IBM FlashSystem 5200 Product Guide

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IBM FlashSystem 5200 Product Guide

This IBM® Redbooks® Product Guide publication describes the IBM FlashSystem® 5200 solution, which is a next-generation IBM FlashSystem control enclosure. It is an NVMe end-to-end platform that is targeted at the entry and midrange market and delivers the full capabilities of IBM FlashCore® technology.

It also provides a rich set of software-defined storage (SDS) features that are delivered by IBM Spectrum® Virtualize, including the following features:

► Data reduction and deduplication
► Dynamic tiering
► Thin provisioning
► Snapshots
► Cloning
► Replication
► Data copy services
► Transparent Cloud Tiering
► IBM HyperSwap® including 3-site replication for high availability (HA)

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

The IBM FlashSystem 5200 is a high-performance storage solution that is based on a revolutionary 1U form factor. It consists of 12 NVMe Flash Devices in a 1U storage enclosure drawer with full redundant canister components and no single point of failure.

It is designed for businesses of all sizes, including small, remote, branch offices and regional clients. It is a smarter, self-optimizing solution that requires less management, which enables organizations to overcome their storage challenges.

Flash has come of age and price point reductions mean that lower parts of the storage market are seeing the value of moving over to flash and NVMe-based solutions. The IBM FlashSystem 5200 advances this transition by providing incredibly dense tiers of flash in a more affordable package. With the benefit of IBM FlashCore Module compression and new QLC flash-based technology becoming available, a compelling argument exists to move away from Nearline SAS storage and on to NVMe.

With the release of IBM FlashSystem 5200 Software V8.4, extra functions and features are available, including support for new Distributed RAID1 (DRAID1) features, GUI enhancements, Redirect-on-write for Data Reduction Pool (DRP) snapshots, and 3-site replication capabilities.

Flash for less than the cost of disk

Integral to the IBM FlashSystem 5200 solution is the IBM FlashCore technology. The recent evolution of this technology saw the introduction of inline hardware compression and decompression.

The IBM FlashSystem 5200 system with IBM FlashCore Modules NVMe type drives features built-in hardware data compression as standard, and this data reduction is "always on". This compression is implemented in hardware by using field-programmable gate arrays (FPGAs) within each module and 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.

Compression and decompression do not affect the performance. It also scales linearly with the number of instances; that is, performance depends on the number of instances, not whether compression is used.

In addition, IBM FlashSystem 5200 control enclosure supports DRP compression and deduplication that can increase the effective capacity of your flash storage up to 5x, which decreases the cost for effective capacity up to 80%.

DRPs support active data, unlike other data reduction solutions. The IBM FlashSystem 5200 control enclosure offers several features benefiting DRP compression workloads. These features include eight Intel core processors with up to 256 GB of memory per node, and a built-in compression accelerator for hardware-assisted compression. In addition, the IBM FlashSystem 5200 system with IBM FlashCore Modules NVMe-type drives applies compression to any data that is not compressed.

The IBM FlashSystem 5200 system also supports the new Storage Class Memory (SCM) type drives. SCM is a new storage media technology that offers high endurance, high IOPS, and ultra-low latencies.

For more information, see "Storage Class Memory" on page 14.

Agile integration

The IBM FlashSystem 5200 system features 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, SAS drives, and IBM FlashCore Modules drives with FIPS 140-2
- ► Inline hardware compression with IBM FlashCore Module type drives
- ► External storage virtualization
- ► Tiering or mirroring to existing cloud storage
- ► Mixed workload consolidation
- ► Nondisruptive data migrations
- ► Concurrent code load

By accelerating physical and virtual applications, the IBM FlashSystem 5200 system can help organizations reduce costs, increase revenue, and improve customer satisfaction for all types of applications, including the following categories:

► Transactional
► Enterprise resource planning (ERP) and supply chain management
► Big data and analytics
► Server and desktop virtualization
► Edge computing
► Cloud Native
► Hybrid and Multi-Cloud

AI-empowered

The IBM FlashSystem 5200 system includes the following AI-empowered characteristics:

► AI-based data placement for optimal data center performance and zero-downtime data migration.

► IBM Storage Insight®, which include AI-empowered predictive analytics, storage resource management, and a support platform that is delivered over the cloud.

Multicloud enabled

With IBM Spectrum Virtualize on-premises, IBM Spectrum Virtualize for Public Cloud V8.4 can enable clients to migrate data to and from supported public cloud providers, including IBM Cloud® and Amazon Web Services (AWS). Clients can create hybrid multicloud solutions for their traditional block data and workloads by using built-in IP replication capabilities; for example, implement Disaster Recovery strategies between on-premises and cloud data centers or between cloud data centers.

IBM Spectrum Virtualize for Public Cloud is deployed on a cloud infrastructure as a service (IaaS) from IBM Cloud or AWS on bare metal servers in IBM Cloud or on Amazon Elastic Compute Cloud (Amazon EC2) instances on AWS, and virtualized AWS Amazon Elastic Block Store (EBS) storage. This setup enables clients to create clustered configurations, such as on-premises while bringing the optimization and virtualization capabilities of IBM Spectrum Virtualize to public cloud infrastructures. These capabilities include most of the key features of IBM Spectrum Virtualize, such as the following features:

► IBM FlashCopy®
► Transparent Cloud Tiering
► Thin provisioning
► Global Mirror
► Metro Mirror
► Global Mirror with change volumes
► IBM Easy Tier® to public cloud IaaS

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

► Storage pooling and automated allocation with thin provisioning

► Easy Tier automated tiering

- ► Deduplication and compression to reduce cloud storage costs
- ► FlashCopy® and remote mirror for local snapshots and remote replication
- ► Support for virtualized and containerized server environments including:
  - – VMware
  - – MicrosoftHyper-V
  - – IBM PowerVM®
  - – Red Hat OpenShift
  - – CRI-O
  - – Kubernetes

For more information about IBM FlashSystem systems and Hybrid Multicloud, see IBM FlashSystem and Hybrid Multicloud.

IBM FlashSystem 5200 Advanced Data Services

The IBM FlashSystem 5200 system provides these advanced data services:

- ► Business continuity with replication services
- ► Data Protection with IBM FlashCopy services
- ► Higher storage efficiency with thin provisioning
- ► DRPs that provide compression with deduplication
- ► IBM Easy Tier
- ► External virtualization
- ► IP quorum support
- ► N_Port ID Virtualization (NPIV) support
- ► VMware vSphere Virtual Volume (VVOL) support and space-efficient copies
- ► Transparent Cloud Tiering
- ► IBM HyperSwap® with remote replication (3-site replication)
- ► Clustering up to 4 x FS5200 systems
- ► DRAID6 and DRAID1 support
- ► Redirect on write snapshot in DRP pools
- ► Child pool support in DRP pools
- ► More SCM dives support
- ► Security enhancements

IBM FlashSystem 5200 enclosures overview

The IBM® FlashSystem 5200 system features the following types of enclosures:

- ► A *control enclosure* manages your storage systems, communicates with the host, and manages interfaces. In addition, it can house up to 12 NVMe-capable flash drives. These drives can be industry standard NVMe types or the exclusive IBM FlashCore Module (FCM) NVMe type and up to 12 optional Storage Class Memory (SCM) type drives.
- ► An *expansion enclosure* increases the available capacity of an IBM FlashSystem 5200 cluster. It communicates with the control enclosure through a dual pair of 12 Gbps serial-attached SCSI (SAS) connections. This enclosure can house many of the flash (solid-state drive (SSD)) and HDD type SAS type drives, depending on which model of enclosure is ordered.

Figure 1 shows the IBM FlashSystem 5200 control enclosure front and 3/4 ISO view. In the front view, you can see the 12 NVMe drives in two rows of six drives.
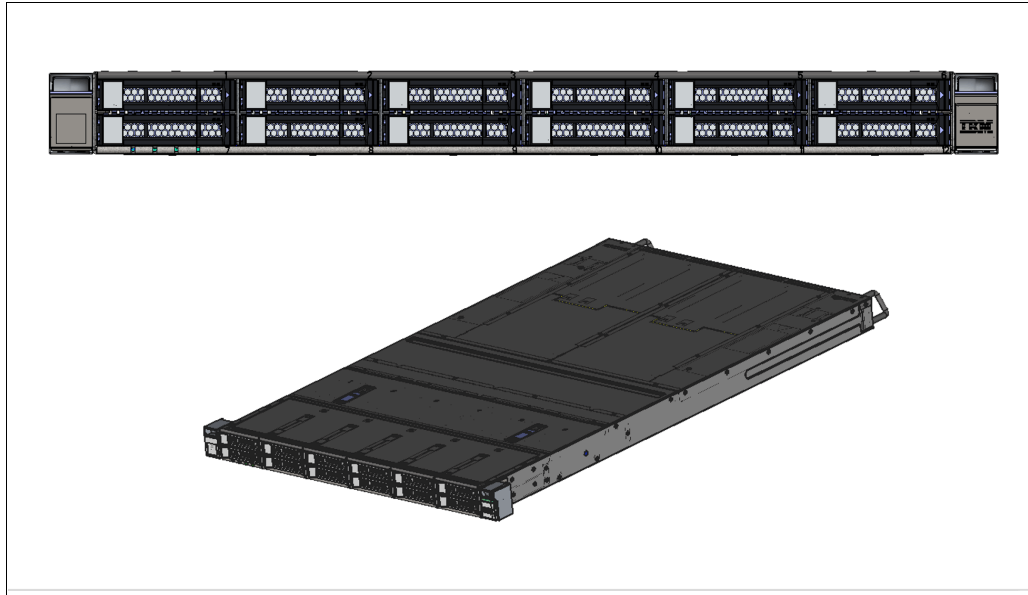

Figure 1   IBM FlashSystem 5200 control enclosure showing the front and 3/4 ISO view

Control enclosures

Each control enclosure can have multiple attached expansion enclosures, which expand the available capacity of the entire system. The IBM FlashSystem 5200 solution supports up to four control enclosures and up to two chains of SAS expansion enclosures per control enclosure.

The IBM FlashSystem 5200 control enclosure supports up to 12 NVMe-capable flash drives in a 1U high form factor and consists of the following machine types and models:

► 4662-6H2 - IBM FlashSystem 5200 control enclosure
► 4662-UH6 - IBM FlashSystem 5200 control enclosure utility model

Note: The 4662 UH6 model is an IBM FlashSystem 5200 solution with a 1-year warranty, and is a 4662 offered in the Storage Utility Offering space. This model is physically and functionally identical to the IBM FlashSystem 4662 6H2 model, except for target configurations and variable capacity billing.

The variable capacity billing uses IBM Spectrum control or IBM Storage Insights to monitor the system usage, which allows allocated storage usage above 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), 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 5200 expansion enclosures consists of the following machine types and models: 4662 models 12G, 24G, and 92G.

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

► IBM FlashSystem 5200 LFF expansion enclosure model 12G offers drive options with up to 12 3.5-inch HDD or SSD flash drives. Up to 240 drives in 20 12G SAS expansion enclosures are supported per IBM FlashSystem 5200 control enclosure. The 12G expansion enclosure is 2U high.

► IBM FlashSystem 5200 SFF expansion enclosure model 24G offers drive options with up to 24 2.5-inch HDD or SSD flash drives. Up to 480 drives in 20 24G SAS expansion enclosures are supported per IBM FlashSystem 5200 control enclosure. The 24G expansion enclosure is 2U high.

► IBM FlashSystem 5200 LFF expansion enclosure model 92G offers drive options with up to 92 3.5-inch (and 2.5-inch drives in carriers) HDD and SSD flash drives. Up to 784 drives in eight 92G SAS expansion enclosures are supported per IBM FlashSystem 5200 control enclosure. The 92G expansion enclosure is 5U high.

Note: The maximum limit of storage that can be managed by the FS5200 is still 32 PB. With higher density drives, this limit might be reached sooner; therefore, measurements must be considered to observe storage consumption.

The IBM FlashSystem 5200 control enclosure can be recognized by the nomenclature on the left and side snap catch cover, which covers the rack-mounting screws. This label contains the machine type, and model and serial numbers of the IBM FlashSystem 5200 control enclosure.

Figure 2 on page 6 shows the IBM FlashSystem 5200 bezel and NVMe drive description.

Figure 2   IBM FlashSystem 5200 bezel and IBM FlashCore Module description

Labeling on the NVMe drive provides the drive type, capacity, and FRU number. The example that is shown in Figure 2 on page 6 is the IBM FlashCore Module NVMe 19.2 TB type.

The IBM FlashSystem 5200 expansion enclosures that are shown next show the size of the respective units and the number of drives in each (12G and 24G only).

Figure 3 shows the IBM FlashSystem 5200 expansion enclosure model 12G and the 12 3.5-inch drives it can contain.

Figure 3   IBM FlashSystem 5200 expansion enclosure model 12G front view

Figure 4 shows the IBM FlashSystem 5200 expansion enclosure model 24G and the 24 2.5-inch drives it can contain.

Figure 4   IBM FlashSystem 5200 expansion enclosure model 24G front view

Figure 5 shows the IBM FlashSystem 5200 expansion enclosure model 92G. This enclosure can contain up to 92 drives of 3.5-inch or 2.5-inch, in-drive carriers.
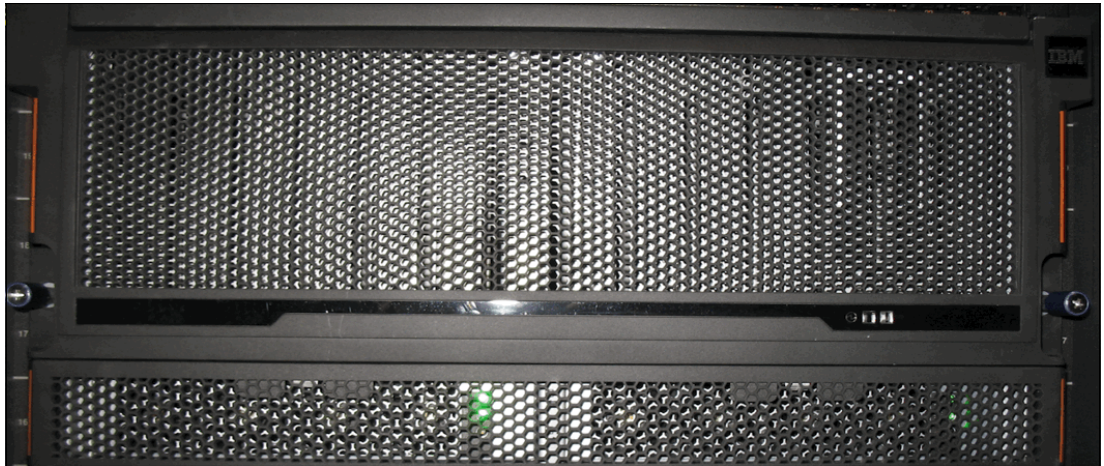

Figure 5   IBM FlashSystem 5200 expansion enclosure model 92G front view

Placing your IBM Flash System family storage system in your infrastructure

This section describes the possible use cases and where to place the FS5200 (or another system belonging to the IBM Flash System family) in the client infrastructure. This kind of solution system can address many possible requirements and can be used to harmonize and simplify an IT storage infrastructure.

FS5200 can be used as a production data repository and a component of a DR solution because a primary system can send data in an efficient way into the hybrid multicloud infrastructure.

In particular, the FS5200 system can meet the following customer requirements:

► First tier repository for production data.

► Primary or target system for data replication or disaster recovery.

► Provide HA services enables the HyperSwap solution with 2 FS5200s in sync replication

► Use Spectrum Virtualize capabilities to manage and virtualize older IBM or non-IBM storage and extend advanced Spectrum Virtualize functions (for example, data reduction) to the external capacity presented by the old storage.

  Old storage systems can be decommissioned or their usage can be extended as an added pool of resources to the Flash System.

► Spectrum Virtualize in FS5200 can provide the intelligent data migration tool from an outer storage to replace it or distribute application workload on more systems

► FS5200 can use Transparent Cloud Tiering (TCT) to move data into the cloud:
  – Use IBM Spectrum Virtualize for Public Cloud on Amazon AWS or other providers.
  – Use the Container Storage Interface (CSI) driver for Red Hat OpenShift Container Platform (which enables Cloud Pak foundation).

► Use IBM software-defined storage (SDS) and IBM Spectrum Suite capabilities, including:
  – Spectrum Scale support, because the Flash system can be used as a repository for several tiers in initial microprogram load (IML) processing.
  – IBM IBM Spectrum Protect as cache or data repository.
  – Spectrum Protect Plus as repository.
  – Copy Data Management.

