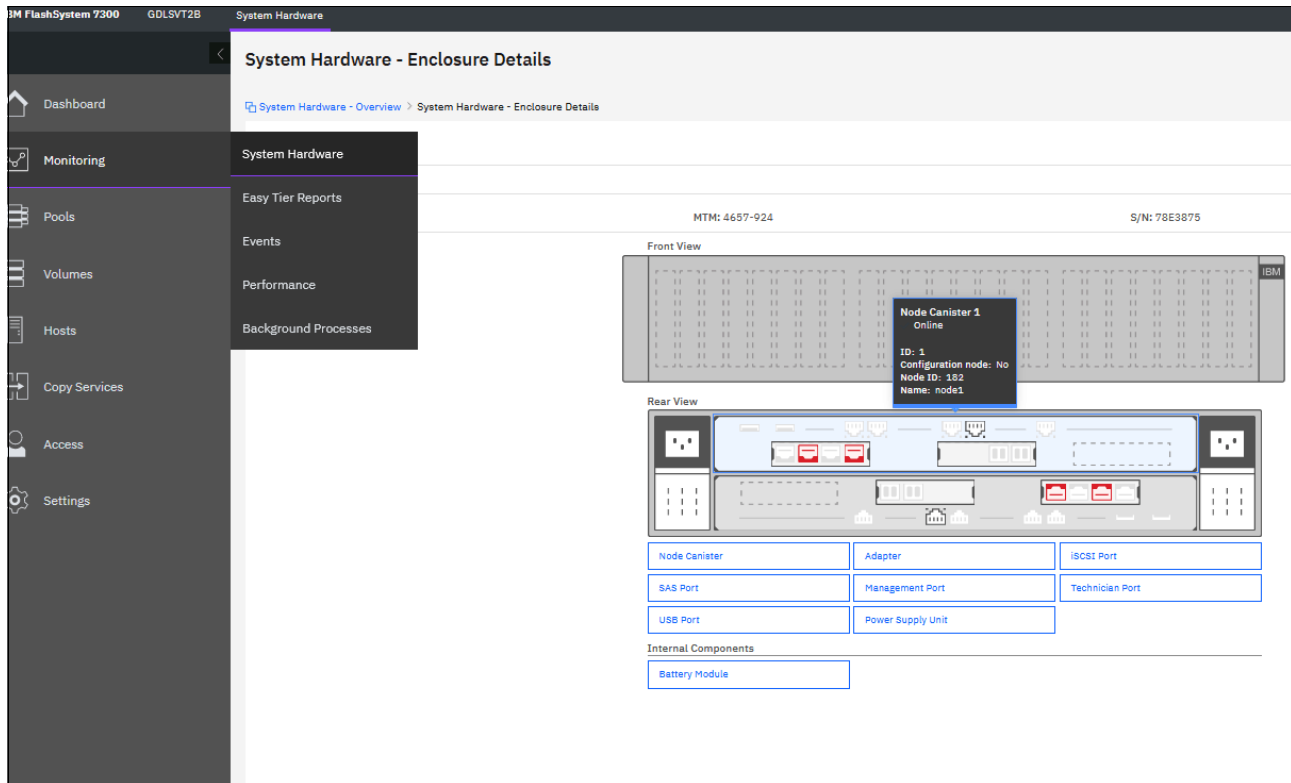


Figure 8 IBM FlashSystem 7300 system overview of the control enclosure

The IBM FlashSystem 7300 system includes a CLI, which is useful for scripting, and a GUI for simple and familiar management of the product. The IBM FlashSystem 7300 system supports Simple Network Management Protocol (SNMP), email forwarding that uses Simple Mail Transfer Protocol (SMTP), and syslog redirection for complete enterprise management access.

With the GUI, you can quickly deploy storage and manage it efficiently. The GUI runs on the IBM FlashSystem 7300 control enclosure, so a separate console is not needed. Point your web browser to the system IP address. You can manage all of the control and expansion enclosures from the GUI.

The IBM FlashSystem 7300 control enclosure node canisters are configured for active-active redundancy. The node canisters run a highly customized Linux-based operating system that coordinates and monitors all significant functions in the system.

The node canisters provide a web interface, Secure Shell (SSH) access, and SNMP connectivity through external Ethernet interfaces. By using the web and SSH interfaces, administrators can monitor system performance and health metrics, configure storage, and collect support data, among other features.

The storage configuration includes defining logical units with capacities, access policies, and other parameters. Except for a web browser or a standard SSH client, no additional software is required on host computers to administer the IBM FlashSystem 7300 system.

Supported platforms

The IBM FlashSystem 7300 system features extensive interoperability and supports a wide range of operating systems that includes Microsoft Windows Server, Linux, and IBM AIX® and IBM i, hardware platforms (IBM Power Systems, and x86 & x86_64 servers), host bus adapters (HBAs), and SAN fabrics. For more information, see this [IBM Support web page](#) and the [IBM System Storage Interoperation Center](#).

IBM FlashSystem 7300 hardware component overview

The following sections provide an overview of the IBM FlashSystem 7300 hardware components.

Control enclosure

The IBM FlashSystem 7300 control enclosure is a 2U rack-mounted NVMe flash memory enclosure that is based on IBM flash technology and provides the primary management interface (GUI) and the host interface configuration. The IBM FlashSystem 7300 control enclosures support Fibre Channel Protocol (FCP), NVMeOF on FC, and iSCSI interfaces. RoCE and iWARP protocols are supported by iSCSI and NVMe RDMA.

The IBM FlashSystem provides the following NVMe technologies:

- ▶ Supports unique world class IBM drives with Inline compression.
- ▶ Supports industry-standard NVMe drives.
- ▶ Option for Intel Optane or Samsung zSSD SCM type drives.
- ▶ NVMe-oF on FC.
- ▶ The IBM FlashSystem 7300 system is offered as two models:
 - 4657 Model 924 - IBM FlashSystem 7300 SFF NVMe Control Enclosure.
 - 4657 Model U7D - IBM FlashSystem 7300 SFF NVMe Control Enclosure.

Note: The U7D utility-based model uses fixed configurations because they are Capacity on Demand (CoD)-based offerings.

- ▶ Macroefficiency with up to 1380 TB of raw maximum protected capacity with Inline hardware data compression if you use IBM FCMs.
- ▶ Support for industry-standard NVMe drives with up to 368 TB of maximum raw capacity.
- ▶ Extreme performance with IBM MicroLatency FCMs.
- ▶ Optional expansion enclosures provide tiering options with SSD flash drives.

The IBM FlashSystem 7300 configuration includes the following components:

- ▶ A total of 1–4 IBM FlashSystem 7300 control enclosures.
- ▶ A total of 1–12 IBM FlashSystem 7000 SFF or Large Form Factor (LFF) 2U expansion enclosures.
- ▶ A total of 1–4 IBM FlashSystem 7000 LFF High Density (LFF HD) expansion enclosures per 7300 control enclosure.

The control enclosure includes integrated AC power supplies and battery units inside each of the node canisters. These batteries supply power to the control enclosure during a sudden power loss or failure so that the system can correctly commit all transactions to the storage medium.

The IBM FlashSystem 7300 control enclosure includes the following features:

- ▶ Full internal redundancy:
 - Redundant and hot-swappable node canisters.
 - Redundant and hot-swappable batteries within each node canister.
 - Redundant and hot-swappable power supplies, DIMMs, and fans.
- ▶ The control enclosure supports up to 24 NVMe 2.5-inch drives, which can be IBM FCMs or industry-standard NVMe drives:
 - The following 2.5-inch (SFF) IBM FCMs are supported in IBM FlashSystem 7300 control enclosures:
 - 4.8 TB 2.5-inch NVMe FCM
 - 9.6 TB 2.5-inch NVMe FCM
 - 19.2 TB 2.5-inch NVMe FCM
 - 38.4 TB 2.5-inch NVMe FCM
 - The following 2.5-inch (SFF) NVMe industry-standard drives are supported in IBM FlashSystem 7300 control enclosures:
 - 1.92 TB 2.5-inch NVMe flash drive
 - 3.84 TB 2.5-inch NVMe flash drive
 - 7.68 TB 2.5-inch NVMe flash drive
 - 15.36 TB 2.5-inch NVMe flash drive
 - 30.72 TB 2.5-inch NVMe flash drive
 - A maximum of twelve 1.6 TB NVMe Storage Class Memory Drives.
 - All drives are dual-port and hot-swappable. Drives of the same form factor and connector type can be intermixed within an enclosure.
 - All flash modules must be of the same type and capacity within the same DRAID6 array.
- ▶ Some other considerations for DRAID:
 - DRAID 1 is recommended for array configurations of three drives.
 - DRAID 1 is recommended for array configurations of four or five drives depending on capacity and performance requirements, with DRAID 5 alternatively as an RPQ.
 - DRAID 1 and DRAID 6 are recommended for array configurations of 6 drives depending on capacity and performance requirements.
 - DRAID 6 is recommended for array configurations with seven or more drives.
 - DRAID 5 is available through a SCORE request for array configurations of three to eight drives.
- ▶ Each IBM flash memory module contains IBM enhanced flash chips, FPGA chips, an IBM PowerPC® processor, and dynamic random access memory (DRAM) devices that are connected to the flash controllers and processor.
- ▶ Total 40 cores (Two node canisters, each with two 10-core processors).
- ▶ Cache options from 256 GB (128 GB per canister) to 1.5 TB (768 GB per canister).
- ▶ Eight on-board 10 Gbps Ethernet ports standard for iSCSI connectivity.
- ▶ 32 Gbps FC, 10/25 Gbps Ethernet, and 100 Gbps Ethernet ports for FC and iSCSI connectivity.

- ▶ A PCIe adapter that provides 12 Gbps SAS ports for expansion enclosure attachment.

The IBM FlashSystem 7300 control enclosure supports FCP with point to point (FC-P2P), arbitrated loop (FC-AL), and switched fabric (FC-SW) topologies. FC interfaces can be configured as N_port or NL_port types.

The FC ports are configured in NPIV mode. Therefore, the user must check that this configuration is preferred for their installation. If not, this configuration must be changed from the default when you set up the SAN infrastructure.

Full active-active multipathing across all interfaces is supported, although host software support for this function can vary.

Figure 9 shows the front view of the IBM FlashSystem 7300 control enclosure.



Figure 9 IBM FlashSystem 7300 control enclosure front view

The IBM FlashSystem 7300 control enclosure also includes the following expansion features:

- ▶ Capability for adding into clustered systems with more IBM FlashSystem 7300 control enclosures.

Note: Machine type 4657 FlashSystem 7300 systems can be clustered with other FlashSystem 7300 systems only. Clustering with machine types 2076, 4664, 4666, 9846, or 9848 is *not* supported.

- ▶ For expansion enclosure Model 12G and Model 24G, a maximum of 12 SAS-attached expansion enclosures are supported per IBM FlashSystem 7300 control enclosure. The maximum number of supported drives is 144 SAS HDD type drives with expansion Model 12G and 288 SSD/SAS type drives with expansion Model 24G.
- ▶ For expansion enclosure Model 92G, a maximum of 4 HD LFF expansion enclosures per 7300 controller, which provides a maximum of 368 SAS HDD type drives.

Figure 10 shows the components of the IBM FlashSystem 7300 control enclosure from the rear, which includes the interface cards, power supply units, and the USB and Ethernet ports. All components are concurrently maintainable, except for the passive mid-plane and power interposer board. All external connections are from the rear of the system.

