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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 (artificial intelligence) AI, big data analytics, and cloud environments, the 7300 helps enterprises overcome resource constraints and maximize existing investments.

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

- Data reduction and deduplication
- Dynamic tiering
- Thin provisioning
- Snapshots
- Cloning
- Data copy services
- Transparent Cloud Tiering
- Policy-based replication and policy-based high availability (policy-based HA)
- Ransomware Threat Detection

Scale-out and scale-up configurations further enhance capacity and throughput for better availability.

Note: This guide explores the IBM FlashSystem 7300's hardware features and the new features offered by IBM Storage Virtualize 8.7. For more information on IBM Storage Virtualize 8.7 features refer to IBM Storage Virtualize for SAN Volume Controller and FlashSystem Family Getting Started Guide.

Benefits

The IBM FlashSystem 7300 delivers a powerful combination of performance, security, and cost-efficiency for modern businesses. The following are its key benefits:

- **High performance:** NVMe technology and IBM FlashCore Modules provide exceptional speed, enabling faster application response times and smoother data processing. This translates to quicker task completion and improved user experience.

- **Enhanced security:** The FlashSystem 7300 prioritizes data protection. Features like IBM Safeguarded Snapshot safeguard your valuable information from cyberattacks and ransomware threats by creating isolated, immutable copies. This ensures data integrity and minimizes downtime in case of breaches.
- **Cost-effectiveness:** Data reduction technologies like built-in hardware data compression and data tiering pools significantly reduce storage requirements. This translates to lower storage costs without sacrificing performance. Additionally, the FlashSystem 7300 offers flexible capacity options, allowing you to scale storage as your needs evolve.
- **Simplified management:** Built on IBM Storage Virtualize software, the FlashSystem 7300 offers centralized management for all your storage systems. AI-driven automation streamlines data tiering and simplifies storage administration, freeing up IT resources for other tasks.
- **Hybrid cloud ready:** The FlashSystem 7300 seamlessly integrates with hybrid cloud environments. This allows you to manage data across on-premises and cloud storage, providing greater flexibility and scalability for your IT infrastructure.

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 1 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.

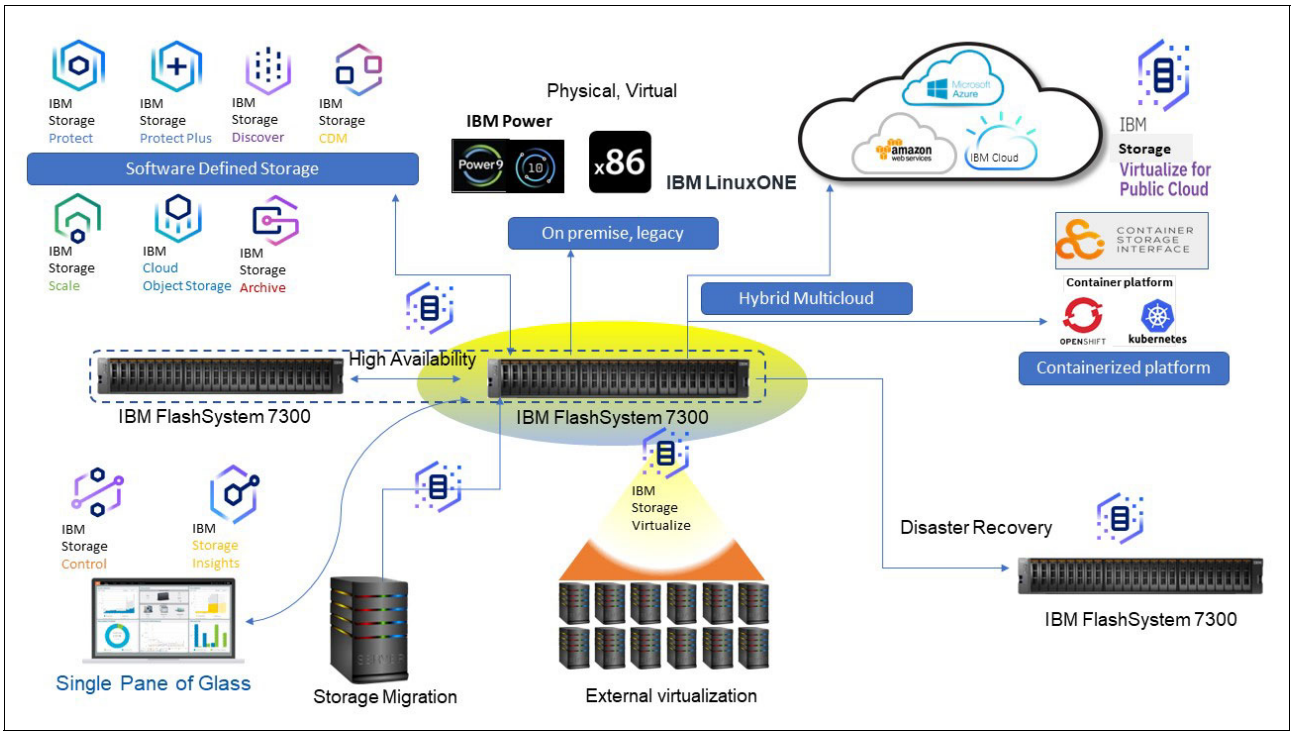

Figure 1 Fully deployed IBM FlashSystem 7300 sample scenario

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.

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

Figure 2 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 3 on page 6 shows the IBM FlashSystem 7300 bezel and NVMe drive.

