

IBM FlashSystem Enterprise Solution with SAN Volume Controller

***A Recipe for Dramatically Improving
Application Performance, Storage Capacity and
Total Cost of Ownership***

A Robert Frances Group Publication

Published December 2013

Principal Authors

Cal Braunstein
CEO, Chief Research Officer
Robert Frances Group, Inc.

Gary MacFadden
Principal Research Analyst
Robert Frances Group, Inc.

Table of Contents

INTRODUCTION	1
DATA STORAGE, SOLUTIONS AND SERVICES GROWTH	1
THE NEED FOR SPEED – ANYWHERE, ANYTIME	2
ENTERPRISE HDD SALES STILL DOMINATE, FOR NOW	2
HOW TO SOLVE CAPACITY, COST AND PERFORMANCE CHALLENGES.....	3
WHY HDDS COST MORE THAN IBM FLASHSYSTEM ENTERPRISE SOLUTION	5
FLASHSYSTEM, SVC AND HIGH AVAILABILITY	8
KEY FINDINGS	8
RECOMMENDATIONS.....	9
CONCLUSION	11
END NOTES	11

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

INTRODUCTION

The performance advantages of deploying enterprise-grade Flash, whether implemented in a hard disk drive form-factor like SSDs or in a rack-mounted array, are well known to savvy application owners and IT executives. What is much less well understood is how Flash technology, when paired with complementary technologies such as real-time compression and a storage virtualization solution, dramatically improves data storage capacity and overall storage costs for supporting mission-critical applications where the need for speed or lower latency is paramount.

Despite conventional wisdom regarding the total cost of ownership (TCO) for high-performance storage, Flash is not 10x or 20x the cost of conventional performance-grade, spinning, hard disk drives (HDDs). The HDD portion of a conventional storage solution may represent less than 20% of the TCO, while the other 80%-plus is attributable to floor space, power and cooling, capacity growth, additional administration, maintenance, additional equipment, and software costs. A thoughtfully engineered, performance-centric, storage tier leveraging IBM FlashSystem™ technology and the latest version of SAN Volume Controller™ (SVC) is in reality a lot less expensive than a comparably performing all-HDD solution – as we shall see.

DATA STORAGE, SOLUTIONS AND SERVICES GROWTH

Demand for data storage capacity continues to grow at an unprecedented level, roughly 40% or more per year within most data-intensive enterprises.¹ Major drivers include requirements for storing and making use of the overwhelming variety of Big Data, including documents, emails and other forms of messaging or social media, images, machine data and video as well as a booming analytics industry. Analytics touches every type of transaction in every industry, whether online ad serving, dating, gaming or shopping, financial modeling and trading, fraud detection, genomic and other types of medical research, predictive analytics and sentiment analysis.

Meanwhile, most enterprises have data center floor space constraints and limited data storage capacity for supporting test environments or backing up and replicating data. Many enterprises also have limited primary storage capacity. At the same time, cloud computing services have emerged as a major force in providing secure, elastic, and agile enterprise-class storage capacity and offer varying degrees of performance based on user or application requirements, quality of service (QoS) or service level agreements (SLAs).

IBM FlashSystem Enterprise Solution with SAN Volume Controller: *A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership*

Cloud service providers (CSPs), such as Amazon, are among the largest consumers of data storage and are on the leading edge of deploying innovative storage solutions leveraging Flash. Enterprises that manage their own multi-petabyte data stores are looking to emulate web-scale storage deployment models to improve the efficiencies and speed of the services they provide to their internal customers.

THE NEED FOR SPEED – ANYWHERE, ANYTIME

Accompanying data growth is the desire for quicker access to data and faster time to complete queries and transactions – in other words, a faster time-to-value. The proliferation of various personal mobile devices used for work – the so-called BYOD² phenomenon – has created challenges for enterprise IT but also produced enormous productivity gains for users. Virtual Desktop Infrastructures (VDI) have lessened IT's pain in having to simultaneously support multiple mobile device standards such as Microsoft *Windows*, *iOS* from Apple and Google's *Android* operating system.

