

IBM SAN Volume Controller Model SV3 Product Guide (For IBM Storage Virtualize 8.6)

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Storage



IBM SAN Volume Controller Model SV3 Product Guide

This IBM® Redpaper Product Guide describes the IBM SAN Volume Controller Model SV3 solution, which is a next-generation IBM SAN Volume Controller.

Built with IBM Storage Virtualize software and part of the IBM Storage family, the IBM SAN Volume Controller is an enterprise-class storage system. It helps organizations achieve better data economics by supporting the large-scale workloads that are critical to success.

Data centers often contain a mix of storage systems. This situation can arise as a result of company mergers or as a deliberate acquisition strategy. Regardless of how they arise, mixed configurations add complexity to the data center. Different systems have different data services, which make it difficult to move data from one to another without updating automation.

Different user interfaces increase the need for training and can make errors more likely. Different approaches to hybrid cloud complicate modernization strategies. Also, many different systems mean more silos of capacity, which can lead to inefficiency.

To help simplify the data center and to help improve flexibility and efficiency in deploying storage, enterprises of all types and sizes use the IBM SAN Volume Controller, which is built with IBM Storage Virtualize software. This software simplifies infrastructure and eliminates differences in management, function, and even hybrid cloud support.

IBM SAN Volume Controller introduces a common approach to storage management, function, replication, and hybrid cloud that is independent of storage type. It is the key to modernizing and revitalizing your storage.

IBM SAN Volume Controller provides a rich set of software-defined storage (SDS) features that are delivered by IBM Storage Virtualize that includes the following examples:

- ▶ Data reduction and deduplication
- ▶ Dynamic tiering
- ▶ Thin-provisioning
- ▶ Snapshots
- ▶ Cloning
- ▶ Replication and data copy services
- ▶ Data at rest
- ▶ Cyber resilience
- ▶ Transparent Cloud Tiering
- ▶ IBM HyperSwap® including three-site replication for high availability (HA)
- ▶ Enhanced Stretch Cluster

Performance and flexibility at the core

IBM SAN Volume Controller is an integrated, modular, highly scalable system. IBM SAN Volume Controller engines are deployed in pairs for high availability. A system contains one to four pairs. In addition, a maximum of four hot spare nodes can be configured to deliver even greater availability for the solution.

IBM SAN Volume Controller systems can be upgraded without disruption with more engines for greater performance. Two engine models are available to suit different needs. Each Model SV3 engine supports double the connectivity and memory of the previous Model SV2 engine and approximately doubles the performance. Each engine also includes dual power supplies, dual batteries, and redundant cooling.

Each Model SV3 engine has two 2.4 GHz Intel Ice Lake CPUs with 24 cores. A maximum of 1.5 TB of memory can be configured per node. In a maximum sized cluster of 8 nodes, you can use the performance and efficiency of 12 terabytes of memory and a maximum of 32 petabytes of storage.

IBM SAN Volume Controller Model SV3 supports host attachment by using 16/32 Gbps Fibre Channel, and 10/25 Gbps and 100 Gbps Ethernet with iSCSI and NVMe Remote Direct Memory Access (RDMA) options.

Agile integration

The IBM SAN Volume Controller system includes the following agile characteristics:

- ▶ Fully integrated system management
- ▶ Application-aware data services
- ▶ Advanced Encryption Standard (AES) data-at-rest encryption
- ▶ Tiering or mirroring to existing or Public Cloud storage
- ▶ Mixed workload consolidation
- ▶ Nondisruptive data migrations
- ▶ Concurrent code load

By accelerating physical and virtual applications, the IBM SAN Volume Controller 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
- ▶ Cloud native
- ▶ Hybrid and multicloud

AI-empowered

IBM SAN Volume Controller features the following AI characteristics:

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

Multicloud enabled

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

- ▶ Migrate data between on-premises and public cloud data centers or between public cloud data centers. Enjoy consistent data management between on-premises storage and the public cloud.
- ▶ Implement DR strategies between on-premises and public cloud data centers.
- ▶ Enable cloud-based DevOps with replication of data from on-premises sources.
- ▶ Improve cyber resilience with copies on Amazon Web Services (AWS) by using “air gap” snapshots to S3 and IBM Safeguarded Copy on Microsoft Azure.

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

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

On Azure, deploy directly from the Azure Apps Marketplace through predefined Azure Resource Manager templates that automatically and securely install the software, and deploy a high availability two-node cluster on selected Azure virtual machines (VMs). Attach shared Azure Managed Disk SSDs to the cluster for high availability.

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

IBM Storage Virtualize on-premises and IBM Storage Virtualize for Public Cloud together enable a hybrid multi-cloud 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 Storage Virtualize provides the following functions:

- ▶ Storage pooling and automated allocation with thin provisioning
- ▶ IBM Easy Tier® automated tiering
- ▶ Deduplication and compression to reduce cloud storage costs
- ▶ IBM FlashCopy® and remote mirror for local snapshots and remote replication
- ▶ IBM Safeguarded Copy for Cyber Resiliency
- ▶ Support for virtualized and containerized server environments, including:
 - VMware
 - MicrosoftHyper-V
 - IBM PowerVM®
 - Red Hat OpenShift
 - CRI-O
 - Kubernetes

Rock-solid data resilience

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

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

Customized to your specific application mix, IBM FlashSystem® Cyber Vault builds on IBM Safeguarded Copy to help reduce cyberattack recovery times.

A Cyber Vault solution runs continuously and monitors snapshots as they are created automatically by Safeguarded Copy. By using standard database tools and automation software, Cyber Vault checks Safeguarded Copy snapshots for corruption. If Cyber Vault finds such changes, those changes are an immediate sign that an attack might be occurring.

When preparing a response, knowing the last snapshots with no evidence of an attack speeds determining which snapshot to use. Because Safeguarded Copy snapshots are on the same storage as operational data, recovery is fast by using the same snapshot technology. With these advantages, Cyber Vault is designed to help reduce cyberattack recovery time from days to just hours.

Advanced data services

The IBM SAN Volume Controller system provides the following advanced data services:

- ▶ Business continuity with replication services across a maximum of three sites
- ▶ Data protection with IBM FlashCopy services
- ▶ HA with IBM HyperSwap
- ▶ Higher storage efficiency with thin provisioning
- ▶ Data reduction pools (DRPs) that provide compression with deduplication
- ▶ Data-at-rest AES-XTS 256 encryption
- ▶ IBM Easy Tier
- ▶ External virtualization
- ▶ Data migration
- ▶ IP quorum support
- ▶ N_Port ID Virtualization (NPIV) support
- ▶ VMware vSphere Virtual Volume (VVOL) support and space-efficient copies
- ▶ Transparent Cloud Tiering
- ▶ Data and cyber resilience with IBM Safeguarded Copy
- ▶ Container support with the IBM block storage CSI driver
- ▶ Performance scaling through clustering

IBM SAN Volume Controller enclosure overview

IBM SAN Volume Controller includes the following key characteristics:

- ▶ It manages your storage systems, communicates with the host, and manages interfaces.
- ▶ It is highly scalable, which provides an easy growth path from 2–8 nodes by pairs. The nodes are paired for redundancy and reliability.
- ▶ It is SAN interface-independent. It supports Fibre Channel (FC), FC-NVMe, iWARP, RoCE, Fibre Channel over Ethernet (FCoE), and internet Small Computer Systems Interface (iSCSI). It is also open for future enhancements.
- ▶ It is host independent for fixed block-based Open Systems environments.
- ▶ It is external storage system independent, which provides a continuous and ongoing process to qualify more types of storage systems.

Figure 1 shows the IBM SAN Volume Controller Model SV3 enclosure front view.

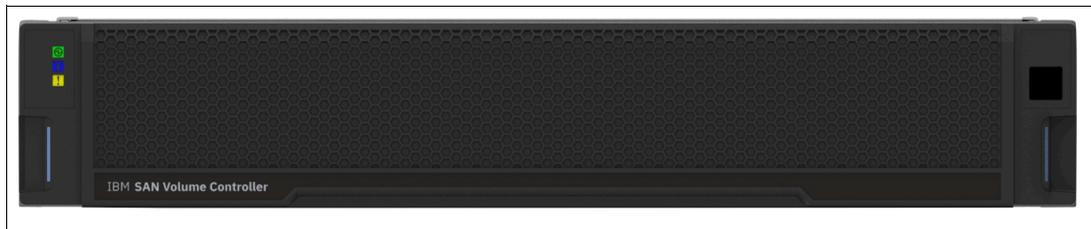


Figure 1 IBM SAN Volume Controller Model SV3 enclosure front view

Two IBM SAN Volume Controller Model SV3 enclosures are clustered to form an I/O group. They are sold in pairs of enclosures to ensure redundancy while serving the virtualized storage arrays that they control. A maximum of four I/O groups can be clustered for a total of eight IBM SAN Volume Controller Model SV3 enclosures working together.

The IBM SAN Volume Controller Model SV3 enclosure consists of the following machine types and models:

- ▶ 2145-SV3 - IBM SAN Volume Controller Model SV3 enclosure (12 months warranty)
- ▶ 2147-SV3 - IBM SAN Volume Controller Model SV3 enclosure (36 months warranty)

The SAN Volume Controller 2147-SV3 is physically identical to the 2145-SVC. The SAN Volume Controller 2147-SV3 is sold with Enterprise Class Support (ECS), which is an enhanced service offering, and includes a 3-year warranty instead of a 1-year warranty.

Enterprise Class Support includes the following services:

- ▶ Technical advisor support for improved usage planning and problem management.
- ▶ IBM Service Support Representatives (SSRs) to complete the following tasks:
 - Onsite product set-up and installation (including software)
 - Configuration support
 - Installation of a maximum of six software updates (remote preferred) during the warranty period
- ▶ Enhanced response times for Severity 1 problems.

Note: IBM SAN Volume Controller 2147-SV3 nodes can be clustered with IBM SAN Volume Controller 2145-SV3 nodes only if the extra IBM Support Terms and Conditions service that upgrades IBM SAN Volume Controller 2145-SV3 to the equivalent IBM SAN Volume Controller 2147-SV3 is purchased.

Figure 2 shows the IBM SAN Volume Controller Model SV3 rear view.