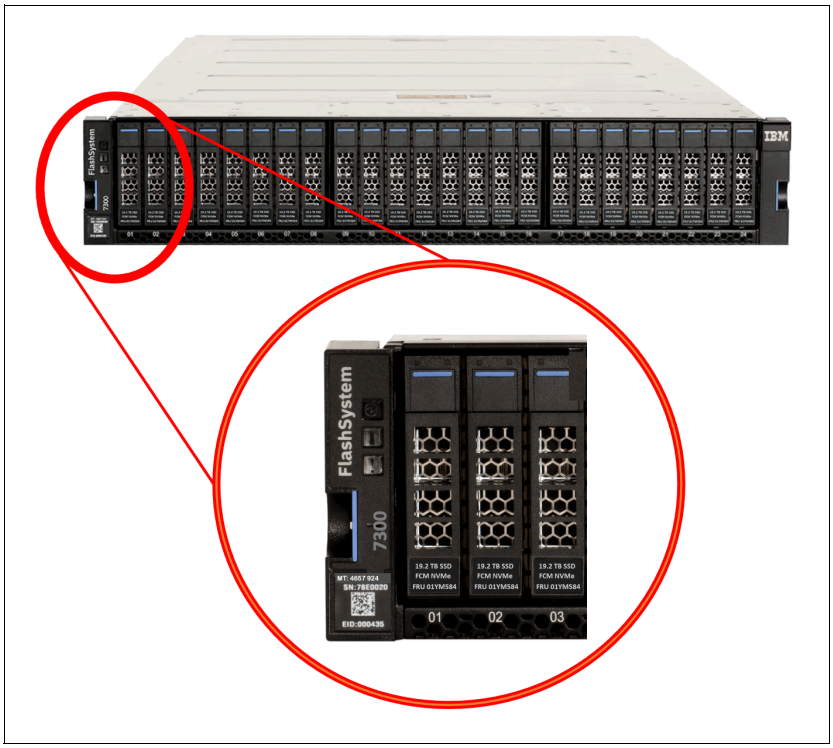

Figure 3 IBM FlashSystem 7300 bezel and IBM FCM description

Labeling on the NVMe drive provides the drive type, capacity, type of drive, and FRU number. The example that is shown in Figure 3 is the IBM FCM NVMe 19.2 TB.

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.
- High availability solutions such as policy-based high availability (HA).
- 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 13.

For more information on IBM Storage Virtualize features refer to IBM Storage Virtualize for SAN Volume Controller and FlashSystem Family Getting Started Guide.

Also, refer to the 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.

What is new with IBM Storage Virtualize V8.7.0

In this section we discuss several important features that are available with IBM Storage Virtualize V8.7.0. For a complete list of the new features see IBM Documentation What’s new in Version 8.7.

Policy-based high availability 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 4.

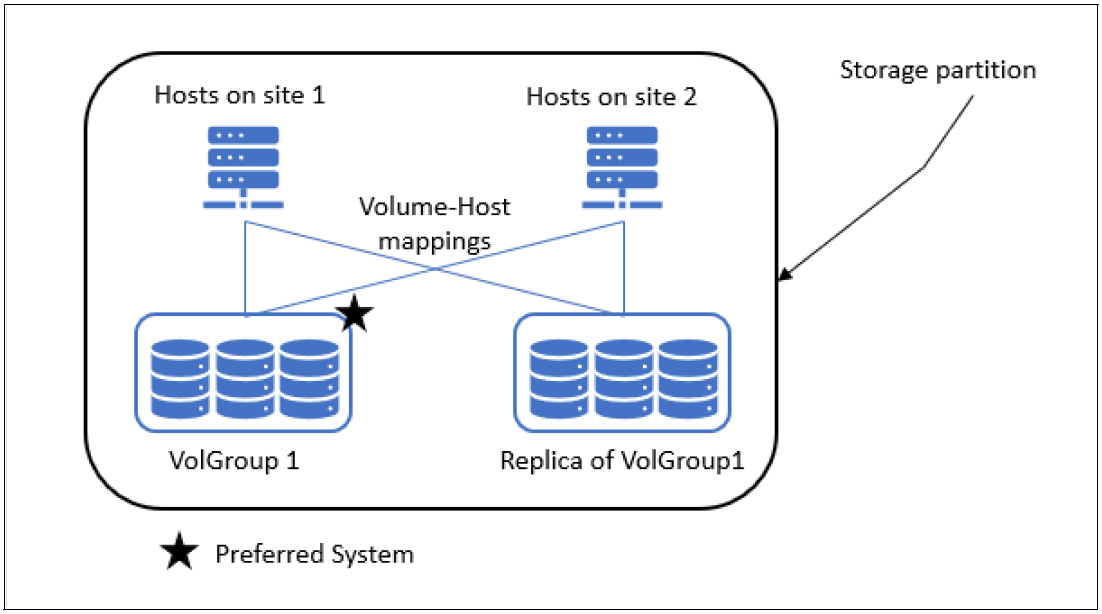

Figure 4 Storage partitions

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.

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 5. At the time of this writing, Flash Grid features (partitions mobility) are manageable with IBM Storage Insights Pro only.