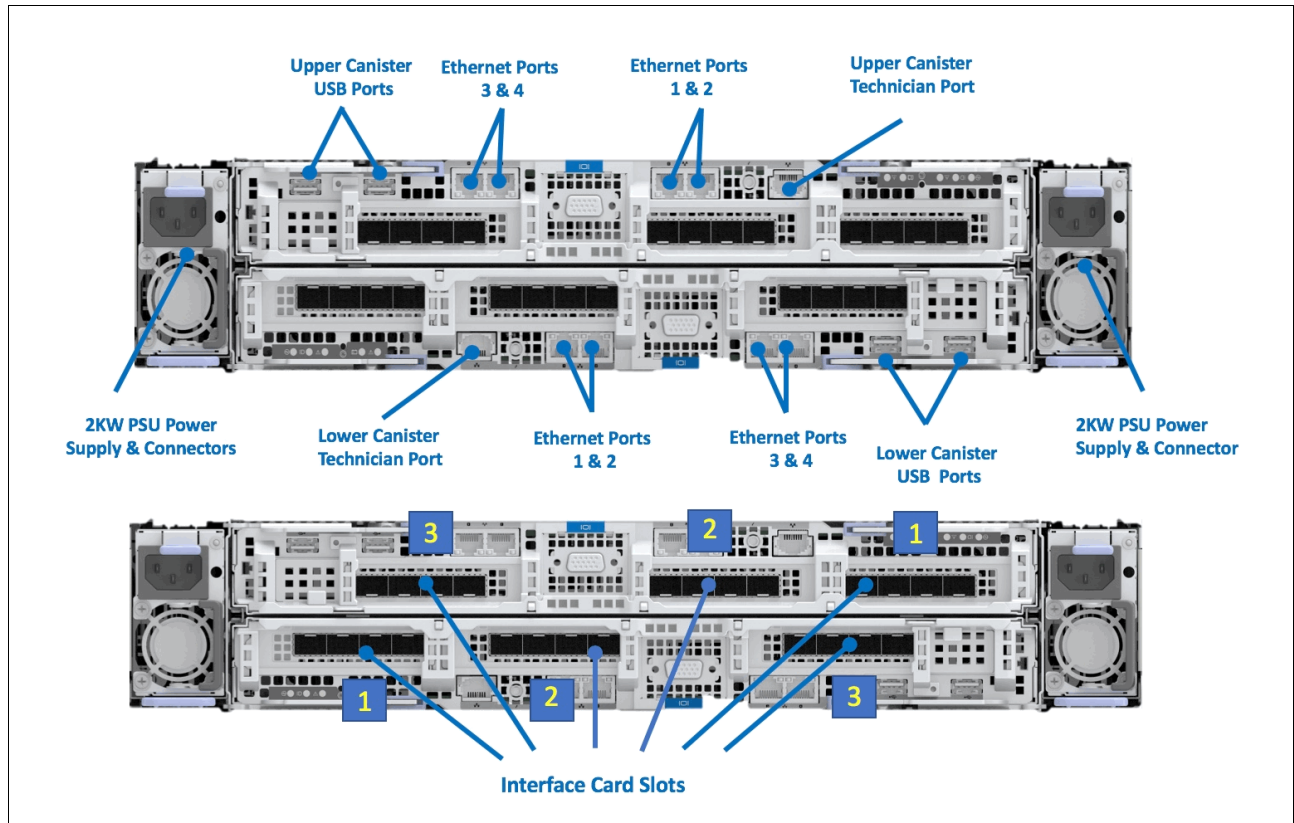


Figure 10 Rear view of IBM FlashSystem 7300 control enclosure

Note: The upper node canister is mounted upside down in the expansion enclosure. Therefore, the port numbering must be read right to left.

IBM FlashSystem 7300 Utility Model U7D

The IBM 4657 Model U7D is the FlashSystem 7300 hardware component that is used in the Storage Utility Offering space. It is physically and functionally identical to the FlashSystem 7300 Model 924, except for target configurations and variable capacity billing.

The variable capacity billing uses IBM Storage Insights to monitor the system usage, which allows allocated storage usage that is greater than a base subscription rate to be billed per TB, per month. Allocated storage is identified as storage that is allocated to a specific host (and unusable to other hosts), whether data is written.

For thin-provisioning, the data that is written is considered used. For thick provisioning, the total allocated volume space is considered used.

IBM FlashSystem 7300 Utility Model U7D provides a variable capacity storage offering. These models offer a fixed capacity, with a base subscription of approximately 35% of the total capacity.

IBM Storage Insights is used to monitor system usage, and capacity that is used. This usage is billed on a capacity-used basis. With this billing structure, you can grow or shrink usage, and pay for the configured capacity only.

IBM FlashSystem utility models are provided for customers who can benefit from a variable capacity system, in which billing is based only on provisioned space. The hardware is leased through IBM Global Finance on a three-year lease, which entitles the customer to use approximately 30–40% of the total system capacity at no extra cost (customer individual contract dependent). If storage needs increase beyond that initial capacity, usage is billed based on the average daily provisioned capacity per terabyte per month, on a quarterly basis.

Example: A total system capacity of 115 TB

A customer has an IBM FlashSystem 7300 utility model with 4.8 TB NVMe drives for a total system capacity of 115 TB. The base subscription for such a system is 40.25 TB. During the months where the average daily usage is less than 40.25 TB, no extra billing occurs.

The system monitors daily provisioned capacity and averages those daily usage rates over the month. The result is the average daily usage for the month.

If a customer uses 45 TB, 42.5 TB, and 50 TB in three consecutive months, IBM Storage Insights calculates the overage as listed in Table 2 (rounding to the nearest terabyte).

Table 2 Billing calculations based on customer usage

Average daily	Base	Overage	To be billed
45 TB	40.25 TB	4.75 TB	5 TB
42.5 TB	40.25 TB	2.25 TB	2 TB
50 TB	40.25 TB	9.75 TB	10 TB

The total capacity that is billed at the end of the quarter is 17 TB per month in this example.

Flash drive expansions can be ordered with the system in all supported configurations. Table 3 lists the feature codes that are associated with the U7D utility model billing.

Table 3 7300 U7D utility model billing feature codes

Feature code	Description
#AE00	Variable Usage 1 TB/month
#AE01	Variable Usage 10 TB/month
#AE02	Variable Usage 100 TB/month

These features are used to purchase the variable capacity that is used in the utility models. The features (#AE00, #AE01, and #AE02) provide terabytes of capacity beyond the base subscription on the system. Usage is based on the average capacity that is used per month. The prior three months’ usage is totaled, and the corresponding number of #AE00, #AE01, and #AE02 features ordered quarterly.

Billing

The local project office compiles the usage information from IBM Storage Insights on a quarterly basis. This data is compared to the base system capacity subscription. Any provisioned capacity beyond that base subscription is billed per terabyte per month on a quarterly basis.

The calculated usage is based on the average use over a month. In a highly variable environment, such as managed or cloud service providers, this subscription enables the system to use only as much as is necessary during any month. Usage can increase or decrease and is billed based on the usage.

Provisioned capacity is considered capacity that is reserved by the system. Thick-provisioned storage and thin-provisioned storage use flash drive space differently. For thick-provisioned storage, the provisioned capacity is the amount that is allocated to a host, whether it has data that is written. For thin-provisioned environments, the provisioned capacity is the amount of data that is written.

IBM FlashSystem 7300 expansion enclosures

IBM FlashSystem 7300 expansion enclosures are 2U or 5U rack-mounted units. The expansion enclosures are offered in the following models with several drive features:

► FlashSystem 7000 LFF Expansion Enclosure (4657 Model 12G):

Supports a maximum of 12 LFF 3.5-inch HDD drives that can be formatted as DRAID 1 or DRAID 6.

High-capacity, archival-class, nearline 7,200 rpm drives in: 6 TB, 8 TB, 10 TB, 12 TB, 14 TB, 16 TB, 18 TB, and 20 TB.

► FlashSystem 7000 SFF Expansion Enclosure (4657 Model 24G)

Supports a maximum of 24 SFF 2.5-inch drives that can be formatted as DRAID 1 or DRAID 6:

- 800 GB 3DWPD 2.5-inch drives
- High-performance, enterprise class disk 10,000 rpm drives in: 1.2 TB, 1.8 TB, and 2.4 TB
- Flash drives in: 1.92 TB, 3.2 TB, 3.84 TB, 7.68 TB, 15.36 TB, and 30.72 TB

► FlashSystem 7000 HD LFF Expansion Enclosure (4657 Model 92G)

Supports a maximum of 92 LFF 2.5-inch High-Density Drives in a 3.5-inch carrier, and can be formatted as DRAID 1 or DRAID 6:

- High-capacity, archival-class, nearline 7,200 rpm drives in: 6 TB, 8 TB, 10 TB, 12 TB, 14 TB, 18 TB, and 20 TB.
- High-performance, enterprise class disk 10,000 rpm drives in: 1.2 TB, 1.8 TB, and 2.4 TB. These drives are 2.5-inch drives in 3.5-inch carriers.
- Flash drives in: 1.92 TB, 3.2 TB, 3.84 TB, 7.68 TB, 15.36 TB, and 30.72 TB (these are 2.5-inch drives in 3.5-inch carriers)

Multiple expansion enclosures are supported per IBM FlashSystem 7300 control enclosure, which provides:

- A maximum of 144 drives with expansion enclosure 4657 Model 12G (12 drives in 12 expansion enclosures)
- A maximum of 288 drives with expansion enclosure 4657 Model 24G (24 drives in 12 expansion enclosures)
- A maximum of 368 drives with expansion enclosure 4657 Model 92G (92 drives in 4 expansion enclosures)

On each SAS chain, the systems can support a maximum SAS chain weight of 5 or 6 depending on code level:

- ▶ Each 4657-12G or 4657-24G expansion enclosure adds a value of 1 to the SAS chain weight.
- ▶ Each 4657-92G expansion enclosure adds a value of 2.5 to the SAS chain weight.

Note: Each SAS chain can have a maximum total *chain weight* of 5 or 6 depending on code level. Each 92G enclosure has a chain weight of 2.5; each 12G or 24G enclosure has a chain weight of 1.

For example, it is valid to have two 92G enclosures and one 24G enclosure (total chain weight of 6). For more information, see [Enclosures](#).

Figure 11 shows the front view of the IBM FlashSystem 7000 Expansion Enclosure Model 12G.



Figure 11 Front view of the IBM FlashSystem 7000 LFF Expansion Enclosure Model 12G

The 12G model of the IBM FlashSystem 7000 LFF expansion enclosure includes the following features:

- ▶ Two expansion canisters
- ▶ 12 Gbps SAS ports for attachment to the IBM FlashSystem 7300 control enclosures
- ▶ 2U 19 inch rack-mount enclosure with AC power supplies

Figure 12 shows the rear view of IBM FlashSystem 7000 LFF Expansion Enclosure Model 12G.



Figure 12 Rear view of IBM FlashSystem 7000 Expansion Enclosure Model 12G

Figure 13 shows the front view of the IBM FlashSystem 7000 Expansion Enclosure Model 24G.



Figure 13 Front view of the IBM FlashSystem 7000 SFF Expansion Enclosure Model 24G

The 24G model of IBM FlashSystem 7000 SFF Expansion Enclosure includes the following features:

- ▶ Two expansion canisters
- ▶ 12 Gbps SAS ports for attachment to the IBM FlashSystem 7300 control enclosures
- ▶ 2U 19 inch rack-mount enclosure with AC power supplies

Figure 14 shows the rear view of IBM FlashSystem 7000 SFF Expansion Enclosure Model 24G.



Figure 14 Rear view of IBM FlashSystem 7000 Expansion Enclosure Model 24G

IBM FlashSystem 7000 LFF HD Expansion Enclosure Model 92G delivers the following features:

- ▶ A maximum of 92 drives are top-loaded into drive slots of the expansion enclosure
- ▶ 5U 19 inch rack-mount enclosure with slide rail and cable management assembly
- ▶ Redundant 200–240 V AC power supplies, new C19/C20 PDU power cord required

Figure 15 shows the front view of IBM FlashSystem 7000 LFF HD Model 92G Expansion Enclosure.



Figure 15 Front view of IBM FlashSystem 7000 LFF Model 92G Expansion Enclosure

Figure 16 shows the rear view of IBM FlashSystem 7000 LFF model 92G Expansion Enclosure.