Flash storage solutions have proven to be instrumental in alleviating bottlenecks for VDI applications and other traditionally I/O-bound applications such as OLTP and database queries. While IOPS, or input/output instructions per second, is a key factor in measuring data storage performance, lowering latency (the time it takes to complete a transaction) is critical. Traditional HDDs have moving parts, including spinning disks and an actuator arm – not too dissimilar from a record player. It takes time, usually measured in milliseconds, for the arm to seek and “read” the requested data. It also takes time to update data and “write” it back to disk, increasing disk latency and slowing transactions. Flash has the advantage of no moving parts and can perform reads and writes anywhere from 10x to 100x faster than HDDs.

Flash storage not only improves data access time, it enables work that otherwise would not be possible. If a query that would take 5 seconds to run with data stored on Flash instead took almost 10 minutes using HDD, imagine the impact on the workflow of various professionals, including a doctor looking up a patient history or a sales rep trying to retrieve a potential buyer's previous purchases or credit information.

Flash storage not only improves data access time, it enables work that would otherwise not be possible.

ENTERPRISE HDD SALES STILL DOMINATE, FOR NOW

Despite performance advantages of Flash, HDDs still outsell SSDs for enterprise data storage solutions by 30 to 1 or more.³ There are at least two primary reasons why. First, enterprise HDD demand, in general, remains strong, even as sales are showing signs of decline. The second factor for continued enterprise adoption of HDDs is the lower cost per gigabyte and higher capacity argument.

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

According to a recent TrendFocus, Inc., report,⁴ enterprise HDD sales eased slightly in Q2 2013 and are expected to be flat in Q4, which may be an early indication that enterprise HDD sales are finally softening. However, the adoption of Flash storage solutions may be only partly responsible. Compression, deduplication, and storage virtualization are likely also cutting into HDD sales.

HDDs have continued to push the envelope on delivering high capacity, up to 6TB per drive. Yet, Flash systems are not far behind, with 4TB SSDs available today. The logic for increasing drive capacity is obvious: More capacity per drive means a smaller, greener and lower-cost footprint. Perhaps the greatest gating factor for continuing HDD sales dominance remains cost per gigabyte. A raw gigabyte of enterprise HDD storage may cost less than 10 cents, whereas a raw “gig” of lower-cost Flash (there are several grades of enterprise Flash) may cost as much as \$2. However, the cost per gigabyte and capacity comparisons are not relevant when performance is the primary goal. In addition, Flash drives – because they have no moving parts – tend to be more reliable and longer lasting than HDDs.⁵

It is possible that within 5 to 10 years, Flash solutions will not only completely dominate the enterprise performance storage space for Tier 1, mission-critical applications, Flash will also compete with HDDs for Tier 2 storage applications. Until that occurs, enterprise storage buyers will continue to rely on HDDs for capacity requirements and look to data storage vendors for innovative solutions for improving HDD performance and lowering costs.

HOW TO SOLVE CAPACITY, COST AND PERFORMANCE CHALLENGES

Ironically, the best way to improve HDD data access speed while reigning in costs and lowering capacity demand is the introduction of a Flash storage layer to manage “hot” data and also to compress most data before it is stored or archived to HDD.

The following chart demonstrates the TCO of a data storage performance tier configuration for a fictitious \$1-billion company over 5 years (includes 25% capacity growth each year). The comparison assumes an initial requirement of 500 terabytes of “raw” HDD for the performance tier – roughly one-third of the company’s total storage assets – and the need for 800,000-plus IOPS at the outset.⁶