Figure 6 shows an IBM Flash system 5200 as the main provider of advanced data services for on-premises and in a hybrid multicloud system.
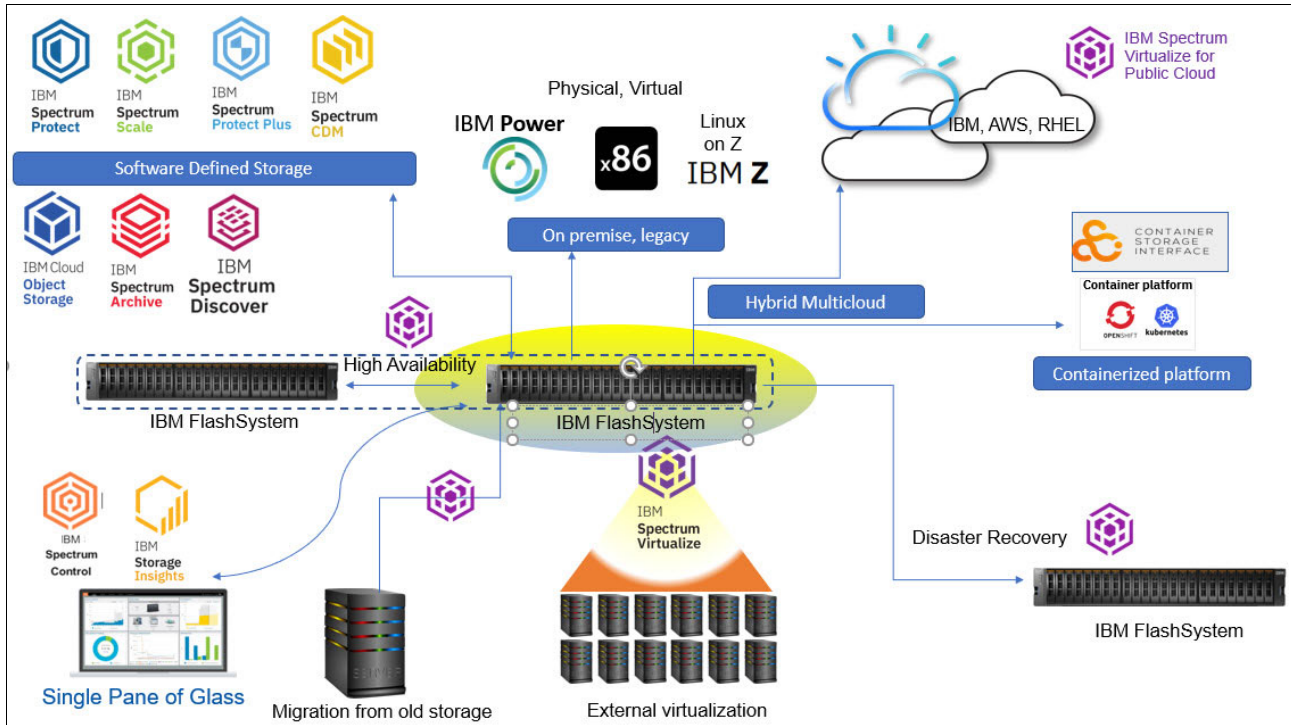

Figure 6   IBM Flash system 5200 as the main provider of advanced data services

The modern and advanced data services that are provided by a storage system should cover several scopes concurrently. The IBM Flash Family components (including FS5200) all share this main characteristic.

Because all IBM FlashSystem products share the functions and software layer, it is easy to select the suitable system that can match performance, capacity, and functional requirements.

For example, looking at Figure 6, we can select the fundamental and modern use case with an on-premises shared storage system that is connected to older (in the primary IT location) and containerized environments. This configuration enables the remote connection to feed the remote cloud counterpart equipped with the same software platform. This platform enables the requested extended services, such as archiving and testing.

All of these capabilities are provided by the common SDS solution that is called IBM Spectrum Virtualize.
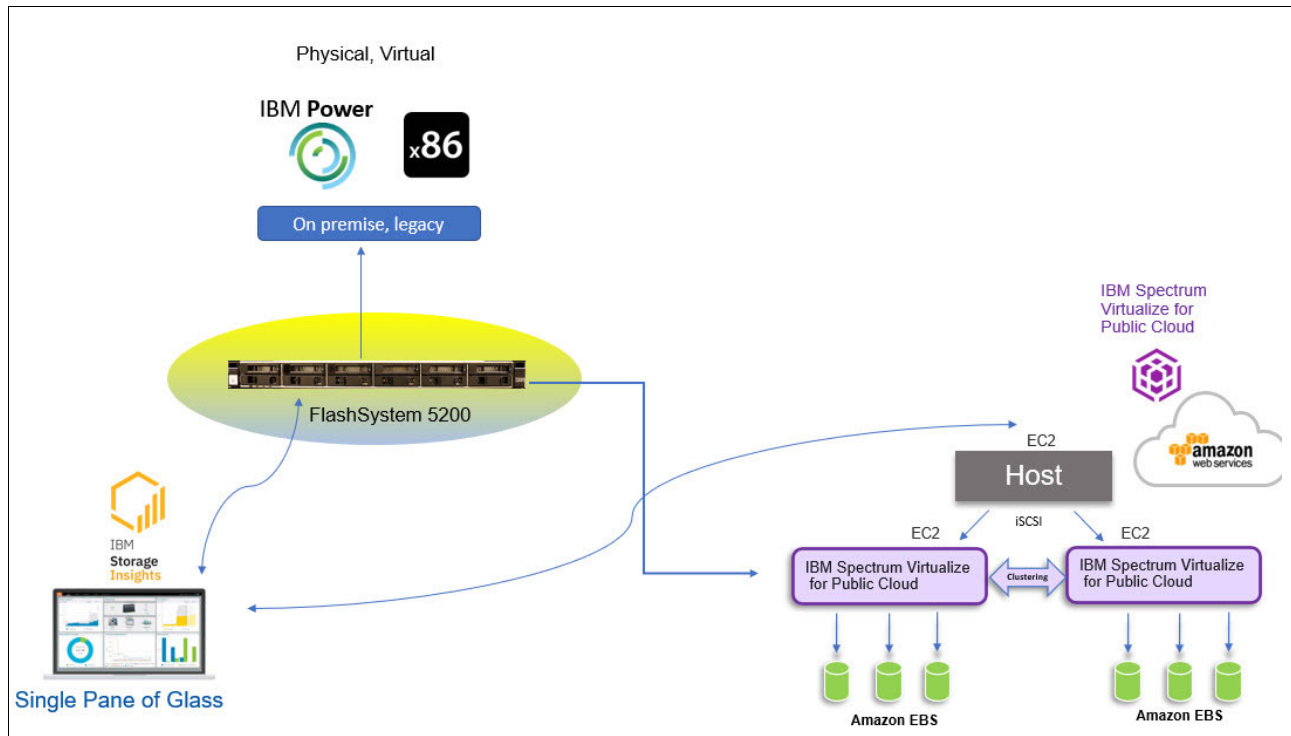
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This example is shown in Figure 7.

Figure 7   Sample scenario

Spectrum Virtualize is included in all the IBM FlashSystem storage products (for example FS5200) and can be deployed in the AWS or RHEL cloud platforms.

Did you know?

The IBM FlashSystem 5200 system runs IBM Spectrum Virtualize V8.4.0, which provides the following functions:

► Supports the IBM FlashCore® Module NVMe type drives with IBM enhanced flash technology.

► The IBM FlashSystem® 5200 control enclosure supports up to 12 ultra-low latency 2.5-inch (SFF) 4.8 TB, 9.6 TB, 19.2 TB, or 38.4 TB IBM FlashCore Module NVMe types or up to 12 NVMe 800 GB, 1.92 TB, 3.84 TB, 7.68 TB, or 15.36 TB industry-standard drives, or a mixture of both.

► Supports up to 12 NVMe SCM Drives in capacities 375 GB, 750 GB, 800 GB, and 1.6 TB.

► IBM FlashCore Module NVMe types provide automatic data compression and encryption without affecting the system performance.

► The IBM FlashSystem 5200 system can use IBM Security™ Key Lifecycle Manager or USB key encryption. Up to four IBM Security Key Lifecycle Manager key servers are supported.

► Offers hardware-based AES 256 data-at-rest encryption by using USB key and IBM Security Key Lifecycle Manager key server-based encryption, with no performance impact.

► RSA enables IBM support personnel to access the system to complete troubleshooting tasks.

- ► Consistency protection for Global Mirror, Metro Mirror replication, and High Availability.
- ► Management GUI support for host clusters, including private and shared volume mappings.
- ► Throttling allows customers to control resources that are used when the system is processing I/Os on hosts, host clusters, volumes, copy offload operations, and storage pools.
- ► TCT is a function of IBM Spectrum® Virtualize that uses IBM FlashCopy mechanisms to produce a point-in-time snapshot of the data.
- ► Provides flexible interface types, including FC and Ethernet (iWARP and RDMA over Converged Ethernet [RoCE] protocols) to easily integrate into SAN and iSCSI network environments.
- ► IBM Storage Insights offers some key capabilities that help clients meet the demands that are put on IT by helping to build the connective fabric between IBM, storage, and the user. IBM Storage Insights provides advanced customer service and monitors the performance, capacity, and health of each device.
- ► Supports DRAID1 and DRAID6 protections to provide the suitable level of reliability and performances.
- ► The 5200 can support up to 340 TB usable or 790 TB effective in 1U.
- ► The 5200 can support the following expansion models with a SAS expansion card that is installed in the second adapter slot: 12G, 24G, 92G, F12, F24, F92. The expansion enclosures are reused from theV5000E/FS5000H family. Note that connecting enclosures from Storwize V5000E/FS5000 to FS5200 is not supported.

Current release functions

This section describes several new functions and features that are available in the current IBM FlashSystem 5200 release.

New in IBM FlashSystem 5200 Software V8.4.0

The following functions are included in IBM FlashSystem 5200 Software V8.4.0:

- ► 3-site Data Replication for HyperSwap, which supports the following use cases:
  - – Disaster scenarios
  - – Site maintenance
  - – Link failure cases
- ► Security updates:
  - – IBM is releasing a new set of options to allow a security administrator to create policies for passwords, account lockout, session timeout.
  - – Create a single system-wide policy that applies to all local accounts (session timeouts also apply to remote accounts).
  - – Configurable CLI timeout.
  - – HTTP proxy server for cloud Call Home and Storage Replication Adapter (SRA) log upload.
  - – NVME drive security updates (new events and sense data to better identify and resolve NVMe drive encryption errors) and secure data deletion.

- ► UI modernization updates:
  - – Modernized syslog servers window.
  - – New host dialog.
  - – New Add Storage experience.
  - – Modernized remote copy experience (2-site and 3-site).
- ► DRAID-1:
  - – 2-member drives per array (0 rebuild area)
  - – 3 - 16 member drives per array (1 rebuild area)
  - – System recommendation is to create DRAID-1 in arrays up to six drives
- ► Data reduction child pools:
  - – User can create child pools in data reduction parent pools.
  - – Data reduction child pools are created without a quota and can use entire parent capacity.
- ► DRP:
  - – Redirect-on-write for DRP snapshots adds a redirect-on-write (RoW) alternative to the copy-on-write (CoW) capabilities.
  - – Comprestimator always on.
  - – RAID Reconstruct Read (3R), which uses RAID capabilities, asks DRP for a specific data block reconstruction when detecting a potential corruption.
- ► Miscellaneous:
  - – Updates to maximum configuration limits.
  - – 8.4.0 mirrored VDisk fast format enhancements.
  - – 8.4.0 FC-NVMe enhancements.
  - – 8.4.0 improved handling of memory errors.
  - – SCM restrictions lifted. For more information, see "Storage Class Memory" on page 14.
  - – As of Spectrum Virtualize 8.3.1.2 and SI/ Spectrum Control 5.3.7 or later, data collection can be done with Monitor (least privileged) role. As each node writes a statistics file, it automatically is uploaded to the configuration node.
  - – 8.4.0 DNS support enhancements.

IBM FlashCore technology

At the heart of the IBM FlashSystem 5200 system is IBM FlashCore technology (if the IBM FlashCore Module NVMe type drives 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. It is implemented completely in hardware; no processor intervention is required.
- ► IBM FlashCore Modules, which are designed for low latency, density, and reliability.
- ► IBM Advanced Flash Management, which improves flash endurance over standard implementations without sacrificing latency.
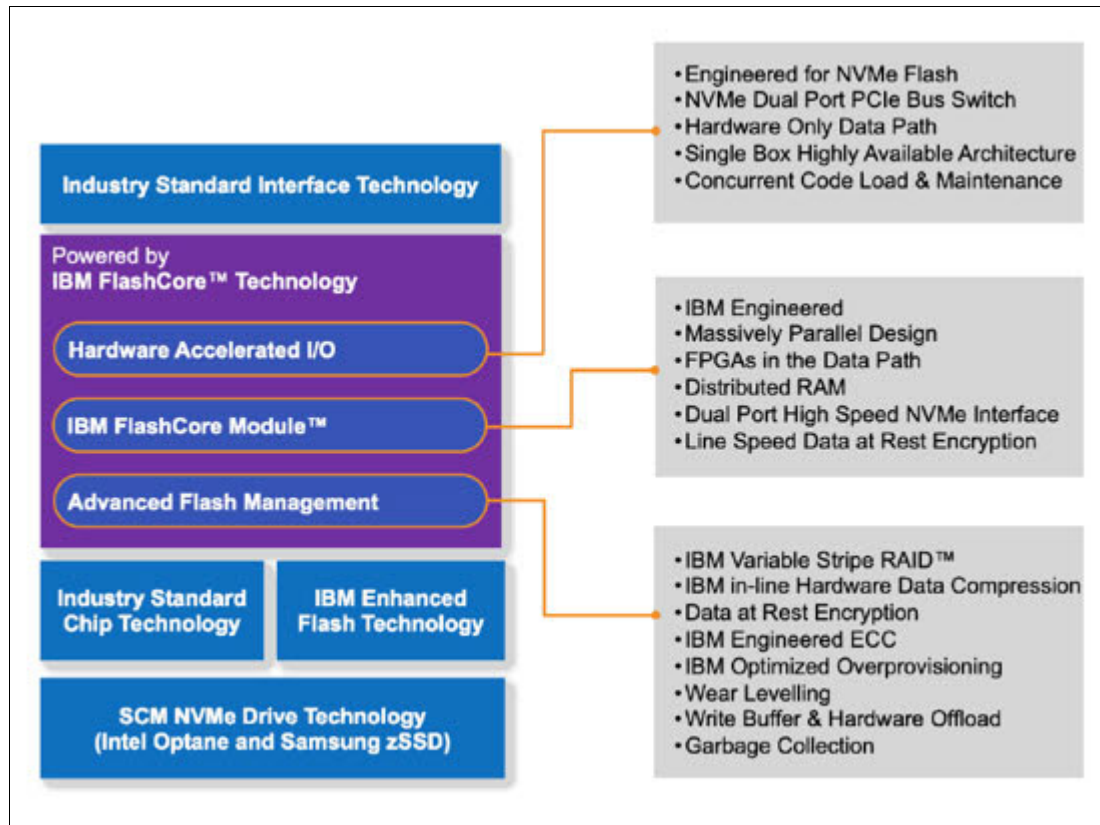
Figure 8 shows IBM FlashCore technology.

Figure 8   IBM FlashCore technology

IBM released the second generation of FlashCore Modules (FCMs). The innovative design of these custom-designed modules delivers improved performance, capacity, and reliability.

Clients can experience latency as low as 70 microseconds, which helps remove bottlenecks in their workloads. The outstanding performance of FCMs includes data reduction that is obtained from embedded hardware. Data reduction occurs as fast as data can be written to the modules.

Capacity takes a step forward with a new 38.4 TB module. Although that capacity sounds impressive, it does not really tell the whole story. Because each FCM delivers wire-speed compression and IBM provides a 2-to-1 compression guarantee, clients obtain 76.8 TB in a 2.5-inch small form factor device. Therefore, clients can see 790 TB of effective raw capacity in only 1U of space and do that without affecting performance.

A less obvious benefit of the FCMs is greatly enhanced flash endurance. Many factors help deliver up to 7 x greater flash endurance than an industry-standard, commodity solid-state-drive (SSD), which translates to fewer issues for clients. It also means that time does not have to be spent dealing with failing SSDs and drive rebuilds.

For more information about IBM FlashCore technology, see What is flash storage?.

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Storage Class Memory

SCM is an industry-wide standard definition for non-volatile memory devices that perform faster (~10μs) than traditional NAND SSDs (100μs), but slower than dynamic random access memory (DRAM); 100 ns.

The technology pricing sits between DRAM and traditional NAND. Price is significantly more expensive than traditional NAND drives.

At the time of this writing, the following vendors are most prevalent in the marketplace:

► Intel (3D Xpoint memory technology in Optane drives)
► Samsung (zNAND memory technology in zSSDs)

The IBM FlashSystem 5200 system supports the new low-latency, high-speed SCM drives in any of the slots of the control enclosure. The drives are inserted into the control enclosure from right to left, bottom row to top row. The control enclosure can contain up to 12 SCM drives (which completely populates the control enclosure).

Figure 9 shows the SCM drive locations in the IBM FlashSystem 5200 control enclosure. The SCM Drives are populated in reverse slot order (slots 12 - 7, then slots 6 - 1).
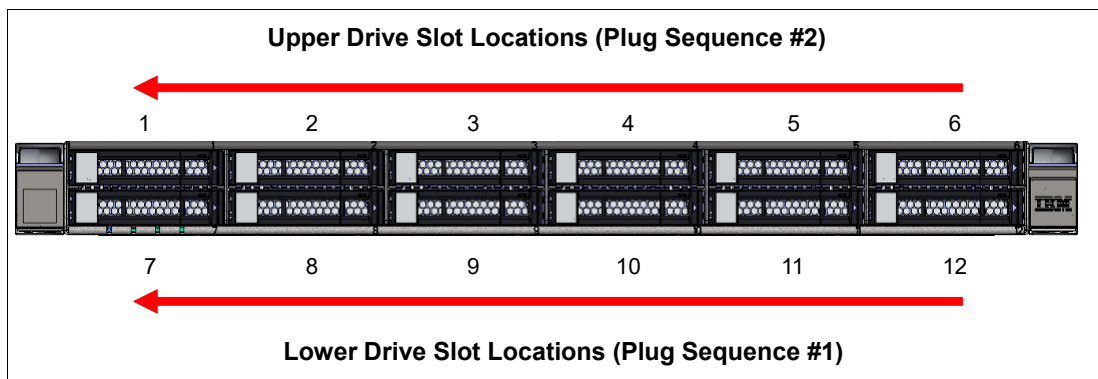

Figure 9   SCM Drive locations slots

SCM and Easy Tier

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 tier0_flash that is used for NVMe NAND drives that are supported today. Easy tier features the following levels:

► Storage Class Memory

 Storage Class Memory 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

 Tier 0 flash tier exists when the pool contains high-performance flash drives.