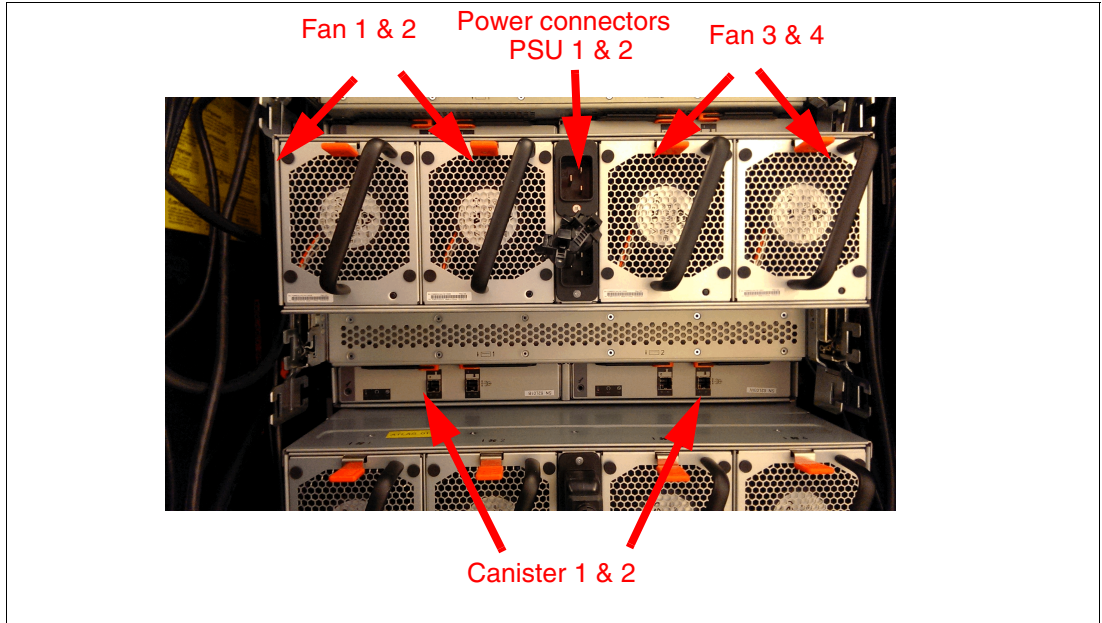


Figure 16 Rear view of IBM FlashSystem 7000 LFF model 92G Expansion Enclosure

Scalability and performance

The IBM FlashSystem 7300 system includes the following scalability and performance features:

- ▶ A maximum of 829.44 TB usable and 1.75 PB effective flash capacity in only 2U with 3:1 compression without Expansions.
- ▶ A maximum of 3.3 PB usable and 10.69 PB maximum flash capacity in only 8U with 5:1 compression without Expansions.
- ▶ Extra scalability through expansion enclosures models 12G, 24G, and 92G, and increased raw capacity to a maximum of 32 PB.
- ▶ IBM FlashSystem 7300 can deliver a maximum of 2.3 million IOPS, with latency down to 70 microseconds (μ s) and a maximum bandwidth of 35 GBps from a single system.
- ▶ A clustered FlashSystem 7300 can scale linearly and delivers 9.2 million IOPS and 140 GBps on a fully configured 4x IBM FlashSystem 7300 cluster.

Note: Performance and available bandwidth depend on the workload. Use the IBM Storage Modeler (STORM) to retrieve the performance and bandwidth data for your system. For more information, see [STORM - Storage Memory Objects Report](#).

Advanced functions

The IBM FlashSystem 7300 system provides the following advanced functions:

- ▶ Policy-based HA for IBM FlashSystem 7300
- ▶ IBM Flash Grid
- ▶ Safeguarded Snapshot
- ▶ Increased security features
- ▶ NVMe over Fabrics
- ▶ Portsets
- ▶ IP quorum base support
- ▶ Data reduction tools
- ▶ N-Port ID virtualization support
- ▶ VMware integration
- ▶ External virtualization

Policy-based HA for IBM FlashSystem 7300

Policy-based HA for IBM FlashSystem 7300 is available with IBM Storage Virtualize V8.7.0 and later. This ensures continuous application data access even in case of primary storage system failures. Policy-based HA maintains synchronized data copies on a peer system, allowing applications to access data from either system. This active/active solution enables simultaneous I/O to both copies while maintaining data synchronization. Synchronous replication guarantees data consistency between production volumes. Volume groups manage consistency across application-dependent volumes. Storage partitions facilitate easy management of highly available resources by grouping related volume groups, hosts, and mappings. To prevent conflicts, IP Quorum determines the active management system. You can flexibly add or modify volumes, volume groups, hosts, and mappings within existing partitions or create new ones. See Figure 17.

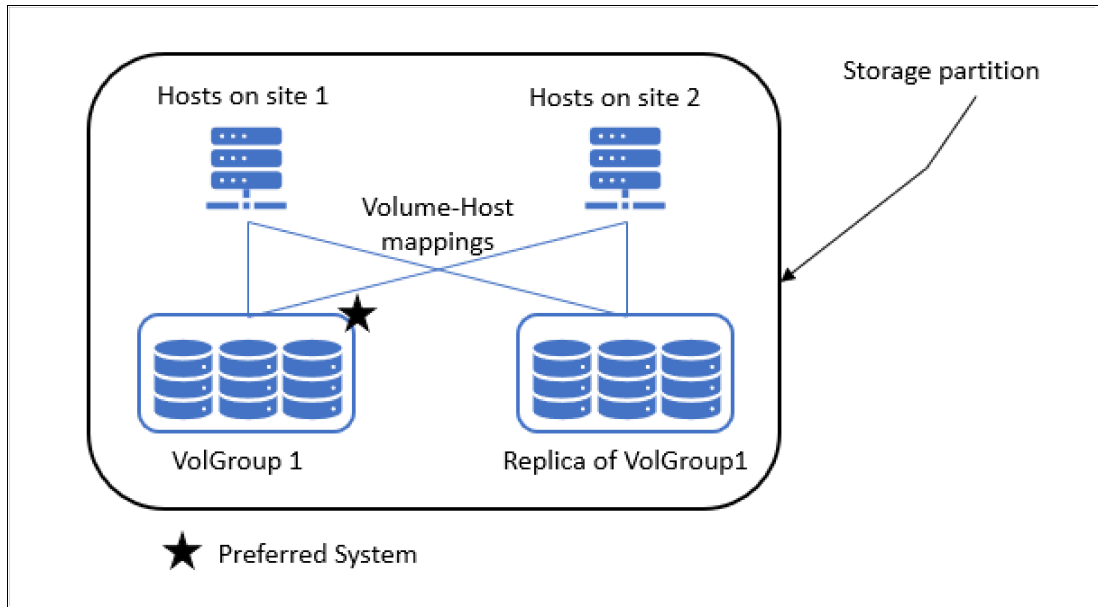


Figure 17 Storage partitions

Storage partitions simplify HA management by automating host mapping to volume group replicas across both systems. Hosts seamlessly access volumes with identical UIDs. To maintain consistency, HA replicates not only data but also storage partition configurations, including host definitions and mappings. Configuration changes are typically managed on the preferred system and synchronized to both. The preferred system is usually the system where the partition is managed and remains accessible during disconnections. Hosts can access volumes through the preferred system or, if host locations are set, directly from the local storage system. Volume groups, storage partitions, and policies are centrally managed on the active management system, which can fail over in case of an outage. Local hosts automatically switch to the remote system using ALUA multipathing during local site failures.

For more information on policy-based HA refer to *Ensuring Business Continuity: A Practical Guide to Policy-Based Replication and Policy-Based High Availability for IBM Storage Virtualize Systems*, [SG24-8569](#).

IBM Flash Grid

IBM Storage Virtualize, with storage partitions and volume groups, separates business continuity requirements like HA and replication from hardware systems, enabling multiple software-defined virtual storage systems within a single FlashSystem deployment. Flash Grid empowers users to create federated, scalable clusters of independent storage devices, surpassing traditional scale-out limitations. It offers linear performance, capacity, and resource growth with up to eight systems. Unlike previous "per I/O group" clustering, Flash Grid focuses on system-level scale-out, simplifying management and reducing hardware compatibility constraints. This approach enables easier hardware replacement, capacity balancing, and non-disruptive application data migration through storage partition migration. Clients can aggregate IBM FlashSystem or SVC systems into a single, highly available, manageable storage grid.

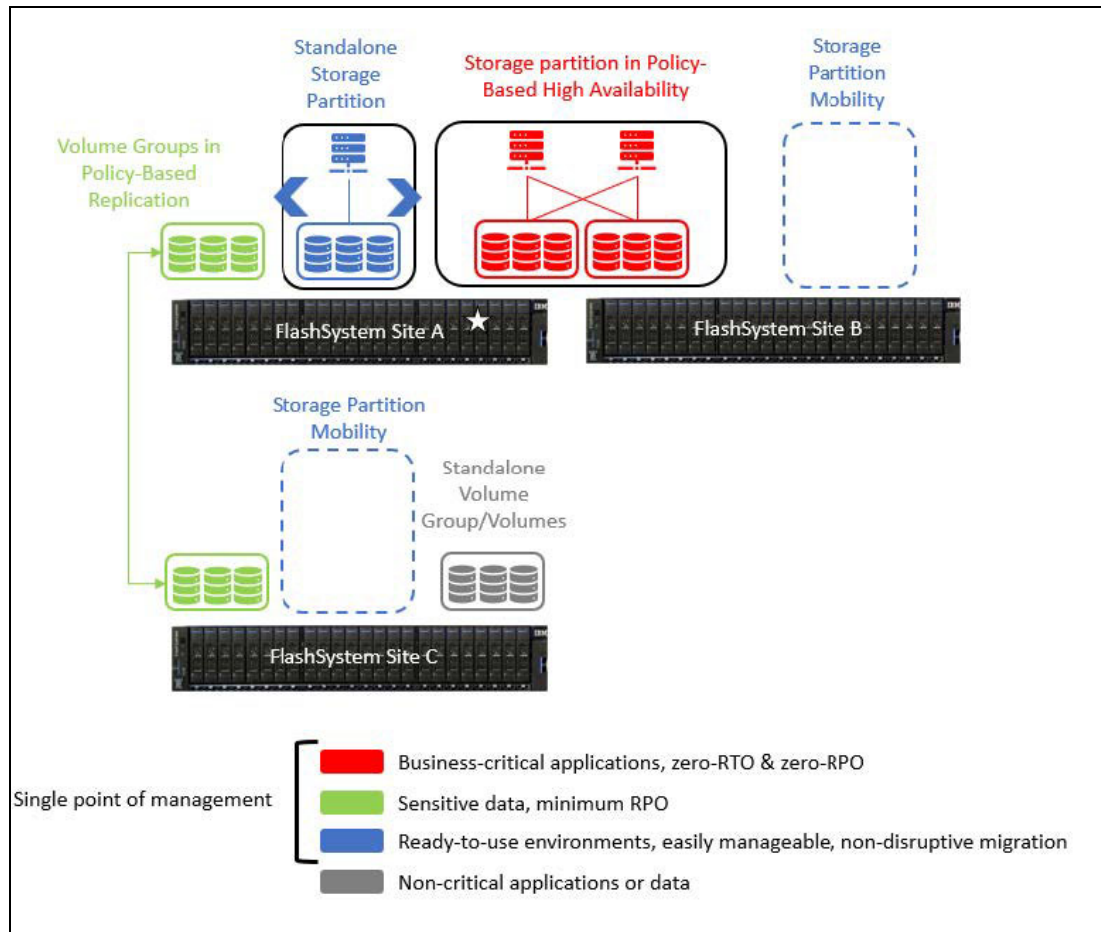


Figure 18 IBM Flash Grid concept

Once storage partitions are configured, they can easily be moved from a system to another, manually balanced by users over several systems and sites. They can also be stretched over two sites for high availability. See Figure 18. At the time of this writing, Flash Grid features (partitions mobility) are manageable with IBM Storage Insights Pro only.

It is possible to use the CLI to create a Flash Grid and add or remove systems in a Flash Grid.

Safeguarded Snapshot

IBM Safeguarded Snapshot (previously called Safeguarded Copy) regularly creates isolated, separated from server, immutable snapshots of data to help protect against cyberattacks, malware, acts of disgruntled employees, and other data corruption. Because Safeguarded snapshots are on the same FlashSystem storage as operational data, recovery is faster than restoring from copies stored separately.