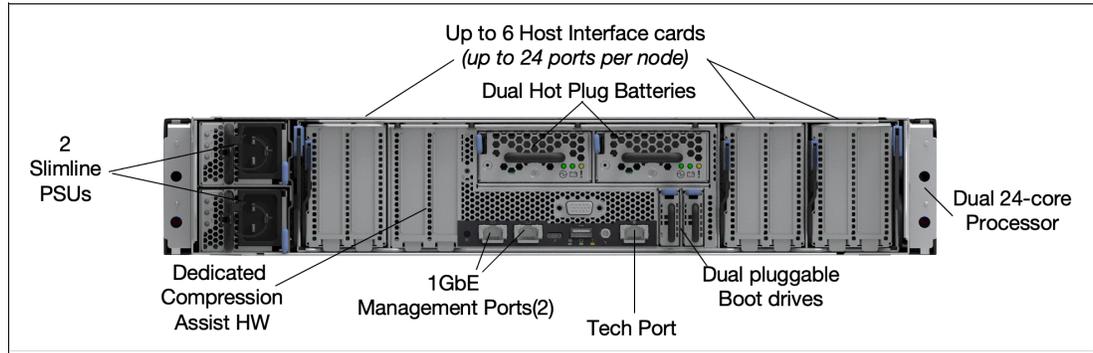


Figure 2 IBM SAN Volume Controller Model SV3 detailed rear view

Each IBM SAN Volume Controller Model SV3 enclosure includes the following features:

- ▶ One node canister with two 24-core processors and options for a maximum of 1.5 GB memory to deliver an IBM SAN Volume Controller clustered system total of 3 TB memory.
- ▶ A maximum of three I/O adapter cages to add a maximum of six PCIe adapter features:
 - 32 Gbps / 6 Fibre Channel Adapters
 - 64 Gbps / 3 Fibre Channel Adapters
 - 10/25 Gbps Ethernet connectivity
 - 100 Gbps Ethernet connectivity
- ▶ Dedicated Compression QAT adapter card
- ▶ Dual hot-swappable:
 - Batteries
 - Boot drives
 - AC power supplies
- ▶ 2U, 19-inch rack mount enclosure

For more information about configuration and limit restrictions, see this [V8.6.1.x Configuration Limits and Restrictions for IBM System Storage SAN Volume Controller](#).

Note: IBM SAN Volume Controller Model SV3 does *not* support any type of expansion enclosure.

Placing your IBM SAN Volume Controller Model SV3 in your infrastructure

Various possible use cases exist for the IBM SAN Volume Controller Model SV3, all of which can address many technical or business requirements. In addition, the IBM SAN Volume Controller Model SV3 nodes can be used to simplify the overall storage architecture.

The IBM SAN Volume Controller Model SV3 nodes can be used in the following use cases:

- ▶ Externally virtualizing IBM or non-IBM storage by using IBM Storage Virtualize, which extends advanced functions (such as data reduction, encryption, and replication) to those storage subsystems. This storage virtualization feature enables all the externally virtualized storage to be used as:
 - First tier storage repository for production data.
 - Primary or target systems for Data Replication or DR.
 - Multiple tiers of storage based on drive media types such as hard disk drives (HDDs), commodity solid-state drives (SSDs), NVMe, or SCMs.
- ▶ Data migration from IBM or non-IBM storage with IBM Storage Virtualize.
- ▶ Hybrid cloud storage:
 - By enabling communication between an on-premises deployment of IBM Storage Virtualize and IBM Storage Virtualize for Public Cloud.
 - By deploying the Container Storage Interface (CSI) driver for Red Hat OpenShift Container Platform to provide persistent storage for on-premises or cloud-based containerized applications.
 - By the use of Transparent Cloud Tiering (TCT) to convert data into an object store for backup to certain available cloud instances.
- ▶ Support and interoperability within the IBM Storage Software Suite:
 - IBM Storage Scale where the storage systems that are virtualized behind the IBM SAN Volume Controller Model SV3 nodes can be used as the back-end storage repository for metadata, primary data or in initial microprogram load (IML) processing.
 - IBM Storage Protect and IBM Storage Protect Plus with which the storage systems that are virtualized behind the IBM SAN Volume Controller Model SV3 nodes can be used as cache or data repository.
 - IBM Copy Data Management where the storage systems that are virtualized behind the IBM SAN Volume Controller Model SV3 nodes can be used as cache or as a copy services target.

Figure 3 shows a pair of IBM SAN Volume Controller Model SV3 nodes that are fully deployed in a hybrid multicloud environment. They are externally virtualizing various on-premises storage subsystems.

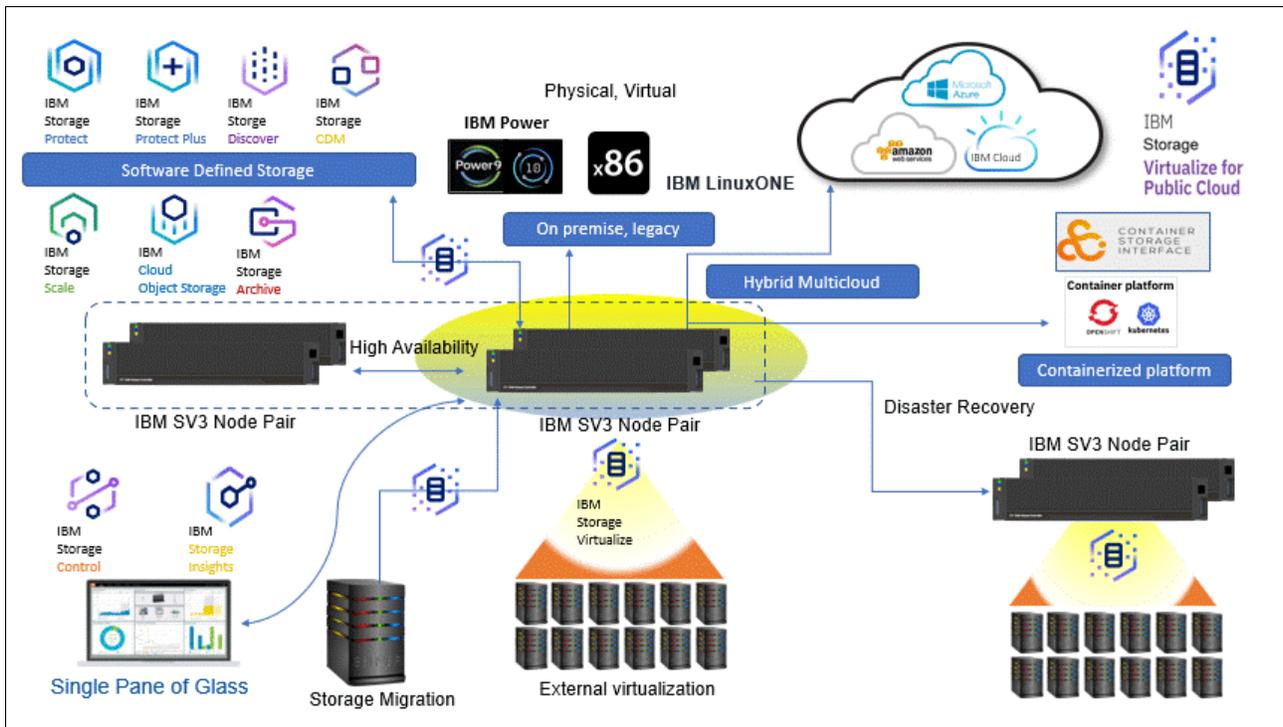


Figure 3 Fully deployed IBM SAN Volume Controller Model SV3 single node pair in sample scenario

The IBM SAN Volume Controller Model SV3 nodes can support multiple Open System hosts and interoperability with all the software from the IBM Storage Suite of products.

In this scenario, the IBM SAN Volume Controller Model SV3 nodes provide the following benefits:

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

Additional benefits of the SAN Volume Controller Model SV3

Each SAN Volume Controller Model SV3 node runs IBM Storage Virtualize 8.6 and provides the following benefits:

- ▶ A high-performance hardware engine with two 24-core 2.4 GHz processors and a maximum of 1.5 TB of cache memory. Each engine also contains dual hot plug batteries and a pair of hot-swappable boot drives.
- ▶ Support for 32 Gbps and 64 Gbps Fibre Channel (FC), 10/25 GbE or 100 GbE iSCSI, and NVMe RDMA connectivity. The ability to intermix these port options also is supported.
- ▶ Simplified connectivity by using portsets, which enables host connectivity ports to be grouped for more effective zoning and management.
- ▶ External virtualization for over 500 different IBM and non-IBM storage subsystems, which allows these systems to take advantage of the following advanced functions:
 - Autonomic tiering through Easy Tier, which enables workload data to be placed on the most suitable storage media. This autonomic tiering extends to all drives types, including HDDs, commodity SSDs, NVMe drives, and SCM.
 - Advanced copy services, such as Volume Mirroring, FlashCopy (point-in-time-copy), Metro Mirror (synchronous replication), and Global Mirror (asynchronous replication) for data protection and DR.
 - Cyber resiliency with Safeguarded Copy, which provides rapid ransomware recovery by using immutable, untouchable snapshots that are based on FlashCopy technology.
 - Software-based AES-256 data at rest encryption and key management through one of the following products:
 - IBM Security® Guardium® Key Lifecycle Manager
 - Gemalto SafeNet KeySecure key server
 - Thales CipherTrust Manager key server

Note: A maximum of four key servers are supported.

- Software-based AES-256 data at rest encryption by using USB keys. This can be used without key servers or can be combined with the usage of key servers.
- Remote Support Assistance (RSA), which enables IBM support personnel to access the system to complete troubleshooting tasks.
- Multiple management modes by using a graphical user interface (GUI) or a Linux-based command-line interface (CLI).
- Performance throttling that allows control of used resources when the system is processing host I/O, advanced functions, or copy services.
- Transparent Cloud Tiering with which a FlashCopy volume can be backed up to an S3 object store, such as AWS or IBM Cloud.
- Easy access and compatibility with IBM Storage Insights, which offers advanced performance monitoring for back-end storage that is virtualized behind an IBM SAN Volume Controller cluster.
- More access security through multi-factor authentication.

Current release functions

This section describes several new functions and features that are available on the current IBM Storage Virtualize V8.6.0 release running on IBM SAN Volume Controller Model SV3.

New in IBM Storage Virtualize Software V8.6.0

For a complete list of changes for V8.6.0, see [What's new in 8.6.0](#).

- ▶ Support for Non-Volatile Memory express (NVMe) over TCP host connectivity.
The Ethernet-based hosts connect to the system through the node-to-node IP addresses. These can be assigned based off of the host attach functionality and port assignments of the node. Depending on your system configuration, Ethernet configurations can include iSCSI, NVMe over RDMA, or NVMe over TCP.
- ▶ Support for Node CLI to shutdown individual Fibre Channel ports.
This command can enable or disable the Fibre Channel port features. The Fibre Channel port supports features like fabric device management interface (FDMI) registration, discovery, and port state.
- ▶ Support for iSCSI performance improvement.
- ▶ Support for 1024 iSCSI hosts per I/O group:
 - A maximum of 1024 hosts per I/O group for all supported node types
 - A maximum of 1024 sessions per system iSCSI target from different iSCSI hosts
 - A maximum of 2048 sessions per I/O group from iSCSI hosts with a maximum of four sessions from one iSCSI host to each system iSCSI target
- ▶ Support for migrating remote copy to policy-based replication.
Policy-based replication uses volume groups and replication policies to automatically deploy and manage replication. Policy-based replication can simplify configuring, managing, and monitoring replication between two systems. With policy-based replication, you can replicate data between systems with minimal management, higher throughput, and reduced latency compared to the remote-copy function.
- ▶ Support for SMTP authentication
- ▶ Support for TLS 1.3.
Security of all key server communications is governed by TLS 1.2 and TLS 1.3 protocols. Encryption keys are distributed between nodes in the system using TLS 1.2 and TLS1.3. The system uses AES-256 encryption that uses OpenSSL library interfaces. To establish a connection between the key server and the system, the key server or services must support the configured TLS version.
- ▶ Support for DNS check to be turned off.
- ▶ Support for FDMI information in Call Home.
The Fabric Device Management Interface (FDMI) enables any storage endpoint to register itself to the Fibre Channel (FC) fabric and query the HBA and port details of the entire fabric.