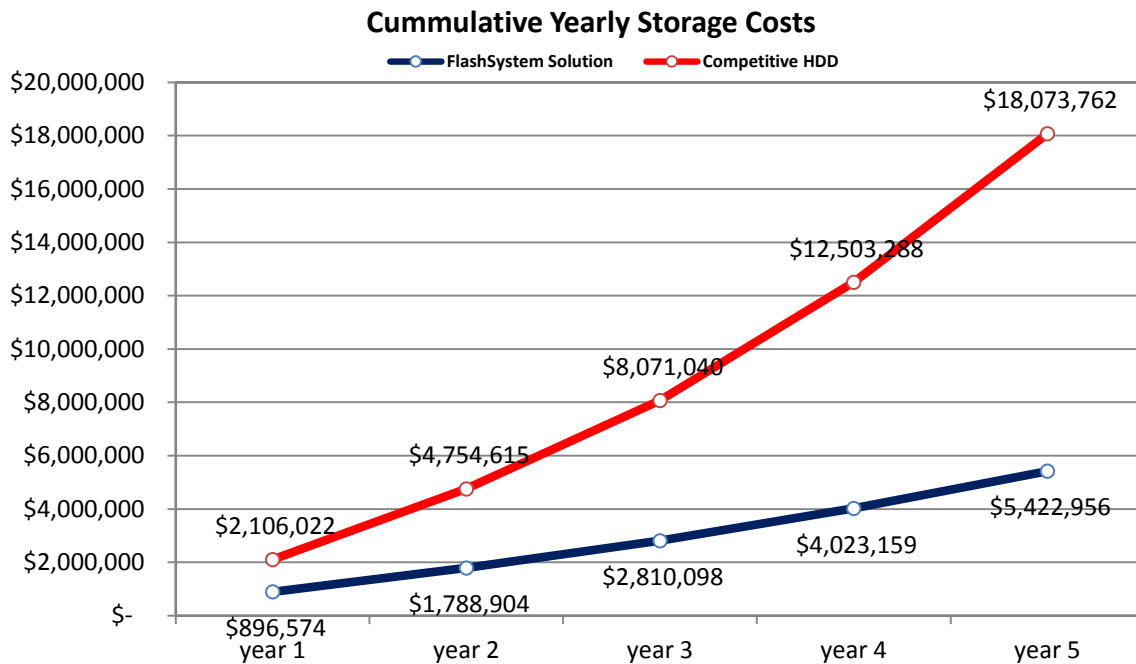
IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

IBM FlashSystem Solution vs Traditional HDD TCO Comparison			
	FlashSystem	Traditional HDD	Discounts included in TCO analysis
Purchase Analysis			
Total Purchase Price	\$ 2,795,385	\$ 5,461,739	40 TB Flash + 210 TB Storwize usable +SVC vs. 500 TB HDD \$355K FlashSys \$1.57/GB Storwize vs. \$1.97/GB 15k RPM HDD Storwize 219 1.2 TB drives; HDD 2,778 300 GB drives; 25% AGR FlashSystem 90% utilization Storwize & HDD 60% utilization FlashSystem 860,000 IOPS vs. 833,400 IOPS HDD production costs only; no dev/test/DR basic storage and SVC software (including RT compression)
cost per drive			
number of initial drives			
utilization rates			
drive performance			
Purchase Price - hardware	\$ 1,933,614	\$ 2,938,710	
Purchase price - software	\$ 861,772	\$ 2,523,029	
One Time Expenses annualized			
hardware yearly cost	\$ 386,723	\$ 587,742	includes 8% financing over 5 years storage administrator costs \$160K per year fully-loaded assumes bulk purchases Warranty plus 24x7x4 support for 5 years assumes basic storage software and SVC costs (hybrid)
deployment	\$ 14,536	\$ 34,675	
provisioning	\$ 87,123	\$ 70,203	
warranty	\$ 127,681	\$ 384,062	
software	\$ 172,354	\$ 504,606	
Ongoing Expenses			
Administrator costs	\$ 203,550	\$ 1,215,651	\$160k/FTE, 200 TB/admin HDD, 400 TB Storwize, 500 TB FlashSys annual training costs 1.25% of administrator costs warranty for year 1 plus maintenance years 2 through 5 FlashSystem 300 watts, Storwize 27 watts, HDD 42 watts each \$800/sq ft/rack (FlashSystem uses 2 racks, HDD 12 to 29 racks)
Administrator training	\$ 2,544	\$ 15,196	
Maintenance - software	\$ 47,639	\$ 280,654	
Power and Cooling	\$ 18,441	\$ 427,565	
Facilities	\$ 24,000	\$ 94,400	
Average Yearly Cost	\$ 1,084,591	\$ 3,614,752	FlashSystem \$5,422,956 HDD \$18,073,762 in 5 years 5 yr NPV: FlashSystem \$4,250,162 HDD \$13,902,453