The Safeguarded child-pool capability on the IBM Storage Virtualize family of products was introduced in an earlier version. The IBM Storage Virtualize family of products includes IBM FlashSystem products, IBM SAN Volume Controller, and IBM Storage Virtualize for Public Cloud.

HA configurations mitigate against physical component failure and provide small Recovery Point Objective (RPO) and Recover Time Objective (RTO). Continuous protection and

operation occur if a component fails. IBM Storage Virtualize HA configurations, such as policy-based high availability, provide such protection.

DR is designed to have a slightly higher RPO and RTO. Therefore, DR is in a position to provide an airgap to protect against corruption to the data that is replicated immediately in an IBM Storage Virtualize HA configuration, such as policy-based high availability.

However, because DR solutions at the storage layer are replicating only data, any logical corruption eventually is replicated to the DR site as well.

One way to provide adequate protection against logical data corruption is to take periodic snapshots of the data and to have that data stored in a non-modifiable state that is inaccessible to administrators, servers, and applications. These Safeguarded snapshots can then serve as recovery points from which the data can be restored to a pre-corruption state. The corruption can be the result of an errant batch job, a disgruntled employee, or a ransomware attack.

For more information about Safeguarded Snapshot, see *Data Resiliency Designs: A Deep Dive into IBM Storage Safeguarded Snapshots*, [REDP-5737](#).

Increased security features

IBM Storage Virtualize enhances security with multi-factor authentication (MFA), requiring multiple forms of verification for login. This strengthens protection against unauthorized access, especially in cloud environments. Integrated with IBM Security Verify, MFA provides granular control over user access and simplifies monitoring. Additionally, the software supports single sign-on (SSO) via Microsoft Active Directory Federation Services (AD FS) for efficient user logins.

For more information, see *IBM Storage Virtualize, IBM FlashSystem, and IBM SAN Volume Controller Security Feature Checklist*, [REDP-5678](#).

NVMe over Fabrics

NVMe is a high-speed interface optimized for flash storage, designed to deliver low latency and high throughput. This standard enables direct communication between the host system and flash-based storage devices, bypassing traditional bottlenecks.

The NVMe protocol is an interface specification for communicating with storage devices and it is functionally the same as other protocols, such as SATA and SAS. However, the NVMe interface was designed for fast storage media, such as flash-based SSDs and low-latency nonvolatile storage technologies.

Typically, NVMe storage devices are directly attached to a host system over a PCIe bus, and the NVMe controller is contained in the storage device. This architecture eliminates the need for another I/O controller between the CPU and the storage device and results in reduced latency, throughput scalability, and simpler system designs.

This design was implemented in the IBM FlashSystem 7300, with its dual-ported PCIe-based NVMe drives.

However, the PCIe bus has a limit to the number of NVMe drives that can be attached to a host over the bus to a few tens of devices. Also, because the maximum length of PCIe cabling is a few meters, the flexibility of deploying PCIe NVMe drives outside the host server is limited and data center level scalability is not feasible.

NVMe over Fabrics (NVMe-oF) overcomes the limitations of the SCSI protocol and the limited number of concurrent queues by extending the benefits of low latency and high efficiency of the NVMe technology across network fabrics. This feature supports sharing of NVMe storage at a large scale of 100s or 1000s of devices and over distance.

Figure 19 on page 36 shows that the NVMe architecture supports many different network fabric technologies.

The NVMe transport layer can be mapped to different network fabric technologies.

As of this writing, the NVMe transport layer supports the NVMe over Fabrics by using Fibre Channel (referred to as FC-NVMe or NVMeFC) main fabric transport.

FC-NVMe uses FCP as its transport mechanism, which is similar to RDMA, because it places the data transfer in control of the target and transfers data direct from host memory. In addition, FC-NVMe allows for a host to send commands and data together (first burst), which eliminates the first data read by the target and provides better performance at distances.

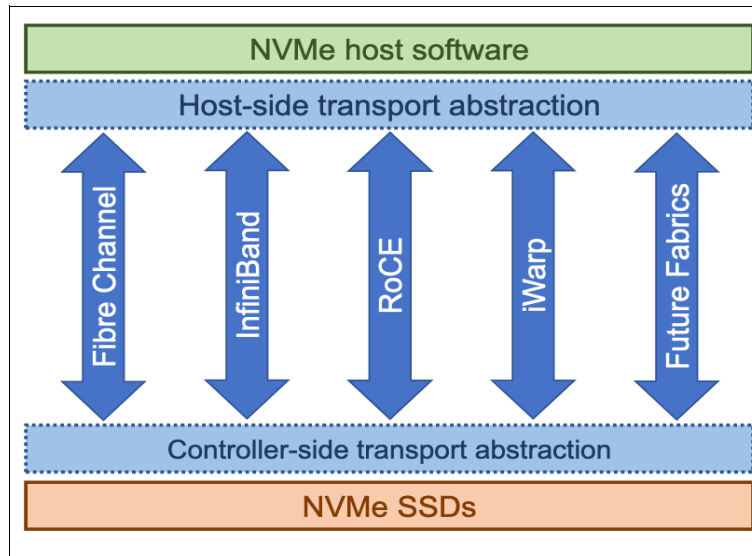


Figure 19 NVMe technology support options

The NVMe over Fabrics interface uses the same model of submission and completion queues as PCIe NVMe. It maintains the same asynchronous submission and completion model and achieves similar benefits in terms of latency, efficiency, and scalability as the NVMe technology because of the shortened code paths and lockless concurrency in multi-core environments.

IBM FlashSystem 7300 supports NVMe protocols by way of the various PCIe adapters that can be ordered and installed in the control enclosure. For more information about these options, see “Host I/O connectivity and expansion enclosure adapters” on page 50.

For more information about NVMeoF protocols and architecture, see *IBM Storage and the NVMe Express Revolution*, [REDP-5437](#).

Portsets

IBM FlashSystem 7300 is designed for multi-tenancy where multiple clients can share storage resources. In multi tenancy environments, it might be a requirement that clients use storage ports that are connected to different networks to isolate traffic from other clients.

Portsets are groupings of logical addresses that are associated with the specific traffic types. The system supports IP portsets for host attachment, back-end storage connectivity, and IP replication traffic. In addition, FC portsets can be configured for host attachment.

After you create portsets and assign IP addresses, you can assign hosts, host clusters, and IP partnerships to the portset for those traffic types.

IP quorum base support

For reduced implementation and operation costs for a HA solution, you can use IP quorum base support to use lower-cost IP network-attached hosts as a quorum disk. Up to 5 instances are supported. policy-based high availability implementations require FC storage on a third site to cope with tie-breaker situations if the intersite link fails, and when connectivity between sites 1 and 2 is lost. In a policy-based high availability setup, a quorum disk at the third site is needed. The quorum disk on the third site must be the active quorum disk. Only the active quorum disk acts as a tie breaker.

A quorum device is also used to store a backup copy of important system configuration data. Just over 256 MB is reserved for this purpose on each quorum device.

A system can have only one active quorum device that is used for a tie-break situation. However, the system uses up to three quorum devices to record a backup of system configuration data to be used if a disaster occurs. The system automatically selects one quorum device to be the active quorum device.

For more information about configuring quorum disks within two or three sites, see [Configuring quorum](#).

Note: Fibre Channel over IP (FCIP) connectivity is not supported between nodes when a policy-based high availability system is configured without the use of inter-switch links (ISLs).

Data reduction tools

Compression and de-duplication are a key part of the IBM FlashSystem 7300 system. IBM Comprestimator and Data Reduction Estimator Tool is the key sizing tool that is used to estimate how much capacity savings that a client can expect. IBM Comprestimator and Data Reduction Estimator Tool can recognize the patterns of the client data and estimate the compressibility of data per volume.

IBM FlashSystem models are supported by the IBM Comprestimator, which is available as a stand-alone tool and found in the IBM FlashSystem 7300 GUI. IBM FlashSystem models also support the stand-alone Data Reduction Estimator Tool (DRET). The DRET is a host-based application that is used to estimate the amount of compression and de-duplication on the IBM FlashSystem 7300 system for specific workloads. For more information about DRET, see [IBM Data Reduction Estimator Tool \(DRET\) for SVC, Storwize and FlashSystem products](#).

For more information about the IBM Comprestimator, see [IBM FlashSystem Comprestimator](#).

Choose your data reduction approach and use the tools to estimate the amount of usable storage that is required by reviewing the following tools.

Figure 20 on page 38 shows how to start the Estimate Compression Saving option from the GUI.

From the main menu, click **Volumes** → **Volumes** and select one volume. Then, right-click to open the menu and select **Capacity Savings** → **Estimate Compression Saving**.

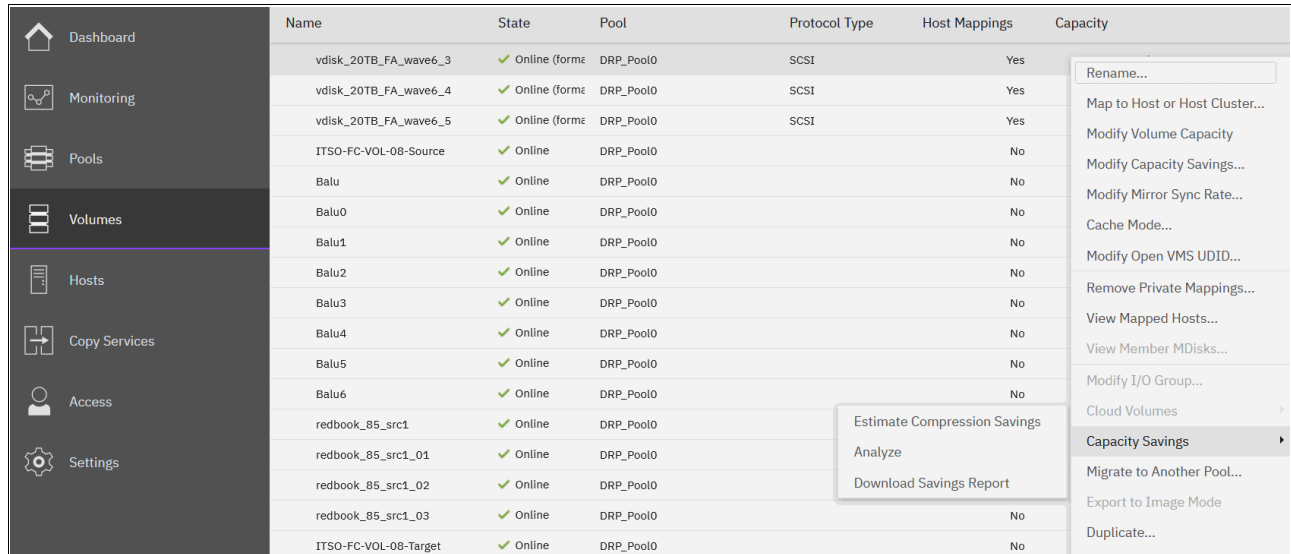


Figure 20 Estimate Compression Saving from the GUI

The following methods can be used to estimate compression and savings on FCM and DRP approaches:

- ▶ IBM FCM - IBM FCM Compression:
 - Use the FCM option.
 - Do not use the Estimate Compression Saving option in the GUI to calculate the IBM FCM savings.
- ▶ DRP compression:
 - Use the DRP option.
 - Workloads that are on any IBM Storage Virtualize platform can use the Estimate Compression Saving option in the GUI.
- ▶ DRP compression and deduplication:
 - IBM Comprestimator and Data Reduction Estimator Tool shows the savings for thin-provisioning, compression, and deduplication.
 - IBM Comprestimator and Data Reduction Estimator Tool reads entire volumes to identify de-duplicated data, so it takes longer to run.

For more information about DRP compression and setup, see *Introduction and Implementation of Data Reduction Pools and Deduplication*, [SG24-8430](#).

N-Port ID virtualization support

IBM Storage Virtualize software offers NPIV support. Use NPIV to virtualize WWPNs, which increases redundancy during firmware updates and scheduled maintenance where WWPNs transparently move to the controller that is not being maintained. As a consequence, FC-attached hosts experience zero path reduction during controller outages.