- ▶ Support for version 2 metadata volume for VMware Virtual Volumes (vVols).
IBM Storage Virtualize versions 8.6.0.0 and later support a version 2 metadata volume when configuring VMware Virtual Volumes (vVols). A metadata volume created on earlier versions uses a version 1 metadata format. It is recommended that users migrate the metadata volume from version 1 to version 2 to take advantage of future feature updates for vVols.
- ▶ Enhancement to IBM Storage Insights for threat detection.
A key part of monitoring your system includes the detection of potential ransomware attacks. Compression and cyber resiliency statistics for volumes are collected every 5 minutes to ensure that you have the latest storage metadata for detecting those types of attacks. With these statistics, IBM Storage Insights builds a historical model of a storage system to identify when and where ransomware attacks might be occurring. For more information on statistics, see [Starting statistics collection](#).
- ▶ Support for non-superuser ability to manage the system.
Users can manage all functions of the system, including managing users, user groups, user authentication, and configuring encryption. Users with the Security Administrator role can run any system commands from the command-line interface (CLI) except for the **satask** command from the CLI. Only the superuser ID can run the **satask** command. Like the Administrator role, users with Security Administrator privileges can also create and configure the Safeguarded Copy function and create and manage Safeguarded policies. Also, they can change or remove existing Safeguarded backup copies and child pools that are used as Safeguarded backup locations.
- ▶ Support for downloading software patches through Call Home by using Restful API.
- ▶ With IBM Storage Virtualize 8.6.0 or later, more than a single DRAID array can be used that is made of compressing drives in the same storage pool.

Highlights

IBM Storage Virtualize 8.6 delivers support for IBM SAN Volume Controller Model SV3 for machine types 2145 and 2147.

This release provides the advanced software functions of IBM Storage Virtualize software to IBM Storage Virtualize SV3 hardware. It also adds NVMe Remote Direct Memory Access (RDMA) support and Multifactor authentication.

IBM Software Subscription and Support

All distributed software licenses include IBM Software Subscription and Support, which is also referred to as Software Maintenance, for 12 months from the date of acquisition. This support provides a streamlined way to acquire IBM software and assure technical support coverage for all licenses. Extending coverage for a total of five years from date of acquisition can be elected.

While your Software Subscription and Support is in effect, IBM provides assistance for your routine, short-duration installation and usage (how-to) questions, and code-related questions. IBM provides assistance by telephone and, if available, electronic access, only to your information systems (IS) technical support personnel during the normal business hours (published prime shift hours) of your IBM support center. (This assistance is not available to your users.) IBM provides Severity 1 assistance 24 hours a day, 365 days a year.

A Technical Account Manager serves as the key customer interface for in-scope hardware and software. This interface delivers partnership and consultancy, and direct engagement on high-priority support cases.

IBM FlashWatch overview

IBM FlashWatch is a new offering from IBM that provides the following features that are included in the purchase of the product:

- ▶ Acquisition:
 - High availability guarantee:
 - Proven 99.9999% availability
 - Optional 100% commitment when HyperSwap is used
 - Data reduction guarantee:
 - 3:1 self-certified
 - A maximum of 5:1 with workload profiling
 - All-inclusive licensing
All storage functions are included in the licensing cost for internal storage.
- ▶ Operation:
 - Cloud analytics
Storage Insights are 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 three years with full flexibility.
 - Cloud-like pricing
Storage Utility pricing features monthly payments for only the storage that you use.
 - No cost migration
A total of 90 days no-cost data migration from over 500 storage controllers, IBM, and non-IBM.

For more information about the IBM FlashWatch offering, see [IBM FlashWatch FAQ](#) and contact your IBM Sales representative or IBM Business Partner.

The IBM FlashWatch offering is applicable across the IBM Storage Virtualize family, with the Product Matrix in the FAQ detailing the elements that are applicable against which product.

IBM Storage Insights

IBM Storage Insights is another part of the monitoring capability of the IBM Storage Virtualize SV3 system and supplements the views that are available in the GUI.

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

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

IBM Storage Insights includes the following features:

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

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

Customer dashboard

Figure 4 on page 14 shows a view of the IBM Storage Insights main dashboard and the systems that it monitors.

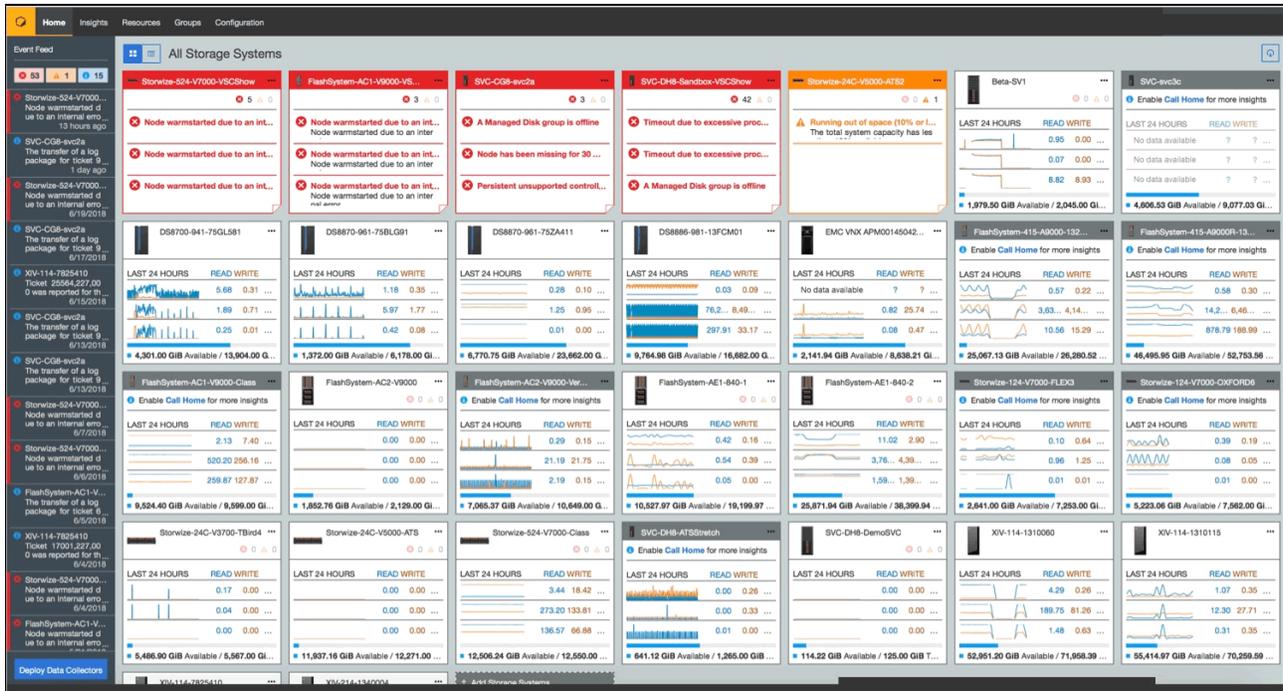


Figure 4 IBM Storage Insights dashboard

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

For more information about the architecture and design overview of IBM Storage Insights, see Implementation Guide for IBM Storage FlashSystem and IBM SAN Volume Controller (for IBM Storage Virtualize 8.6), [SG24-8542](#).

IBM Storage Insights: Information and registration

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

- ▶ [Fact Sheet](#)
- ▶ [Demonstration](#)
- ▶ [IBM Documentation](#)
- ▶ [Registration](#)

IBM Spectrum Connect

IBM Storage Virtualize SV3 Software V8.6.0 supports integration of VMware APIs for Storage Awareness (VASA) and vStorage API for Array Integration (VAI) by using IBM Spectrum® Connect V3.2.5 (formally known as *IBM Storage Control Base*) or later. 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 Spectrum Connect](#).

IBM Spectrum 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 Enterprise Class Support

IBM Enterprise Class Support (ECS) is available for only the IBM SVC systems that are purchased with a 3-year warranty (see Table 1).

Table 1 Machine types that qualify for Enterprise Class Support

Component	Machine type model
IBM SVC Control Enclosure	2147 - SV3

The ECS offering provides the following key enhancements to the product base 3-year warranty terms and conditions:

- ▶ IBM Technical Advisor to proactively improve problem management and communication
- ▶ Software and product installation
- ▶ Configuration support
- ▶ Onsite and remote software updates a maximum of six times during the warranty period
- ▶ Enhanced response times for high severity problems

During the warranty period, and with a current active software maintenance agreement, the customer is entitled to enhanced response times for Severity 1 problems. IBM also provides an IBM Service Support Representative (IBM SSR) to perform onsite product set-up and installation. In addition, the IBM SSR or IBM Remote Support Center performs a maximum of six software updates during the warranty period.

IBM Technical Advisor support is provided during the warranty period. This support enhances end-to-end support for the customer's complex IT solutions. IBM Technical Advisor uses an integrated approach for coordinated, cross-team support to enable customers to maximize IT availability.

An IBM Technical Advisor works with customers, sales teams, and IBM Business Partners to ensure that the Technical Delivery Assessment (TDA) checklist and site planning steps are complete. Also, with the 3-year warranty, an IBM Technical Advisor proactively plans the software updates to ensure that workstation, network access, user ID, and software download steps are complete before deploying the IBM SR or IBM Remote Support Center to perform the software update.

IBM SAN Volume Controller Model SV3 GUI

Because IBM SAN Volume Controller enclosures cluster two nodes to form a system, a single management interface is used for IBM SAN Volume Controller Control enclosures. Each IBM SAN Volume Controller canister is an individual server in an IBM SAN Volume Controller clustered system on which the IBM SAN Volume Controller software runs.

You can access the GUI by opening any supported web browser and entering the management IP addresses. You can connect from any workstation that can communicate with the IBM SAN Volume Controller system. The IBM SAN Volume Controller Control enclosure is delivered in a two 2U 19-inch rack-mount enclosure. The IBM SAN Volume Controller system features IBM engineer (SSR) installation as part of the product offering.

Figure 5 shows the IBM SAN Volume Controller GUI dashboard.

