Economical Storage for Diverse Workloads—Evaluating Next Generation IBM Storwize V5000

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Economical Storage for Diverse Workloads

With continued demands for greater capacity and faster storage systems, enterprises look for solutions that meet their needs for supporting differing workloads in their environments. There are a wide variety of workloads from applications that differ in performance and capacity demands. Additionally, there is variation in the need for advanced capabilities such as data protection and high availability with business continuity. Workload differences and advanced feature requirements exist across enterprises of every size. What is common is that these enterprises want the most economical solution for storing and managing information that has the characteristics to fulfill the workload requirements. The advanced functions that are required for many workloads and environments are usually only available in higher cost storage systems. To meet economic goals with storage systems that have advanced functions has been a struggle. A new generation of storage systems are bringing the functions needed at new price points to meet diverse workload requirements.

The storage solution must be able to scale to meet the predicted increase in workload and handle additional workloads expected to be introduced. The scaling includes not only addressing the additional capacity needs but also commensurate requirements around performance and connectivity. The enterprise features required are capabilities needed in operations for protection, availability, manageability, and business continuity. These capabilities all can be traced to economics of storing and managing information, either directly from operation improvements or impacts from interruptions that may occur without them.

Because of advanced enterprise feature differences, storage systems have historically been separated as to the applicability to different sizes of enterprise environments. Because of the need to meet workload demands with the most economical solution, storage systems are evaluated on their capabilities including needed advanced features rather than using an historical categorization to determine the best solution. Here we will relate the evaluation of the new generation IBM Storwize V5000 storage systems for enterprise environments with features and performance to meet a diverse set of workloads and do so with compelling economics.

In this document, we look more closely at system characteristics and advanced implementation of virtualizing underlying storage technology to explain use of the system to meet demands for differing workloads. The new IBM Storwize V5000 is the next generation of a mature system that offers a wide range of advanced features without the risks associated with new technology.

Flexibility in Solution Design

In evaluating a storage solution to meet current and predicted needs, the ability to be flexible with configurations and model upgrades enables the widest range of use and adaptability to meet changes encountered. Meeting current requirements based on performance and features is the first consideration but flexibility in exploiting additional features and increasing performance and capacity

without disrupting the environments adds value to the solution. The basic architecture and the ability to virtualize storage, to compress data, to encrypt data, to offer high availability configurations and automated tiering, gives the new Storwize V5000 with multiple models an advantage as a storage solution spanning different environments.

From SVC to V5000

One of the first storage software-based solutions to gain significant traction was IBM's SAN Volume Controller otherwise known as SVC. IBM has over twenty thousand installations of SVC and the number is still growing. The reason is easy to understand. Users can manage an often complex storage environment from a single point of control. And they can do so with a common set of functions across differing attached storage devices—functionality needed for production environments like local and remote replication, snapshots, and storage tiering.

Next generation IBM Storwize V5000

IBM continues to update the storage engine that virtualizes attached storage devices or systems that is a direct descendent from the SVC. It is the next generation of the Storwize V5000 that brings an economical solution with the capabilities to meet diverse workloads. It represents an implementation of IBM's core storage software virtualization engine—IBM Spectrum Virtualize—that is accessible and manageable by IT generalists as well as server virtualization administrators.

Like its predecessors, new Storwize V5000 has an architecture that virtualizes internal devices and in the largest model, externally attached storage systems. The V5000 presents the image of a target storage volume to the host. However, access to storage of both local and external devices is abstracted by the V5000 controller pairs to optimize capacity and performance while enabling a common set of features with centralized administration.

Storwize controllers are deployed together in pairs called an I/O group. The I/O Group uses IBM's custom software for high availability. In case of an I/O path failure between the host and storage devices, non-disruptive failover is performed within an I/O group. A pair is a minimum configuration. Currently, the largest V5000 model supports a maximum of two pairs of controllers making up a clustered system or system.

The new Storwize V5000 comes in three models (V5010, V5020, and V5030) that increase in functionality and capacity. The V5010 and V5020 models will be able to be non-disruptively upgraded to the next larger model by replacing canisters in the fourth quarter of 2016 (see Figure 1 below for configuration details).