Important: On the IBM FlashSystem 7300 system NPIV is enabled by default. Therefore, if the customer does not want to use it, they must disable it before configuring FC ports for host communications.

VMware integration

IBM Storage Virtualize software includes the following features, which enable tight integration with VMware:

- ▶ vCenter plug-in
Enables monitoring and self-service provisioning of the system from within VMware vCenter.
- ▶ vStorage APIs for Array Integration (VAAI) support
This function supports hardware-accelerated virtual machine (VM) copy and migration and hardware-accelerated VM initiation, and accelerates VMware Virtual Machine File System (VMFS).
- ▶ Microsoft Windows System Resource Manager (SRM) for VMware Site Recovery Manager
Supports automated storage and host failover, failover testing, and failback.
- ▶ VVOL integration for better usability
The migration of space-efficient volumes between storage containers maintains the space efficiency of volumes. Cloning a VM achieves a full independent set of VVOLs. Resiliency is also improved for VMs if volumes start running out of space.

Before the availability of VVOLs, a VM in a VMware environment was presented as a VMware disk that was called a VMware Virtual Machine Disk (VMDK). The VMDK file represented a physical disk to the VM. The operating system that is installed on the VM accessed the VMDK.

The VMDK file was placed in a file system that is called VMFS, which is hosted by a standard volume (LUN). For example, it can be implemented on an external storage system, such as the IBM FlashSystem 7300 system. With the availability of the VVOL technology, each VM disk can now be mapped to an external storage volume, such as an IBM FlashSystem 7300 volume.

With VVOL, the IBM FlashSystem 7300 solution recognizes individual VMDK files. Therefore, data operations, such as snapshot and replication, can be performed directly by the IBM FlashSystem 7300 system at the VMDK level rather than the entire VMFS data store.

Note: The integration of VVOL with the IBM FlashSystem 7300 system is based on the VMware APIs for Storage Awareness (VASA). IBM support for VASA is delivered as part of the embedded VASA Provider starting with IBM Storage Virtualize 8.5.1.0.

For more information about VMware integration, see *IBM Storage Virtualize and VMware: Integrations, Implementation and Best Practices*, [SG24-8549](#).

External virtualization

The IBM FlashSystem 7300 can manage external storage arrays through virtualization, offering features like thin provisioning, data replication, and easy data migration. By incorporating external storage into a unified pool, it simplifies management and enables efficient capacity utilization. This approach also protects applications from underlying storage changes, minimizing downtime. Additional licensing is required for external storage virtualization.

Scaling up and scaling out

The IBM FlashSystem 7300 system has a scalable architecture that enables flash capacity to be added, or scaled up, to support multiple applications by adding expansion enclosures. Scale out expands NVMe capacity, with the processing power to use that capacity to linearly scale IOPS and bandwidth. As a result, your organization can gain a competitive advantage through a more flexible, responsive, and efficient storage environment.

The IBM FlashSystem 7300 system has the following flexible scalability configuration options:

- ▶ Base configuration
- ▶ Scale up: Add capacity
- ▶ Scale out: Add control enclosures and capacity

Each IBM FlashSystem 7300 has two canisters, which are also called nodes or controllers. Each canister contains the CPUs, cache memory, PCIe adapters, and other hardware to communicate to the NVMe drives and connected hosts. These canisters are housed in a chassis that is known as a control enclosure.

It is possible to connect up to a maximum of four control enclosures to form a cluster.

Table 4 lists the values of the CPUs, cache memory, raw NVMe drive size, and PCIe adapters for each number of control enclosures.

Table 4 Maximum values for each canister and control enclosure

Element	Number of CPUs	Maximum cache memory (GiB)	Maximum NVMe 24 drive capacity raw (TiB)	Inclusive onboard Ethernet ports	Maximum PCIe ports (FC or Ethernet)
One Canister	2	768	N/A	4	12
One Enclosure	4	1536	922	8	24
Two Enclosures	8	3072	1844	16	48
Three Enclosures	12	4608	2766	24	72
Four Enclosures	16	6144	3688	32	96

A basic configuration of an IBM FlashSystem 7300 storage platform consists of one IBM FlashSystem 7300 control enclosure. For a balanced increase of performance and scale, up to four IBM FlashSystem 7300 control enclosures can be clustered into a single storage system, which multiplies performance and capacity with each addition.

The clustered IBM FlashSystem 7300 system can include dedicated internal FC switches for internal communications. However, other methods are available to configure the switches and ports to provide performance improvements.

For more information about how to restrict the FC ports for control enclosure inter-node connections and host connections, see [SAN configuration and zoning rules summary](#).

With the scalable IBM FlashSystem 7300 configurations, you can add up to three IBM FlashSystem 7300 control enclosures to the storage system.

A single IBM FlashSystem 7300 enclosure can provide up to 829 TiB in usable capacity when using all recommended settings (DRAID6 and a 10+P+Q stripe layout). These default settings are used when an array is defined by using the GUI wizard.

The following RAID types are available on the IBM FlashSystem 7300:

- ▶ DRAID 1
- ▶ DRAID 5 (RPQ only)
- ▶ DRAID 6

All RAID types are now DRAID, which was developed to support larger arrays and especially arrays of larger drive modules. The technology can significantly shorten the rebuild time by distributing data, parity, and spare capacity over all member drives of an array. By using DRAID arrays, you can dynamically expand an array with newly added drives to the system.

IBM FCMs provide hardware compression at no extra cost. It is integrated into the drive module and is always enabled. The compression effectiveness depends on the type and structure of user data. Overall, IBM expects a compression ratio up to 3:1, which achieves an effective capacity in a single enclosure of 1382 TiB.

When incorporating DRPs with deduplication and compression, potentially an even higher data reduction ration of a maximum of 5:1 is achievable, depending on the data structure.

The IBM FlashSystem 7300 system is expandable to 32 PB by using SSDs and HDDs in expansion enclosures as tiered capacity. More FlashSystem expansion enclosures are attached through the optional SAS Expansion Enclosure Attach card (FC# ADBA).

Maximum capacity configurations

Table 5 lists the maximum usable capacity, and maximum effective capacity for scalable configurations that are built on the IBM FlashSystem 7300 control enclosures.

Table 5 IBM FlashSystem 7300 maximum usable and effective capacity.

Number of control enclosures	Maximum usable capacity by using DRAID6 with 24 drives (TiB)	Maximum effective capacity (TiB) with inline FCM Drive compression 3:1 ratio	Maximum effective capacity (TiB) with software data reduction 5:1 ratio
One	663	1989	3315
Two	1326	3978	6630

Number of control enclosures	Maximum usable capacity by using DRAID6 with 24 drives (TiB)	Maximum effective capacity (TiB) with inline FCM Drive compression 3:1 ratio	Maximum effective capacity (TiB) with software data reduction 5:1 ratio
Three	1989	5967	9945
Four	2652	7956	13260

Note: IBM FCM inline compression is hardware-based and operates at line speed, having no effect on the performance.

Capacity expansion by using expansion enclosures

The IBM FlashSystem 7300 system supports the addition of expansion enclosures to extend capacity.

Note: The IBM Storage Virtualize maximum storage limit is 32 PB.

The list of available drive module options to be installed in expansion enclosures can be found in “IBM FlashSystem 7300 hardware component overview” on page 23.

High-density (HD) Enclosure Model 92G accepts SAS SSDs and HDDs. With these tiering options, you can have four enclosures per control enclosure, with a maximum capacity of 998 TB each using 30.72 TB flash drives.

Note: To support SAS-attached expansion enclosures, a SAS Enclosure Attachment adapter, feature code an ADBA, must be installed in the control enclosure of the IBM FlashSystem 7300 system.

Figure 21 shows the maximum enclosure configuration with 92G expansions.

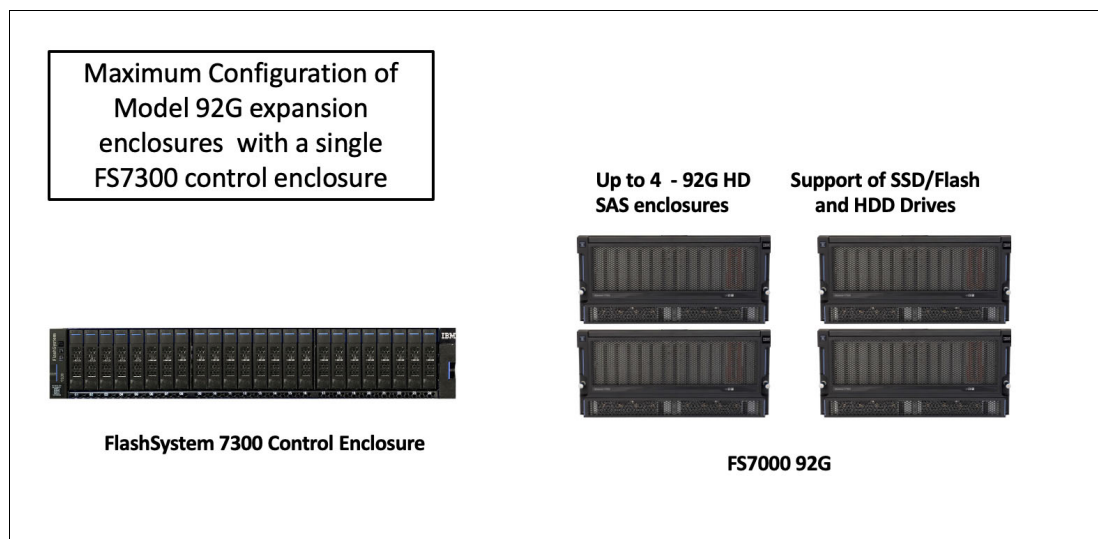


Figure 21 Maximum configuration for model 92G enclosures

IBM FlashSystem 7000 LFF Expansion Enclosure Model 12G offers new tiering options with HDDs. Each LFF expansion enclosure supports up to 12 3.5-inch HDDs.

IBM FlashSystem 7000 SFF Expansion Enclosure Model 24G offers new tiering options with HDD or SSD flash drives. Each SFF expansion enclosure supports a maximum of 24 2.5-inch flash SSD or HDDs.

A maximum of 12 expansion enclosures are supported per IBM FlashSystem 7300 control enclosure, which supports a maximum of 288 SAS SSD and HDD drives.

Figure 22 shows the maximum configuration of 20 expansion enclosures in the 12G or 24G models.

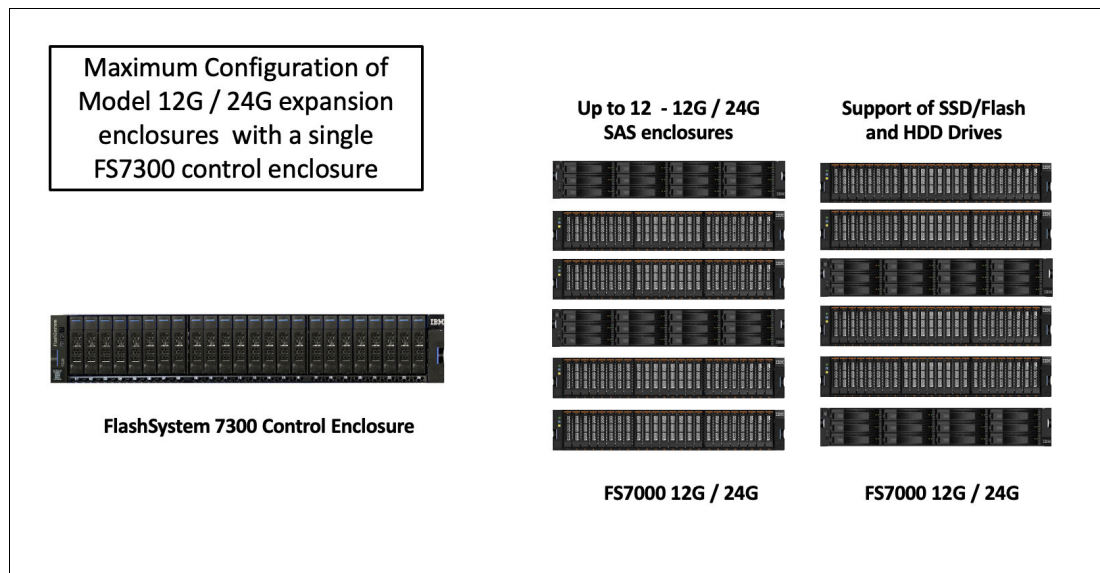


Figure 22 Maximum configuration for model 12 G / 24 G enclosures

RAID types

The IBM FlashSystem 7300 system supports DRAID 1 and DRAID 6. Traditional RAID is *not* supported.