Copyright © 2013 by Robert Frances Group

As the chart above illustrates, IBM FlashSystem Enterprise Solution, a combination of the FlashSystem 820 and SAN Volume Controller (SVC) with Real-Time Compression, costs 70% less per year than a pure-play HDD solution. Furthermore, when one looks at the expenses on a year-over-year basis (see chart, below) one can easily see how the use of the FlashSystem solution approach contains cost, while the traditional method has costs rising exponentially.

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership



Data storage buyers should expect these results to be welcome news for a number of business stakeholders, including application owners who want their apps to run faster, CIOs looking to meet performance and capacity demands, facilities management executives crunched for floor space in the data center and CFOs eager to flatten or reduce data storage expenditures.

WHY HDDS COST MORE THAN IBM FLASHSYSTEM ENTERPRISE SOLUTION

For almost 50 years, the conventional way of buying data storage was to focus primarily on capacity. If capacity were the only consideration, then HDDs would be less expensive by an order of magnitude or more. However, in today’s business environment, speed trumps capacity.

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

Latency = Performance: By today's standards, HDDs are very slow. A good measure of latency for enterprise-class, high-performance HDDs would be 3 to 5 milliseconds, whereas FlashSystem 820 latency is rated at 100 microseconds or up to 50x faster. In terms of IOPS, the other performance benchmark used for data storage drives, the fastest enterprise-grade HDDs are rated at roughly 400 IOPS per drive, whereas a single, enterprise-grade, near-commodity-level Flash drive can produce more than 400,000 IOPS. In other words, an application requiring 400,000 IOPS would need 1,000 "high-performance" HDDs to meet the same performance requirements as a single Flash drive. Today's application workloads are mostly IOPS or I/O intensive, including all transaction-oriented and analytic workloads such as OLTP and OLAP.

Disk Utilization: To boost HDD performance and lower latency, less data is placed on each disk, a process referred to as "short stroking" which minimizes the distance an actuator arm has to travel across a spinning disk to read or write data. This limits the storage capacity of each disk or what is referred to as the utilization rate per drive.

No moving parts in Flash systems removes the need for short stroking. Utilization rates for the FlashSystem are 90% or greater, even with overhead for RAID 5 data protection included in the configuration; whereas 60% utilization is at the high end of the spectrum for short-stroked, high-performance HDDs.

More Disks = More Management Costs: More disks equate to more floor space taken up in the data center, more wiring, more enclosures and the need for more people to manage additional storage assets. High-performance HDDs need to spin faster and carry less capacity, thus the 15k rpm, 300-gigabyte drives used in this TCO comparison.

Higher Licensing Fees: In aggregate, HDDs command a higher licensing fee for storage management software (usually priced per disk drive), and warranties are higher as HDDs have moving parts and breakdown more often than SSDs or Flash systems, which have no moving parts.

FlashSystem vs. All HDD (TCO highlights, Performance storage)

FlashSystem cost 70% less than all HDD storage solution over 5 years (\$5.4m vs. \$18.1m)

Energy consumption advantage for FlashSystem vs. all HDD 24:1 (\$427k for all HDD vs \$18k for FlashSystem over 5 years)

Storage Administration over 5 years costs 6x more for all HDD (\$203k for FlashSystem vs. \$1,215k)

Software maintenance fees for all HDD 6x higher than for FlashSystem (\$281k for all HDD vs. \$48k for FlashSystem over 5 years)

All HDD facilities cost 4x more than FlashSystem (\$94k for all HDD vs. \$24k for FlashSystem over 5 years)

IBM FlashSystem Enterprise Solution with SAN Volume Controller: *A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership*

Power and Facilities Costs: More disks take up more space in the data center and consume more power. Even if power consumption were equal for each HDD and SSD drive, without Flash storage in the mix, many more drives are necessary. With the introduction of the FlashSystem Enterprise Solution, the IBM configuration is able to utilize higher-capacity, lower-wattage Storwize HDDs as the Flash systems meet the bulk of performance (IOPS) requirement.