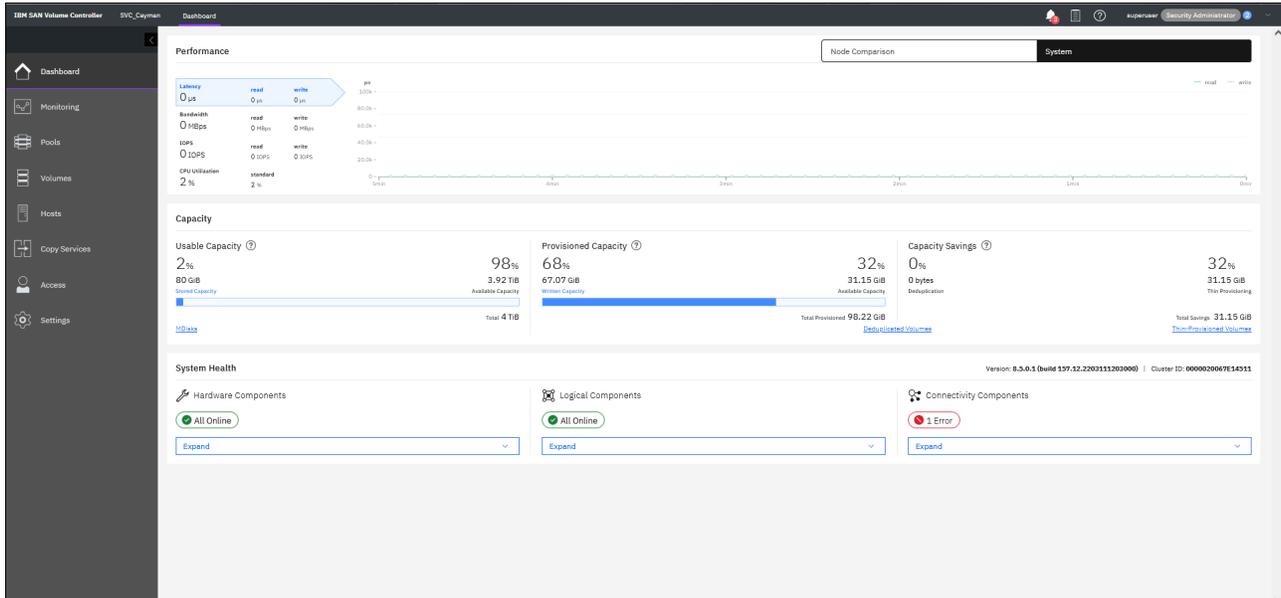


Figure 5 IBM SAN Volume Controller GUI showing the dashboard

Figure 6 shows the Control Enclosure window. You can open this window by selecting **Monitoring** → **System Hardware** from the left graphical menu.

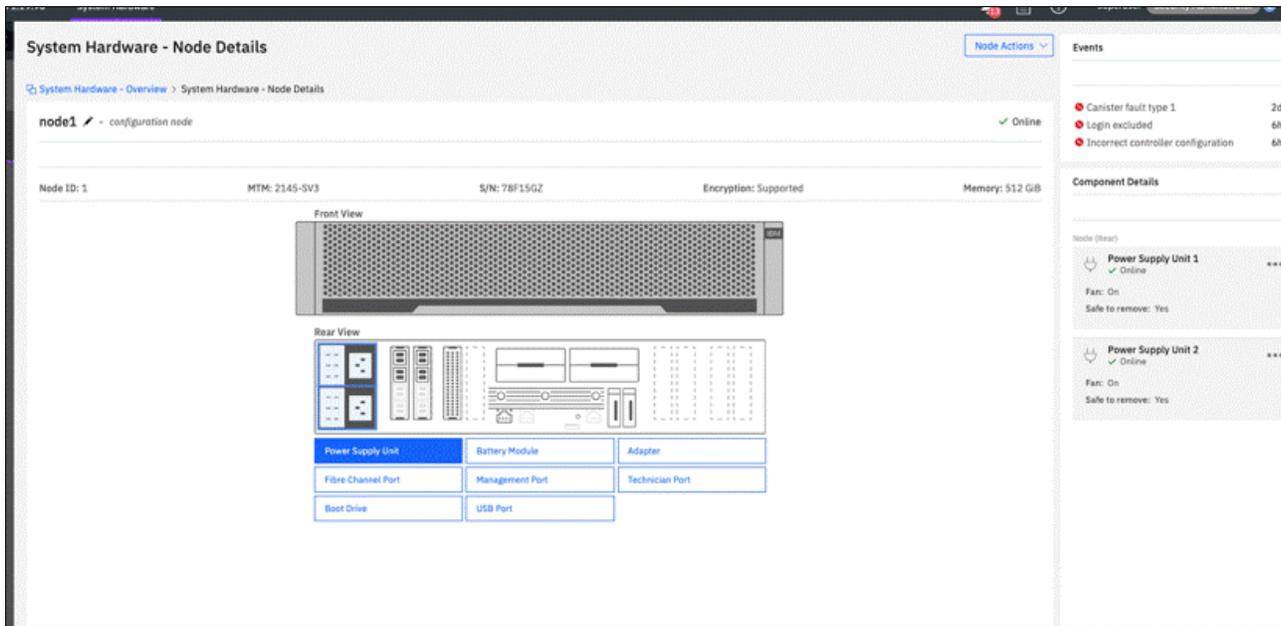


Figure 6 IBM SAN Volume Controller overview of the control enclosure: One Node

The IBM SAN Volume Controller includes a CLI, which is useful for scripting, and an intuitive GUI for simple and familiar management of the product.

The IBM SAN Volume Controller 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 SAN Volume Controller 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 SAN Volume Controller 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 SAN Volume Controller system beyond a web browser or a standard SSH client.

Supported platforms

The IBM SAN Volume Controller system features extensive interoperability with support for a wide range of operating systems that includes Microsoft Windows Server, Linux, and IBM AIX® and IBM i; a range of hardware platforms that includes IBM Power Systems, x86, and x86_64 servers; host bus adapters (HBAs); and SAN fabrics.

For more information, see the following resources:

- ▶ [V8.6.0.x Configuration Limits and Restrictions for IBM System Storage SAN Volume Controller](#)
- ▶ [IBM System Storage Interoperation Center](#)

IBM SAN Volume Controller Model SV3 hardware overview

The IBM SAN Volume Controller Storage Engine Model SV3 is a 2U rack-mounted enclosure that provides the primary management interface (GUI) and the host interface configuration. The IBM SAN Volume Controller Model SV3 support FC Protocol (FCP and FC-NVMe) and iSCSI interfaces. For iSCSI, the RoCE and iWARP protocols are supported.

Figure 7 shows the front view of the IBM SAN Volume Controller Model SV3 enclosure.

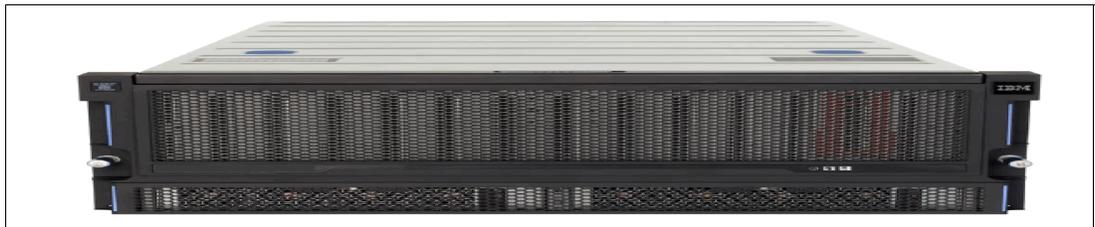


Figure 7 IBM SAN Volume Controller Model SV3 enclosure front view

The following machine warranties are offered for the IBM SAN Volume Controller Model SV3 system:

- ▶ Machine type 2145-SV3 with a 12-month warranty
- ▶ Machine type 2147-SV3 with a 36-month warranty and extra Enterprise Class Support

The IBM SAN Volume Controller Model SV3 enclosure includes integrated AC power supplies (PSU). These batteries supply power to the enclosure during a sudden power loss or failure so that the system can correctly commit all transactions to the external virtualized storage medium.

The IBM SAN Volume Controller Model SV3 enclosure includes the following features:

- ▶ Two Intel Ice Lake processors running at 2.4 GHz
- ▶ 512 GB memory standard, with options to increase memory to a maximum of 1.5 TB per IBM SAN Volume Controller node
- ▶ Hot-swappable boot drives
- ▶ Built-in hardware-assisted compression acceleration for DRP compression workloads
- ▶ Six I/O card slots with options for 32 Gbps FC and 25 Gbps and 100 Gbps Ethernet cards and three I/O card slots with options for 64 Gbps FC.
- ▶ Two 1 Gbps Ethernet ports for management, and a separate service technician port
- ▶ Two AC power supplies
- ▶ Two hot-swappable batteries
- ▶ The ability to cluster IBM SAN Volume Controller systems with previous generation IBM SAN Volume Controller Storage Engine models

Figure 8 shows a top view of the IBM SAN Volume Controller Model SV3 enclosure. Highlighted are the various components of the enclosure and the canister.

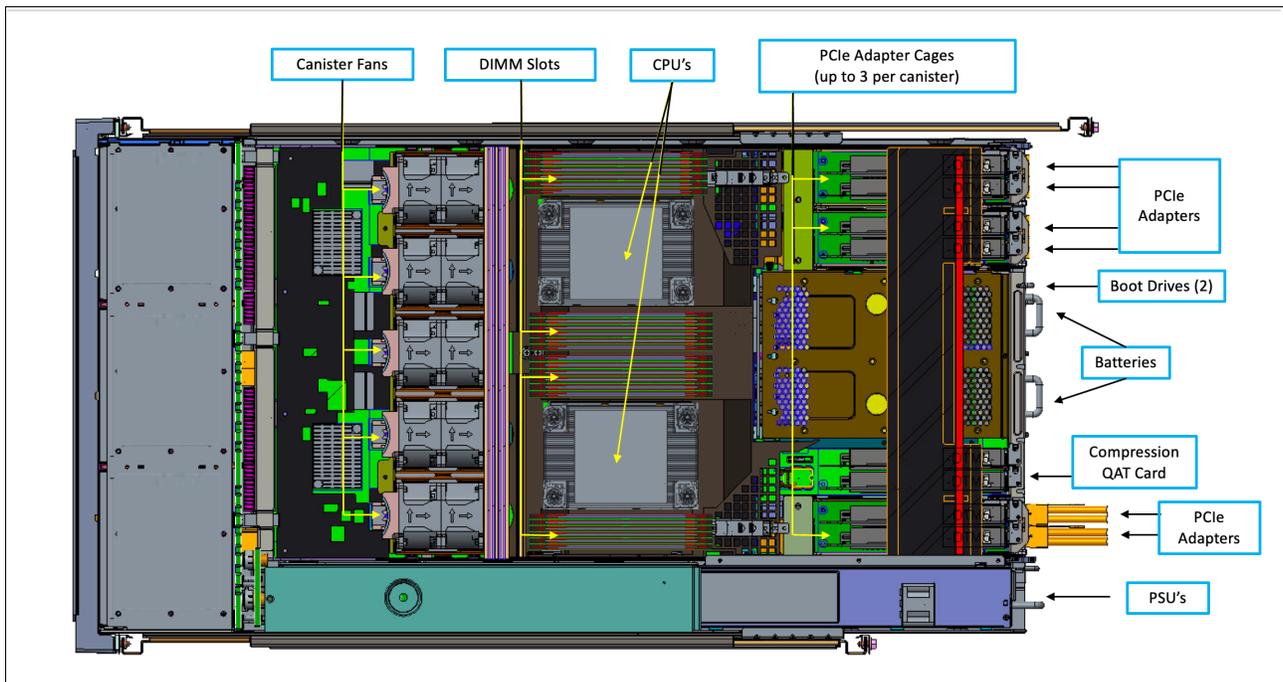


Figure 8 Top view of the IBM SAN Volume Controller Model SV3 enclosure

- ▶ Each canister contains the following components and quantities:
 - CPU (2)
 - DIMM Slots (4)
 - Battery (2)
 - Canister Fans (5)
 - Power Supply PSU (2)

- PCIe adapters cages (4)
- PCIe adapter cards (0-6)
- PCIe Compression QAT card (1)
- PCIe adapter blanking plates (0-6)

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

Figure 9 shows the rear view of the IBM SAN Volume Controller Model SV3 enclosure. All components are concurrently maintainable, except for the passive midplanes. All external connections are from the rear of the system.