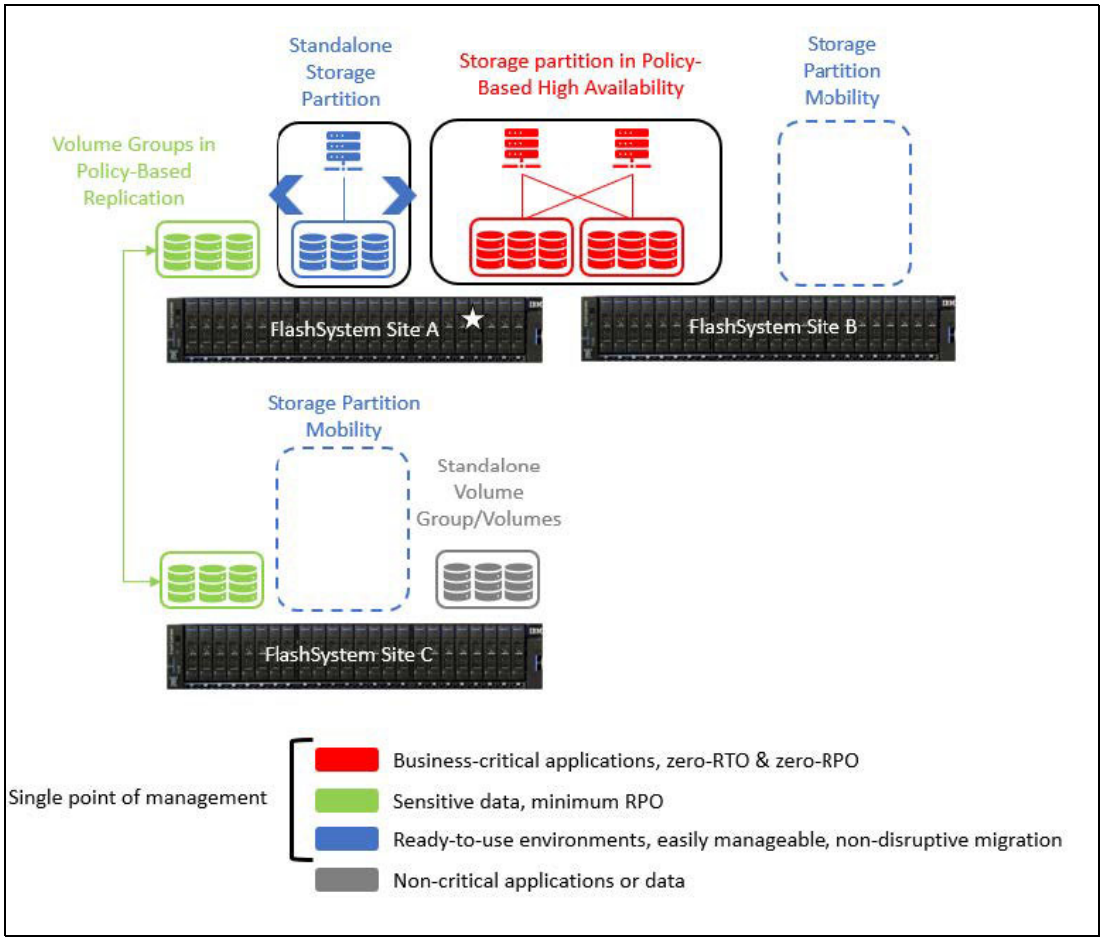

Figure 5 IBM Flash Grid concept

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.

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

As described in Cyber Resilience, you can combine the power of IBM Storage Defender and IBM Storage FlashSystem to fight ransomware and implement a more resilient data storage environment.

Here is an example of how our cyber security features can help you minimize downtime after an attack. Figure 6 illustrates the time it takes to recover all your data without the Cyber Resilience function.

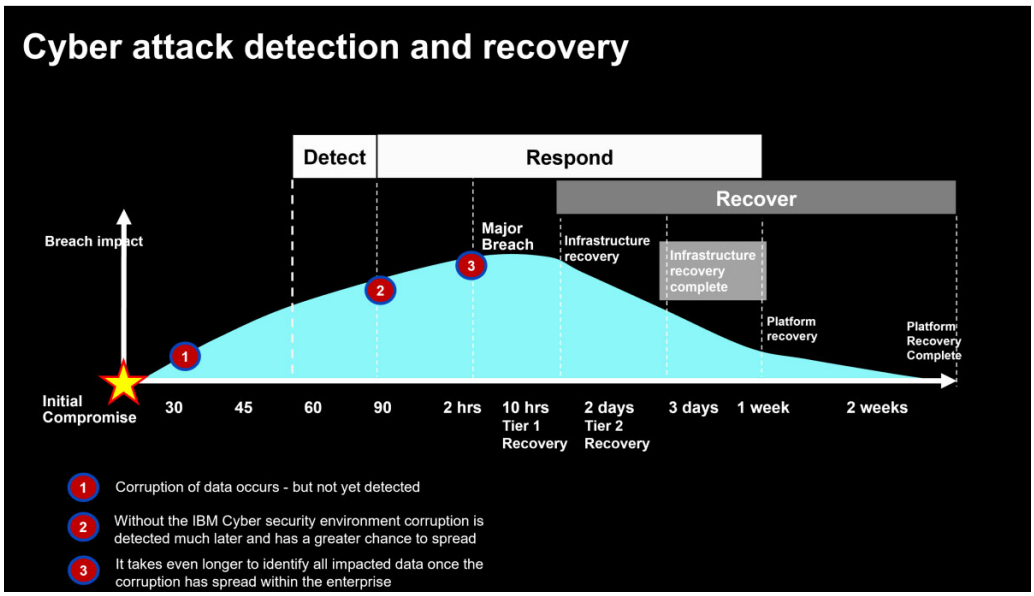

Figure 6 Cyber attack detection and recovery without cyber security functions

Figure 7 shows you how long it takes to recover after an attack with Cyber Resilience function.