SVC Storage Virtualization and Compression: According to IBM, [SAN Volume Controller](#) (SVC) “is a storage virtualization system with a single point of control for storage resources.” Storage virtualization allows multiple physical storage devices that may or may not be geographically dispersed to be managed from a single console. SVC is storage agnostic, meaning it manages storage devices manufactured by IBM or from a variety of other storage suppliers.




Due to the deployment of SVC with Real-Time Compression (RTC) and Flash as a “caching” layer between the server processing data and the storage media, the IBM solution only requires 250 TBs of data storage to start. A 2/1 compression ratio used for this TCO is a very conservative estimate. IBM suggests customers have achieved up to 5/1 compression ratios utilizing RTC.

Storage compression technologies available from traditional HDD vendors are often not used in performance environments as they can appreciably slow response time. Independent lab validation indicates that IBM SVC with real-time compression and multiple engines, as configured in our example above (6-core, 4 node, 24 GB/node - x3650M4 configured for redundancy and high availability), does not appreciably degrade performance – unlike many traditional disk compression solutions. In addition, the lab test indicated SVC was able to reduce consumed storage capacity by 82%.⁷

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership



IBM FlashSystem Portfolio

Extreme Performance	MicroLatency™	Macro Efficiency	Enterprise Reliability
<p>IBM FlashSystem IBM Flash System 720/820 IBM Flash System 710/810</p>	<p>Extreme Performance</p> 	<ul style="list-style-type: none"> • Boost enterprise productivity • Improve application performance • Ideal for OLTP, data warehousing and OLAP environments • High availability system 	
<p>IBM FlashSystem Enterprise Solution IBM Flash System 820 San Volume Controller (SVC)</p>	<p>Enterprise Features</p> 	<ul style="list-style-type: none"> • Acceleration of applications • Enterprise feature sets to ensure data protection 	
<p>IBM Storwize V7000 FlashSystem Edition IBM Flash System 820 IBM Storwize V7000</p>	<p>Performance Economics</p> 	<ul style="list-style-type: none"> • Acceleration of applications • Competitive economics • Enterprise feature sets to ensure data protection 	

1 ibm.com/storage/flash ©2013 IBM Corporation [IBM FlashSystem Overview](#)

FLASHSYSTEM, SVC AND HIGH AVAILABILITY

The IBM FlashSystem Enterprise Solution includes SVC with RTC and has been configured to be highly available as most enterprise mission-critical applications cannot fail, whether due to disaster, downtime for backup or technology refreshes. While HDD solutions can be configured for high availability, our example is not since that would have added even more cost. SVC with its redundant controllers and other components is designed to maintain availability and performance regardless of any internal system component failures.

Likewise, the IBM FlashSystem 820 in our example is configured using mirrored Flash arrays to maximize redundancy, and each array has built-in battery backups as well as redundant RAID controllers, fans, power supplies and management control processors to ensure data availability and integrity along with minimizing the chance of lost transactions.⁸

KEY FINDINGS

- The IBM FlashSystem 820 combined with SAN Volume Controller (SVC) and Real-Time Compression (RTC) outperforms traditionally configured all-HDD, high-performance storage solutions in both overall costs (TCO) and storage asset utilization.⁹
- While it is possible to configure an all-HDD solution with an equal amount of IOPS to the

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

IBM FlashSystem Enterprise Solution configuration shown here, the cost to do so is prohibitive. Moreover, latency issues inherent with the electro-mechanical design of HDDs limit their ability to achieve the sub-100-microsecond latency and performance of enterprise-grade Flash.