Figure 9 Rear view of IBM SAN Volume Controller Model SV3 enclosure

Figure 10 shows a more detailed view of the rear of the enclosure.

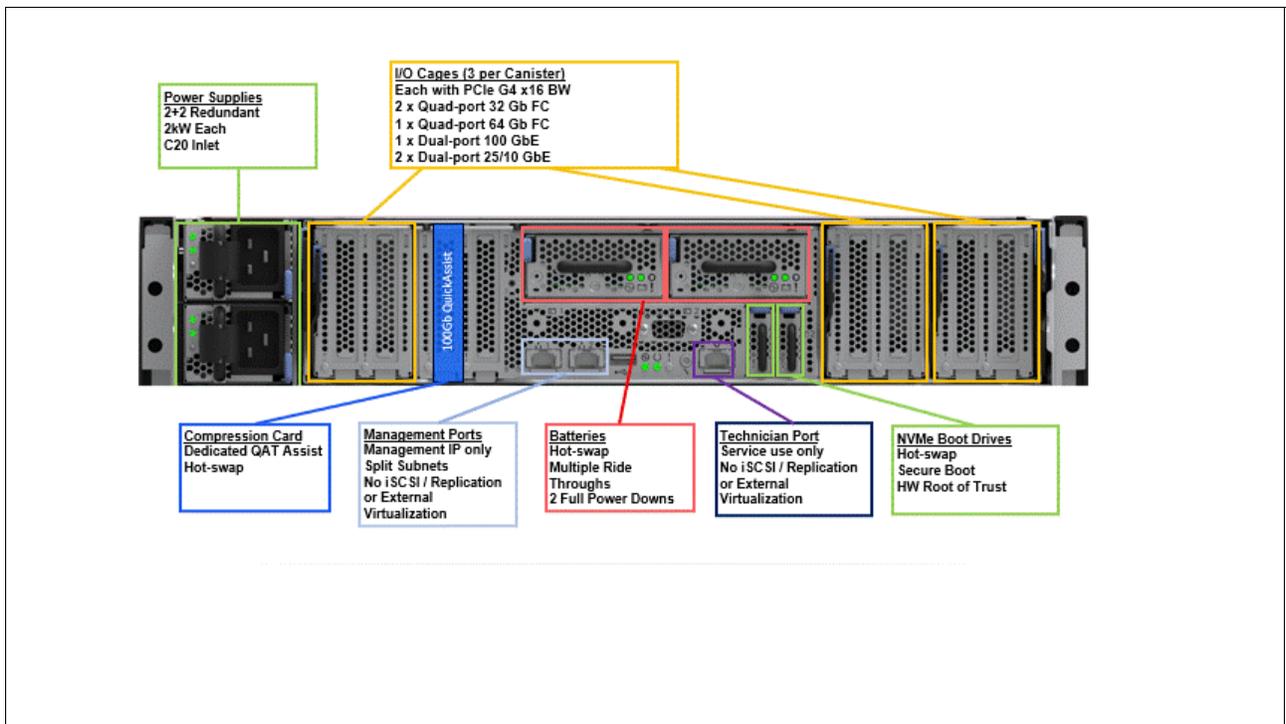


Figure 10 IBM SAN Volume Controller Model SV3 enclosure detailed rear view

Figure 10 shows the enclosure with two PSUs, the canister with three PCIe G4 interface cages, two batteries, two boot drives. and the technician, USB, and management Ethernet ports.

The PCIe adapters plug into the adapter cages and any unused PCIe adapter slots include a blanking plate assembly in place. These assemblies ensure and maintain the correct air flow

for cooling through the canister. A dedicated compression QAT card is also included in the canister.

Note: IBM SAN Volume Controller Model SV3 does not support any type of expansion enclosure.

Scalability and performance

Scaling capacity and performance is done by expanding the IBM SAN Volume Controller cluster with more I/O groups. A maximum of four I/O groups can form a single IBM SAN Volume Controller cluster. Expanding an IBM SAN Volume Controller cluster by adding nodes and I/O groups is independent of the configured topology.

The capacity expansion is possible through attaching FC and iSCSI storage systems to virtualize the provided capacity. The architectural limit is 32 PB in virtualized capacity.

A single I/O group of SV3 nodes is capable of approximately 7 million IOPS and >70 GBps throughput.

Note: All performance that is provided through the IBM SAN Volume Controller is limited by the actual capabilities of the virtualized back-end systems.

Advanced features

The IBM SAN Volume Controller Model SV3 provides the following advanced features:

- ▶ HyperSwap for IBM SAN Volume Controller Model SV3
- ▶ Safeguarded Copy
- ▶ IBM FlashSystem Cyber Vault
- ▶ Increased security features
- ▶ NVMe over Fabrics
- ▶ Portsets
- ▶ IP quorum base support
- ▶ Data reduction tools
- ▶ N-Port ID virtualization support
- ▶ VMware integration
- ▶ External virtualization
- ▶ Policy-based replication

HyperSwap for IBM SAN Volume Controller Model SV3

HyperSwap for IBM SAN Volume Controller Model SV3 is available with IBM Storage Virtualize software V8.6.0 and later. You can use HyperSwap to present each volume to two I/O groups. The configuration tolerates combinations of node and site failures by using the same flexible choices of host-multipathing driver interoperability as are available for the IBM SAN Volume Controller Model SV3 system. The use of FlashCopy helps maintain a golden image during automatic resynchronization.

Important: Because remote mirroring is used to support the HyperSwap capability, remote mirroring licensing is a requirement for the use of HyperSwap. For more information, see “Software and licensing” on page 38.

IBM Storage Virtualize software V8.6.0 or later includes remote mirroring of volumes. IBM Storage Virtualize is used to provide functions for externally virtualized storage.

The HyperSwap function uses a HyperSwap topology to spread the nodes of the system across two sites, with storage at a third site that acts as a tie-breaking quorum device. Consider the following points:

- ▶ The HyperSwap topology locates both nodes of an I/O group in the same site. Therefore, to get a volume that is resiliently stored on both sites, at least two I/O groups are required.
- ▶ The HyperSwap topology uses extra system resources to support a fully independent cache on each site. This configuration provides full performance, even if one site is lost. In some environments, a HyperSwap topology provides better performance than a stretched topology.
- ▶ The HyperSwap function can now be configured through a new CLI that greatly simplifies the setup process to a handful of commands. The HyperSwap function also adds the ability to configure and manage local HyperSwap through the GUI for simpler configuration and operation.
- ▶ Hosts and IBM SAN Volume Controller Model SV3 nodes are in one of two failure domains or sites.
- ▶ Volumes are visible as a single object across both sites (I/O groups).

Figure 11 shows how the HyperSwap function works.

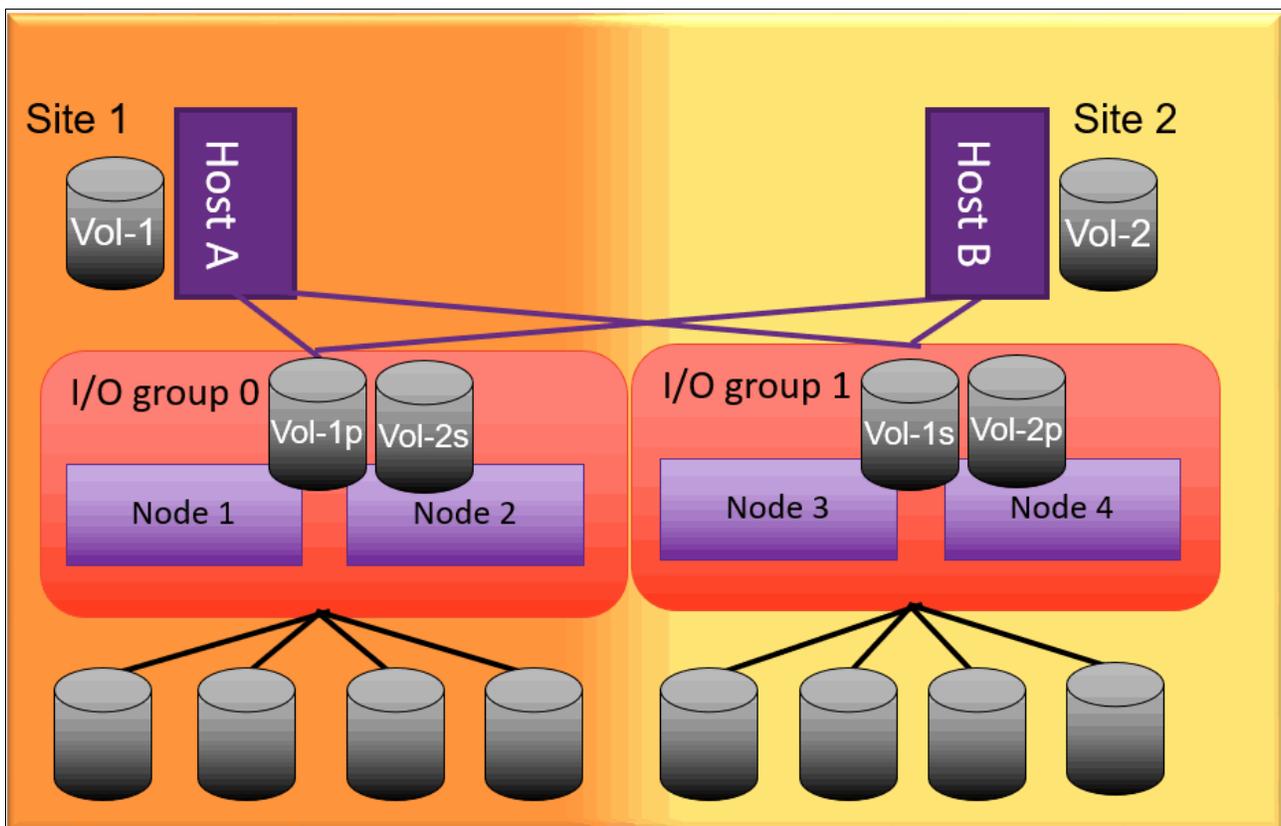


Figure 11 HyperSwap function

Each primary volume (“p” in Figure 11) has a secondary volume (“s” in Figure 11) 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 SAN Volume Controller Model SV3 HyperSwap function and is transparent to the hosts.

HyperSwap features the following characteristics:

- ▶ The HyperSwap function for IBM SAN Volume Controller Model SV3 is available with two or more I/O groups.
- ▶ You can design a multiple-step CLI-based configuration on a single system by performing simple object creation through the GUI and CLI.
- ▶ Data is stored on two sites in parallel.
- ▶ The maximum distance between sites is 300 km (186.4 miles). The limiting factor is the roundtrip time of 80 ms.
- ▶ Two independent copies of data are maintained. Four are maintained if you use extra 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.
- ▶ A maximum of 2000 highly available volumes can be used.
- ▶ Requires a remote mirroring license for volumes. Exact license requirements can vary by product.

Safeguarded Copy

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

The system integrates with IBM Copy Services Manager to provide automated backup copies and data recovery.

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

HA configurations mitigate against physical component failure and provide small Recovery Point Objective (RPO) and Recover Time Objective (RTO). Continuous protection and operation occur if a component fails. IBM Storage Virtualize HA configurations, such as HyperSwap and Stretch Cluster, provide such protection.