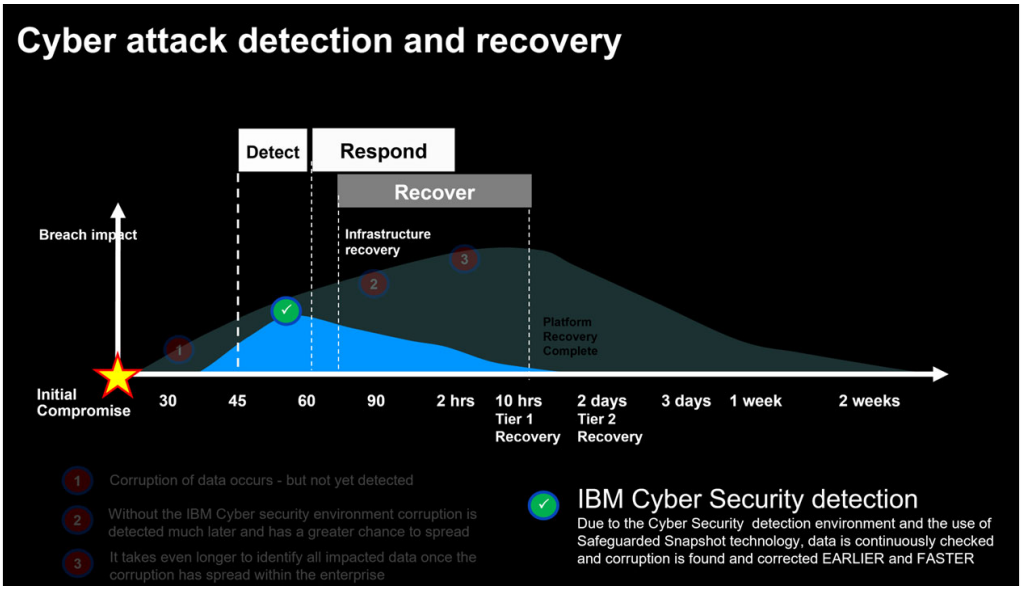

Figure 7 Cyber attack detection and recovery with Cyber security functions

How to assess your business cyber resilience: You can take the two part cyber resilience evaluation to learn how prepared your organization is for cyber threats.

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 8 shows IBM FlashCore technology.

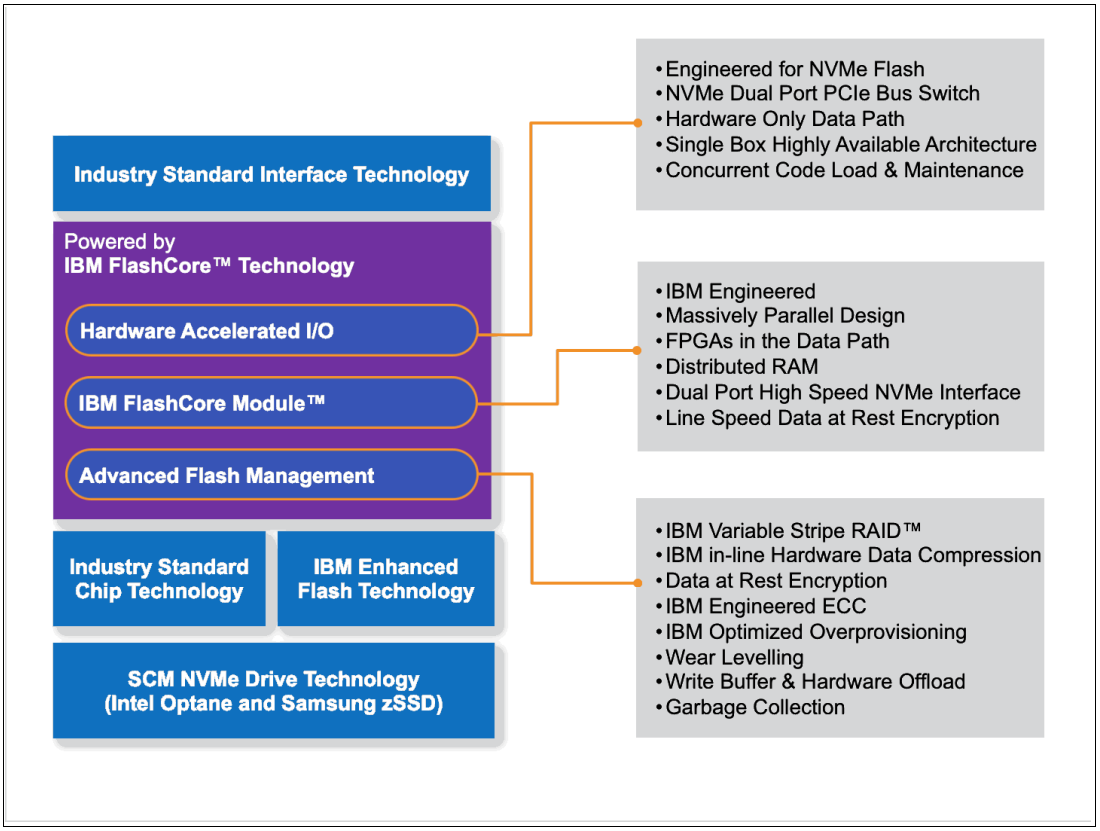

Figure 8 IBM FlashCore technology

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 µs) than traditional NAND SSDs (100 µs) 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 TRAID 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 9 on page 14 shows IBM Storage Expert Care levels.