The following rules apply for DRAID building:

- ▶ DRAID 6 is used for all drive types:
 - SCM Class drives
 - FCMs
 - Industry-standard flash drives
- ▶ DRAID 1 is used if in any drive class 6 or fewer drives are present.
- ▶ All drives in a single array must be of the same type, technology, and size.
- ▶ Only one DRAID array is used per pool.

For more information about the types of supported RAID configurations, see [Array Configurations](#).

Manageability and security

The IBM FlashSystem 7300 system offers many improvements on the manageability and security features as compared to previous models.

In general, the manageability and security of the range of systems. The changes that are implemented in version 8.7 code on these systems include the following examples:

- ▶ Safeguarded Snapshot is a technology that is derived from the technology that is used in the IBM DS8000® line. It consists of a copy that cannot be changed or deleted after it is created. Also, storing sensitive copies in immutable storage, cloud environments, or offline write-once read many (WORM) tape devices is an option to provide physical air-gap protection.
- ▶ Advanced security for data at rest with hardware-accelerated AES-XTS 256 encryption.
- ▶ IBM has applied for FIPS 140-3 Level 1 certification for IBM FCMs generation 4 in the IBM FlashSystem 7300. At the time of writing, the application is on the NIST modules-in-progress list.
- ▶ A GUI and a CLI are available to manage the IBM FlashSystem 7300 control enclosures and the IBM FlashSystem 7000 expansion enclosures:
 - The GUI is supported in any supported browser.
 - The IBM FlashSystem 7300 CLI supports a collection of commands that you can use to manage the IBM FlashSystem 7300 system.
 - In the 7300 system, the GUI and the command-line support MFA for increased security.
- ▶ The IBM FlashSystem 7300 system running IBM Storage Virtualize 8.7.0 software supports the Representational State Transfer (REST) model API. The REST API consists of command targets that are used to retrieve system information and to create, modify, and delete system resources.
- ▶ Secure Remote Access (SRA) provides a secure connection for IBM Remote Support, which can perform remote troubleshooting and code load, and obtain diagnostic logs.
- ▶ Email and SNMP alerts are part of the standard alerting options.
- ▶ Syslog redirect to send system log messages to another host.
- ▶ Combined password and SSH key authentication is now supported as a first factor for local users.
- ▶ By using role-based access control, methods of access to the system are restricted at a user group level. GUI, CLI, and REST API access can now be restricted.
- ▶ The log-in grace time and session timeout duration can now be configured according to the customer's policies.
- ▶ The following MFA options can be used:
 - Cloud-based IBM Security Verify Integration supports a wide range of secondary authentication factors because it uses an industry-standard protocol, OpenID Connect. It also aligns with other products that support this solution, such as IBM Storage Scale.
 - Single sign-on support by using Microsoft's Active Directory Federation Services can be used on-premises to support access cards and dark sites.

For more information refer to the following resources:

- ▶ [Cyber Resilience](#)
- ▶ IBM Redbooks *Data Resiliency Designs: A Deep Dive into IBM Storage Safeguarded Snapshots*, [REDP-5737](#)

- ▶ IBM Storage Virtualize, IBM Storage FlashSystem, and IBM SAN Volume Controller Security Feature Checklist - For IBM Storage Virtualize 8.6, [REDP-5716](#)

Encryption

Like its predecessors, IBM FlashSystem 7300 data encryption is based on the industry standard AES-XTS 256 encryption, as defined in the IEEE 1619-2007 standard and NIST Special Publication 800-38E as XTS-AES-256.

The data encryption key is protected by a 256-bit AES key wrap of a key that is derived from the access key that is stored on the USB flash drive. The wrapped key is stored in the system in nonvolatile form.

Encryption on the IBM FlashSystem 7300 system requires the following feature codes:

- ▶ Encryption Enablement (#ACE8)

This feature enables the encryption function. A single instance of this feature enables the function on the entire IBM FlashSystem 7300 system, also known as a cluster, which includes the IBM FlashSystem 7300 control enclosure and all attached IBM FlashSystem 7300 expansion enclosures, and on externally virtualized storage subsystems.

- ▶ USB flash drives (#ACEA)

IBM Security Guardium Key Lifecycle Manager or Gemalto Safenet Keysecure are required for encryption key management.

- ▶ Encryption USB Flash Drives (Four Pack) Optional (#ACEA)

This feature provides four USB flash drives for storing the encryption master access key.

Unless IBM Security Guardium Key Lifecycle Manager or Gemalto Safenet Keysecure is used for encryption keys management, a total of three USB flash drives are required per IBM FlashSystem 7300 cluster when encryption is enabled in the cluster, regardless of the number of systems in the cluster. If encryption is used in a cluster, this feature should be ordered on one IBM FlashSystem 7300 system, which results in a shipment of four USB flash drives.

- ▶ Encryption using key servers

A key server is a centralized system that generates, stores, and sends encryption keys to the system. Some key server providers support replication of keys among multiple key servers. If multiple key servers are supported, you can specify up to four key servers that connect to the system over a public network or a separate private network. The system supports IBM Security Guardium Key Lifecycle Manager, Thales CipherTrust Manager, or Gemalto SafeNet Key Secure key servers to handle key management on the system.

These supported key server management applications create and manage cryptographic keys for the system and provide access to these keys through a certificate. Only one type of key server management application can be enabled on the system at a time.

Authentication takes place when certificates are exchanged between the system and the key server. Certificates must be managed closely because expired certificates can cause system outages. Key servers must be installed and configured before they are defined on the system.

IBM Security Guardium Key Lifecycle Manager key servers support Key Management Interoperability Protocol (KMIP), which is a standard for encryption of stored data and management of cryptographic keys. For more information, see [Encryption](#).

Encryption can be applied to virtualized storage arrays, even if the virtualized array does not include encryption capabilities. In this scenario, the encryption is done by using IBM Storage

Virtualize software. Encrypted volumes do not affect applications, which eases implementation and operation.

In addition, the IBM FlashSystem 7300 system features the following functions, which require that you purchase Encryption Enablement Pack #ACE9:

- ▶ Encryption Activation
Adding an encryption license to a system is *not* concurrent and must be done at array initialization time.
- ▶ Encryption Deactivation
Removing encryption is *not* concurrent and destroys any data that is on the array.
- ▶ Encryption Rekey
Changing the encryption key on a previously initialized system is concurrent and can be done while the array is in use.

Self-encrypting drives

The IBM FCs and NVMe drives, including the SCMs, in the IBM FlashSystem 7300 control enclosure are self-encrypting drives (SEDs). With SEDs, you can encrypt the data on the drive within the hardware.

These types of flash drives include the following features:

- ▶ Encryption of data is done in the electrical circuit of the drive. Therefore, it is not affected by performance issues from software encryption.
- ▶ Data encryption keys never leave the confines of the SED, and are never loaded into CPU or memory.
- ▶ You can perform a fast cryptographic erasure of an SED by using a single CLI command to replace the data encryption key or revert the entire device to factory settings.
- ▶ Supports a security feature that is called auto-lock, which protects against someone inserting your drive into another system and accessing your data.
- ▶ Drives automatically lock themselves on power loss and require an access key at start time to unlock and allow I/O operations.
- ▶ If an SED is taken from a system with encryption and placed in another system, the drive data is not readable. The system posts an error message that indicates that it is locked. The only way to use the drive is to format it. This formatting also performs a cryptographic erase by removing any encryption keys; therefore, all of the data on the drive is destroyed.

Combining system encryption with self-encrypting drives

Important: You can use SEDs without enabling encryption on the system, but, unless they are configured with extra protection, SEDs are unlocked by default at start time.

With system level encryption in IBM Storage Virtualize you can use USB flash drives or IBM Security Guardium Key Lifecycle Manager to manage access to encrypted objects on the system. This feature ensures that when a system is powered, this extra encryption key is required to read the data on the drives.

Consider the following points:

- ▶ SEDs are always encrypting, and you cannot stop them from being encrypted.
- ▶ You can use SEDs without enabling encryption on the system; however, SEDs are unlocked by default unless they are configured with extra protection.

- ▶ With system encryption in IBM Storage Virtualize, you can use USB flash drives or IBM Security Guardium Key Lifecycle Manager to manage access to encrypted objects on the system.
- ▶ Software in the operating system is required to manage an access key that can be used to lock and unlock the SEDs and bring them online for I/O.

Therefore, the best solution is to use the SEDs with the Encryption Enablement Pack and USB or IBM Security Guardium Key Lifecycle Manager encryption, or a mixture of both. This configuration ensures the maximum level of encrypting for your data that is on the system.

Transparent Cloud Tiering and encryption

TCT is a licensed function that enables volume data to be copied and transferred to cloud storage. The system supports creating connections to cloud service providers to store copies of volume data in private or public cloud storage.

With TCT, administrators can move older data to cloud storage to increase available capacity on the system. Point-in-time snapshots of data can be created on the system and then copied and stored on cloud storage.

An external cloud service provider manages the cloud storage, which reduces storage costs for the system. At the time of this writing, IBM supports the OpenStack Swift and Amazon S3 cloud service providers.

The following considerations apply to TCT and encryption:

- ▶ When a cloud account is created, it must continue to use the same encryption type throughout the life of the data in that cloud account. Even if the cloud account object is removed and remade on the system, the encryption type for that cloud account might not be changed while back up data for that system exists in the cloud provider.
- ▶ When performing rekeying operations on a system that has an encryption-enabled cloud account, perform the commit operation *immediately* after the prepare operation. Retain the previous system master key on a USB or in the keyserver because this key might be needed to retrieve your cloud backup data when performing a T4 recovery or an import.
- ▶ The `restore_uid` option is not used when the backup is imported to a new cluster.
- ▶ Importing TCT data is supported from only systems whose backup data was created at V7.8.0.1 or later.
- ▶ TCT uses Sig V2 when connecting to Amazon regions, and does not currently support regions that require Sig V4.

For more information, see [Transparent Cloud Tiering](#).

Secure drive erasure process

The IBM FlashSystem 7300 system running IBM Storage Virtualize V8.5.0 or later provides methods to securely erase data from a drive or boot drive when a control enclosure is decommissioned or before a drive is removed from the system during a repair activity.

Secure data deletion erases or overwrites all traces of data from a data storage device. The original data on that device becomes inaccessible and cannot be reconstructed. You can securely delete data on individual drives and on a boot drive of a control enclosure. The methods and commands that are used to securely delete data enable the system to be used in compliance with European Regulation EU2019/424.

The following types of drives can be used for this process:

- ▶ Expansion enclosure SAS SSDs

- ▶ IBM FCMs and industry-standard NVMe drives
- ▶ Control enclosure node canister SSD boot drives

The methods that the system uses to securely delete data from the drives varies according to the CLI commands that each type of drive can support. The completion time for the erase procedure also varies, depending on the amount of data and the method that is used to delete the data. In each case, when the operation completes, the result is that the data on the drive is inaccessible.

Table 6 lists the types of erasure, methods that are used, and time that is taken to securely delete data from drives.

Table 6 Comparison of methods to securely delete data from drives

Priority	Deletion type	Method	Completion time
1	Cryptographic erase	Changes the encryption key and makes the data inaccessible.	Instant
2	Block erase	Quickly raises and lowers the voltage level of the storage element. Physical blocks are altered with a vendor-specific value.	Fast
3	Data Overwrite	Replaces data with random data.	Slow

The methods that are used to securely delete data vary according to manufacture, drive type, and drive firmware. For more information, see the documentation that is provided by the drive manufacturer.

If a drive supports more than one data deletion method, the system uses the highest-priority method.