DR is designed to have a slightly higher RPO and RTO. Therefore, DR is in a position to provide an air-gap to protect against corruption to the data that is replicated immediately in an IBM Storage Virtualize HA configuration, such as HyperSwap or Stretch Cluster. However, because DR solutions at the storage layer are replicating only data, any logical corruption eventually is replicated to the DR site.

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

For more information about Safeguarded Copy, see *IBM FlashSystem Safeguarded Copy Implementation Guide*, [REDP-5654](#).

IBM FlashSystem Cyber Vault

The IBM FlashSystem Cyber Vault solution complements IBM Safeguarded Copy and can be used with IBM SAN Volume Controller SV3. IBM FlashSystem Cyber Vault automatically scans the copies that are created regularly by Safeguarded Copy looking for signs of data corruption that is introduced by malware or ransomware. This scan serves two purposes:

- ▶ It can help identify a classic ransomware attack rapidly after such an attack starts.
- ▶ It is designed to help identify which data copies were affected by an attack.

Armed with this information, customers are positioned to more quickly identify when an attack is underway and to more rapidly identify and recover a clean copy of their data.

IBM FlashSystem Cyber Vault includes the following features:

- ▶ Detect cyberattacks early to minimize damage
- ▶ Speed recovery from an attack
- ▶ Reduce recovery time from days or weeks to just hours
- ▶ Enable forensic analysis of attack

The IBM FlashSystem Cyber Vault solution is a blueprint that is implemented by IBM Lab Services or IBM Business Partners.

For more information about IBM FlashSystem Cyber Vault, contact your IBM representative or IBM Business Partner.

Increased security features

With IBM Storage Virtualize software V8.6.0 and later, administrators can enable Multifactor authentication (MFA) to increase security.

Single-factor authentication methods alone, such as username and password combinations, do not provide the level of protection and security that is required in cloud and hybrid-cloud environments. With MFA support, security administrators can reinforce account protection, create granular access for users and user groups, and monitor access more efficiently at a system level.

MFA requires users to provide multiple pieces of information when they log in to the system to prove their identity. MFA uses any combination of two or more methods (called *factors*) to authenticate users to your resources and protect those resources from unauthorized access. The system integrates with IBM Security Verify to provide MFA for system users.

Also available with IBM SAN Volume Controller Model SV3 is single-sign on. With single sign-on, users need to provide their credentials only once when they sign in to more systems, rather than repeatedly providing the credentials for every individual system. The system supports Microsoft Active Directory Federation Services (AD FS) to provide single sign-on.

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

NVMe over Fabrics

The NVMe protocol is an open collection of standards and interfaces that fully uses the benefits of nonvolatile 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 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 SATA and SAS. However, the NVMe interface was designed from the ground up for fast storage media, such as flash-based SSDs and low-latency nonvolatile storage technologies.

NVMe storage devices are typically directly attached to a host system over a PCI Express (PCIe) bus. The NVMe controller is contained in the storage device, which alleviates the need for another I/O controller between the CPU and the storage device. This architecture results in less latency, throughput scalability, and simpler system designs.

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

Figure 12 shows that the NVMe architecture supports many different network fabric technologies.

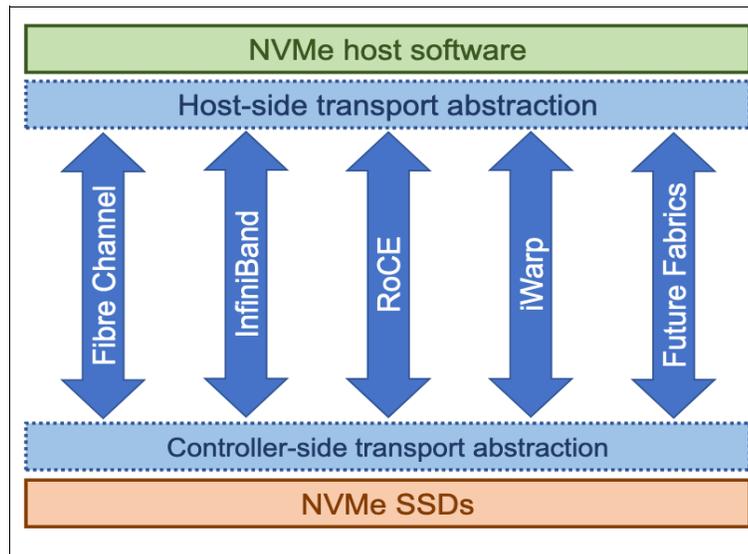


Figure 12 NVMe technology support options

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

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

FC-NVMe uses Fibre Channel Protocol (FCP) as its transport mechanism, which places the data transfer in control of the target and transfers data direct from host memory, which is 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-oF interface uses the same model of submission and completion queues as PCIe NVMe. It maintains the same asynchronous submission and completion model and achieves similar benefits in terms of latency, efficiency, and scalability as the NVMe technology because of the shortened code paths and lockless concurrency in multi-core environments.

IBM SAN Volume Controller Model SV3 supports NVMe protocols by way of the various PCIe adapters that can be ordered and installed in the control enclosure. For more information about these options, see “Host I/O connectivity and Expansion Enclosure adapters” on page 34.

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

Portsets

IBM SAN Volume Controller SV3 is prepared for multi tenancy where multiple clients can share storage resources. In multi tenancy environments, it can be a requirement that clients use storage ports that are connected to different networks to isolate traffic from other clients.

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

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

IP quorum base support

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

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

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

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

Note: Fibre Channel over IP (FCIP) connectivity is *not* supported between nodes when a 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 SAN Volume Controller SV3 system. IBM Comprestimator and Data Reduction Estimator Tool is the key sizing tool to estimate how much capacity savings a customer can expect. IBM Comprestimator and Data Reduction Estimator Tool can recognize the patterns of the customer data and estimate the compressibility of data per volume.

IBM SAN Volume Controller SV3 is supported by the IBM Comprestimator and the stand-alone Data Reduction Estimator Tool (DRET). The Comprestimator is available as a stand-alone tool and is found in the IBM SAN Volume Controller GUI. The DRET tool is a host-based application that estimates the amount of compression and de-duplication on the IBM SAN Volume Controller SV3 system for specific workloads.

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

Figure 13 shows how to start the Estimate Compression Saving option from the GUI.

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

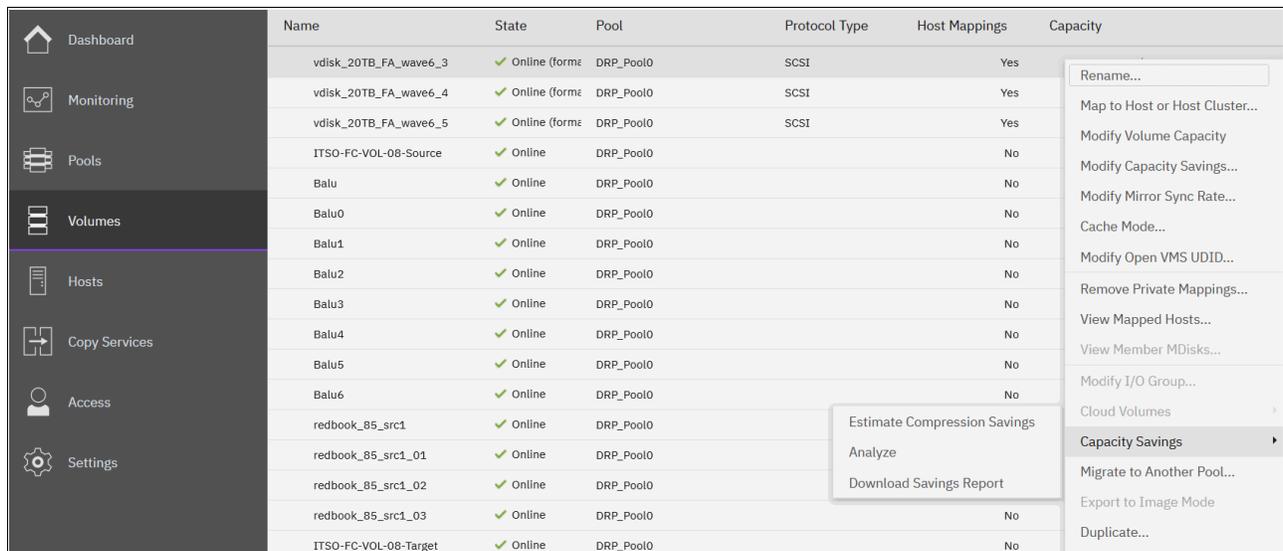


Figure 13 Estimate Compression Saving from the GUI

To estimate compression and savings on DRP approaches:

- ▶ DRP compression:
 - Use the DRP option
 - Workloads that are on any IBM Storage Virtualize platform can use the Estimate Compression Saving option in the GUI
- ▶ DRP compression and deduplication:
 - IBM Comprestimator and Data Reduction Estimator Tool shows the savings for thin-provisioning, compression, and deduplication
 - IBM Comprestimator and Data Reduction Estimator Tool reads entire volumes to identify de-duplicated data; therefore, it takes longer to run.

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

N-Port ID virtualization support

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

Important: On the IBM SAN Volume Controller SV3 system, NPIV is enabled by default. If you do not want to use NPIV, then you must turn it off before configuring FC ports for host communications.

VMware integration

IBM Storage Virtualize software V8.6.0 and later includes the following features, which enable tight integration with VMware:

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

Before the availability of VVOLs, a VM in a VMware environment was presented as a VMware disk that was called a *VMware Virtual Machine Disk* (VMDK). This file represented a physical disk to the VM, which can be accessed by the operating system that is installed on the VM in the same way that a physical volume on a regular server was installed.

The VMDK file was placed in a file system that is called VMFS, which is hosted by a standard volume (LUN). For example, it can be implemented on an external storage system, such as the IBM SAN Volume Controller SV3 system. With the availability of the VVOL technology, each VM disk can now be mapped to an external storage volume (for example, an IBM SAN Volume Controller volume).

With VVOL, the IBM SAN Volume Controller SV3 solution recognizes individual VMDK files. Therefore, data operations, such as snapshot and replication, can be performed directly by the IBM SAN Volume Controller system at the VMDK level rather than the entire VMFS data store.

Note: The integration of VVOL with the IBM SAN Volume Controller SV3 system is based on the VMware APIs for Storage Awareness (VASA). IBM support for VASA is delivered as part of IBM Storage Connect. VASA V2 is required to use the VVOL capability.

For more information of VMware integration, see *IBM FlashSystem and VMware Implementation and Best Practices Guide*, [SG24-8505](#).

External virtualization

The IBM SAN Volume Controller SV3 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 SAN Volume Controller SV3 system to manage the capacity of other disk systems with external storage virtualization.

When the IBM SAN Volume Controller system virtualizes a storage system, its capacity becomes part of the IBM SAN Volume Controller system. The capacity is managed in the same manner as the capacity on internal flash modules within the IBM SAN Volume Controller Model SV3 system. Capacity in external storage systems inherits all the functions and ease of use of the IBM SAN Volume Controller system.

You can use IBM SAN Volume Controller SV3 to preserve your investments in storage, centralize management, and make storage migrations easier with storage virtualization and Easy Tier.