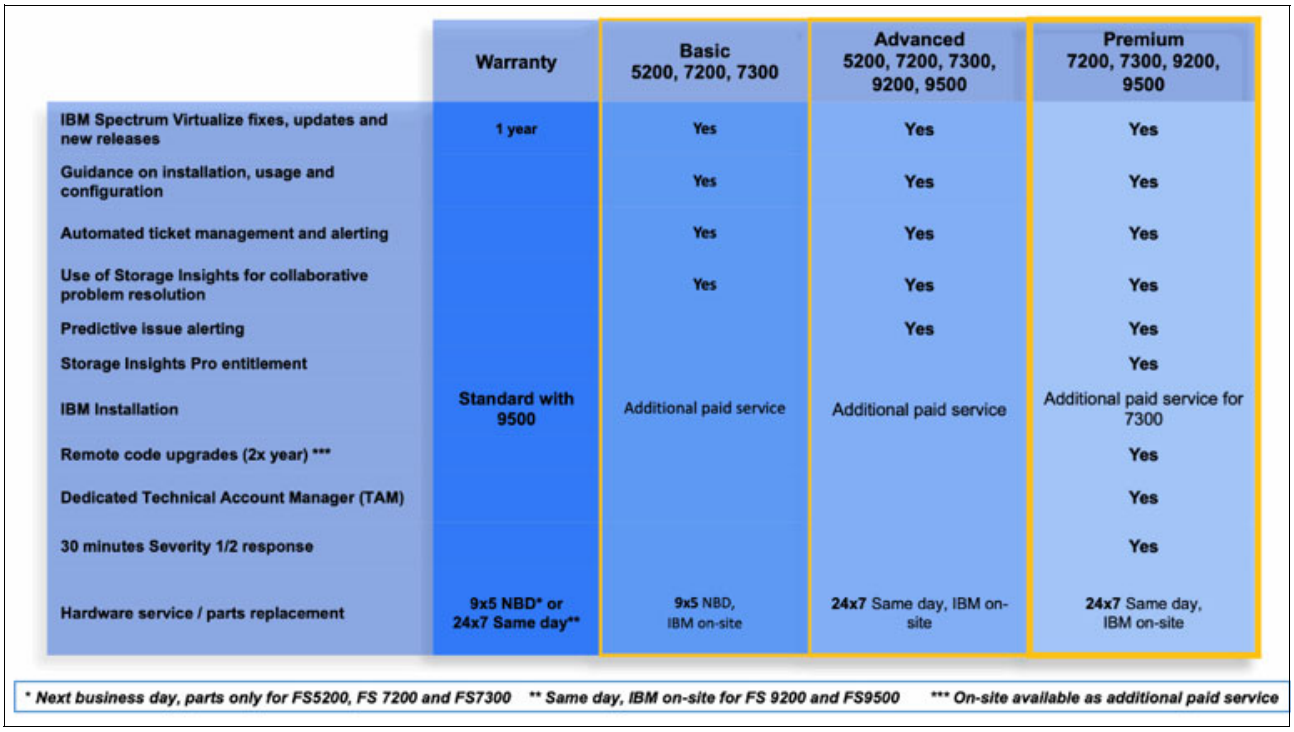

Figure 9 IBM Storage Expert Care levels

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.

Table 1 Overview of the available IBM Storage Assurance features

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

Years	Upfront	Annual	Quarterly	Monthly
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 performance 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.

Note: IBM Storage Assurance program comes with the following guarantees:

- 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.

This program is available for FlashSystem 5300, FlashSystem 7300 and FlashSystem 9500 and their all flash-expansions. For high-level contract term details and country availability, see IBM Storage Assurance Perpetual Contract Details and Country Availability.

For more information see IBM Storage Assurance.

Optional guarantees

Several optional guarantees are available to enhance your IBM FlashSystem 7300 investment. Contact your IBM Storage representative for more details.

60 second cyber recovery guarantee

Once configured by IBM Expert Labs, the FlashSystem 60 second 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 guarantee also includes capabilities such as the ransomware threat detection capabilities as part of the tools to detect an attack.

3:1 data compression guarantee

IBM offers a 3:1 data compression 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.

Sustainability guarantee

Because of the innovative IBM FlashCore Modules, the FlashSystem devices are able to guarantee that they will not exceed a certain energy efficiency (W/TB) amount across all FlashCore Module drive configurations, reducing carbon emissions. This improves client's environmental impact from their data storage with some configurations guaranteed as low as a 1.7 W/TB maximum, supporting green IT initiatives.

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 10 on page 18 shows the IBM FlashSystem 7300 GUI dashboard.