For more information about the CLI commands that are used to run this secure erase function, see [Secure data deletion](#).

Reliability, availability, and serviceability

IBM FlashSystem 7300 delivers the following enterprise-class reliability features, much like its predecessors:

- ▶ IBM FlashSystem 7300 control enclosures support concurrent code load. Onsite and remote code upgrades are supported. However, for Onsite code loads, an extra feature #AHY2 must be purchased. For code loads to the FCM drives, you must also purchase #AHY2.
- ▶ The components of the IBM FlashSystem 7300 are one of the following configurations:
 - Hot-swappable. All system functions remain the same.
 - Concurrently replaceable. All functions remain, but elements might be offline. Performance or availability might be affected.

The IBM FlashSystem 7300 control enclosure includes two clustered node canisters that contain hot-swappable and concurrently replaceable components:

- Hot-swappable:
 - Secure boot drives
 - Batteries
 - PSUs (2 per canister)
 - NVMe or FCM drives

- Concurrently replaceable:
 - Fan modules
 - Memory DIMMs
 - Trusted Platform Module (TPM)
 - PCIe adapters
 - Node canister

If an IBM FCM failure occurs, critical customer applications can remain online while the defective module is replaced because a spare module is available.

- ▶ IBM enhanced technology in the SCM drives for higher storage density and improved performance can coexist with FCM3 or FCM4 drives in the IBM FlashSystem 7300 for even more demanding workloads.
- ▶ By using 3-site data copies with synchronous and asynchronous data copies, greater flexibility is available in creating DR and HA solutions.

Options and feature codes

This section describes the options and feature codes of the IBM FlashSystem 7300 control enclosure.

Memory options

Table 7 lists the various memory option feature codes.

Table 7 IBM FlashSystem 7300 memory options per control enclosure

Base memory (GB)	#ACGJ Plant or Field Upgrade (GB)	#ACGB Plant or Field Upgrade (GB)	Total memory (GB)
256	N/A	N/A	256
256	512	N/A	768
256	512	768	1536

The following feature codes are available:

- ▶ (#ACGJ) - 512 GB Cache upgrade.

This feature indicates that the base machine is configured with 512 GB (256 GB for each node canister). Selecting this feature determines the cache upgrade paths of the machine.

- ▶ (#ACGB) - 768 GB Cache upgrade.

This feature provides another 768 GB of cache (384 GB for each node canister) to increase the total system cache by 768 GB.

Note: A quantity of one ACGJ must be ordered with this feature if not already fitted.

Mandatory feature: Boot Drive Pair

The #ACGV - 240 GB M.2 Boot drive Pair feature is mandatory and indicates that each canister of the base machine is configured with dual 240 GB M.2 boot drives.

Host I/O connectivity and expansion enclosure adapters

Six PCIe slots are available for port expansions in the IBM FlashSystem 7300 control enclosure. Each canister has three PCIe adapter slots and both canisters must have the same configuration. The PCIe adapter feature codes offer a pair of adapters to ensure that they are supplied symmetrically in each canister.

The IBM FlashSystem 7300 control enclosure can be configured with three I/O adapter features to provide up to twenty-four 32 Gbps FC ports or up to twelve 10/25 Gbps or twelve 100 Gbps Ethernet ports. The control enclosure also includes eight 10 Gbps Ethernet ports as standard for iSCSI connectivity and two 1 Gbps Ethernet ports for system management. A feature code is also available to include the SAS expansion adapter if the user wants to implement the optional expansion enclosures.

Note: The SAS Expansion adapter does *not* support SAS hosts.

Figure 23 shows the connectivity options for the different adapters that are available at time of this writing.

Adapter	Host attachment	Virtualization	Clustering	Replicat.
32 Gb Fibre Channel 4 ports; PCIe-Gen4 8x	FC NVMe over FC	FC	FC	FC
25 Gb Ethernet iWARP 2 ports; PCIe-Gen3 8x	iSCSI; iSER (*)	iSCSI	SCORE!	IP
25 Gb Ethernet RoCE 2 ports; PCIe-Gen3 8x	iSCSI; iSER (*), NVMe over RoCE v2	iSCSI	— (**)	IP
100 Gb Ethernet RoCE 2 ports; PCIe-Gen4 16x	iSCSI NVMe over RoCE v2	—	—	—

(*) = iSER host attachment still supported with older machines, but not with FS9500/FS7300/SV3.
 (**) = Clustering over iSER-RoCE still supported with older machines via SCORE, but not recommended.

Figure 23 Connectivity options

For more information about the limits and rules for adapter placement to ensure correct best practices, see [IBM Storage Virtualize FAQ: IBM Storage Virtualize with the IBM FlashSystem family and IBM SAN Volume Controller](#).

Table 8 lists the maximum host port count per building block configuration (1, 2, 3, or 4 control enclosures.)

Note: All connectivity ports are NVMe-oF hardware-ready.

Table 8 Maximum host port count per control enclosure

Number of control enclosures	32 Gbps FC	Onboard 10 Gbps iSCSi ports	25 Gbps iSCSI (RoCE)	25 Gbps iSCSI (iWARP)	100 Gbps iSCSI (RoCE)
One	24	8	12	12	12
Two	48	16	24	24	24

Number of control enclosures	32 Gbps FC	Onboard 10 Gbps iSCSI ports	25 Gbps iSCSI (RoCE)	25 Gbps iSCSI (iWARP)	100 Gbps iSCSI (RoCE)
Three	72	24	36	36	36
Four	96	32	48	48	48

Table 9 lists the current features for host connectivity for the IBM FlashSystem 7300 control enclosure 4657-924 and 4657-U7D machine types.

Table 9 Supported expansion enclosure and interface components MTMs 4657-924 and 4657-U7D

Item	Feature code	Description	Ports
32 Gbps FC 4 Port Adapter (Pair)	#ADBE	This feature provides two I/O adapters. It is used to add 32 Gbps FC connectivity.	Each adapter has four 32 Gbps FC ports and shortwave SFP transceivers.
25 Gbps Ethernet (RoCE) Adapter (Pair)	#ADBB	This feature provides two I/O adapters. It is used to add 25 Gbps Ethernet connectivity. Supports RoCE V2.	Each adapter has two 25 Gbps Ethernet ports without SFP28 transceivers.
25 Gbps Ethernet (iWARP) Adapter (Pair)	#ADBC	This feature provides two I/O adapters. It is used to add 25 Gbps Ethernet connectivity. Supports RDMA with iWARP.	Each adapter has two 25 Gbps Ethernet ports without SFP28 transceivers.
100 Gbps Ethernet (RoCE) Adapter Cards (Pair)	#ADB8	This feature provides two I/O adapter cards, each with two 100 Gbps Ethernet ports. It is used to add 100 Gbps Ethernet connectivity to the FlashSystem 7300 control enclosure and is designed to support RDMA with RoCE 2.	Each adapter has two 100 Gbps Ethernet Ports. Supplied without optics or cables.
SAS Expansion Enclosure Attach Card (Pair)	#ADBA	This feature provides two 4-port 12 Gbps SAS expansion enclosure attachment adapters. This feature is used to attach up to 12 expansion enclosures.	Each adapter has two active out of the four SAS ports.
25 Gbps Ethernet SW SFP28 Transceivers (Four)	#ACHP	This feature provides four 25 Gbps shortwave SFP28 transceivers to populate a pair of 25/10 Gbps Ethernet host interface cards. These transceivers are used to set the card ports to 25 Gbps.	Requires feature ADBB, or ADBC.
10 Gbps Ethernet SW SFP+ Transceivers (Four)	#ACHQ	This feature provides four 10 Gbps shortwave SFP+ transceivers to populate a pair of 25/10 Gbps Ethernet host interface cards. These transceivers are used to set the card ports to 10 Gbps.	Requires feature ADBB or ADBC.
32 Gbps FC LW SFP Transceivers (Pair)	#ACHV	This feature provides two 32 Gbps longwave SFP transceivers for use with 32 Gbps FC I/O ports.	Feature ADBE is a prerequisite. The maximum allowed is eight for each instance of #ADBE.
100 Gbps Ethernet QSFP28 SR4 Transceivers (Four)	#ACHX	This feature provides four 100 Gbps Ethernet QSFP28 SR4 transceivers; enough for 1 pair of 100 Gbps Ethernet cards.	Requires feature ADB8.
10 Gbps Ethernet SFP+ RJ45 Transceivers (Four)	#ACJ2	This feature provides four 10Gbe SFP+ to RJ45 transceivers; enough for 1 pair of Gbps Ethernet cards.	Requires feature ADBB or ADBC.

Cables

The following cables are available:

- ▶ (#ACSQ): 1 m OM3 Fibre Cable (LC)
- ▶ (#ACSR): 5 m OM3 Fibre Cable (LC)
- ▶ (#ACSS): 10 m OM3 Fibre Cable (LC)
- ▶ (#ACST): 25 m OM3 Fibre Cable (LC)
- ▶ (#ACUA): 0.6 m 12 Gbps SAS Cable (mSAS HD)
- ▶ (#ACUB): 1.5 m 12 Gbps SAS Cable (mSAS HD)
- ▶ (#ACUC): 3 m 12 Gbps SAS Cable (mSAS HD)
- ▶ (#ACUD): 6 m 12 Gbps SAS Cable (mSAS HD)

IBM Storage Class Memory, FCMs, and industry-standard NVMe drive options

The IBM FlashSystem 7300 system supports SCM drives, IBM FCMs, industry-standard flash drives, and an intermix of all three.

IBM FCMs combine IBM MicroLatency technology, advanced flash management, and reliability into a 2.5-inch SFF NVMe with built-in, performance-neutral hardware compression and encryption.

For improved flexibility, IBM FlashSystem 7300 systems also support various industry-standard self-encrypting NVMe flash drives.

The available NVMe flash drive uses the following feature codes:

- ▶ (#ADSA): 4.8 TB NVMe FCM3
- ▶ (#ADSB): 9.6 TB NVMe FCM3
- ▶ (#ADSC): 19.2 TB NVMe FCM3
- ▶ (#ADSD): 38.4 TB NVMe FCM3
- ▶ (#ADSE): 4.8 TB NVMe FCM4
- ▶ (#ADSF): 9.6 TB NVMe FCM4
- ▶ (#ADSG): 19.2 TB NVMe FCM4
- ▶ (#ADSH): 38.4 TB NVMe FCM4
- ▶ (#ADT2): 1.92 TB NVMe Flash Drive
- ▶ (#ADT3): 3.84 TB NVMe Flash Drive
- ▶ (#ADT4): 7.68 TB NVMe Flash Drive
- ▶ (#ADTC): 1.6 TB NVMe Storage Class Memory Drive

Consider the following limitations and points about drives on the IBM FlashSystem 7300:

Note: DRAID 5 is supported only by way of RPQ.

- ▶ IBM FCMs:
 - DRAID 6 (minimum 6, maximum 128)
 - DRAID 5 (minimum 4, maximum 128) RPQ only
 - DRAID 1 (minimum 2, maximum 16)
 - Only DRAID1 and DRAID6 are supported for compressed drives
 - IBM FCMs in the same RAID array must be of the same capacity

Important: FCM2 can not work together with FCM3 and FCM4 in the same RAID array. If you plan to upgrade or expand your FCM2 system you have to create a separate new RAID array with either FCM3 or FCM4 and upgrade your system onto a supported software level. Note that FCM2 and FCM3 are already withdrawn.

FCM3 and FCM4 can work together in the same RAID array, but the FCM4 drives will work like FCM3 drives without the enhanced Ransomware Detection features.

To benefit from all the new Ransomware Detection features, you need all drives to be FCM4 and your IBM Storage Virtualize code level to be at least 8.6.3.