IBM SAN Volume Controller SV3 system provides nondisruptive operations because of storage virtualization. Virtualization 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, so you have minimal downtime.

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

Policy-based Replication

Policy-based replication is a feature that can provide simplified configuration and management of asynchronous replication between two systems.

Policy-based replication uses volume groups to automatically deploy and manage replication. This feature significantly simplifies configuring, managing, and monitoring replication between two systems. Policy-based replication simplifies asynchronous replication with the following key advantages:

- ▶ Uses volume groups instead of consistency groups. With volume groups, all volumes are replicated based on the assigned policy.
- ▶ Simplifies administration by removing the need to manage relationships and change volumes.
- ▶ Automatically manages provisioning on the remote system.
- ▶ Supports easier visualization of replication during a site failover.
- ▶ Automatically notifies you when the recovery point objective (RPO) is exceeded.
- ▶ Easy-to-understand status and alerts on the overall health of replication.

Policy-based replication is supported in version 8.5.2 or later on the following products:

- ▶ IBM SAN Volume Controller
- ▶ IBM Storage FlashSystem 9500

- ▶ IBM Storage FlashSystem 9200
- ▶ IBM Storage FlashSystem 9100
- ▶ IBM Storage FlashSystem 7300
- ▶ IBM Storage FlashSystem 7200
- ▶ IBM Storage FlashSystem 5200
 - requires a minimum of 128 GiB memory in each node canister
- ▶ IBM Storage Virtualize for Public Cloud

For more information about concepts and objects that are related to PBR, see [Policy-based replication](#) and *Policy-Based Replication with IBM Storage FlashSystem, IBM SAN Volume Controller and IBM Storage Virtualize*, [REDP-5704](#).

Manageability and security

The IBM SAN Volume Controller Model SV3 system offers many improvements on the manageability and security features as compared to previous models. In general, it features the manageability and security of the new range of systems. Also, because of the latest version of the software, it is greatly improved.

Some of the most important features and improvements include the following examples:

- ▶ Safeguarded copy is a technology that is derived from the technology that is used in the IBM DS8000® systems. It consists of a copy that cannot be changed or deleted after it is created. It also stores sensitive copies in immutable storage, cloud environments, or offline write-once read many (WORM) tape devices to provide physical air-gap protection.
- ▶ Advanced security for data at rest with hardware-accelerated AES-XTS 256 encryption.
- ▶ A GUI and a CLI to manage the IBM SAN Volume Controller Model SV3 control enclosures are available. The GUI is supported in any supported browser. The IBM SAN Volume Controller Model SV3 CLI supports a collection of commands that you can use to manage the IBM SAN Volume Controller Model SV3 system. In the SAN Volume Controller SV3 system, the GUI and the command-line support Multi Factor Authentication (MFA) for increased security.
- ▶ Representational State Transfer (REST) application programming interface (API).

The IBM SAN Volume Controller Model SV3 system running IBM Storage Virtualize 8.6.0 or later 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.

- ▶ Secure Remote Access (SRA) provides a secure connection for IBM Remote Support, which can perform remote troubleshooting and code load, and obtain diagnostic logs.
- ▶ Email and SNMP alerts are part of the standard alerting options.
- ▶ Syslog redirect to send system log messages to another host.
- ▶ Combined password and SSH key authentication are now supported as a first factor for local users.
- ▶ Restrict methods of access to the system at a user group level. GUI, CLI, and REST API access can now be restricted (Role Based Access Control).
- ▶ Login grace time and session timeout duration can now be configured according to a customer's policies.

- ▶ The SAN Volume Controller Model SV3 can use two MFA options:
 - Cloud-based IBM Security Verify Integration. This feature supports a wide range of secondary authentication factors because it uses an industry-standard protocol OpenID Connect. It also aligns with other products that support this solution, such as IBM Storage Scale.
 - Single sign-on support by using Microsoft's Active Directory Federation Services (on-premises). The advantage of this technology is that it supports access cards and dark sites in the future.
- ▶ For the IBM SAN Volume Controller Model SV3, features were added to enable a hardware root of trust to protect against physical access attacks, and to prevent running foreign code. Therefore, trying to modify the code on the boot drive is not possible. When an attacker replaces the boot drive with their own, the UEFI secure boot detects the issue, rejects the boot drive, and does not boot. The UEFI secure boot feature ensures that if code is running on an IBM SAN Volume Controller Model SV3, then the code is running from an encrypted disk and was signed by IBM.
- ▶ IBM Cyber Vault, which is a combination of the following hardware and software to provide a comprehensive approach to Cyber Resiliency:
 - Immutable copies of data, which is created by IBM Safeguarded copies.
 - Pro-active monitoring. By using IBM Storage Insights, a recommended service from IBM, early warnings of a possible attack are sent out. Integration with IBM QRadar® is also recommended.
 - Rapid Recovery

The monitoring of the IBM Cyber Vault snapshots that are created by Safeguarded copies is a continuous process. Monitoring is done by using standard database tools and other software. In this way, IBM Cyber Vault checks Safeguarded Copy snapshots for corruption. If any corruption is found, it is considered a sign of a possible attack.
 - Data Copy Test and Validation

Data copies are in an isolated environment to check whether they are corruption free and recovery procedures are in place. Also, forensics and diagnostics services are available to check the validity of the data copies.

All these IBM Cyber Vault solutions can be implemented by IBM Lab services or an IBM Business Partner by using the IBM Frameworks for IT Cyber Resiliency. However, more software (IBM QRadar, IBM Security Guardium Data Protection, and so on) might be required.
- ▶ An interactive management GUI with excellent management and monitoring features.
- ▶ Native scheduler for snapshots

For creating and managing crash-consistent copies of data, external software is no longer required. For application-consistent copies, an external (third party) orchestrator with application awareness is still needed.

Encryption

Like its predecessors, IBM SAN Volume Controller Model SV3 data encryption is based on the industry standard AES-XTS 256 encryption, as defined in the IEEE 1619-2007 standard and NIST Special Publication 800-38E as XTS-AES-256. The data encryption key is protected by a 256-bit AES key wrap of a key that is derived from the access key that is stored on the USB flash drive. The wrapped key is stored in the system in nonvolatile form.

Encryption on the IBM SAN Volume Controller Model SV3 system requires the following feature codes:

- ▶ Encryption Enablement (#ACE5)

This feature enables the encryption function. A single instance of this feature enables the function on externally virtualized storage subsystems.

USB flash drives (#ACEB), IBM Security Guardium Key Lifecycle Manager, Gemalto Safenet Keysecure, or Thales CipherTrust Manager key servers are required for encryption key management.

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

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

When encryption is enabled in the cluster, if key servers are not used for encryption keys management, a total of three USB flash drives are required per IBM SAN Volume Controller Model SV3 cluster, regardless of the number of systems in the cluster. If encryption is used in a cluster, this feature is ordered on one IBM SAN Volume Controller Model SV3 system, which results in a shipment of four USB flash drives.

A key server is a centralized system that generates, stores, and sends encryption keys to the system. Some key server providers support replication of keys among multiple key servers. If multiple key servers are supported, you can specify a maximum of four key servers that connect to the system over both a public network and a separate private network. The system supports IBM Security Guardium Key Lifecycle Manager, Thales CipherTrust Manager, or Gemalto SafeNet Key Secure key servers to handle key management on the system. These supported key server management applications create and manage cryptographic keys for the system and provide access to these keys through a certificate. Only one type of key server management application can be enabled on the system at a time. Authentication takes place when certificates are exchanged between the system and the key server. Certificates must be managed closely because expired certificates can cause system outages. Key servers must be installed and configured before they are defined on the system.

IBM Security Guardium Key Lifecycle Manager key servers support Key Management Interoperability Protocol (KMIP), which is a standard for encryption of stored data and management of cryptographic keys.

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

Encryption can be applied to virtualized storage arrays, even if the virtualized array does not have encryption capabilities. In this scenario, the encryption is done by using IBM Storage Virtualize software. Encrypted volumes are transparent to applications, which eases implementation and operation. In addition, the IBM SAN Volume Controller Model SV3 system includes 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 nonconcurrent and destroys any data that is on the array.
- ▶ **Encryption Rekey.** Changing the encryption key on a previously initialized system is concurrent and can be done while the array is in use.

These operations require that you purchase an Encryption Enablement Pack (#ACE5).

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 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 backup data for that system exists in the cloud provider.
- ▶ When performing rekeying operations on a system that has an encryption-enabled cloud account, perform the commit operation immediately after the prepare operation. Retain the previous system master key (on a USB or in the keyserver) because this key might be needed to retrieve your cloud backup data when performing a T4 recovery or an import.
- ▶ The **restore_uid** option 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 [Transparent cloud tiering](#).

Reliability, availability, and serviceability

IBM SAN Volume Controller Model SV3 delivers the following enterprise-class reliability features, much like its predecessors:

- ▶ IBM SAN Volume Controller Model SV3 Control Enclosures support concurrent code load: Onsite and remote code upgrades are supported. However, an extra feature #AHY2 must be purchased for onsite code loads.

- ▶ Flexibility
 - The IBM SAN Volume Controller Model SV3 control enclosure has two clustered node canisters that contain hot-swappable and concurrently replaceable components:
 - Hot swappable. All system functions remain the same:
 - Secure boot drives
 - Batteries
 - PSUs
 - Concurrently replaceable. All functions remain, but elements might be offline; therefore, performance or availability might be affected:
 - Fan modules
 - Memory DIMMs
 - Trusted Platform Module (TPM)
 - PCIe adapters
 - Node canister
- ▶ Three-site data copies. By using three-site data copies, with synchronous or asynchronous data copies, greater flexibility exists in creating DR and HA solutions.

Options and feature codes

This section describes the options and feature codes of the IBM SAN Volume Controller SV3.

Memory options

Table 2 lists the following memory options by feature code:

Table 2 IBM SAN Volume Controller SV3 memory options per IBM SAN Volume Controller node

Base Memory (GB)	#ACHA Plant or Field Upgrade (GB)	#ACHC Plant or Field Upgrade (GB)	Total Memory (GB)
512	N/A	N/A	512
512	512	N/A	1024
512	512	512	1536

- ▶ (#ACHA): 512 GB Cache upgrade
 - This feature provides another 512 GB of cache to increase the total storage node engine cache to 1024 GB. This feature is recommended for high IOPS, low latency, and DRP workloads.
- ▶ (#ACHC): Additional 512 GB Cache upgrade
 - This feature provides another 512 GB of cache to increase the total storage node engine cache to 1536 GB. This feature is recommended for the maximum in high IOPS, low latency, and DRP workloads.

Host I/O connectivity and Expansion Enclosure adapters

Each Model SV3 storage engine has six I/O card slots, which are grouped into pairs and contained within an IO cage. These I/O cages can contain a pair of 32 Gbps FC cards (AH1E), or a pair of matched 25 Gbps Ethernet cards (AH1F or AH1G), or a single 100 Gbps Ethernet card (AH1H).

Consider the following points:

- ▶ I/O cage 1 must contain a pair of 32 Gbps FC cards, or a matched pair of 25 Gbps Ethernet cards, or a single 100 Gbps Ethernet card.
- ▶ I/O cage 2 can contain a pair of 32 Gbps FC cards, or a single 100 Gbps Ethernet card, or can be left empty.
- ▶ I/O cage 3 can contain a pair of 32 Gbps FC cards, or a matched pair of 25 Gbps Ethernet cards, or a single 100 Gbps Ethernet card, or can be left empty

FC (AH1E) cards are supplied with the suitable transceivers.