► Tier 1 flash

 Tier 1 flash tier exists when the pool contains tier 1 flash drives. Tier 1 flash drives typically offer larger capacities, but slightly lower performance and write endurance characteristics.

► Enterprise tier

 Enterprise tier exists when the pool contains enterprise-class MDisks, which are disk drives that are optimized for performance.

► Nearline tier

Nearline 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, specially for metadata (directory volume lookups). This example is one of the main use cases for SCM drives in an IBM FlashSystem 5200 system.

SCM and RAID configurations

SCM drives feature the following rules regarding RAID supported configurations:

► Distributed DRAID 1 with two drives (including distributed spare capacity) or more and is the best practice recommendation and configuration.

► Distributed DRAID 5 with four drives (including distributed spare capacity) or more is supported.

► Distributed DRAID 6 with six drives (including distributed spare capacity) or more 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 much longer to format a drive than a typical NVMe drive. The drive formats can take up to 15 minutes; therefore, the user must be patient and wait until the process completes.

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

► 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 Service and Support options

The IBM FlashSystem 5200 system announces with a new set of IBM Storage Expert Care Service and Support options. These options provide new levels (and a matrix), of service cover, with the options of 1 - 5 years duration.

Base warranty

The IBM FlashSystem 5200 models 6H2 and UH6 control enclosures are sold with a one-year, parts-only warranty at the point of ordering. The customer must then choose between the Silver or Gold services offering and also the duration of the contract, which can be 1 - 5 years.

This level of one-year, parts-only base warranty also applies to the IBM FlashSystem 5200 models 12G, 24G, and 92G expansion enclosures. These enclosures also must have the same service level offering applied to them as the IBM FlashSystem 5200 control enclosure to which they are going to be attached at the point of the initial order.

Note: The duration of the contract for these expansion enclosures does not have to be the same as the control enclosure. This flexibility gives the customer the ability to choose the length of service cover they require.

Service and support levels

The following warranty and service levels available for the IBM FlashSystem 5200 with IBM Storage Expert Care service and support:

Note: The following keys terms are used in this list:
- ► CRU: Customer Replaceable Unit
- ► NBD: Next Business Day
- ► SBD: Same Business Day
- ► LMC: Licensed Machine Code
- ► 24/7/4: 24 Hours per day/7 days a week/4-hour response
- ► 9x5: 9 hrs per day, Monday - Friday only (no weekends or public holidays).

- ► Base warranty:
  - – Parts Only
  - – HW CRU (9x5 available as exception)
  - – Remote Technical Support included (HW only)

- ► Basic:
  - – 9x5, NBD
  - – HW CRU (9x5 available as exception)
  - – SW/LMC Subscription and Support
  - – Storage Insights basic (ticket opening)
  - – Remote Technical Support (HW and SW)
  - – Client or Business Partner installation

- ► Advanced:
  - – 24x7x4, SBD
  - – IBM Onsite Repair (includes hardware, CRU)
  - – SW/LMC subscription and support
  - – Storage Insights with Predictive Support
  - – Remote Technical Support (hardware and software)

Service contract duration

This section details the contract duration and renewal terms:
- ► Annual: 1, 2, 3, 4 or 5 years
- ► Renewable: On an annual auto-renewal basis

Figure 10 on page 17 shows an overview of the various service levels that are available with the IBM FlashSystem 5200. The basic and advanced offerings are designated by a new machine type and model, plus a numerical value to denote the number of years for which the contract runs.

For example, consider the following service offering 4663-B03:

- ► 4663: Service offering machine type for IBM FlashSystem 5200
- ► B: Denotes basic level of service offering
- ► 03: Denotes the offering is for three years duration

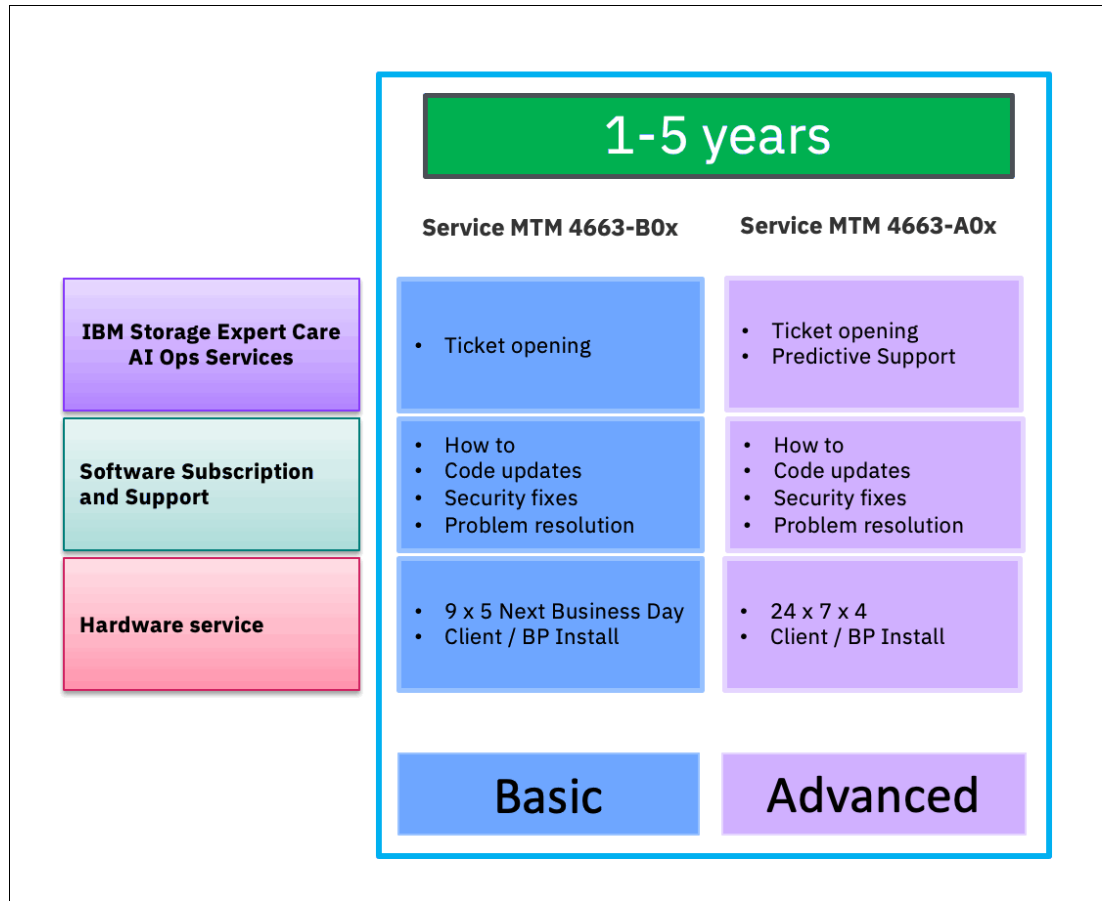Figure 10 shows IBM Storage Expert Care Service and Support options.

Figure 10   IBM Storage Expert Care Service and Support options

For more information about these offerings, contact your local IBM Sales representative or IBM reseller.

IBM FlashWatch overview

IBM FlashWatch is a new offering from IBM to compliment the purchase of the IBM FlashSystem 5200 system. It provides the following features that are included in the purchase of the product:

- ► Acquisition:
  - – HA Guarantee:
    - • Proven 99.9999% availability
    - • Optional 100% commitment when HyperSwap is used
  - – Data Reduction Guarantee:
    - • 2:1 self-certified
    - • Up to 5:1 with workload profiling

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- – All-inclusive Licensing

    All storage function included in licensing cost for internal storage

- ► Operation:

    - – IBM Storage Expert Care

        1 - 5 years of 9x5 or 24x7 support (selectable at product purchase time)

    - – Cloud Analytics

        Storage Insights included at no extra cost to proactively manage your environment

    - – Flash Endurance Guarantee

        Flash media is covered for all workloads while under warranty or maintenance

- ► Migration:

    - – IBM Flash Momentum - Storage Upgrade Program

        Replace your controller and storage every 3 years with full flexibility.

    - – Cloud-like Pricing

        Storage Utility pricing has monthly payments for only the storage that you use.

    - – No Cost Migration

        90 day, no-cost data migration from over 500 storage controllers (IBM and non-IBM).

For more information about the IBM FlashWatch offering, see the IBM FlashWatch FAQ.

The IBM FlashWatch offering is applicable across the IBM Spectrum Virtualize family. The Product Matrix in the FAQ describes which elements are applicable against which product.

IBM Storage Insights

IBM Storage Insights is a part of the monitoring and ensuring continued availability of the IBM FlashSystem 5200.

Available at no charge, cloud-based IBM Storage Insights provides a single dashboard that provides a clear view of all of your IBM block storage. You can make better decisions by seeing trends in performance and capacity.

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

The following features are included:

- ► A unified view of IBM systems:

    - – Provides a single window to see all of your system's characteristics.
    - – See all of your IBM storage inventory

- ► Provides a live event feed so that you know, up to the second, what is occurring with your storage and enables you to take action fast.

- ► IBM Storage Insight® collects telemetry data and Call Home data, and provides up-to-the-second system reporting of capacity and performance.

- ► Overall storage monitoring:

    - – The overall health of the system.

    - – Monitor the configuration to see whether it meets the best practices.

- System resource management to determine whether the system is being overly taxed and provide proactive recommendations to fix it.

► Storage Insights provides advanced customer service with an event filter that enables the following functions:

- The ability for you and support to view, open, and close support tickets, and track trends.

- Auto log collection capability to enable you to collect the logs and send them to IBM before support starts investigating the problem. This feature can save as much as 50% of the time to resolve the case.

In addition to the free Storage Insights, the Storage Insights Pro option is available. This option is a subscription service that provides longer historical views of data, which offers more reporting and optimization options. It also supports IBM file and block storage with EMC VNX and VMAX.

Figure 11 shows the comparison of Storage Insights and Storage Insights Pro.

Product Comparison

	Capability	IBM Storage Insights (Free)	IBM Storage Insights Pro (Subscription)
Monitoring	Health, Performance and Capacity	✓	✓
	Filter events to quickly isolate trouble spots	✓	✓
	Drill down performance workflows to enable deep troubleshooting		✓
	Application / server storage performance troubleshooting		✓
	Customizable multi-conditional alerting		✓
Support Services	Simplified ticketing / log workflows and ticket history	✓	✓
	Proactive notification of risks (select systems)	✓	✓
Device Analytics	Part failure prediction	✓	✓
	Configuration best practice	✓	✓
	Customized upgrade recommendation	✓	✓
TCO Analytics	Capacity planning		✓
	Performance planning		✓
	Application / server storage consumption		✓
	Capacity optimization with reclamation planning		✓
	Data optimization with tier planning		✓

Figure 11   Storage Insights and Storage Insights Pro Chart

Architecture, security, and data collection

Figure 12 shows the architecture of the Storage Insights application, the supported products, and the three main teams of people who can benefit from the use of the tool.
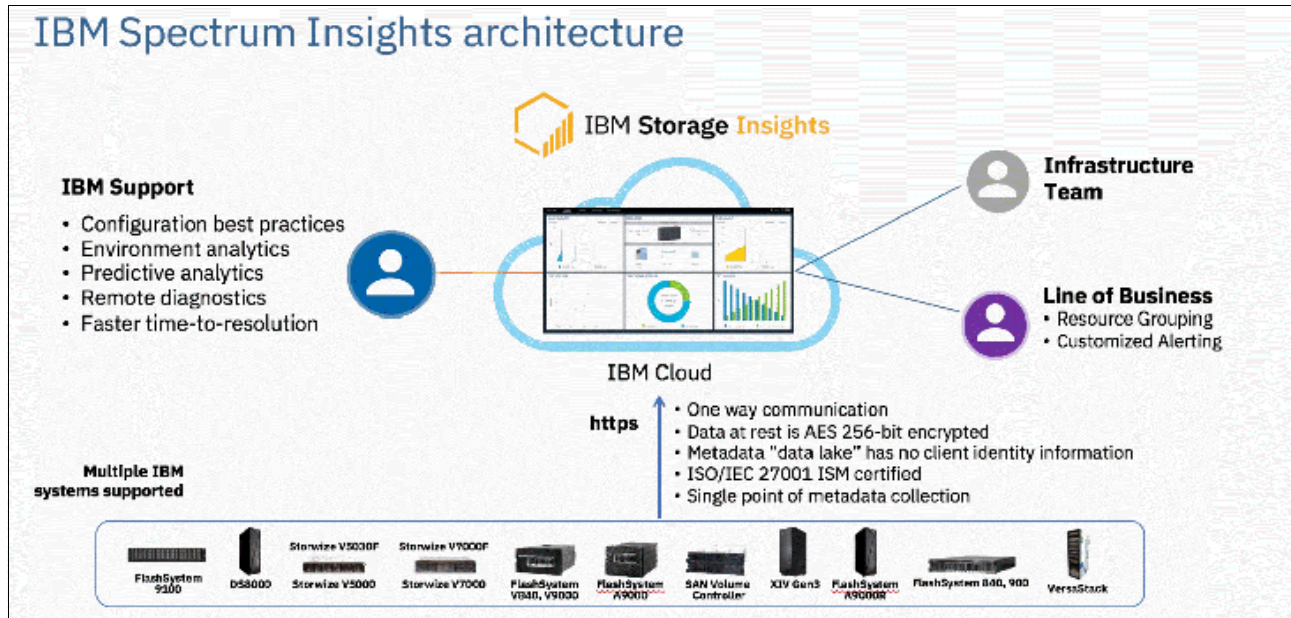

Figure 12   Spectrum Insights Architecture

Storage Insights provides a lightweight data collector that is deployed on a customer supplied server. This server can be a Linux, Windows, or AIX® server, or a guest in a virtual machine (for example, a VMware guest).

The data collector streams performance, capacity, asset, and configuration metadata to your IBM Cloud instance.

The metadata flows in one direction: from your data center to IBM Cloud over HTTPS. In the IBM Cloud, your metadata is protected by physical, organizational, access, and security controls. IBM Storage Insights is ISO/IEC 27001 Information Security Management certified.

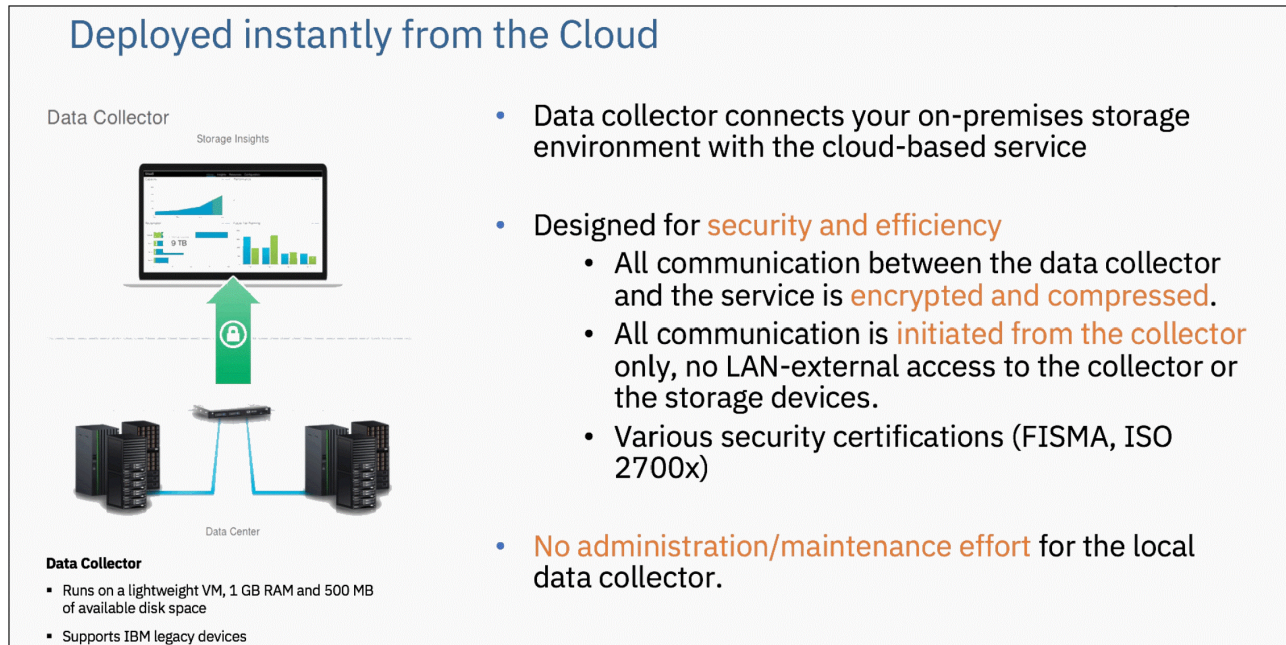Figure 13 shows the data flow from systems to the IBM Storage Insights cloud.

Figure 13   Data flow from the storage systems to the IBM Storage Insights cloud

Collected metadata

The following metadata about the configuration and operations of storage resources is collected:

► Name, model, firmware, and type of storage system.

► Inventory and configuration metadata for the storage system's resources, such as volumes, pools, disks, and ports.

► Capacity values, such as capacity, unassigned space, used space, and the compression ratio.

► Performance metrics, such as read and write data rates, I/O rates, and response times.

The application data that is stored on the storage systems cannot be accessed by the data collector.

Accessing the metadata

Access to the metadata that is collected is restricted to the following users:

► The customer who owns the dashboard.

► The administrators who are authorized to access the dashboard, such as the customer's operations team.

► The IBM Cloud team that is responsible for the day-to-day operation and maintenance of IBM Cloud instances.

► IBM Support for investigating and closing service tickets.