- ▶ Industry-standard NVMe drives:
 - DRAID 6 (minimum 6, maximum 128)
 - DRAID 5 (minimum 4, maximum 128) RPQ only
 - DRAID 1 (minimum 2, maximum 16)
 - Industry-standard NVMe drives in the same RAID array must be of the same capacity
- ▶ SCM NVMe drives:
 - Two drive minimum (varies by RAID type), 12 drives maximum
 - DRAID 6 (minimum 6, maximum 12)
 - DRAID 5 (minimum 4, maximum 12) RPQ only
 - DRAID 0 (minimum 2, maximum 12)
 - SCM NVMe drives in the same RAID array must be of the same capacity

IBM FlashSystem 7000 Expansion Enclosure options (Models 12G, 24G, and 92G)

The following SAS flash SSD and HDD drive feature codes are available:

- ▶ Supported on Model 12G only (maximum of 12):
 - (#AHD4): 6 TB 7.2 K 3.5-inch HDD
 - (#AHD5): 8 TB 7.2 K 3.5-inch NL HDD
 - (#AHD6): 10 TB 7.2 K 3.5-inch NL HDD
 - (#AHD7): 12 TB 7.2 K 3.5-inch NL HDD
 - (#AHD8): 14 TB 7.2 K 3.5-inch NL HDD
 - (#AHD9): 16 TB 7.2 K 3.5-inch NL HDD
 - (#AHDA): 18 TB 7.2 K 3.5-inch NL HDD
 - (#AHDB): 20 TB 7.2 K 3.5-inch NL HDD
- ▶ Supported on Model 24G only (maximum of 24):
 - (#AHF3): 1.2 TB 10K 2.5-inch HDD
 - (#AHF4): 1.8 TB 10K 2.5-inch HDD
 - (#AHF5): 2.4 TB 10K 2.5-inch HDD
 - (#AHH9): 800 GB 3DWPD 12 Gbps SAS 2.5-inch Flash Drive
 - (#AHHG): 1.92 TB 12 Gbps SAS 2.5-inch Flash Drive
 - (#AHHH): 3.84 TB 12 Gbps SAS 2.5-inch Flash Drive
 - (#AHHJ): 7.68 TB 12 Gbps SAS 2.5-inch Flash Drive
 - (#AHHK): 15.36 TB 12 Gbps SAS 2.5-inch Flash Drive
 - (#AHHL): 30.72 TB 12 Gbps SAS 2.5-inch Flash Drive
- ▶ Supported on Model 92G only (maximum of 92):
 - (#AH73): 1.2 TB 10K 3.5-inch HDD
 - (#AH74): 1.8 TB 10K 3.5-inch HDD

- (#AH75): 2.4 TB 10K 3.5-inch HDD
- (#AH77): 6 TB 7.2 K 3.5-inch NL HDD
- (#AH78): 8 TB 7.2 K 3.5 NL HDD
- (#AH79): 10 TB 7.2 K 3.5 NL HDD
- (#AH7A): 12 TB 7.2 K 3.5-inch NL HDD
- (#AH7B): 14 TB 7.2 K 3.5-inch NL HDD
- (#AH7C): 16 TB 7.2 K 3.5-inch NL HDD
- (#AH7J): 1.92 TB 12 Gbps SAS 3.5-inch Flash Drive
- (#AH7K): 3.84TB 12 Gbps SAS 3.5-inch Flash Drive
- (#AH7L): 7.68 TB 12 Gbps SAS 3.5-inch Flash Drive
- (#AH7M): 15.36 TB 12 Gbps SAS 3.5-inch Flash Drive
- (#AH7N): 30.72 TB 12 Gbps SAS 3.5-inch Flash Drive
- (#AH7X): 18 TB 7.2k 12 Gbps SAS NL 3.5-inch Flash Drive

Note: For more information about Expert Care Features, see [Sales Manual Family 4657+01 IBM FlashSystem 7300](#).

Physical and electrical specifications

Specifications for the control and expansion enclosures are listed in the following sections.

IBM FlashSystem 7000 control enclosure (4657-924 and 4657-U7D)

The IBM FlashSystem 7000 control enclosure features the following specifications:

- ▶ Physical:
 - Height: 8.8 cm (3.5 in.)
 - Width: 48.3 cm (19.0 in.)
 - Depth: 85.0 cm (33.5 in.)
 - Approximate weight:
 - Empty: 38.5 kg (84.7 lb.)
 - Fully configured: 44 kg (97 lb.) without rails
- ▶ Air temperature:
 - Operating: 5–35° C (41–95° F) 0–3048 m (0–10,000 ft.). Above 900 m, decrease maximum air temperature 1° per 300 m
 - Nonoperating: 1–50° C (34–122° F)
- ▶ Relative humidity:
 - Operating: 8–80% noncondensing
 - Nonoperating: 8–80% noncondensing
- ▶ Electrical power:
 - Voltage range: 200–240 V AC
 - Frequency: 50–60 Hz
 - Power: 2000 W (power varies with configuration and system usage; the maximum is shown)
 - Heat dissipation (BTU per hour): 6825
 - Acoustical noise emission: 8.1 bels (idling), 8.1 bels (operating)

IBM FlashSystem 7000 LFF and SFF Expansion Enclosure (4657 Model 12G and 4657 Model 24G)

The IBM FlashSystem 7000 Expansion Enclosure 12G/24G features the following specifications:

- ▶ Physical:
 - Height: 8.7 cm (3.4 in.)
 - Width: 48.3 cm (19.0 in.)
 - Depth: 55.6 cm (21.9 in.)
 - Approximate weight:
 - Empty: 16.7 kg (36.8 lb)
 - Fully configured: 25.0 kg (55.1 lb)
- ▶ Air temperature:
 - Operating: 5–35° C (41–95° F) 0–3048 m (0–10,000 ft). Above 900 m, decrease maximum air temperature 1° per 175 m
 - Nonoperating: 1–50° C (34–122° F)
- ▶ Relative humidity:
 - Operating: 8–80% noncondensing
 - Nonoperating: 8–80% noncondensing
- ▶ Electrical power:
 - Voltage range: 100–240 V AC
 - Frequency: 50–60 Hz
 - Power: 800 W
 - Heat dissipation (BTU per hour): 1,037
 - Acoustical noise emission: 6.2 bels (idling), 6.2 bels (operating)

IBM FlashSystem 7000 High Density LFF Expansion Enclosure (4657 Model 92G)

The IBM FlashSystem 7000 High Density Expansion Enclosure 92G has the following specifications:

- ▶ Physical specifications:
 - Height: 22.2 cm (8.75 in.)
 - Width: 48.3 cm (19.0 in.)
 - Depth: 96.8 cm (38.1 in.)
 - Approximate weight:
 - Empty: 67.0 kg (147.7 lb)
 - Fully configured: 135.0 kg (297.0 lb)
- ▶ Air temperature:
 - Operating: 5–35° C (41–95° F) 0–3048 m (0–10,000 ft). Above 900 m, decrease maximum air temperature 1° per 300 m
 - Nonoperating: 1–50° C (34–122 degrees F)
- ▶ Relative humidity:
 - Operating: 8–80% noncondensing
 - Nonoperating: 8–80% noncondensing

- ▶ Electrical power:
 - Voltage range: 180–264 V AC
 - Frequency: 47–63 Hz
 - Power: 2400 W
 - Heat dissipation (BTU per hour): 8,189
 - Acoustical noise emission: 8.5 bels (idling), 8.5 bels (operating)

Note: All noise emission levels that are stated are the declared (upper limit) sound power level in bels, for a random sample of machines. All measurements are made in accordance with ISO 7779 and reported in conformance with ISO 9296.

Software and licensing

All IBM FlashSystem 7300 systems feature IBM Storage Virtualize Software V8.5 or later preinstalled. The IBM FlashSystem 7300 is licensed machine code. All features are inclusive except for external virtualization and encryption, which is a feature code that is enabled for those countries that allow it.

Any connected storage that is not an IBM FlashSystem 7300 control enclosure requires the External Virtualization license per storage capacity unit (SCU) that is based on the tier of storage that is available on the external storage system. In addition, if you use FlashCopy and Remote Mirroring on an external storage system, you must purchase a per-tebibyte license to use these functions.

Consider the following points:

- ▶ IBM FlashSystem 7300 control enclosures support external storage virtualization. The use of the external virtualization capability is entitled through the acquisition of IBM Storage Virtualize Software for SAN Volume Controller (PID 5641-VC8 in AAS and PID 5725-M19 in IBM Passport Advantage®).
- ▶ With the IBM FlashSystem 7300 system, a license also is needed for the hardware-assisted encryption, Encryption Enablement #ACE8, if it is purchased. This feature code is needed if you want to use USB-Key encryption, Security Key Lifecycle Manager-based encryption, or both on the control enclosure.

It is a best practice to use the Encryption USB Drive Pack feature (#ACEA). This feature provides four USB flash drives for storing the encryption master access key. A total of three USB flash drives are required per FlashSystem cluster when encryption is enabled in the cluster, regardless of the number of systems in the cluster. If encryption is to be used in a cluster, this feature is ordered on one FlashSystem, which results in a shipment of four USB flash drives.

- ▶ External virtualization licenses from the IBM SAN Volume Controller can be used for the IBM FlashSystem 7300.
- ▶ A storage system that is used only as a quorum device does not require a software license.

To set these licenses, use the Licensed Function page in the System Setup wizard. If you are adding these licenses to a system, select **Settings** → **System** → **Licensed Function** in the management GUI. You can also use the `chlicense` CLI command to update current license settings on the system.

For more information about IBM Storage Virtualize licensing, see [Licensed functions](#).

IBM Storage Virtualize External Licensing

The IBM FlashSystem 7300 supports differential, capacity, and key-based licensing. For example, with external virtualization, differential licensing charges different rates for different types of storage. This paradigm provides cost-effective management of capacity across multiple tiers of storage. Licensing for these functions is based on the number of storage capacity units (SCUs) that are purchased.

With other functions, such as remote mirroring and FlashCopy, the license grants a specific number of terabytes of capacity for that function. Key-based licenses require an authorization code and key to be downloaded to the system before the function can be used.

Note: SCUs are needed only for virtualized storage that does not have the 5641-VC8 license.

The SCU is defined in terms of the category of the storage capacity, as listed in Table 10.

Table 10 SCU category definitions

License	Drive class	SCU ratio
SCM	Storage Class Memory (SCM) devices	SCU equates to 1.00 TB usable of Category 1 storage
Flash	All flash devices, other than SCM drives	SCU equates to 1.18 TB usable of Category 1 storage
Enterprise	10 K or 15 K rpm drives	SCU equates to 2 TB usable of Category 2 storage
Nearline	Nearline Serial ATA (SATA) drives	SCU equates to 4.00 TB usable of Category 3 storage

Table 11 shows an example of calculating SCUs. The example is a customer who virtualizes external disk arrays with 5 TB SCM devices, 30 TB SSD flash drives, 400 TB Enterprise drives, and 800 TB Nearline capacity.

Table 11 Example of calculating SCUs

Category	Type	Capacity	Rule	Number of SCUs
Category 1	SCM	5	/ 1	5
Category 1	SSD	30	/ 1.18	26
Category 2	Enterprise	400	/ 2	200
Category 3	Nearline	800	/ 4	200
Total		1235		431

As shown in Table 11, 431SCUs are required for the example. When you calculate the number of SCUs per category, fractions must be rounded up to the next higher integer number.

For more information about IBM Storage Virtualize Differential Licensing, see [Licensed functions](#) and search for “7X00 licensed functions”.

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Ordering information

For more information about ordering IBM FlashSystem 7300 expansions, see “Scaling up and scaling out” on page 40.

For more information about ordering hardware features, see “IBM FlashSystem 7300 GUI” on page 21.

For more information about ordering software licenses, see “Software and licensing” on page 57.

Related information

For more information, see the following resources:

- ▶ IBM Documentation for IBM FlashSystem:
<https://www.ibm.com/docs/en/flashsystem-7x00/8.7.x>
- ▶ IBM FlashSystem 7300 product page:
<https://www.ibm.com/products/flashsystem-7300>
- ▶ IBM Offering Information page (announcement letters and sales manuals):
http://www.ibm.com/common/ssi/index.wss?request_locale=en
- ▶ IBM FlashSystems & SAN Volume Controller FAQ
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- ▶ IBM FlashSystem Family FAQ
Overview of the IBM FlashSystem family with guidance on how to select the product that is right for you:
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- ▶ IBM FlashWatch FAQ
Guidance about the IBM FlashWatch programs:
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