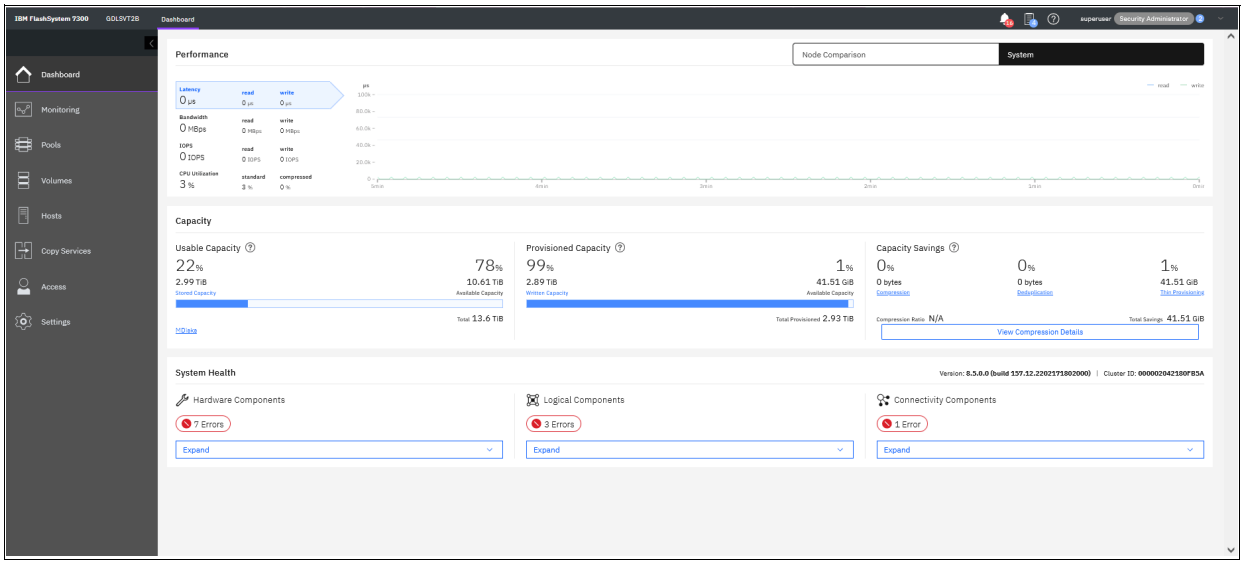

Figure 10 IBM FlashSystem 7300 GUI showing the dashboard

Figure 11 shows the control enclosure window. Open this window by selecting **Monitoring** → **System Hardware** from the left side menu.

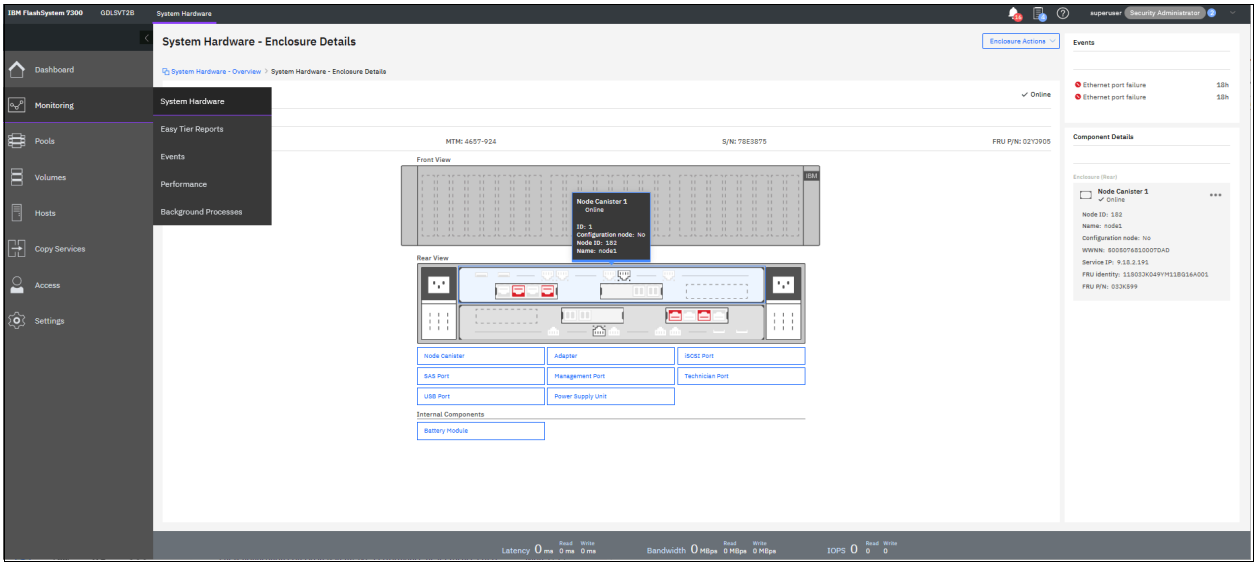

Figure 11 IBM FlashSystem 7300 system overview of the control enclosure

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.

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.

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 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.

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 12 on page 22 shows the front view of the IBM FlashSystem 7300 control enclosure.

Figure 12 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 13 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.