Customer dashboard

Figure 14 shows a view of the Storage Insights main dashboard and the systems that it is monitoring.
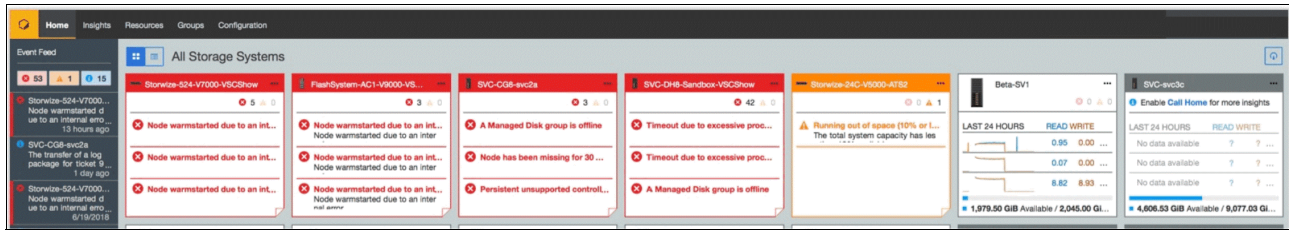

Figure 14   Storage Insights Dashboard

More views and images of dashboard displays and drill downs can be found in the supporting documentation that is listed in the following sections.

For more information about Storage Insights and for the user to sign up and register for the free service, see the following resources:

► Fact Sheet
► Demonstration
► Security Guide
► IBM Knowledge Center
► Registration link

IBM Spectrum Control Connect

Using IBM Spectrum Control Connect V3.7.0 (formally known as IBM Spectrum Control Base) or later, IBM FlashSystem 5200 Software V8.4 supports:

► IBM Storage Provider for VMware VASA
► IBM Storage Enhancements for VMware vSphere Web Client
► IBM Storage Plug-in for VMware vRealize Orchestrator 2, 3
► IBM Storage Management Pack for VMware vRealize Operations Manager 3, 4
► IBM Storage Automation Plug-in for PowerShell

This centralized server system consolidates a range of IBM storage provisioning, virtualization, cloud, automation, and monitoring solutions through a unified server platform. For more information about this feature, see IBM Documentation.

IBM Spectrum Control Connect 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.

IBM FlashSystem 5200 GUI

The IBM FlashSystem 5000 family systems include an easy-to-use management GUI that runs on one of the node canisters in the 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.

The IBM FlashSystem 5200 and IBM FlashSystem 5000 systems use a GUI with the same look and feel as other IBM FlashSystem family solutions for a consistent management experience across all platforms. The GUI features an improved overview dashboard that provides all information in an easy-to-understand format. It also enables visualization of effective capacity. With the GUI, you can quickly deploy storage and manage it efficiently.
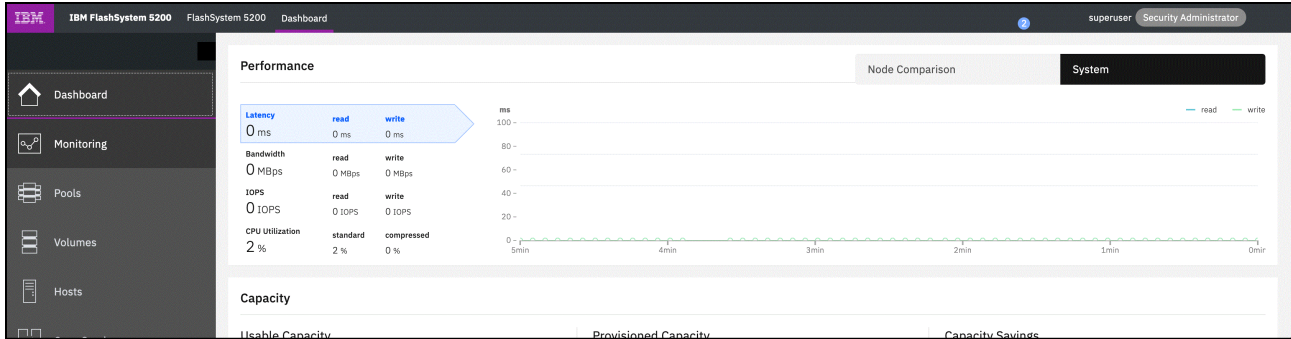
Figure 15 shows GUI Dashboard.

Figure 15   Graphical user interface dashboard

Figure 16 shows the control enclosure window. You can open this window by selecting **Monitoring** → **System Hardware** from the left menu.
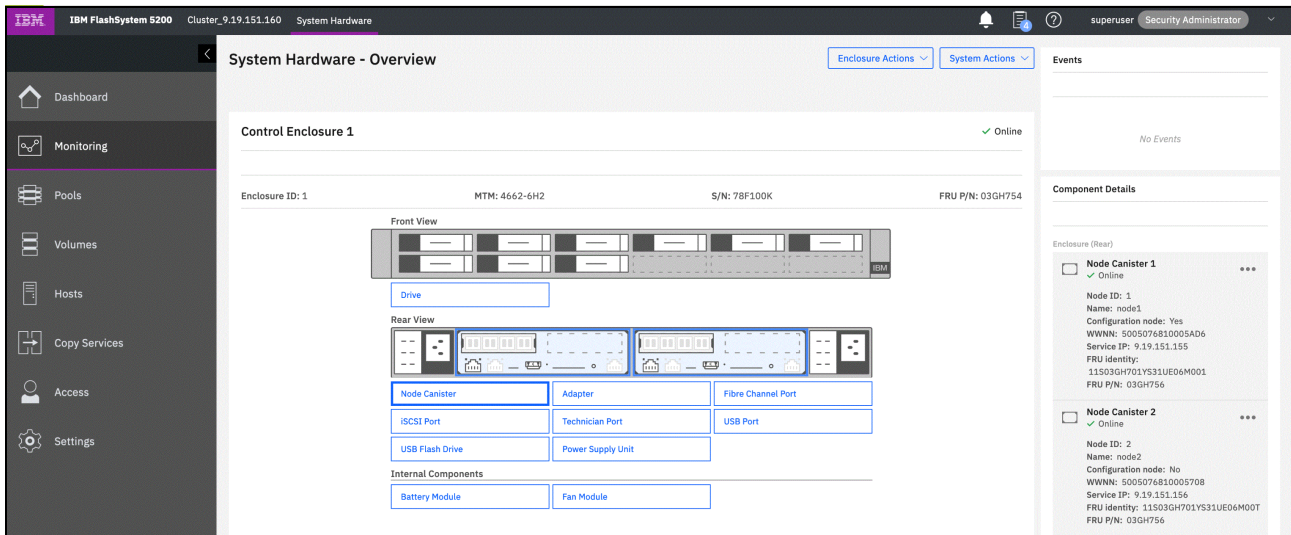

Figure 16   IBM FlashSystem 5200 system overview of the control enclosure

The IBM FlashSystem 5200 system includes a command-line interface (CLI), which is useful for scripting, and an intuitive GUI for simple and familiar management of the product. The IBM FlashSystem 5200 system supports SNMP email forwarding that uses Simple Mail Transfer Protocol (SMTP), and syslog redirection for complete enterprise management access.

By using the GUI, you can quickly deploy storage and manage it efficiently. The GUI runs on the IBM FlashSystem 5200 control enclosure; therefore, a separate console is not needed. Point your web browser to the system IP address, and you can manage all of the expansion enclosures from one place.

The IBM FlashSystem 5200 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. No software must be installed on host computers to administer the IBM FlashSystem 5200 system beyond a web browser or a standard SSH client.

Supported platforms

The IBM FlashSystem 5200 system has extensive interoperability with support for a wide range of operating systems (Microsoft Windows Server 2008 and 2012, Linux, and IBM AIX®, and IBM i), hardware platforms (IBM System x, IBM Power Systems, and x86 servers that are not from IBM), host bus adapters (HBAs), and SAN fabrics.

For more information, see IBM System Storage Interoperation Center (SSIC).

IBM FlashSystem 5200 hardware component overview

The IBM FlashSystem 5200 control enclosure is a 1U rack-mounted NVMe flash memory enclosure that is based on IBM flash technology. It provides the primary management interface (GUI) and the host interface configuration. The IBM FlashSystem 5200 control enclosures support FC Protocol (FCP and FC-NVMe) and iSCSI interfaces. For iSCSI, the RoCE and iWARP protocols are supported.

Figure 17 shows the front view of the IBM FlashSystem 5200 control enclosure. Also shown are six NVMe drives that are installed in upper slots 1 - 6 and six fillers in lower slots 7 - 12.
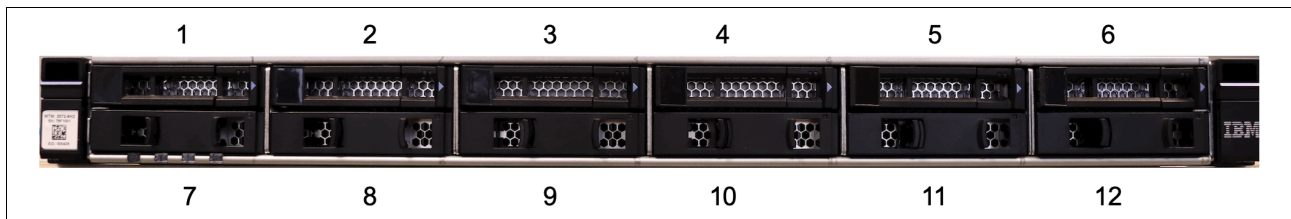
Figure 17   IBM FlashSystem 5200 control enclosure front view with drive slot locations

The IBM FlashSystem provides the following NVMe technologies:

► Supports unique world class IBM FlashCore Module drives with inline compression.
► Supports industry-standard NVMe drives.
► Option for Intel Optane or Samsung zSSD SCM type drives.
► NVMe-oF on FC.
► IBM FlashSystem 5200 system is offered as two models:
  – 4662 model 6H2: IBM FlashSystem 5200 NVMe control enclosure
  – 4662 model UH6: IBM FlashSystem 5200 NVMe control enclosure utility model

> **Note:** The 4662-UH6 utility-based model features fixed configurations because they are Capacity on Demand (CoD) based offerings.

- ► Macroefficiency with up to 460 TB of raw maximum protected capacity with inline hardware data compression if you use IBM FlashCore Module NVMe types.

- ► Support for industry-standard NVMe drives with up to 184 TB of maximum raw capacity.

- ► Extreme performance with IBM MicroLatency® FlashCore Modules.

- ► Optional expansion enclosures that provide tiering options with SSD flash and HDD drives.

The IBM FlashSystem 5200 configuration consists of the following components:

- ► A total of 1 - 4 IBM FlashSystem 5200 control enclosures
- ► A total of 1 - 20 IBM FlashSystem 5200 SFF/LFF expansion enclosures
- ► A total of 1 - 8 IBM FlashSystem 5200 LFF High Density (HD) expansion enclosures

The following machine warranties are offered for the IBM FlashSystem 5200 system:

- ► Machine type 4662-6H2 with a 12-month, parts-only warranty
- ► Machine type 4662-UH6 with a 12-month, parts-only warranty

The IBM FlashSystem 5200 control enclosure includes integrated AC power supplies (PSU) and battery units inside each of the 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 5200 control enclosure includes the following features:

- ► Full internal redundancy:

  - – Redundant and hot-swappable canisters
  - – Redundant and hot-swappable batteries within each canister
  - – Hot-swappable PCI Express (PCIe) adapters
  - – Redundant and hot-swappable power supplies, DIMMs, and fans

Figure 18 shows a top view of the IBM FlashSystem 5200 enclosure. Highlighted are the various components of the control enclosure and the two canisters.
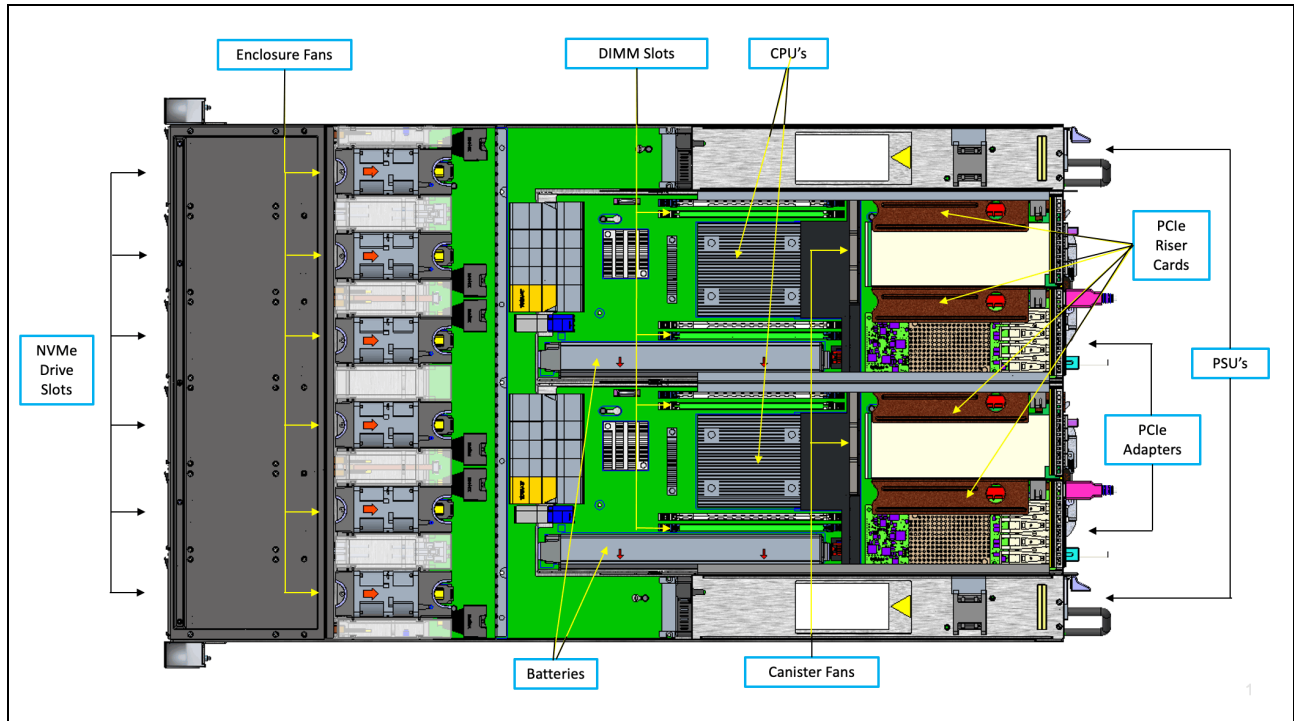
Figure 18   Top view of the IBM FlashSystem 5200 enclosure

► Control enclosure:

   – Two canisters that are placed side by side
   – 12 NVMe drive slots
   – Six enclosure fan assemblies

► Each canister contains the following components and quantities:

   – CPU (1)
   – DIMM Slots (4)
   – Battery (1)
   – Canister Fans (3)
   – Power Supply PSU (1)
   – PCIe adapters (0-2)
   – PCIe riser cards (2)
   – PCIe adapter blanking plates (0-2)

Note: The number of PCIe adapters is configurable at product ordering time and can be added or removed by a sales MES.

Figure 19 shows the rear view of the IBM FlashSystem 5200 control enclosure. You can see the two canisters side by side, the interface cards, power supply units, and the various USB and Ethernet ports. All components are concurrently maintainable, except for the passive midplanes. All external connections are from the rear of the system.
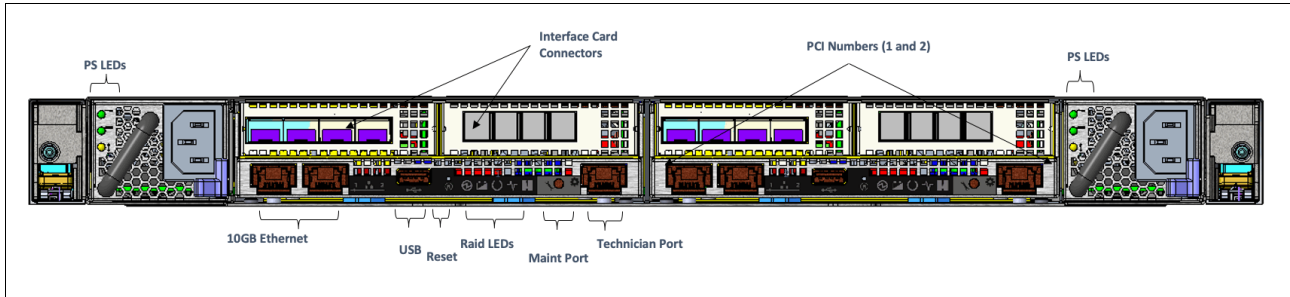
Figure 19   Rear view of IBM FlashSystem 5200 control enclosure

Figure 20 shows a more detailed view of the rear of a canister.
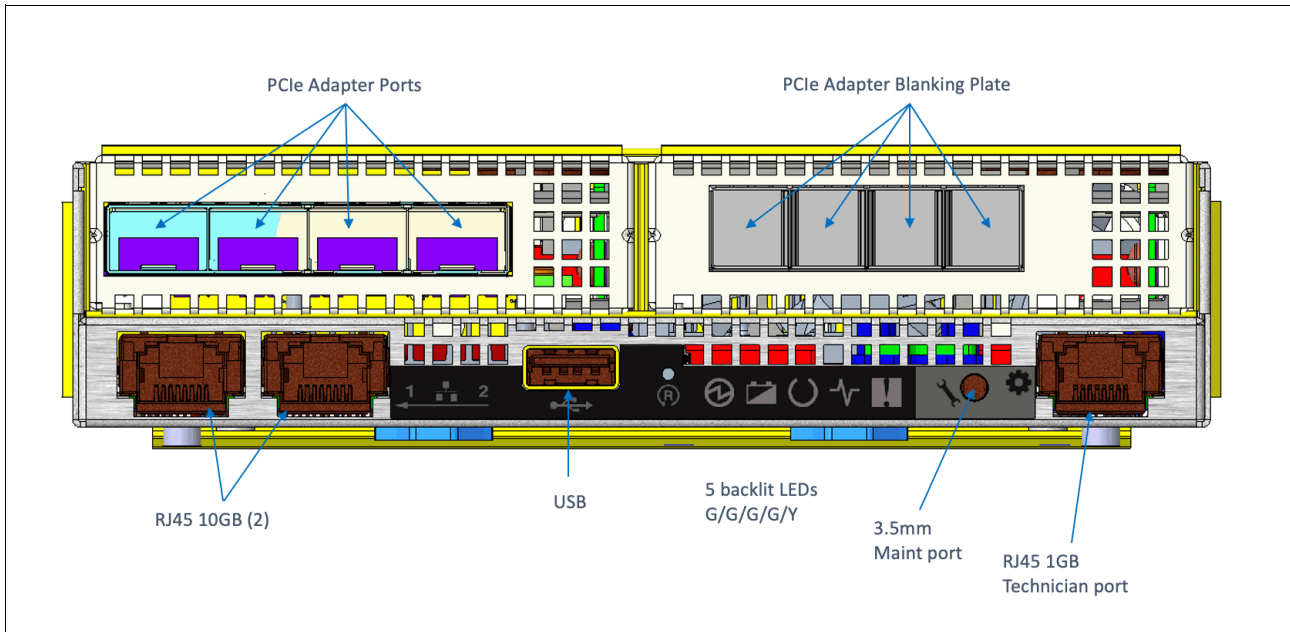
Figure 20   IBM FlashSystem 5200 canister rear view

In Figure 20, you can see the various connections ports (RJ45 and USB) and the PCIe adapters. The PCIe adapter that is shown on the left is populated with a four-port card. The adapter that is on the right side is not present and a blanking plate assembly is in place to ensure and maintain the correct air flow for cooling, through the canister.