Ethernet cards (AH1F, AH1G, and AH1H) are not supplied with any transceivers. Supported transceivers (ACHN, ACHR, and ACHZ) and RJ45 adapters (ACJ1) can be purchased with the control enclosure, or the customer can supply their own cables (MPO FC cables, AOC, DAC, and splitters) if they are listed as supported in the product documentation.

Consider the following points:

- ▶ All Ethernet cards can be used with the iSCSI protocol.
- ▶ 25 Gbps iWARP Ethernet cards can also be used for clustering.
- ▶ 25 Gbps and 100 Gbps RoCE Ethernet cards can be used for NVMe RDMA.

The system includes two 1 Gbps Ethernet ports for management, and a separate service technician port.

Figure 14 shows the connectivity options for the different adapters at time of this writing.

Adapter	Supported Protocols	Supported Optics	Ports
32/64 Gb Fibre Channel	Fibre Channel FC-NVMe	32Gb / 64Gb SW SFP 32Gb / 64Gb LW SFP	4
12G SAS	SAS Expansion	mini-HD	2
25Gb iWARP Ethernet	iSCSI Cluster/hyperswap over iWARP (RPQ only)	10Gb RJ45 SFP+ SFP28 and more*	2
25Gb RoCE Ethernet	iSCSI NVMe/RDMA	10Gb RJ45 SFP+ SFP28 and more*	2
100Gb RoCE Ethernet	NVMe/RDMA iSCSI**	QSFP28 MPO QSFP28 LC 100Gb DAC and more*	2

Figure 14 Connectivity options

For more information about the limits and rules for adapter placement to ensure correct best practices, see [IBM FlashSystems & SAN Volume Controller FAQ](#).

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

Table 3 Maximum host port count per IBM SAN Volume Controller

Number of IBM SAN Volume Controllers	32 Gbps FC	64 Gbps FC	100 Gbps iSCSI (RoCE)	10/25 Gbps iSCSI (RoCE)	10/25 Gbps iSCSI (iWARP)
One	48	24	12	16	16
Two	96	48	24	32	32
Three	144	74	36	48	48
Four	192	96	48	64	64

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

Table 4 lists the current features for host and connectivity for the IBM SAN Volume Controller.

Table 4 Current host and connectivity features

Item	Feature code	Description	Ports
32 Gbps FC 4-port adapter pair	#AH1E	This feature provides one I/O adapter card with four 32 Gbps Fibre Channel ports and shortwave SFP transceivers. It is used to add 32 Gbps FC connectivity to the IBM SAN Volume Controller Storage Engine. This card also supports longwave transceivers that can be intermixed on the card with shortwave transceivers in any combination. Longwave transceivers are ordered by using feature ACHV.	Each adapter has four 32 Gbps FC ports and shortwave SFP transceivers.
25 GbE (RoCE) 2-port adapter	#AH1F	This feature provides one I/O adapter card with two 25 Gbps Ethernet ports, with no transceivers. It is used to add 25 Gbps Ethernet connectivity to the SAN Volume Controller Storage Engine and is designed to support iSCSI and NVMe RDMA. Note: This adapter does not support FCoE connectivity.	Each adapter has two 25 Gbps Ethernet ports. No transceivers.
25 GbE (iWARP) 2-port adapter	#AH1G	This feature provides one I/O adapter card with two 25 Gbps Ethernet ports, with no transceivers. It is used to add 25 Gbps Ethernet connectivity to the SAN Volume Controller Storage Engine and is designed to support iSCSI and RDMA with iWARP for clustering. Note: This adapter does not support FCoE connectivity.	Each adapter has two 25 Gbps Ethernet ports. No transceivers.

Item	Feature code	Description	Ports
100 GbE Card (RoCEv2) 2-port adapter	#AH1H	This feature provides one I/O adapter card with two 100 Gbps Ethernet ports, with no transceivers. It is used to add 100 Gbps Ethernet connectivity to the SAN Volume Controller Storage Engine and is designed to support iSCSI and NVMe RDMA. Note: This adapter does not support FCoE connectivity.	Each adapter has two 100 Gbps Ethernet ports. No transceivers.
64 Gbps FC 4-port adapter pair	#AH1J	This feature provides one I/O adapter card with four 64 Gbps Fibre Channel ports and shortwave SFP transceivers. It is used to add 64 Gbps FC connectivity to the IBM SAN Volume Controller Storage Engine. This card also supports longwave transceivers that can be intermixed on the card with shortwave transceivers in any combination. Longwave transceivers are ordered by using feature ACHV.	Each adapter has four 64 Gbps FC ports and shortwave SFP transceivers.
100 GbE SW QSFP28 SR4 Transceivers (pair)	#ACHN	This feature provides two 100 Gbps Ethernet software QSFP28 transceivers, for use with adapter AH1H.	N/A
10 GbE SW SFP+ Transceivers (pair)	#ACHR	This feature provides two 10 Gbps Ethernet software SFP+ transceivers, for use with adapter AH1F or AH1G.	N/A
32 Gbps FC LW SFP Transceivers (pair)	#ACHV	This feature provides two 32 Gbps longwave SFP transceivers for use with 32 Gbps FC I/O ports.	N/A
25 GbE SW SFP28 Transceivers (Pair)	#ACHZ	This feature provides two 25 Gbps Ethernet software SFP28 transceivers, for use with adapter AH1F or AH1G.	N/A
10 GbE SFP+ RJ45 Transceivers (Pair)	#ACJ1	This feature provides two 10 Gbps Ethernet software SFP+ RJ45 transceivers, for use with adapter AH1F or AH1G.	N/A

Cables

The following cable feature codes are available:

- ▶ #ACSQ: 1 m OM3 Fiber Cable (LC)
- ▶ #ACSR: 5 m OM3 Fiber Cable (LC)
- ▶ #ACSS: 10 m OM3 Fiber Cable (LC)
- ▶ #ACST: 25 m OM3 Fiber Cable (LC)

IBM SAN Volume Controller Expansion Enclosure

Note: The IBM SAN Volume Controller SV3 does not support external expansion enclosures.

Physical and electrical specifications

Specifications for the control and Expansion Enclosures are listed in the following sections.

IBM SAN Volume Controller (2145-SV3 and 2147-SV3)

The Control Enclosure includes the following specifications:

- ▶ Physical specifications of one Node. IBM SAN Volume Controller Model SV3 consists of 2 Nodes:
 - Height: 8.7 cm (3.5 in.)
 - Width: 44.6 cm (19.0 in.)
 - Depth: 82.6 cm (33.5 in.)
 - Approximate weight: 32 kg (70.54 lb)
- ▶ Air temperature:
 - Operating: 5 - 35°C (41–95°F) 0–3048 m (0–10,000 ft). Above 950 m, reduce maximum air temperature 1° per 300 m
 - Nonoperating: 1–45°C (34–113°F).
- ▶ Relative humidity:
 - Operating: 8%–80% noncondensing
 - Nonoperating: 8%–80% noncondensing
- ▶ Electrical power:
 - Voltage range: 200–240 V AC
 - Frequency: 50–60 Hz
 - Power: 809 W (Power varies with configuration and system usage; the maximum is shown)
 - Heat dissipation (BTU per hour): 2760
 - Acoustical noise emission: 6.9 bels (idling), 6.9 bels (operating)

Note: Consider the following points:

- ▶ 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.
- ▶ The IBM SAN Volume Controller SV3 does *not* support expansions.

Software and licensing

All IBM SAN Volume Controller Model SV3 systems feature IBM Storage Virtualize Software V8.6 or later preinstalled. The following product numbers are for the base licenses for each model of the IBM SAN Volume Controller Model SV3 system:

- ▶ IBM Storage Virtualize Software for SAN Volume Controller V8 (5641-VC8)
IBM Storage Virtualize Software for SAN Volume Controller V8 (5641-VC8) requires at least one IBM SAN Volume Controller Model SV3 for installation.
- ▶ IBM SAN Volume Controller virtualized external expansion enclosure capacity must be licensed as managed storage with an IBM SAN Volume Controller base license.

Note: The IBM SAN Volume Controller Model SV3 does *not* support expansion enclosures.

All features are inclusive except for encryption and external virtualization. Any connected storage 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-tebabyte license for the external storage systems to use these functions.

Consider the following points:

- ▶ The IBM SAN Volume Controller supports only external storage virtualization. Use of the external virtualization capability is entitled through the acquisition of IBM Storage Virtualize Software for IBM SAN Volume Controller (SW PID 5641-VC8 in AAS and SW PID 5725-M19 in IBM Passport Advantage®).
- ▶ With the IBM SAN Volume Controller system, a license exists for the hardware-assisted encryption if it is purchased (Encryption Enablement Pack [#ACE2]). 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.
- ▶ It is recommended to use the Encryption USB Drive Pack feature (#ACEB). This feature provides two USB flash drives for storing the encryption master access key. If encryption is to be used in a cluster, this feature should be ordered on one IBM SAN Volume Controller, which results in a shipment of two USB flash drives.

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

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

IBM Storage Virtualize External Virtualization Licensing

The IBM SAN Volume Controller 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 multiple tiers of storage. Licensing for these functions is based on the number of SCUs that are purchased.

With other functions, such as remote mirroring and FlashCopy, the license grants a specific number of tebibytes (TiB) 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 virtualized storage only.

The SCU is defined in terms of the category of the storage capacity, as listed in Table 5.

Table 5 SCU category definitions

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

Any storage use case that is not listed in Table 5 is classified as Category 1.

Table 6 shows an example of calculating SCUs. The example is a customer who virtualizes external disk arrays with 5 TB SCM devices, 30 TB SSD flash drives, 400 TB Enterprise drives, and 800 TB Nearline capacity.

Table 6 Example of calculating SCUs

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

A total of 431 SCUs are required for the example that is shown in Table 6. When you calculate the number of SCUs per category, fractions must be rounded up to the next higher integer number.

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

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Ordering information

For more information about ordering hardware features, see “Options and feature codes” on page 33.

For more information about ordering software licenses, see “Software and licensing” on page 38.

Related information

For more information, see the following resources:

- ▶ *Implementation Guide for IBM FlashSystems and Storage Virtualize Version 8.6*, SG24-8542
<https://www.redbooks.ibm.com/abstracts/sg248542.html>
- ▶ *Introduction and Implementation of Data Reduction Pools and Deduplication*, SG24-8430:
<http://www.redbooks.ibm.com/abstracts/sg248430.html>
- ▶ IBM Documentation - IBM SAN Volume Controller:
<https://www.ibm.com/docs/en/sanvolumecontroller/8.6.x>
- ▶ IBM SAN Volume Controller product page:
<https://www.ibm.com/products/san-volume-controller>
- ▶ IBM Offering Information page (announcement letters and sales manuals):
http://www.ibm.com/common/ssi/index.wss?request_locale=en
- ▶ IBM Storage Virtualize FAQ
Details about the IBM Storage Virtualize products, covering the IBM FlashSystem family and SAN Volume Controller:
<https://www.ibm.com/downloads/cas/2DWAMWRB>
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