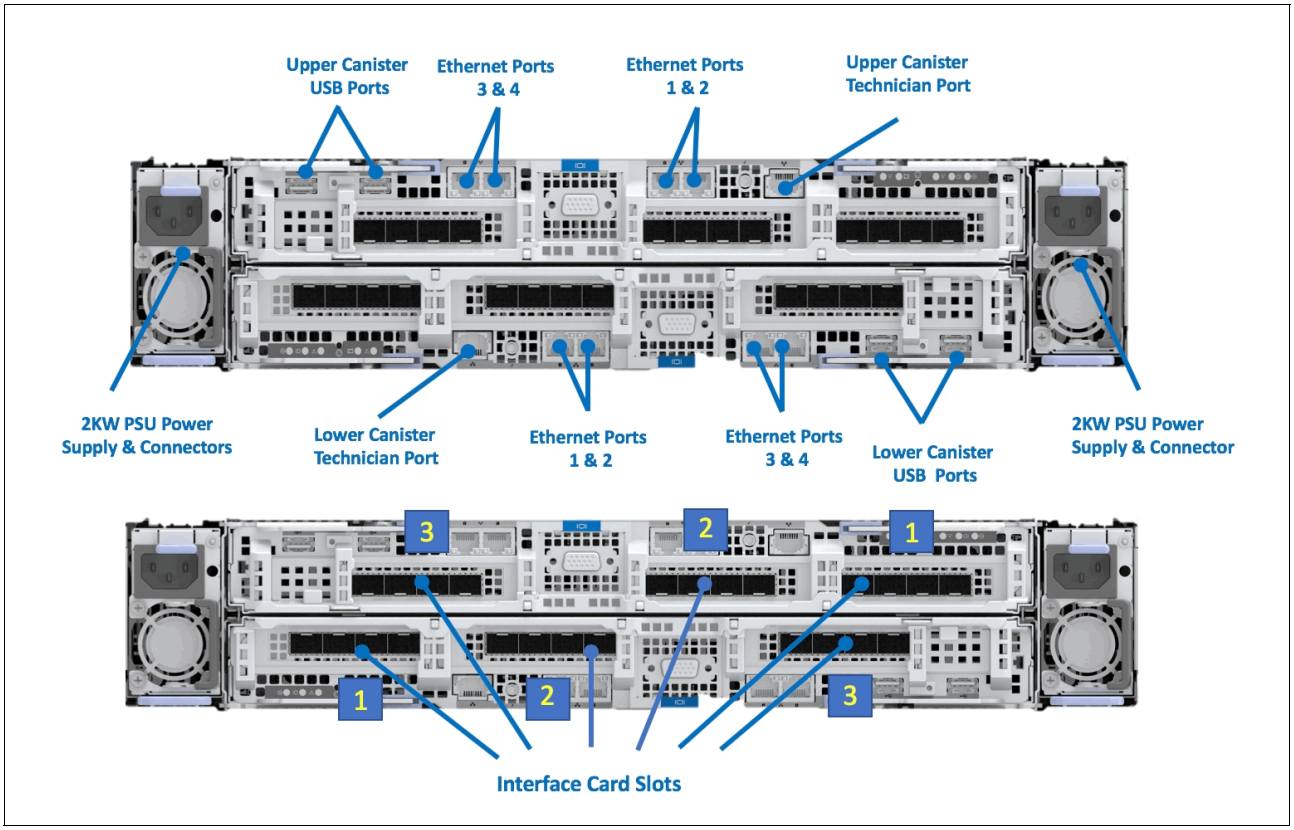

Figure 13 Rear view of IBM FlashSystem 7300 control enclosure

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 1or DRAID.
  - 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 1or 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 1or 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 14 shows the front view of the IBM FlashSystem 7000 Expansion Enclosure Model 12G.

Figure 14 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 15 shows the rear view of IBM FlashSystem 7000 LFF Expansion Enclosure Model 12G.

Figure 15 Rear view of IBM FlashSystem 7000 Expansion Enclosure Model 12G

Figure 16 shows the front view of the IBM FlashSystem 7000 Expansion Enclosure Model 24G.

Figure 16 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 17 shows the rear view of IBM FlashSystem 7000 SFF Expansion Enclosure Model 24G.

Figure 17 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 18 shows the front view of IBM FlashSystem 7000 LFF HD Model 92G Expansion Enclosure.

Figure 18 Front view of IBM FlashSystem 7000 LFF Model 92G Expansion Enclosure

Figure 19 shows the rear view of IBM FlashSystem 7000 LFF model 92G Expansion Enclosure.

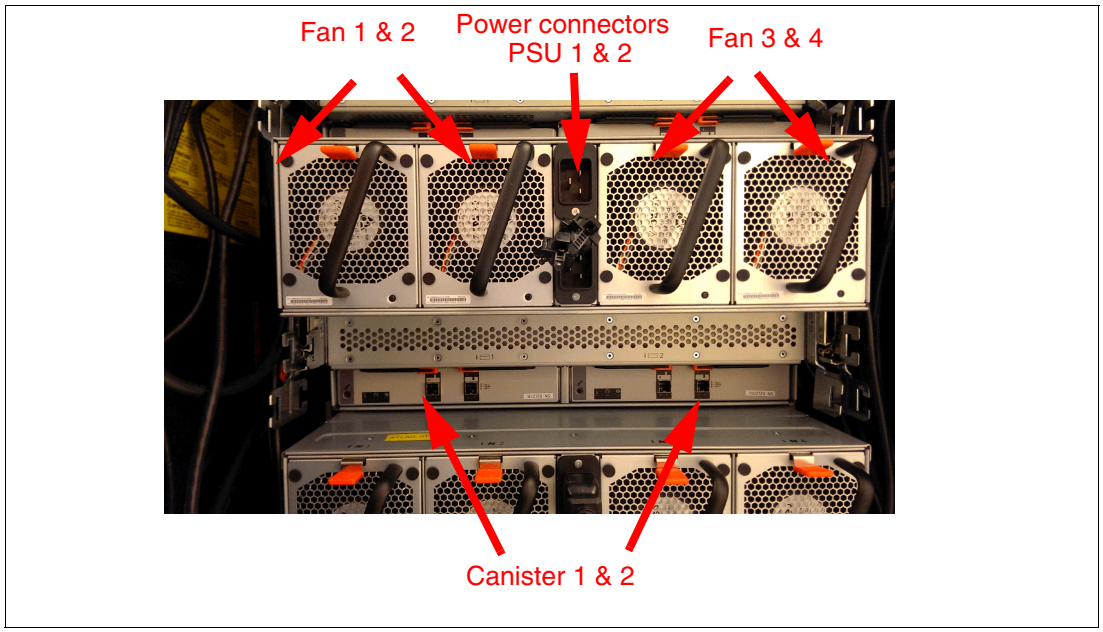

Figure 19 Rear view of IBM FlashSystem 7000 LFF model 92G Expansion Enclosure

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 (µs) 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.