	Storwize V5010	Storwize V5020	Storwize V5030
Solid State 2.5-inch Drives (SSD)	200, 400, 800 GB, 1.6 and 3.2 TB	200, 400, 800 GB, 1.6 and 3.2 TB	200, 400, 800 GB, 1.6 and 3.2 TB
2.5-inch (Small form factor) Disk Drives	15k, 10k, 7.2K rpm; Capacities from 300 GB to 2 TB/drive	15k, 10k, 7.2K rpm; Capacities from 300 GB to 2 TB/drive	15k, 10k, 7.2K rpm; Capacities from 300 GB to 2 TB/drive
3.5-inch (Large form factor) Disk Drives	15k, 10k, 7.2K rpm; Capacities from 300 GB to 8 TB/drive	15k, 10k, 7.2K rpm; Capacities from 300 GB to 8 TB/drive	15k, 10k, 7.2K rpm; Capacities from 300 GB to 8 TB/drive
Maximum Drives Supported	264 drives per system with 10 expansion enclosures: SFF enclosure: 24 x 2.5-inch drives LFF enclosure: 12 x 3.5-inch drives	264 drives per system with 10 expansion enclosures: SFF enclosure: 24 x 2.5-inch drives LFF enclosure: 12 x 3.5-inch drives	504 drives per system with 20 expansion enclosures and 1,008 drives in two-way clustered: SFF enclosure: 24 x 2.5-inch drives LFF enclosure: 12 x 3.5-inch drives
Connectivity - standard	1 Gb/s iSCSI	12 Gb/s SAS 1 Gb/s iSCSI	10 Gb/s iSCSI 1 Gb/s iSCSI
Connectivity – optional	16 Gb/s FC 12 Gb/s SAS 10 Gb/s iSCSI or FCoE	16 Gb/s FC 10 Gb/s iSCSI or FCoE	16 Gb/s FC 12 Gb/s SAS 10 Gb/s FCoE
Cache – per system	16 GB	16 or 32 GB	32 or 64 GB (128 GB with clustered pair configurations)
Capacity – per system	264 devices, 1PB	264 devices, 1 PB	504 devices, 2 PB or 1,008 device, 4 PB in clustered configuration
Processors	Two core (two thread)	Two core (four thread)	Six core

Figure 1. New IBM Storwize V5000 model Configurations (Source: IBM)

Figure 2. IBM Storwize V5000 Enclosure for SSD and 2.5" Disks (Source: IBM)

Figure 3: IBM Storwize V5000 Expansion Rack with solid state and mechanical disk (Source: IBM)

Software and Advanced Functions

Storwize V5000 software is built on Spectrum Virtualize software. Advanced function software availability depends on the model as follows:

Available on all models:

- Thin Provisioning – economically allocate space on demand
- Data Migration – transparently move data between volumes and from other systems
- FlashCopy – point-in-time copies of data for data protection and replication usage
- Remote Mirror – data protection across distance
- Easy Tier – economic use of different storage technologies with intelligent data placement and movement

- Encryption (exception: model V5010) – data at rest security

Additional advanced functions available on the model V5030 only:

- External storage system virtualization – optimize utilization and provide advanced features
- HyperSwap – business continuity and workload movement between infrastructure environments
- Real-time Compression – maximizing effective capacity for storing data

Advanced functions are discussed in more detail below.

New Generation V5000 Performance

In addition to the advanced capabilities and economical price of the new generation Storwize V5000, the performance of the different models covers a wide range of requirements for different workloads. Performance increases with the use of SSDs and Easy Tier optimizes the economics of having both SSDs and HDDs configured by intelligently placing and moving data based on access characteristics.

Performance tests done by IBM show that starting with the Storwize V5010, the performance essentially doubles from one model to the next. This gives customers a clear understanding of performance expectations and the path moving forward in upgrading systems to the next model as performance demands increase. Positioned below the V7000 in the Storwize family, the new generation V5000 gives additional choices for performance with enterprise features at economical price points.

Advanced Functions from IBM Spectrum Virtualize

FlashCopy—is IBM's host-independent creation of point in time copies across logical devices. FlashCopy implements copy-on-write technology for space efficiency at the virtual disk volume or VDisk level. Consistency Groups can also be established for related volume sets. FlashCopy targets may become restore points for the source system without breaking the source/target relationship and without having to wait for the original copy operation to complete. Multiple targets and multiple rollback points are supported. IBM now offers multiple ways to implement FlashCopy technology (Cascaded, Incremental, Space Efficient, etc.) supported on the V5000[1].

Thin Provisioning—also called "Space Efficient VDisks" is done at the VDisk level. Here, the physical storage capacity consumed is allowed to be less than the capacity reported to the host. Thinly provisioned VDisks may be configured to automatically add capacity available to the host once a specific

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[1] For more information on Flash Copy as well as other V5000 features and advanced functions, see the Evaluator Group's IBM Storwize 5000 Product Analysis

threshold is crossed. Regular VDisks may be converted into thin provisioned VDisks. Capacity is allocated with a granularity of either 32 KB, 64, 128 or 256 KB.