IBM FlashSystem 5200 NVMe drive options

The IBM FlashSystem 5200 control enclosure supports up to 12 NVMe 2.5-inch drives, which can be the IBM FlashCore Module NVMe type drives or the industry-standard NVMe drives.

The following 2.5-inch (SFF) IBM FlashCore Module NVMe types are supported in IBM FlashSystem 5200 control enclosures:

► 4.8 TB 2.5-inch NVMe FlashCore Module

► 9.6 TB 2.5-inch NVMe FlashCore Module

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► 19.2 TB 2.5-inch NVMe FlashCore Module

► 38.4 TB 2.5-inch NVMe FlashCore Module

Distributed RAID 6 (recommended) and Distributed RAID 5 are supported.

The following 2.5-inch (SFF) NVMe industry-standard flash drives are supported in IBM FlashSystem 5200 control enclosures:

► 800 GB 2.5-inch
► 1.92 TB 2.5-inch
► 3.84 TB 2.5-inch
► 7.68 TB 2.5-inch
► 15.36 TB 2.5-inch

Traditional RAID 10, Distributed RAID 6 and Distributed RAID 5 are supported. It is recommended that you use Traditional RAID 10 or Distributed RAID 6.

The drive modules in the IBM FlashSystem 5200 control enclosure are required to be plugged in a specific order (see Figure 21). The top row of drives is labeled slot 1 - 6; the bottom row of drives is labeled as slot 7 - 12.

The plug rules for populating drives follow the numbering of the slots, as shown in Figure 21.
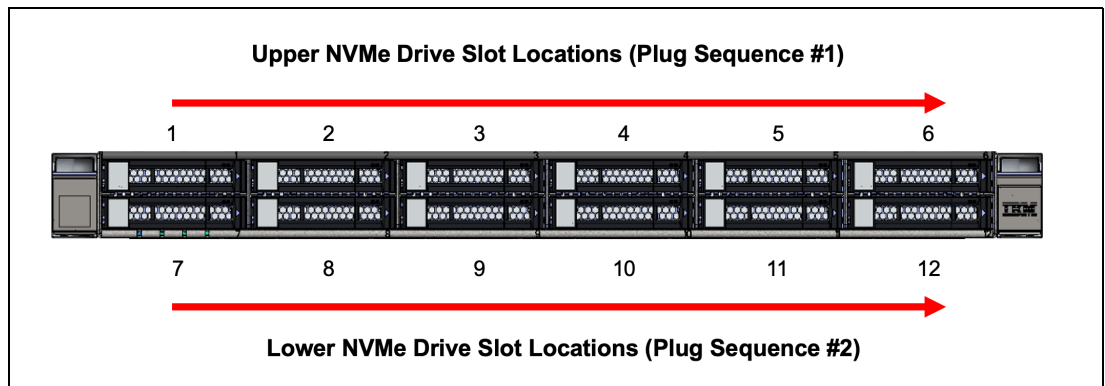
Figure 21   NVMe drive slot locations and plugging rules

All slots must be filled regardless of the number of drive modules. If a slot does not have a drive module installed, a filler must be used to ensure correct air flow through the enclosure.

Figure 22 shows the first four NVMe drives plugged and eight fillers installed.
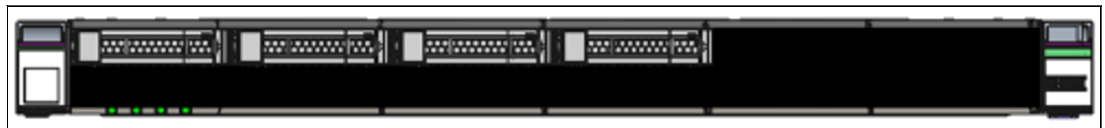
Figure 22   IBM FlashSystem 5200 NVMe drive slots with four drives populated and eight fillers

Figure 23 shows the first eight NVMe drives plugged and four fillers installed.

Figure 23   IBM FlashSystem 5200 NVMe drive slots supported by eight drives populated and four fillers

It also supports up to 12 NVMe SCM Drives in following capacities:

- – 375 GB NVMe
- – 750 GB NVMe
- – 800 GB NVMe
- – 1.6 TB NVMe
- – 3.2 TB NVMe

> **Note:** SCM drives feature a special plugging sequence. They are plugged in *reverse* sequence in drive slots 12 - 1. For more information, see "Storage Class Memory" on page 14.

► Distributed RAID 1 (recommended), 5, 6. TRAID 1 or 10 supported with fewer than four drives can be used but are not recommended because they can cause performance issues. Consider the following points:

- – 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 the same type and capacity within the same DRAID 6 array.

► Each IBM flash core module contains IBM enhanced flash chips, FPGA chips, an IBM PowerPC® processor, and DRAM devices that are connected to the flash controllers and processor.

► Cache options from 64 GB (32 GB per canister) to 512 GB (256 GB per canister) per control enclosure.

► Four 10 Gb Ethernet ports standard for iSCSI connectivity.

► 32 Gb and 16 Gb FC, 25 Gb Ethernet, and 10 Gb Ethernet ports are available for FC and iSCSI connectivity.

► 12 Gb SAS ports for Host Attachment and also expansion enclosure attachments are available.

The IBM FlashSystem 5200 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 come configured in NPIV mode, so 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 also is supported, although host software support for this function can vary.

The IBM FlashSystem 5200 control enclosure also includes the following expansion features:

► Capability for adding into clustered systems with up to three more IBM FlashSystem 5200 control enclosures.

► Up to 20 SAS attached expansion enclosures are supported per IBM FlashSystem 5200 controller pair, which provides up to 240 SSDs or HDDs with expansion model 12G.

► Up to 20 SAS attached expansion enclosures are supported per IBM FlashSystem 5200 controller pair, which provides up to 480 SSDs or HDDs with expansion model 24G.

► Up to eight LFF HD 92G expansion controllers are supported per IBM FlashSystem 5200 control enclosure pair, which provides up to 736 SSD or HDDs drives.

For more information about mixing expansion enclosures and the maximum configurations that are allowed, see V8.4.0.x Configuration Limits and Restrictions for IBM FlashSystem 5x00.

IBM FlashSystem 5200 utility model UH6

IBM FlashSystem 5200 utility models UH6 provide a variable capacity storage offering. These models also 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 the 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, where billing is based on provisioned space only. 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 must 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 5200 utility model with 12 9.6 TB NVMe drives for a total system capacity of 115 TB. The base subscription for such a system is 40.25 TB. No extra billing occurs during the months where the average daily usage is less than 40.25 TB.

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 (see Table 1), rounding to the nearest terabyte.

Table 1   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 2 lists the feature codes that are associated with the UH6 utility model billing.

Table 2   5200 UH6 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 total of 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 be used only as much as is necessary during any month. Usage can increase or decrease, and is billed.

Provisioned capacity is considered capacity that is reserved by the system. In thick-provisioned environments, this capacity is the capacity that is allocated to a host, whether it has data that is written. For thin-provisioned environments, the data that is written is used because of the different ways in which thick- and thin-provisioning use flash drive space.

Figure 24 shows a summary of the IBM FlashSystem 5200 machine types and models.

Machine Type Model	4662-6H2	4662-UH6
Mktg Name	FlashSystem 5200	
Warranty	HW parts only, 1 Year; 9x5 Next Business Day (NBD)	
Install	Customer Set Up (CSU): SSR Install available through priced service offerings	
Software Support & Services	Optional priced service offerings	
Expansion Enclosures	12G, 24G and 92G	
Misc	NVMe FCM , SCM and Industry Standard drives in control enclosures Flash SSD and HDD drives in expansion enclosures	

Figure 24   IBM FlashSystem 5200 machine type and models

IBM FlashSystem 5200 expansion enclosures

IBM FlashSystem 5200 expansion enclosures are 2U or 5U rack-mounted units. The expansion enclosures are offered in the following models with various drive features:

► Model 12 G: Supports up to 12 LFF 3.5-inch drives that can be formatted as RAID 5 or DRAID 6. It supports the following HDD types:

  – 900 GB 10K 3.5-inch
  – 1.2 TB 10K 3.5-inch
  – 1.8 TB 10K 3.5-inch
  – 2.4 TB 10K 3.5-inch
  – 4 TB 7.2K 3.5-inch NL
  – 6 TB 7.2K 3.5-inch NL
  – 8 TB 7.2K 3.5-inch NL
  – 10 TB 7.2K 3.5-inch NL
  – 12 TB 7.2K 3.5-inch NL
  – 14 TB 7.2K 3.5-inch NL
  – 16 TB 7.2K 3.5-inch NL
  – 18 TB 7.2K 3.5-inch NL

- ► Model 24G: Supports up to 24 SFF 2.5-inch drives that can be formatted as RAID 5 or DRAID 6. It supports the following drive types:
  - 900 GB 10K 3.5-inch HDD
  - 1.2 TB 10K 3.5-inch HDD
  - 1.8 TB 10K 3.5-inch HDD
  - 2.4 TB 10K 3.5-inch HDD
  - 2 TB 7.2K 3.5-inch NL HDD
  - 800 GB 3DWPD 2.5-inch Flash Drive
  - 1.92 TB 2.5-inch Flash Drive
  - 3.84 TB 2.5-inch Flash Drive
  - 7.68 TB 2.5-inch Flash Drive
  - 15.36 TB 2.5-inch Flash Drive
  - 30.72 TB 2.5-inch Flash Drive

- ► Model 92 G: Supports up to 92 LFF 2.5-inch HD Drives in a 3.5-inch carrier, and can be formatted as RAID 5 or DRAID 6. It supports the following drive types:
  - 1.2 TB 10K 3.5-inch HDD
  - 1.8 TB 10K 3.5-inch HDD
  - 2.4 TB 10K 3.5-Inch HDD
  - 6 TB 7.2K 3.5-inch NL HDD
  - 8 TB 7.2K 3.5-inch NL HDD
  - 10 TB 7.2K 3.5-inch NL HDD
  - 12 TB 7.2K 3.5-inch NL HDD
  - 14 TB 7.2K 3.5-inch NL HDD
  - 16 TB 7.2K 3.5-inch NL HDD
  - 18 TB 7.2K 3.5-inch NL HDD
  - 1.92 TB 3.5-inch Flash Drive
  - 3.84 TB 3.5-inch Flash Drive
  - 7.68 TB 3.5-inch Flash Drive
  - 15.36 TB 3.5-inch Flash Drive
  - 30.72 TB 3.5-inch Flash Drive

Multiple expansion enclosures are supported per IBM FlashSystem 5200 control enclosure, which provides up to 240 drives with expansion enclosure model 12 G, 480 drives with expansion enclosure model 24 G, and up to 736 drives with expansion enclosure model 92 G.

On each SAS chain, the system can support up to a SAS chain weight of 10:

- ► Each 4662-92G expansion enclosure adds a value of 2.5 to the SAS chain weight.

- ► Each 4662-12G or 4662-24G expansion enclosure adds a value of 1 to the SAS chain weight.

For example, each of the following expansion enclosure configurations has a total SAS weight of 10:

- ► Four 4662-92G expansion enclosures per SAS chain.

- ► Two 4662-92G expansion enclosures and five 4662-12G or 24G expansion enclosures per SAS chain.

Figure 25 shows the front view of the IBM FlashSystem 5200 expansion enclosure model 12G.

Figure 25   Front view of the IBM FlashSystem 5200 SFF expansion enclosure model 12G

The 12G model of IBM FlashSystem 5200 LFF expansion enclosure includes the following features:

► Up to 12 3.5-inch flash SSDs or HDDs
► Two expansion canisters
► 12 Gb SAS ports for attachment to the IBM FlashSystem 5200 control enclosures
► 2U 19-inch rack-mount enclosure with AC power supplies

Figure 26 shows the front view of the IBM FlashSystem 5200 expansion enclosure model 24G.

Figure 26   Front view of the IBM FlashSystem 5200 SFF expansion enclosure model 24G

The 24G model of IBM FlashSystem 5200 SFF expansion enclosure includes the following features:

► Up to 24 2.5-inch flash SSDs or HDDs
► Two expansion canisters
► 12 Gb SAS ports for attachment to the IBM FlashSystem 5200 control enclosures
► 2U 19-inch rack-mount enclosure with AC power supplies

Figure 27 shows the rear view of IBM FlashSystem 5200 LFF expansion enclosure model 12G and IBM FlashSystem 5200 SFF expansion enclosure model 24G.

Figure 27   Rear view of IBM FlashSystem 5200 expansion enclosure models 12G and 24G

IBM FlashSystem 5200 LFF expansion enclosure model 92G delivers the following features:

► Up to 92 drives that are top-loaded into drive slots of the expansion enclosure.

► 5U 19-inch rack-mount enclosure with slide rail and cable management assembly.

► High-performance SSD support, which is available in 1.92 TB, 3.84 TB, 7.66 TB, and 15.36 TB capacity versions.

► Redundant 200 - 240 V AC power supplies (new PDU power cord required).

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Figure 28 shows the front view of IBM FlashSystem 5200 LFF model 92G expansion enclosure.
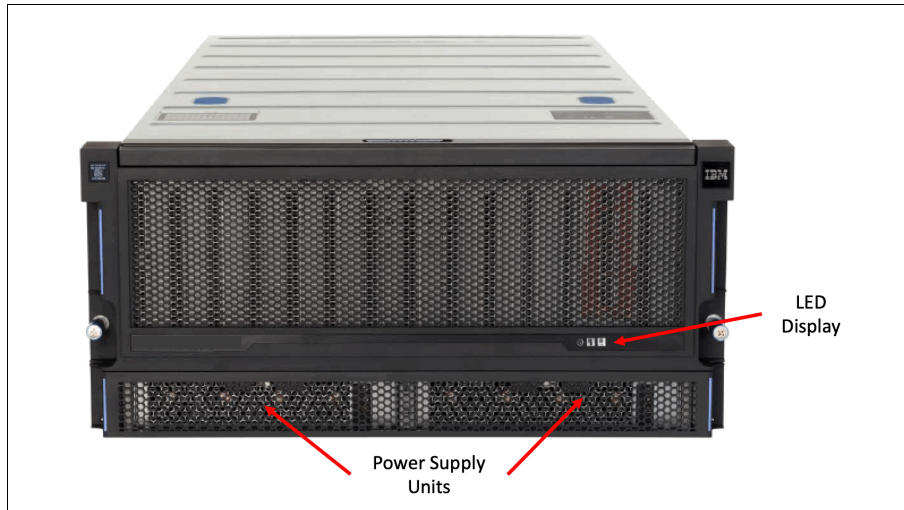
Figure 28   Front view of IBM FlashSystem 5200 LFF model 92G expansion enclosure

Figure 29 shows the rear view of IBM FlashSystem 5200 LFF model 92G expansion enclosure.

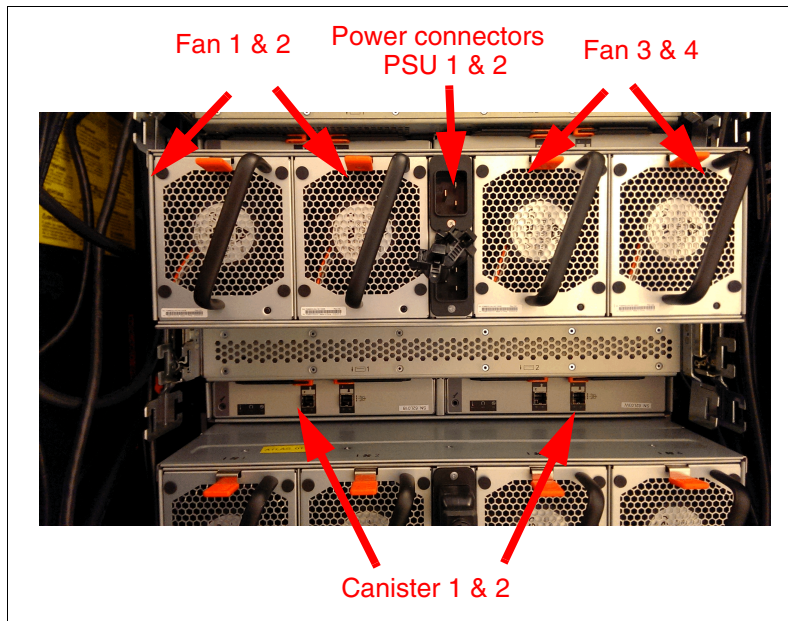*Figure 29   Rear view of IBM FlashSystem 5200 LFF model 92G expansion enclosure*

Scalability and performance

The IBM FlashSystem 5200 system includes the following scalability and performance features:

► Up to 403 TB usable and 806 TB effective flash capacity in only 1U with 2:1 compression.