- Not all compression technologies are created equal. SVC with RTC from IBM does not appreciably affect processing speed and avoids performance bottlenecks while dramatically increasing useable storage space and lowering storage refresh costs. Typically, compression technologies for all HDD storage solutions increase latency.
- More disks mean higher admin, facilities, maintenance and software licensing costs. The FlashSystem is easier to administer, is less prone to hardware failures as it has no moving parts, and has higher utilization rates than traditional HDDs.
- A performance storage approach that deploys Flash to manage read and write traffic between server and storage assets has many performance and cost advantages over traditional high-performance HDDs. Over a 5-year timeframe, the IBM FlashSystem Enterprise Solution will require fewer technology refreshes while maintaining superior utilization at a lower cost. With FlashSystem, higher-capacity HDDs such as Storwize can be deployed within the performance storage tier without degrading performance.
- A traditional, all-HDD, performance-centric storage tier over 5 years will cost 70% more than an IBM FlashSystem configured with SVC and RTC.

RECOMMENDATIONS

Application Owners: Fast, affordable storage technologies such as Flash are enabling applications and users to accomplish tasks that were considered impossible only a few years ago. Beyond the buzz of so-called application-aware storage or software-defined storage solutions (SVC is an example), application owners should understand that storage software solutions coupled with Flash hardware can exponentially increase response time for many of their transaction- and analytics-dependent applications. When performance counts, Flash is available today in a variety of comparatively inexpensive configurations. Find out if your organization has a Flash and storage virtualization strategy and, if so, how it impacts your business needs.

Facilities Managers: Unless you are among the few lucky organizations that has data center space to spare, Flash and SVC with RTC together solve a huge footprint problem as well as lowering power and cooling costs. Introducing a solution such as IBM FlashSystem Enterprise Solution will also help to slow capacity demand. If you haven't already, have a discussion with your CIO or relevant IT staff, application owners, and members of the CFO organization.

CFOs and Finance Departments: Advances in Flash, storage virtualization software, and data compression are disrupting traditional data storage cost paradigms. Storage capacity planning is quickly being augmented or replaced by storage performance planning for all but the most

IBM FlashSystem Enterprise Solution with SAN Volume Controller: A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership

traditional HDD storage applications such as archiving files or inactive data workloads. New business applications that drive revenue and support innovation and decision making thrive on fast storage. Finance departments, if they haven't already, need to develop an aggregated, unified view for storage TCO. When it comes to data storage and storage software, many firms still have separate budgets for IT, facilities management, and lines of business.

IT organizations may be constrained by a storage budget that focuses primarily on capacity, while application owners get charged back for quality of service or SLAs that do not meet their needs. Meanwhile, facilities managers are struggling to lower costs and consolidate data center assets. Finance needs a holistic view of storage costs to determine the true TCO for storage.

CIOs and IT Staff: With IT budgets mostly flat, save specific situations, IBM and other technology service providers estimate that 75% of IT budgets are dedicated to just keeping existing systems running. That does not leave much money left to innovate. Meanwhile, data storage is among the fastest, if not *the* fastest-growing equipment expenditure for IT. CIOs and their staff are expected to improve service levels without necessarily increasing costs. In many IT organizations, the process for acquiring and managing storage is broken. Data is proliferating, in some organizations doubling in size every 18 to 24 months.

Data deduplication and retention policies can help alleviate some of the storage demand. However, demand for more and diverse types of data, including streaming data from social media sites or customer service systems, machine data, medical archives, or financial data, shows no sign of abating. The new world order is more and faster data. At the same time, traditional HDD storage assets still need to be amortized and made more efficient if possible.

All CIOs need to have a Flash and storage virtualization strategy along with a process for deploying new, more advanced technologies to boost performance of existing storage and improve their organization's ability to keep up with the business transformation that is being enabled by disruptive technologies such as Flash, SVC and RTC. CIOs need to pull together the top storage stakeholders, share their vision of how fast storage will help transform the entire organization and make the case for why faster storage is actually a lot less expensive than what they currently have. Physical storage and storage software should be viewed as a strategic technology, not as a necessary expense.

CIOs need to have a Flash and Storage Virtualization strategy along with a process for deploying new, more advanced storage technologies.

All Storage Stakeholders: RFG recommends CIOs, CFOs and other stakeholders use our unified TCO model included in this document as a tool to discuss how the storage cost paradigm can shift from capacity-centric to performance-centric. Modify the tool for your own unique

IBM FlashSystem Enterprise Solution with SAN Volume Controller: *A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership*

requirements by plugging in your anticipated storage costs and requirements.