Easy Tier—performs automated tiering of data across the V5000's solid state disks and hard drives as well as internal and external storage. Easy Tier monitors storage accesses and automatically moves "hot" data objects to the highest performance tier devices. Cooler data is moved to the lower performance, high capacity storage devices. The size of the tiered data object is based on a storage pool setting which can be 16 MB to 8 GB with a default size of 256 MB. Easy Tier supports three performance/capacity tiers, which include solid state and hard disk drives.

Non-Disruptive Data Migration—accomplished between arrays within a V5000 storage system or from external storage attached to a V5000 I/O Group. Data migration operates while allowing access to the volumes being migrated. A primary use case for this function would the retirement or displacement of an older generation storage system—one supported for attachment to the V5000[2].

Real-Time Compression (RTC)—compresses block data entering the V5000 in real time and stores it in compressed form. When accessed, data is decompressed before sending to the host. RTC is supported for both internal storage and external (model V5030) storage systems attached to the V5000. Storing more data for a given physical capacity, called effective capacity, greatly reduces the cost of storage. The efficiency of compression becomes a major economic factor in getting more capacity for the same cost.

Data-at-rest Encryption— supported for both internal and external storage on the model V5030 and on the model V5020 for internal storage only. Encryption is a required data protection feature in many environments such as healthcare and financial services. Not only does the data protection include devices taken from the storage system but also the secure erase of data when the storage is applied to other uses or no longer in use.

Storage devices internal to the V5000 system are encrypted using encryption hardware on the device adapters. The encryption of externally attached storage is done when data is written to the external storage using the internal processor special instructions. External storage encryption is controlled at the storage pool level and managed automatically when migrated with Easy Tier.

HyperSwap— Model 5030 supports a feature called HyperSwap—an active-active stretched cluster implementation that provides an automated disaster recovery and business continuity solution as part of the total package. We believe this to be a significant feature addition, particularly for virtualized server environments. HyperSwap can be seen as a fully automated disaster recovery capability that does

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[2] For more information on V5000 supported third party arrays, see IBM's current support matrix.

not require additional hardware beyond a second V5000 running at a remote site. This capability has significant implications in virtualized server environments that include:

Non-disruptive Operations—assurance of continuous availability for critical business applications running in a virtualized server environment

Workload Mobility—movement of a primary or secondary application VM another location to balance the current workload, or to take the primary application server temporarily off-line for technology updates

Non-disruptive Data Migration—non-disruptively migrate data when performing technology updates and server additions

VMware Integration

IBM Storwize V5000 supports VASA 2.0 and VVOLs beginning with the 7.6 release of Spectrum Virtualize software and the VASA Provider. The VASA 2.0 provider uses IBM Spectrum Control Base running in a virtual machine that communicates with vSphere.

IBM Storwize V5000 also supports the VMware vStorage APIs for Array Integration (VAAI), introduced with vSphere 4.1. VAAI is a set of mechanisms that allow processing for certain data-related services—copying data when creating a new VM, for example—to be offloaded from the ESXi host to a storage array. The intent of these APIs is to streamline the functioning of the ESXi server and speed-up delivery of storage-supported services. These include: Full copy, Block Zeroing and Hardware-Assisted Locking.

Management User Interface

Like a number of IBM storage systems, V5000 offers a web-based GUI for management that was adapted from the IBM XIV storage system. It is an advanced, intuitive management interface initiated by communicating with V5000 nodes over an Ethernet link to an IP address established during installation. It includes a Storage Mobile Dashboard giving administrators basic monitoring capabilities via a mobile device to securely check the health and performance status of V5000.

Evaluator Group Assessment

Meeting the performance and functionality demands for workloads with an economical and efficient system is the basic goal in the evaluation of a storage system. Finding a system that can scale non-disruptively in function, performance, and capacity is also part of the consideration as demands continue to increase. For enterprises, many varied workloads may be served by economical storage systems with attributes of efficiency and scale. The new generation of IBM Storwize V5000 systems have expanded the choices with characteristics and capabilities to address many enterprise environments with midsize workloads at a very attractive cost.

We think that because the V5000, based on the SVC's widely used foundation, enables the new generation models to enter the market as mature and reliable systems. One aspect that speaks to the efficiency of the system is the management application that comes with the V5000. It simplifies installation and ongoing management designed for the IT generalist. It also offers the kind of advanced storage and data management functions that administrators rely upon for mission critical application support. These include point-in-time copy and remote copy, automated performance tiering, and active-active failover. Therefore, we believe that the capabilities, stability, and cost of the new Storwize V5000 make it an excellent storage solution that will provide real value in addressing a diverse set of workloads.

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