► Up to 1.62 PB usable and 8.1 PB maximum flash capacity in only 4U with 5:1 compression.

► Extra scalability through expansion enclosures models 12G, 24G, and 92G and increased raw capacity of up to a maximum of 32 PB.

► The IBM FlashSystem 5200 system can deliver up to 1.5 million IOPS, with latency down to 70μs and bandwidth up to 21GBps from a single system.

► A clustered IBM FlashSystem 5200 system can scale linearly and delivers 6 million IOPS and 84 GBps on a fully configured 4x IBM FlashSystem 5200 cluster.

Advanced functions

The IBM FlashSystem 5200 system provides the following advanced functions:

► HyperSwap
► NVMe over Fabrics (NVMe-oF)
► IP quorum base support
► Data reduction tools
► N_Port ID Virtualization support
► VMware integration
► RAID types
► External Virtualization
► Manageability and security

These advanced functions are described next.

HyperSwap

The IBM HyperSwap function is a high availability feature that provides dual-site access to a volume and is available with IBM FlashSystem 5200. The configuration tolerates combinations of I/O groups and site failures, and uses change volumes to maintain a *golden image* during automatic resynchronization.

The HyperSwap function uses a HyperSwap topology to spread the I/O groups of the clustered system across two sites. It also requires a third site to host a quorum device or IP quorum application that provides an automatic tie-break if a link fails between the two main sites.

HyperSwap features the following characteristics:

► Data is stored on two sites in parallel.

► The maximum distance between sites is 300 km (186.4 miles).

► Two independent copies of data are maintained (four if you use another volume mirroring to two pools in each site).

► HyperSwap uses a standard host multipathing driver.

► Cache data is retained if only one site is online.

► Automatically synchronizes and resynchronizes copies.

► Automatic host-to-storage-system path optimization, based on the host site (requires Asymmetric Logical Unit Access [ALUA] and Target Port Groups Support [TPGS] support from the multipathing driver).

► Consistent state data is retained during resynchronization for DR.

► The maximum number of highly available volumes is 2000.

► A HyperSwap topology system can be configured through site allocation and topology change command-line (CLI) commands. The management GUI configures a HyperSwap topology with the Modify System Topology wizard, which guides you through all the steps easily.

Figure 30 shows how the HyperSwap function works between two FlashSystem 5200 systems.
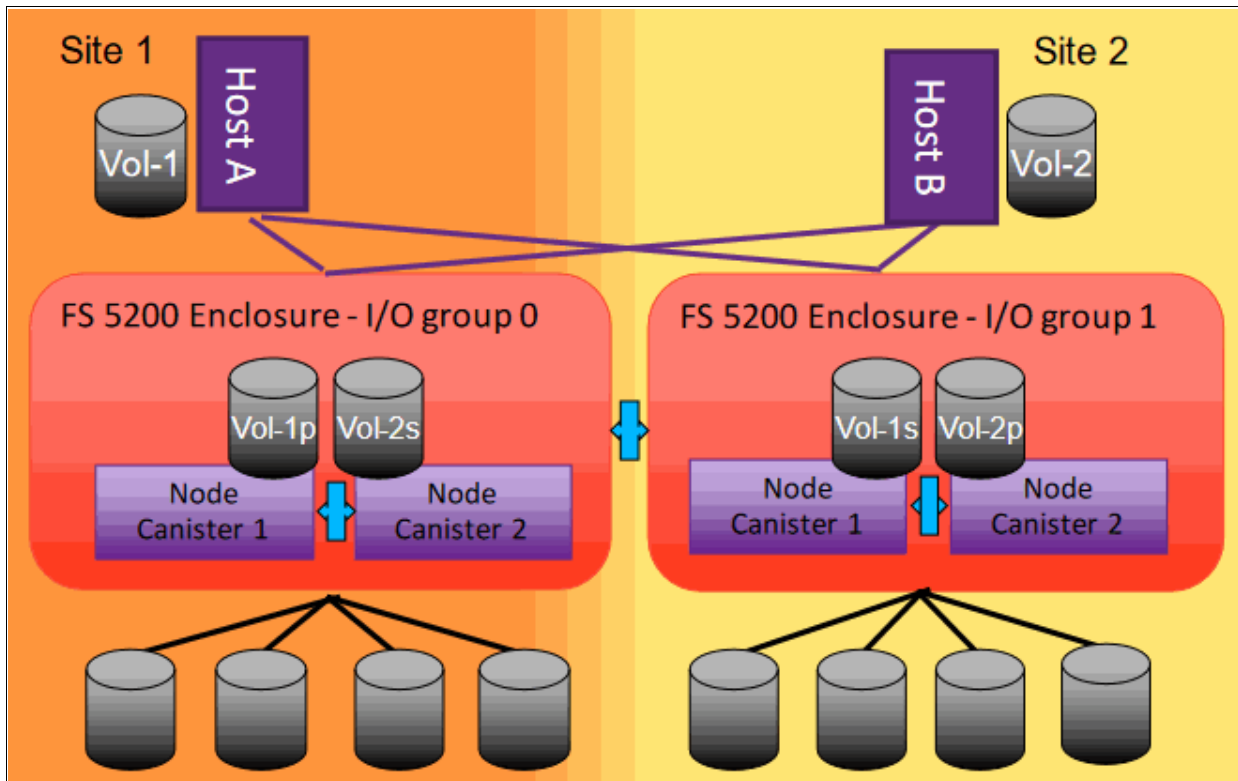
Figure 30   HyperSwap function

Each primary volume (P) has a secondary volume (S) on the opposite I/O group. The secondary volumes are not mapped to the hosts. The dual-write to the secondary volumes is handled by the IBM FlashSystem 5200 HyperSwap function, and is transparent to the hosts.

Consider the following points:

► The HyperSwap topology uses extra system resources to support a fully independent cache at each site. This configuration provides full performance, even if one site is lost.

► Hosts, IBM FlashSystem 5200 control enclosures, and their storage expansions are in one of two failure domains or sites.

► Volumes are visible as a single object across both sites (I/O groups).

A 2-site HyperSwap configuration can be extended to a third site for Disaster Recovery that uses the IBM Spectrum Virtualize 3-Site Orchestrator. IBM Spectrum Virtualize3-Site Orchestrator is a command-line based application that runs on a separate Linux host that configures and manages supported replication configurations on IBM Spectrum Virtualize products. IBM Spectrum Virtualize 3-Site Orchestrator coordinates replication of data for disaster recovery and high availability scenarios between systems that are on three geographically dispersed sites.

Non-Volatile Memory Express over Fabrics

The Non-Volatile Memory Express (NVMe) protocol is an open collection of standards and interfaces that fully uses the benefits of non-volatile memory in all types of computing environments, from mobile to data center. It is designed to deliver high bandwidth and low latency storage access. This section describes the NVMe protocol and interface as it relates specifically to flash-based architectures.

The NVMe protocol is an interface specification for communicating with storage devices and it is functionally the same as other protocols, such as Serial ATA (SATA) and SAS. However, the NVMe interface was designed from the ground up for extremely fast storage media, such as flash-based, low-latency non-volatile storage technologies.

NVMe storage devices are typically directly attached to a host system over a PCIe bus and the NVMe controller is contained in the storage device. This configuration alleviates the need for another I/O controller between the CPU and the storage device. It also results in lower latency, throughput scalability, and simpler system designs.

This design is implemented in the IBM FlashSystem 5200 system, with its dual ported PCIe based NVMe drives.

However, the PCIe bus limits the number of NVMe drives that can be attached to a host over the bus to a few tens of devices. Because the maximum length of PCIe cabling is also only a few meters, the flexibility of deploying PCIe NVMe drives outside the host server is severely 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 to support sharing of NVMe storage at a large scale (100s or 1000s of devices) and over distance.

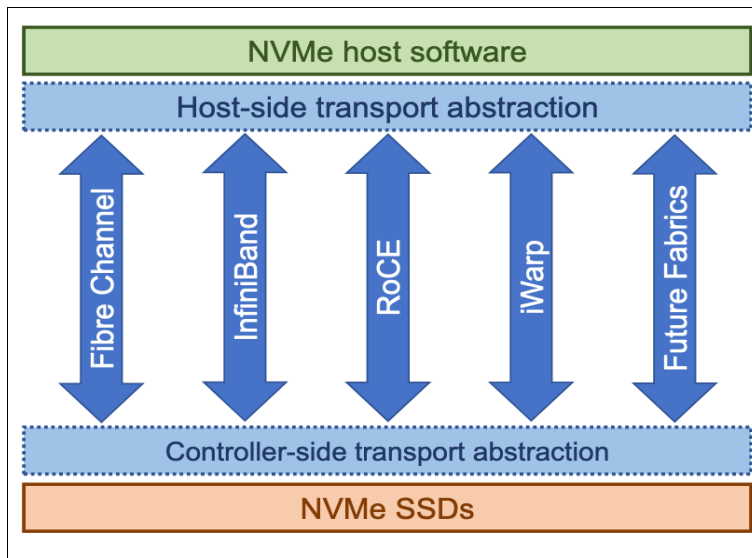Figure 31 shows that the NVMe architecture supports many different network fabric technologies.

Figure 31   NVMe technology support options

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

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NVMe over Fabrics that use FC (FC-NVMe) uses the Fibre Channel Protocol (FCP) as its transport mechanism, which puts the data transfer in control of the target and transfers data direct from host memory, similar to RDMA. 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.

The NVMe over Fabrics interface uses the same model of submission and completion queues as PCIe NVMe. As such, 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.

The IBM FlashSystem 5200 system supports NVMe protocols by way of the various PCIe cards 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.

Note: At the time of this writing, NVMe end-to-end is supported by way of Fibre Channel fabric only.

For more information about NVMeoF protocols and architecture, see *IBM Storage and the NVM Express Revolution*, REDP-5437.

IP quorum base support

For lower implementation operation cost HA solution, you can use IP quorum base support to use IP network-attached hosts as a quorum disk.

In a HyperSwap setup, a quorum disk at the third site is needed by way of FC-storage or IP quorum to cope with tie-breaker situations. 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; however, up to three quorum devices are used to record a backup of system configuration data 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 HyperSwap system is configured without the use of inter-switch links (ISLs).

Data reduction tools

Compression and deduplication are a key part of the IBM FlashSystem 5200 system. IBM Compresstimator and Data Reduction Estimator Tool (DRET) are the key sizing tools to estimate how much capacity savings that a client can expect.

IBM FlashSystem models are supported by the IBM Compresstimator (available as a stand-alone tool and also found in the IBM FlashSystem 5200 GUI) and the stand-alone DRET.

This DRET tool is a host-based application that the user uses to estimate the amount of compression and deduplication on the IBM FlashSystem 5200 system for specific workloads or data set.

Figure 32 shows how to start the Estimate Compression Saving option from the GUI:

1. From the main menu, click **Volumes** → **Volumes** and select one volume.

2. Right-click to see the menu. From this menu, select **Capacity Savings** → **Estimate Compression Saving**.
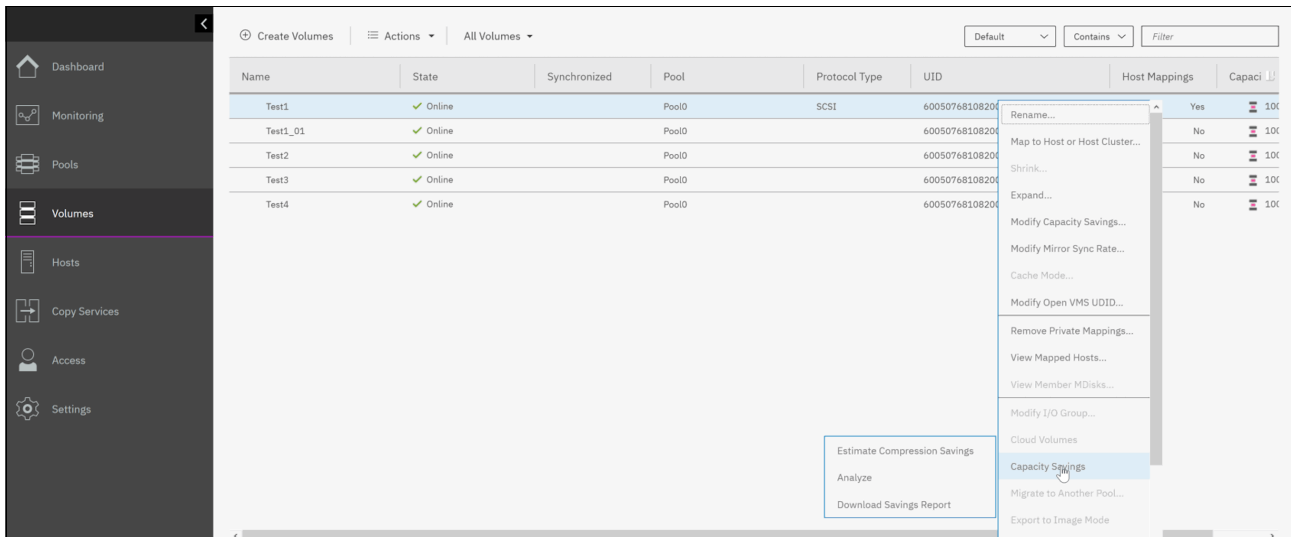
Figure 32   Estimate Compression Saving from the GUI

> **Note:** A DRP has Compresstimator always on.

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

► IBM FlashCore Module - IBM FlashCore Module Compression:

  – Use the FCM option.

  – Do not use the Estimate Compression Saving option in the GUI to calculate the IBM FlashCore Module savings.

► DRP compression:

  – Use the DRP option.

  – Workloads that are on any IBM Spectrum Virtualize platforms can use the Estimate Compression Saving option in the GUI.

► DRP compression and deduplication:

  – IBM Compresstimator and DRET shows the savings for thin-provisioning, compression, and deduplication.

  – IBM Compresstimator and DRET reads entire volumes to identify deduplicated 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

N_Port ID Virtualization (NPIV) is a method for virtualizing a physical Fibre Channel port that is used for host I/O. The use of NPIV increases resilience during firmware updates, scheduled maintenance, or controller issues where the virtual worldwide port names (WWPNs) are transparently moved to the controller that is not being affected. As a result, FC-attached hosts experience a momentary path loss, but the persistence of the WWPNs lessens the multipathing effort on the host considerably during path recovery.

> **Important:** The IBM FlashSystem 5200 system has NPIV enabled by default; therefore, if the customer does not want to use it, they must turn it off before configuring FC ports for host communications.

VMware integration

IBM FlashSystem 5200 includes support for 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.

► VAAI (vStorage API for Array Integration) 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 (Virtual Volumes) 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, and resiliency is 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 Virtual Machine Disk (VMDK) file. This file represented a physical disk to the VM, which was accessed by the operating system that is installed on the VM in the same way that a physical volume on a regular server was presented.

The VMDK file was placed in a file system that is called VMFS, which is hosted by a standard volume (LUN). For example, it might be implemented on an external storage system, such as the IBM FlashSystem 5200 system. With the availability of the vVol technology, each VM disk can now be mapped to an external storage volume (for example, an IBM FlashSystem 5200 volume).

With vVol, the IBM FlashSystem 5200 solution is "aware" of individual VMDK files. Therefore, data operations, such as snapshot and replication, can be performed directly by the IBM FlashSystem 5200 system at the VMDK level rather than the entire VMFS data store.

> **Note:** The integration of vVol with the IBM FlashSystem 5200 system is based on the VASA. IBM support for VASA is delivered as part of IBM Spectrum Connect.

Scaling up and scaling out

The IBM FlashSystem 5200 system's scalable architecture enables flash capacity to be added (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 5200 system features the following flexible scalability configuration options:

► Base configuration
► Scale up: Add capacity
► Scale out: Add control enclosures and capacity

Each IBM FlashSystem 5200 system has two canisters (sometimes also known as *nodes* or *controllers*). Each canister contains the CPUs, cache memory, PCIe cards, and other hardware to communicate to the NVMe drives and connected hosts systems. These two canisters are housed in a chassis that is known as a *control enclosure*.

A maximum of four control enclosures can be connected to form a cluster.

Table 3 lists the values of the CPUs, cache memory, raw NVMe drive size, and PCIe adapters cards for each number of control enclosures.

Table 3   Maximum values for each canister and control enclosure

Element Description	Number of CPUs	Maximum cache memory (GB)	Max NVMe 12 drive capacity (TB)	Inclusive Onboard Ethernet ports	Max PCIe ports (FC / Ethernet)
One Canister	1	256	N/A	2	4 / 2
One Enclosure	2	512	460	4	8 / 4
Two Enclosures	4	1024	920	8	16 / 8
Three Enclosures	6	1536	1380	12	24 / 12
Four Enclosures	8	2048	1840	16	32 / 16

A basic configuration of an IBM FlashSystem 5200 storage platform consists of one IBM FlashSystem 5200 control enclosure. For a balanced increase of performance and scale, up to four IBM FlashSystem 5200 control enclosures can be clustered into a single storage system, which multiplies performance and capacity with each addition.