CONCLUSION

Despite much wider adoption of Flash storage within the enterprise space, HDD is still the overwhelming favorite for meeting storage capacity needs. RFG anticipates Flash will continue to erode the current ratio of 30-to-1 HDD vs. SSD, especially as Flash prices continue to become competitive and the need for speed begins to encroach on previously non-mission-critical application workloads such as real-time analytics and database queries.

There is no question that Flash is faster and, viewed through the lens of performance, it is also a lot less expensive than HDDs. For the foreseeable future, enterprises will also need to manage their existing HDD assets as efficiently as possible.

IBM FlashSystem Enterprise Solution combines high-speed Flash arrays with SAN Volume Controller and Real-Time Compression to deliver a transformative solution that will help users make the leap from capacity-centric storage acquisition practices to the brave new disruptive world of fast data storage as a strategic business asset.

END NOTES

¹ Research from Forrester, Gartner, IDC and other IT advisory firms concur that enterprise data storage growth is at or exceeds 40% per year – conservatively.

² Bring your own device (BYOD) has gained popularity and caused difficulty for IT shops looking to standardize on a single mobile platform.

³ [Trend Focus Report](#), October 2013, indicates 140 million HDDs sold in 2012.

⁴ [Trend Focus Report](#), October 2013, indicates slower growth for HDDs in Q4 2013.

⁵ There is more data available on HDD drive failures than on enterprise Flash. See [How long do HDDs live?](#) Flash storage longevity depends on a number of factors, including the grade of Flash, e.g., MLC or SLC, P/E cycles, garbage collection, striping and other techniques to improve longevity such as adding more server memory. IBM FlashSystem 820 uses eMLC (enterprise multi-level cell) Flash, which accommodates more write cycles than consumer-grade MLC. For more details, consult [IBM FlashSystem data sheet](#).

⁶ Together, RFG and IBM determined that a company with \$1 billion or more in sales would likely be managing at least 1.5 petabytes of data. Some large companies have already reached the 20- to 50-petabyte range.

⁷ [Lab Validation Report produced by ESG](#) for IBM on SVC and Real-Time Compression.

⁸ For more detail on [FlashSystem and SVC Configuration Examples](#), view this recent “Redpaper” authored by IBM Master Inventor Barry Whyte.

⁹ Storage utilization for FlashSystem is much higher as IBM has published only the useable storage number, opposed to a raw storage capacity number that most storage manufacturers publish. For more details, please review the [FlashSystem Data Sheet](#). Two 820s with 20 TBs of useable TBs each is what is used for this TCO.

IBM FlashSystem Enterprise Solution with SAN Volume Controller: *A Recipe for Dramatically Improving Application Performance, Storage Capacity and Total Cost of Ownership*

About IBM

IBM, FlashSystem 820, SAN Volume Controller (SVC) and Real-time Compression are trademarks of International Business Machines Corporation in the United States, other countries or both.

About Robert Frances Group

Cal Braunstein spent 30 years at IBM in management and IT operations and development roles. He is a co-founder, Chief Research Officer and CEO of The Robert Frances Group (RFG). He can be reached at cbraunstein@rfgonline.com

Gary MacFadden is a 20-year veteran of the IT research and advisory industry, Principal Research Analyst and a co-founder of RFG. He can be reached at gary@rfgonline.com.

© 2013 Robert Frances Group, Inc. All rights reserved. <http://www.rfgonline.com/>

No part of this document may be reproduced in any form by any means, nor may it be distributed without the permission of Robert Frances Group, Inc., nor may it be resold or distributed by any entity other than Robert Frances Group, Inc., without prior written authorization of Robert Frances Group, Inc.

THIS DOCUMENT IS PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND. ALL EXPRESS OR IMPLIED REPRESENTATIONS, CONDITIONS, AND WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE DISCLAIMED, EXCEPT TO THE EXTENT THAT SUCH DISCLAIMERS ARE DETERMINED TO BE ILLEGAL..