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 on page 30 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
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 19.

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 20 shows the maximum enclosure configuration with 92G expansions.

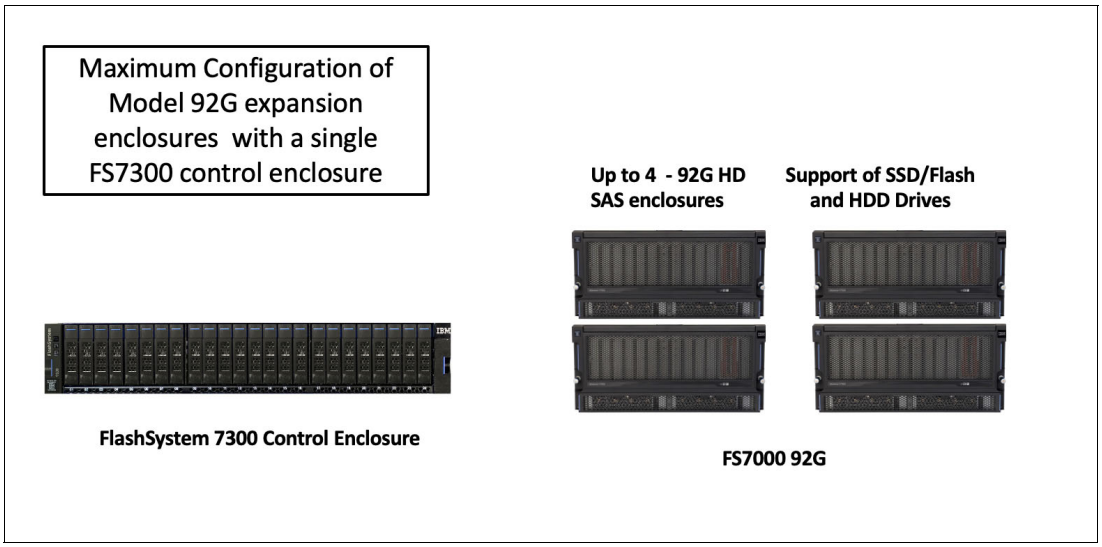

Figure 20 Maximum configuration for model 92G enclosures

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

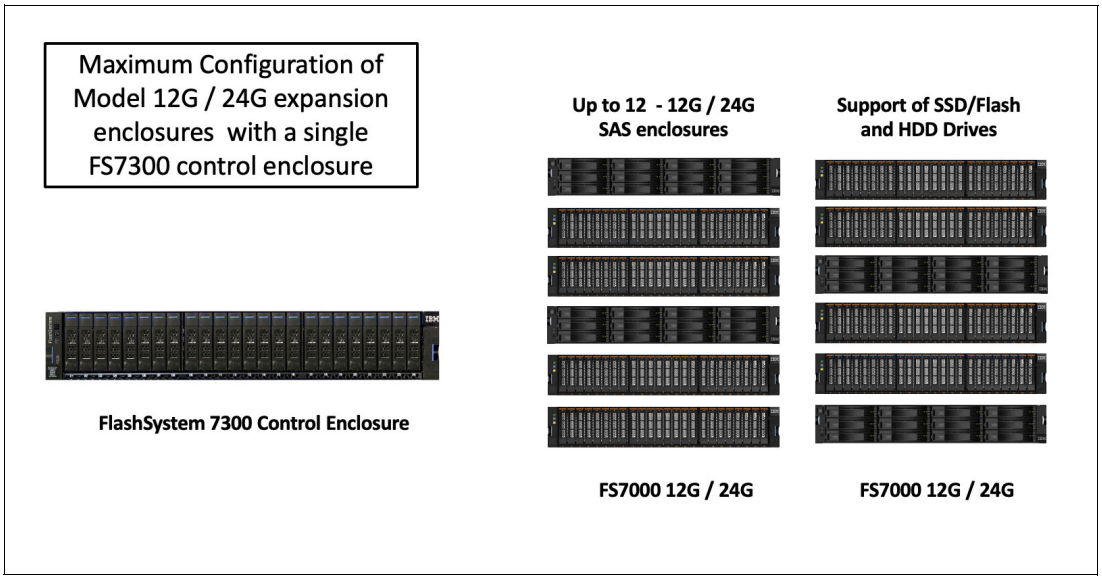

Figure 21 Maximum configuration for model 12 G / 24 G enclosures

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.

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.

For more detailed information on IBM FlashSystem 7300 data encryption refer to *Chapter 18-Security* in IBM Storage Virtualize for SAN Volume Controller and FlashSystem Family Getting Started Guide.

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 6 lists the various memory option feature codes.

Table 6 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 22 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 22 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 7 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 7 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 8 lists the current features for host connectivity for the IBM FlashSystem 7300 control enclosure 4657-924 and 4657-U7D machine types.

Table 8 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 cannot work together with FCM3 and FCM4 in the same RAID array. It 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 8.5 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 is 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 9.

Table 9 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 10 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 10 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 10, 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 29.

For more information about ordering hardware features, see “IBM FlashSystem 7300 GUI” on page 17.

For more information about ordering software licenses, see “Software and licensing” on page 42.

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 Family FAQ

  Overview of the IBM FlashSystem family with guidance on how to select the product that is right for you:

  https://www.ibm.com/downloads/cas/9OGKVW2R
- IBM FlashSystems & SAN Volume Controller FAQ
- https://www.ibm.com/downloads/cas/2DWAMWRB
- 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

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