The clustered IBM FlashSystem 5200 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 Fibre Channel port masking.

In total, an IBM FlashSystem 5200 system can contain a maximum of four IBM FlashSystem 5200 control enclosures. This configuration offers a potential storage capacity of 1.8 PB usable and up to 4.2 PB effective capacity, assuming 2:1 or better hardware compression, when the IBM FlashCore Modules type drives are used.

With software-based data reduction, you can scale to 9 PB effective, assuming 5:1 data reduction that uses compression and deduplication.

The IBM FlashSystem 5200 system is expandable up to 32 PB by using SAS drives in expansion enclosures.

Maximum capacity configurations

Table 4 lists the maximum raw capacity, usable capacity, and maximum effective capacity for scalable configurations that are built on the IBM FlashSystem 5200 control enclosures.

Table 4   IBM FlashSystem 5200 maximum usable and effective capacity within the controller.

Number of control enclosures	Maximum usable capacity by using 12 drives (terabytes)	Maximum effective capacity (terabytes) with inline IBM FlashCore Modules Drive compression @ 2.3:1 ratio	Maximum effective capacity (terabytes) with software data reduction @ 5:1 ratio
One control enclosure	460	1058	2300
Two control enclosures	920	2116	4600
Three control enclosures	1380	3174	6900
Four control enclosures	1840	4232	9200

Consider the following points:

► IBM FlashCore Module NVMe types drives:

  – Six drive minimum
  – DRAID 6 (recommended) and DRAID 5 (supported)
  – IBM FlashCore Modules in the same RAID array must have the same capacity

► Industry-standard NVMe drives:

  – Two drive minimum (varies by RAID type)
  – Traditional RAID 10 and DRAID 6 (recommended) and DRAID 5 (supported)
  – Industry-standard NVMe drives in the same RAID array must have the same capacity

► SCM:

  – Two drive minimum with up to 12 drives of the same type and capacity
  – Distributed RAID 6, 5 or 1, or TRAID 1 or 10 with fewer than four drives

Note: IBM FlashCore Module inline compression is hardware-based and operates at line speed, which does not affect performance.

Expansion enclosures

The IBM FlashSystem 5200 system supports the addition of storage expansion enclosures.

> **Note:** To support SAS-attached expansion enclosures, a 2-port 12 Gbps SAS adapter (slot 2 only) is required to be installed in the control enclosure of the IBM FlashSystem 5200 system.

IBM FlashSystem 5200 HD expansion enclosure model 92G supports up to 92 SAS drives in 3.5-inch carriers. With this tiering option, you can have up to eight enclosures per control enclosure with a maximum capacity of 2826 TB each.

The following 3.5-inch SAS drives are supported in the 92G expansion enclosures:

- ► 1.92 TB, 3.84 TB, 7.68 TB, 15.36 TB, and 30.72 TB flash drive
- ► 1.2 TB, 1.8 TB, and 2.4 TB 10,000 rpm
- ► 6 TB, 8 TB, 10 TB, 12 TB, 14 TB, 16 TB, and 18 TB 7,200 rpm

IBM FlashSystem 5200 SFF expansion enclosure model 24G also offers tiering options. Each SFF expansion enclosure supports up to 24 2.5-inch SAS drives.

The following 2.5-inch SAS drives are supported in the 24G expansion enclosures:

- ► 800 GB, 1.92 TB, 3.84 TB, 7.68 TB, 15.36 TB, and 30.72 TB flash drive
- ► 900 GB, 1.2 TB, 1.8 TB, and 2.4 TB 10,000 rpm
- ► 2 TB 7,200 rpm

Up to 20 expansion enclosures are supported per IBM FlashSystem 5200 control enclosure, which provides up to 480 drives with up to 14.7 PB of SAS SSD capacity.

IBM FlashSystem 5200 SFF expansion enclosure model 12G supports up to 12 3.5-inch SAS drives.

Up to 20 expansion enclosures are supported per IBM FlashSystem 5200 control enclosure, which provides up to 240 drives with up to 4.3 PB of SAS capacity.

The following 3.5-inch SAS drives are supported in the 12G expansion enclosures:

- ► 900 GB, 1.2 TB, 1.8 TB, and 2.4 TB 10,000 rpm
- ► 4 TB, 6 TB, 8 TB, 10 TB, 12 TB, 14 TB, 16 TB, and 18 TB 7,200 rpm

Expansion enclosures can be intermixed within a IBM FlashSystem 5200 system. IBM FlashSystem 5200 systems scale up to 748 drives with the attachment of IBM FlashSystem 5200 expansion enclosures. A IBM FlashSystem 5200 clustered system can contain up to four IBM FlashSystem 5200 systems and up to 2,992 drives.

When attaching expansion enclosures to the control enclosure, you are not limited by the type of the enclosure. The only limitation for each of the two SAS chain is its chain weight. Each type of enclosure has its own chain weight:

- ► Enclosures 12G and 24G have a chain weight of 1.
- ► Enclosure 92G has a chain weight of 2.5.

The maximum chain weight is 10.

For example, you can combine seven 24G and one 92G expansions (7x1 + 1x2.5 = 9.5 chain weight), or two 92G enclosures, one 12G, and four 24G (2x2.5 + 1x1 + 4x1 = 10 chain weight).

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

RAID types

The IBM FlashSystem 5200 system supports the following main distributed DRAID types:

► IBM FlashCore Modules:

  – Six drive minimum with DRAID 6 is recommended.

  – Smaller member drive array configurations are supported by DRAID 1 with restrictions.

  – IBM FlashCore Modules in the same RAID array must be of the same capacity.

► Industry standard NVMe drives:

  – Two drive minimum supported.
  – DRAID 1 recommended with 2 - 6 member drives, with restrictions.
  – DRAID 6 recommended with six and more member drives.
  – DRAID 5 supported by four- or five-member drive arrays only.
  – Industry-standard NVMe drives in the same RAID array must be of the same capacity.

► SCM NVMe drives:

  – Two drive minimum with up to 12 drives.

  – DRAID 1 is recommended with restrictions, and DRAID 5 supported by four- or five-member drive arrays only.

  – Start in slot 24 - 1 in control enclosure.

  – SCM NVMe drives in the same RAID array must be of the same capacity.

Note: SCM NVMe drive support of up to 12 drives is available on the IBM FlashSystem range with Spectrum Virtualize v8.4.

► IBM FlashSystem 5200 expansion enclosure:

  – SAS SSD flash drives: DRAID 6 (recommended), DRAID 1(supported by restrictions), and DRAID 5 (supported by 4- and 5-member drive arrays only).

  – SAS HDD drives: DRAID 6 (recommended), DRAID 1(supported by restrictions) and DRAID 5 (supported only with 4 and 5 member drive arrays).

The extra SAS attached expansion enclosures can be configured with various RAID options. DRAID 6 is preferred for expansion enclosures because of the drive sizes that are used.

Supported array types and RAID levels summary

IBM FlashSystem 5200 systems support IBM FlashCore Module NVMe drives, industry-standard NVMe drives, and SAS drives that are within expansion enclosures. The type and level of arrays varies, depending on the type of drives in the IBM FlashSystem.

The IBM FlashSystem 5200 system does *not* support mixing SAS drives in an array with NVMe drives or mixing IBM FlashCore Modules in an array with industry-standard NVMe drives.

Note: DRAID6 is recommended for all types of drives where applicable, except for SCM drives. Some of the RAID type arrays can be created by using only the CLI, not the GUI.

For more information about the types of supported RAID configurations and restrictions, see Array configuration guidelines for storage systems.

External Virtualization

The IBM FlashSystem 5200 system offers external virtualization technology that helps you manage other IBM or third-party storage arrays with thin-provisioning, space-efficient copies, and DR tools, such as data replication. External virtualization also makes the migration of data from one storage device to another easier.

You can use the IBM FlashSystem 5200 system to manage the capacity of other disk systems with external storage virtualization. When the IBM FlashSystem 5200 system virtualizes a storage system, its capacity becomes part of the IBM FlashSystem 5200 system and is managed in the same manner as the capacity on internal flash modules within the IBM FlashSystem 5200 system. Capacity in external storage systems inherits all the rich functions and ease of use of the IBM FlashSystem 5200 system.

You can use the IBM FlashSystem 5200 system to preserve your investments in storage, centralize management, and make storage migrations easier with storage virtualization, and Easy Tier. The IBM FlashSystem 5200 system provides non-disruptive operations because of storage virtualization.

Virtualization also helps insulate applications from changes that are made to the physical storage infrastructure. When you add storage capacity or a new tier of storage, for example, the changes are transparent to applications; therefore, downtime is minimal.

Any externally virtualized storage needs extra licenses to be purchased and are charged on a capacity basis of the storage that is added.

Manageability and security

The IBM FlashSystem 5200 system offers the following manageability and security features:

► Advanced security for data at rest with hardware-accelerated AES-XTS 256 encryption.

► A GUI to manage the IBM FlashSystem 5200 system and its expansion enclosures. The GUI is available in any supported browser. Included in the GUI is the CLI, which supports a collection of commands that you can use to manage the IBM FlashSystem 5200 system.

► Representational State Transfer (REST) application programming interface (API)

The IBM FlashSystem 5200 system supports the 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.

► RSA provides secure connection for IBM Remote Support, which can perform remote troubleshooting and code load, and obtain diagnostic logs.

► Email alerts.

► SNMP alerts.

► Syslog redirect to send system log messages to another host.

> **Note:** At the time of this writing, the IBM FlashCore Modules in the IBM FlashSystem 5200 system are undergoing a FIPS validation process.

Reliability, availability, and serviceability

The IBM FlashSystem 5200 system delivers the following enterprise-class reliability features:

- ► Concurrent code load enables customer applications to remain online during firmware upgrades to all components, including the flash drives.

- ► Redundant hot-swappable components

  The IBM FlashSystem 5200 control enclosure has two clustered, hot-swappable node canisters that contain hot-swappable fan modules, memory DIMMs, batteries, Trusted Platform Module (TPM), and PCIe adapters. The enclosure also houses two AC power supplies that are N+1 redundant and hot-swappable.

  If an IBM FlashCore Module failure occurs, critical customer applications can remain online while the defective module is replaced because a spare module is available. IBM Distributed RAID (D-RAID) is a patented IBM technology that provides an intra-module RAID stripe within each flash module. Variable Stripe RAID technology helps reduce downtime, and maintains performance and capacity during partial or full flash chip failures.

- ► IBM FlashSystem 5200 control enclosures support concurrent code load. Onsite and remote code upgrades are supported.

IBM FlashSystem 5200 data encryption is based on the AES algorithm, which uses a 256-bit symmetric encryption key in XTS mode, 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 non-volatile form.

Encryption on the IBM FlashSystem 5200 system requires the following feature codes:

- ► Encryption Enablement (#ALE0)

  This feature enables the encryption function. A single instance of this feature enables the function on the entire IBM FlashSystem 5200 system (IBM FlashSystem 5200 control enclosure and all attached IBM FlashSystem 5200 expansion enclosures) and on externally virtualized storage subsystems.

  USB flash drives (#ALEC) or IBM Security Key Lifecycle Manager are required for encryption key management.

- ► Encryption USB Flash Drives (Four Pack) Optional (#ALEC)

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

  Unless IBM Security Key Lifecycle Manager is used for encryption keys management, a total of three USB flash drives are required per IBM FlashSystem 5200 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 5200 system, which results in a shipment of four USB flash drives.

Encryption can be applied to virtualized storage arrays, even if the virtualized array does not have encryption capabilities. In this scenario, the encryption is done by using IBM Spectrum Virtualize software. Encrypted volumes are transparent to applications, which eases implementation and operation. In addition, the IBM FlashSystem 5200 system has the following functions:

- ► 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 also non-concurrent and destroys any data on the array.

- ► Encryption Rekey: Changing the encryption key on a previously initialized system is concurrent and can be done while array is in use.

These operations require that you purchase Encryption Enablement Pack (#ALE0).

Self-encrypting drives

The IBM FlashCore Modules and NVMe Flash SSD type drives, including the SCMs, in the IBM FlashSystem 5200 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 a SED by using a single CLI command to replace the DEK or revert the entire device to factory settings.

- ► Supports a security feature that is called *auto-lock*, which protects against someone plugging 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 drive is taken from a system with encryption and placed in another system, the drive data is not readable. The system posts an error message saying 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

For control enclosures that support NVMe architecture, NVMe-attached drives are self-encrypting and self-compressing. With SEDs that use NVMe architecture, data encryption is completed in the drive. Data encryption keys remain on the drive without being stored in system memory.

In addition, the system supports automatic locks of encrypted drives when the system or drive is powered down. When the drive or system restarts, a master key is required to unlock the drive and continue I/O operations.

Because the encryption of data is done in the electrical circuit of the drive, it is not affected by any potential performance issues from software encryption. If SEDs are encrypting the data, why do you need to enable system encryption in IBM Spectrum Virtualize?

The answer is that you can use SEDs without enabling encryption on the system, but SEDs are unlocked by default at start time (unless configured with extra protection). System level encryption in IBM Spectrum Virtualize allows you to use USB flash drives or IBM Security 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, but SEDs are unlocked by default unless they are configured with extra protection.

- With system encryption in IBM Spectrum Virtualize, you can use USB flash drives or IBM Security 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 Key Lifecycle Manager type 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

Transparent Cloud Tiering (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 free up 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 IBM Cloud, 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 key server) because this key might be needed to retrieve your cloud backup data when performing a T4 recovery or an import.
- The `restore_uid` option should not be used when the backup is imported to a new cluster.
- Importing TCT data is supported only from 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 IBM FlashSystem 5200 TCT at Transparent cloud tiering.

Secure drive erasure process

The IBM FlashSystem 5200 system running IBM Spectrum Virtualize V8.4 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 effectively 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 and HDDs
► NVMe drives (IBM FlashCore Modules and industry standard)
► 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 effectively becomes impossible to access.

Table 5 lists the types of erasure, the methods used, and the time taken.

Table 5   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 the existing 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.

Options and feature codes

This section describes the major options and feature codes that are available for the IBM FlashSystem 5200 control and expansion enclosures.

Memory options

Table 6 lists the memory options by feature code.

Table 6   IBM FlashSystem 5200 memory options

Feature code	Existing memory size per canister (GB)	Memory upgrade (GB)	Total memory per enclosure (GB)	Comments
ALG0	32 GB	N/A	64 GB	Ships two 32 GB DIMMs (DDR4) that are installed with the base system

Feature code	Existing memory size per canister (GB)	Memory upgrade (GB)	Total memory per enclosure (GB)	Comments
ALG1	256 GB	N/A	512 GB	Ships eight 64 GB memory DIMMS (DDR4) that are installed with the base system
ALGC	32 GB	192 GB Cache Upgrade	256 GB	Ships six 32 GB memory DIMMS to add to the system
ALGD	32 GB	512 GB Cache Upgrade	512 GB	Ships eight 64 GB memory DIMMS to replace all existing 32 GB DIMMS

The following cache upgrade feature codes are available:

► (#ALGC): 192 GB Cache upgrade

This feature requires that the base machine is configured with 64 GB (32 GB for each canister) and is upgraded to 256 GB by adding six 32 GB (three per canister) DIMMS to the enclosure.

► (#ALCD): 512 GB Cache upgrade

This feature provides 512 GB of cache (256 GB for each node canister) to replace the existing 32 GB DIMMS with eight (four per canister) 64 GB ones.

Note: Feature Codes ALG0 or ALG1 must be selected in the initial order. ALG1 and ALGD are incompatible.

Host I/O connectivity and expansion enclosure adapters

Four PCIe slots are available for port expansions in the IBM FlashSystem 5200 control enclosure. Each canister has two 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 control enclosure can be configured with two I/O adapter features to provide up to 16 16-Gb FC ports or eight 32 Gb FC, up to 16 10-Gb Ethernet ports, up to 8 25-Gb Ethernet (iSCSI or iSCSI Extensions for RDMA (iSER) capable) ports. The control enclosure also includes four 10 Gb Ethernet ports as standard for iSCSI connectivity and management GUI use, plus two 1 Gb Ethernet maintenance ports for engineering use. A feature code also is available to include the SAS expansion card if the user wants to use optional expansion enclosures of for host-based connections.

Table 7 lists the maximum host port count per building block configuration (1, 2, 3, or 4 control enclosures).

Table 7   Maximum host port count per control enclosure

Number of control enclosures	16 Gb FC	32 Gb FC	On-board iSCSI	10 Gb Ethernet	25 Gb iSCSI	25 Gb iSCSI
One	16	8	4	16	8	8
Two	32	16	8	32	16	16

Number of control enclosures	16 Gb FC	32 Gb FC	On-board iSCSi	10 Gb Ethernet	25 Gb iSCSI	25 Gb iSCSI
Three enclosures	48	24	12	48	24	24
Four	64	32	16	64	32	32

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

Table 8 lists the current features for host and connectivity for the IBM FlashSystem 5200 control enclosure 4662-6H2 and 4662-UH6 machine types.

Table 8   Supported expansion enclosure and interface components MTMs 4662-6H2 and 4662-UH6

Item	Feature code	Description	Ports
16 Gb FC 4 Port Adapter Pair	#ALBJ	This feature provides two I/O adapters. It is used to add 16 Gb FC connectivity.	Each adapter has four 16 Gb FC ports and shortwave SFP transceivers.
32 Gb FC 2 Port Adapter Pair	#ALBK	This feature provides two I/O adapters. It is used to add 32 Gb FC connectivity.	Each adapter has two 32 Gb FC ports and shortwave SFP transceivers.
10 Gb Ethernet Adapter Pair	#ALBL	This feature provides two I/O adapters. It is used to add 10 Gb Ethernet connectivity.	Each adapter has four 10 Gb Ethernet ports and SFP+ transceivers.
25 GbE (RoCE) Adapter Pair	#ALBM	This feature provides two I/O adapters. It is used to add 25 Gb Ethernet connectivity. Supports RoCE V2.	Each adapter has two 25 Gb Ethernet ports and SFP28 transceivers.
25 GbE (iWARP) Adapter Pair	#ALBN	This feature provides two I/O adapters. It is used to add 25 Gb Ethernet connectivity. Supports RDMA with iWARP.	Each adapter has two 25 Gb Ethernet ports and SFP28 transceivers.
12 Gb SAS expansion enclosure Attach Card (Pair)	#ALBQ	This feature provides two 4-port 12 Gb SAS expansion enclosure attachment adapters. This feature is used to attach up to 20 expansion enclosures.	Each adapter only has two active SAS ports per card.
12 Gb SAS Host Adapter Cards (Pair)	#ALBP	This feature provides two 4-port 12 Gb SAS Host attachment adapters.	Two cards with 4 ports and mini-SAS HD connectors for host attachment
16 Gb FC LW SFP Transceivers (Pair)	#ACHU	This feature provides two 16 Gb longwave SFP transceivers for use with 16 Gb FC I/O ports.	#ALBJ is a prerequisite. The maximum allowed is four for each instance of #ALBJ.

Note: For more information, see the *Adapter slot guidelines* at Adapter slot guidelines.

Cables

Table 9 lists the cable feature codes that are available.

Table 9   Cable feature codes and options

Feature code	Description	Comments
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 Gb SAS Cable (mSAS HD)	SAS cable for expansion
ACUB	1.5 m 12 Gb SAS Cable (mSAS HD)	SAS cable for expansion
ACUC	3 m 12 Gb SAS Cable (mSAS HD)	SAS cable for expansion
ACUD	6 m 12 Gb SAS Cable (mSAS HD)	SAS cable for expansion

IBM FlashSystem 5200 control enclosure drive options for models 6H2/UH6

The IBM FlashSystem 5200 control enclosure supports IBM FlashCore Modules, SCMs, industry-standard flash drives, and an intermix of all three.

IBM FlashCore Modules 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 5200 systems also support various industry-standard, self-encrypting NVMe flash drives.

Table 10 lists the available NVMe flash drive feature codes.

Table 10   IBM FlashSystem 5200 control enclosure drive options

Feature code	Description	Comments
AGS5	4.8 TB NVMe FlashCore Module	FCM drive
AGS6	9.6 TB NVMe FlashCore Module	FCM drive
AGS7	19.2 TB NVMe FlashCore Module	FCM drive
AGS8	38.4 TB NVMe FlashCore Module	FCM drive
AGT1	800 GB NVMe Flash Drive	Industry Standard drive
AGT2	1.92 TB NVMe Flash Drive	Industry Standard drive
AGT3	3.84 TB NVMe Flash Drive	Industry Standard drive
AGT4	7.68 TB NVMe Flash Drive	Industry Standard drive
AGT5	15.36 TB NVMe Flash Drive	Industry Standard drive
AGTA	375 GB NVMe SCM Drive	SCM drive
AGTB	750 GB NVMe SCM Drive	SCM drive
AGTE	800 GB NVMe SCM Drive	SCM drive

Feature code	Description	Comments
AGTF	1.6 TB NVMe SCM Drive	SCM drive
AGTG	3.2 TB NVMe SCM Drive	SCM drive

Consider the following points regarding limitations and drives:

► IBM FlashCore Modules:

– Six drive minimum
– DRAID 6 (recommended) or DRAID5 (supported)
– IBM FlashCore Modules in the same RAID array must be of the same capacity

► Industry-standard NVMe drives:

– Two drive minimum (varies by RAID type)
– RAID 10 and DRAID 6 (recommended) and DRAID 5 (supported)
– 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
– Can occupy slots 1-12 in control enclosure (plugged in reverse order slot 12 - 1)
– DRAID 1 preferred, DRAID, 5 and 6 supported
– TRAID 1 and 10 supported but not best practice
– SCM NVMe drives in the same RAID array must be of the same capacity

IBM FlashSystem 5200 expansion enclosure drive options for model 12G

The IBM FlashSystem 5200 expansion enclosure model 12G supports the following drives types and capacities. The model 12G can have a maximum of 12 drives installed.

Table 11 lists the drive matrix for the model 12G.

Table 11   Expansion enclosure model 12G drives type and capacities

Feature code	Description	Comments
AL27	900GB 10K 3.5-Inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL28	1.2 TB 10K 3.5-Inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL29	1.8 TB 10K 3.5-Inch HDD	10K IBM Rational® Portfolio Manager 2.5-inch drive in 3.5-inch carrier
AL2A	2.4 TB 10K 3.5-Inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL39	4 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3A	6 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3B	8 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3C	10 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3D	12 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3E	14 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3F	16 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive
AL3G	18 TB 7.2K 3.5-Inch NL HDD	7200 RPM drive

IBM FlashSystem 5200 expansion enclosure drive options for model 24G

The IBM FlashSystem 5200 expansion enclosure model 24G supports the following drives types and capacities. The model 24G can have a maximum of 24 drives installed.

Table 12 lists the drive matrix for the model 24G.

Table 12   Expansion enclosure model 24G drive types and capacities

Feature code	Description	Comments
AL68	900 GB 10K 2.5-inch HDD	10K RPM drive
AL69	1.2 TB 10K 2.5-inch HDD	10K RPM drive
AL6A	1.8 TB 10K 2.5-inch HDD	10K RPM drive
AL6B	2.4 TB 10K 2.5-inch HDD	10K RPM drive
AL76	2 TB 7.2K 2.5-inch NL HDD	7200 RPM drive
AL8A	800 GB 3DWPD 2.5-inch Flash Drive	
AL80	1.92 TB 2.5-inch Flash Drive	
AL81	3.84 TB 2.5-inch Flash Drive	
AL82	7.68 TB 2.5-inch Flash Drive	
AL83	15.36 TB 2.5-inch Flash Drive	
AL84	30.72T B 2.5-inch Flash Drive	

IBM FlashSystem 5200 expansion enclosure drive options for model 92G

The IBM FlashSystem 5200 expansion enclosure model 92G supports the following drives types and capacities. The model 92G can have a maximum of 92 drives installed.

Table 13 lists the drive matrix for the model 92G.

Table 13   Expansion enclosure model 92G drive types and capacities

Feature code	Description	Comments
AL43	1.2 TB 10K 3.5-inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL44	1.8 TB 10K 3.5-inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL45	2.4 TB 10K 3.5-inch HDD	10K RPM 2.5-inch drive in 3.5-inch carrier
AL47	6 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL48	8 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL49	10 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL4A	12 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL4B	14 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL4C	16 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL4D	18 TB 7.2K 3.5-inch NL HDD	7200 RPM drive
AL4J	1.92 TB 3.5-inch Flash Drive	2.5-inch drive in 3.5-inch carrier

Feature code	Description	Comments
AL4K	3.84 TB 3.5-inch Flash Drive	2.5-inch drive in 3.5-inch carrier
AL4L	7.68 TB 3.5-inch Flash Drive	2.5-inch drive in 3.5-inch carrier
AL4M	15.36 TB 3.5-inch Flash Drive	2.5-inch drive in 3.5-inch carrier
AL4N	30.72 TB 3.5-inch Flash Drive	2.5-inch drive in 3.5-inch carrier

Physical and electrical specifications

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

IBM FlashSystem 5200 control enclosure (4662 models 6H2 and UH6)

The control enclosure features the following specifications:

► Physical specifications:

– Height: 43.5 mm (1.71-inch); 1U Rack Standard

– Width: 446 mm (17.56-inch); 19-inch Rack Standard

– Depth: 816 mm (30.31-inch); from rack mounting flange to power supply handle

– Approximate weight:

• Empty: 10.3 kg (22.7 lb)
• Fully configured: approx. 19.5kg (43 lb) including 4 PCIe cards and 12 drives

► Air temperature:

– Operating: ASHRAE A2: 10° - 35° C (41° - 95° F); 0 - 3050 m (0 - 10,000 ft.). Above 900 m, de-rate maximum air temperature 1° per 300 m.

– Continual operating range 10° - 35° C (50° - 95° F).

– Nonoperating: -40° - 50°C (-40° - 122°F).

► Relative humidity:

– Operating: 8% - 80%, non-condensing (ASHRAE class A2 environment), de-rated by 1°C for each 300 m (984 ft) above 950 m (3,117 ft)

– Non-operating: 8% - 80% noncondensing

– Deliquescent relative humidity (RH): 60%

► Electrical power:

– Voltage range: 200 - 240 V AC

– Frequency: 50 - 60 Hz

– Power:

• High line VAC input 1500 W maximum (200 - 240 V AC, 50/60 Hz; PSU Maximum rating)

• Requires IEC C13 power sockets in PD

• 525 W, typical operation

The maximum power that is required depends on the configuration of the enclosure.

- ► Heat output:
  - – Typical: approximately 1791BTU per hour (525 W)
  - – Maximum configuration: 2883 BTU per hour (845W
  - – Acoustical noise emission: 8.1 bels (idling), 8.1 bels (operating)

IBM FlashSystem 5200 LFF expansion enclosure (4662 model 12G)

The expansion enclosure model 12G has the following specifications:

- ► Physical specifications:
  - – Height: 8.7 cm (3.4 in.); 2U Rack Standard
  - – Width: 44.6 cm (17.56 in.); 19-inch Rack Standard
  - – Depth: 55.6 cm (21.9 in.)
  - – Approximate weight:
    - • Empty: 16.4 kg (36.2 lb)
    - • Fully configured: 26.7 kg (58.9 lb)
- ► Air temperature:
  - – Operating: 5° - 40° C (41° - 104° F); 0 - 3048 m (0 - 10,000 ft). Above 900 m, de-rate maximum air temperature 1°C per 300 m.
  - – Nonoperating: 1° - 50° C (34° F - 122 °F).
  - – Storage: 1° - 60°C (34° - 140°F).
  - – Shipping: -40° - 60°C (-40° - 140°F).
- ► Relative humidity:
  - – Operating: 8% - 80% noncondensing
  - – Nonoperating: 8% - 80% noncondensing
  - – Storage: 5% - 80% noncondensing
  - – Shipping: 5% - 100% condensing, but not precipitating
- ► Electrical power:
  - – Voltage range: 100 - 240 V AC
  - – Frequency: 50 - 60 Hz
  - – Power: 764 W

    Requires IEC C13 power sockets in PDU
  - – Typical: approximately 1791BTU per hour (525 W)
  - – Maximum configuration: 2883 BTU per hour (845W
  - – Acoustical noise emission: 8.1 bels (idling), 8.1 bels (operating)

IBM FlashSystem 5200 SFF expansion enclosure (4662 model 24G)

The expansion enclosure model 24G has the following specifications:

- ► Physical specifications:
  - – Height: 8.75 cm (3.44 in.); 2U Rack Standard
  - – Width: 44.6 cm (17.56 in.); 19-inch Rack Standard
  - – 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° - 40° C (41° - 104° F); 0 - 3048 m (0 - 10,000 ft). Above 900 m, de-rate maximum air temperature 1°C per 300 m.

  - Nonoperating: 1 - 50° C (34° F - 122 °F).

  - Storage: 1° to 60°C (34° - 140°F).

  - Shipping: -40° to 60°C (-40° - 140°F).

► Relative humidity:

  - Operating: 8% - 80% noncondensing
  - Nonoperating: 8% - 80% noncondensing
  - Storage: 5% - 80% noncondensing
  - Shipping: 5% - 100% condensing, but not precipitating

► Electrical power:

  - Voltage range: 100 - 240 V AC

  - Frequency: 50 - 60 Hz

  - Power: 764 W

    Requires IEC C13 power sockets in PDU

  - Heat dissipation (BTU per hour): 2,607

  - Acoustical noise emission: 7.7 bels (idling), 7,7 bels (operating)

IBM FlashSystem 5200 LFF expansion enclosure (4662 model 92G)

The expansion enclosure model 92G has the following specifications:

► Physical specifications:

  - Height: 22.2 cm (8.75 in.); 2U Rack Standard

  - Width: 44.6 cm (17.56 in.); 19-inch Rack Standard

  - 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°-C - 35° C (41° - 95° F) 0 - 3048 m (0 - 10,000 ft). Above 900 m, de-rate maximum air temperature 1°C per 300 m.

  - Nonoperating: 1° - 50° C (34° - 122 °F).

  - Storage: 1° - 60°C (34° - 140°F).

  - Shipping: -40° - 60°C (-40° - 140°F).

► Relative humidity:

  - Operating: 8% - 80% noncondensing
  - Nonoperating: 8% - 80% noncondensing
  - Storage: 5% - 80% noncondensing

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– Shipping: 5% - 100% condensing, but not precipitating

► Electrical power:

 – Voltage range: 200 - 240 V AC

 – Frequency: 47 - 63 Hz

 – Power: 2400 W

 Requires IEC C19 power sockets in PDU

 – 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 5200 functions are provided through IBM Spectrum Virtualize Licensed Machine Code. IBM FlashSystem 5200 requires IBM Spectrum Virtualize software V8.4 or later to operate and it comes preinstalled.

All features are inclusive except for encryption, which is a feature code that is enabled for those countries that allow it, and external virtualization. Any connected storage that is not an IBM FlashSystem 5200 control enclosure or an IBM FlashSystem 5200 expansion enclosure that is attached to the 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 5200 support external storage virtualization. Use of the external virtualization capability is enabled through the acquisition of IBM Spectrum Virtualize Software for SAN Volume Controller (SW PID 5641-VC8 in AAS and SW PID 5725-M19 in IBM Passport Advantage®).

► With the IBM FlashSystem 5200 system, a license exists for the hardware-assisted encryption if it purchased (Encryption Enablement [#ALE0]). This feature code is needed if you want to use USB-Key encryption, IBM Security Key Lifecycle Manager-based encryption, or both on the control enclosure.

► The 5641-VC8 (External Virtualization, FlashCopy, and Remote Mirroring Features) licenses are licensed per enterprise within one country. These licenses are the same licenses as for IBM SAN Volume Controller. Therefore, existing SAN Volume Controller licenses can be used for the IBM FlashSystem 5200 system for these features.

► A storage system that is used only as a quorum device does not need 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 settings on the system.

For more information about IBM Spectrum Virtualize licensing, see Licensed functions.

IBM Spectrum Virtualize External Virtualization Licensing

The IBM FlashSystem 5200 system supports differential, capacity, and key-based licensing. For example, with external virtualization, differential licensing charges different rates for different types of storage. This difference provides cost effective management of capacity across many storage tiers. Licensing for these functions is based on the number of storage capacity units (SCUs) that is 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, such as encryption, require an authorization code and key to be downloaded to the system before the function can be used.

Note: SCUs are needed for only external virtualized storage that does not include the base license.

The SCU is defined in terms of the category of the storage capacity, as listed in Table 14.

Table 14   SCU category definitions

License	Drive class	SCU ratio
SCM	SCM devices	SCU equates to 1.00 TiB usable of Category 1 storage
Flash	All flash devices, other than SCM drives	SCU equates to 1.18 TiB usable of Category 2 storage
Enterprise	10K or 15K RPM drives	SCU equates to 2 TiB usable of Category 3 storage
Nearline	Nearline SATA drives	SCU equates to 4.00 TiB usable of Category 4 storage

Any storage use case that is not listed in Table 14 is classified as Category 1.

Table 15 shows an example of calculating SCUs. The example is a customer who virtualizes external disk arrays with 30 TB SCM drives, 200 TB SSD flash drives, and 2400 TB Nearline capacity.

Table 15   Example of calculating SCUs

Category	Type	Capacity	Rule	Number of SCUs
Category 1	SCM	30	/ 1	30
Category 2	SSD	200	/ 1.18	170
Category 4	Nearline	2400	/ 4	600
Total				**800**

A total of 800 SCUs are required for the example that is shown in Table 15. 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 Spectrum Virtualize Differential Licensing, see Licensed functions.

IBM Global Financing

IBM Global Financing offers competitive financing to credit-qualified customers and IBM Business Partners to assist them in acquiring IT solutions. The offerings include financing for IT acquisition, including hardware, software, and services, from IBM and other manufacturers or vendors. Also offered is commercial financing (revolving lines of credit, term loans, acquisition facilities, and inventory financing credit lines) for IBM Business Partners.

Offerings (for small, medium, and large enterprise customer segments), rates, terms, and availability can vary by country. For more information, contact your local IBM Global Financing organization or see the IBM Global Financing website.

Ordering information

For more information about ordering IBM FlashSystem 5200 expansions, see "Scaling up and scaling out" on page 41.

For more information about ordering hardware features, see "Options and feature codes" on page 49.

For more information about ordering software licenses, see "Software and licensing" on page 58.

Related information

For more information, see the following resources:

► *Introduction and Implementation of Data Reduction Pools and Deduplication*, SG24-8430:

https://www.redbooks.ibm.com/abstracts/sg248430.html

► *Storage and the NVM Express Revolution*, REDP-5437:

https://www.redbooks.ibm.com/abstracts/redp5437.html

► IBM Documentation - IBM FlashSystem 5200:

https://www.ibm.com/docs/en/flashsystem-5x00/8.4.0?topic=v5100v5000e-flashsystem-5200

► IBM FlashSystem 5200 product web page:

https://www.ibm.com/products/flashsystem-5200

► IBM FlashSystem Family Overview 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 FlashWatch FAQ

Guidance for the IBM FlashWatch programs:

https://www.ibm.com/downloads/cas/YVMYPEDE

▶ IBM Spectrum Virtualize FAQ

Information the IBM Spectrum Virtualize products, which covers the IBM FlashSystem family and IBM SAN Volume Controller:

https://www.ibm.com/downloads/cas/2DWAMWRB

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