Flash Ahead:

Leveraging IBM® FlashSystem™ to Dramatically Improve Application Performance and Data Center Economics
Table of Contents

• In Business, Timing Is Everything – Especially for Business-Critical Applications ................................................................. 3

• The Challenge (Hint: It’s NOT Processor Speed) ................................................................. 5

• The Solution: All-Flash Storage Systems .................................................................................. 7

• Getting Started with Flash .................................................................................................... 10

• Additional Resources ........................................................................................................ 12

• Appendix: Some Additional Technical Details on IBM FlashSystem ..................................... 13
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

In Business, Timing Is Everything – Especially for Business-Critical Applications

Anyone who has seen the movie Apollo 13, or is old enough to remember that ill-fated space flight, knows what can happen when mission-critical systems break down. Three NASA astronauts barely survive an explosion that damages their spacecraft on the way to the moon, and it is only through the most heroic efforts, and a modicum of luck, that they are able to make it back home alive. Fortunately, the potential consequences of the failure of most business-critical applications (as opposed to operationally critical apps used in hospital emergency rooms, air traffic control systems, etc.) are seldom so stark. But they can mean the difference between a healthy, growing company and one that is struggling to keep pace with its competitors.

A variety of applications fall under the rubric of “business critical.” They include: business intelligence (BI), online transaction processing (OLTP), online analytical processing (OLAP), virtual desktop infrastructures, high-performance computing and content delivery solutions (such as cloud storage and video on demand).

All of these critical applications have one thing in common: the need for rapid response times to ensure delivery of content that is vital to management, employees, customers and other key business partners.
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

Delays in delivering critical data and in processing can significantly increase business and financial risks. Among other problems, such delays can lead to:

• **The inability to gain timely insight into a business** – If critical data cannot be accessed when and where it is needed, the result is often poor decision making and subpar results that might otherwise have been avoided

• **A sharp decrease in the ability to predict business outcomes** – Good pro forma financial projections at the project, line-of-business and company level depend on timely access to the best data available. An inability to access and perform the necessary analytics on that data can hurt performance

• **Increasing customer dissatisfaction** – In many industries (e.g., financial services, healthcare, travel), when it comes to customer service, having immediate access to current information is a necessity, not a luxury, especially when customers have grown accustomed to 24/7/365 service. In this environment, being unable to deliver the information your customers want, when they want it, can lead not only to lost sales but also to lost customers and market share

• **Unmanageable volumes, variety and velocity of information** – As big data grows even bigger, many IT departments are running into a wall in terms of the performance of key applications. Increasing latency translates into frustrated users and missed opportunities for the business

For the IT manager, determining how to address these concerns while balancing user needs with timely implementation, scalability of solution and ever-present budget restraints is never easy. And in the end, the best solution may not be what you think of first.
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

The Challenge (Hint: It’s NOT Processor Speed)

Historically, the first response to system-wide latency issues has typically been to add or upgrade processing and memory power. But too often this results in minimal improvements at significant cost. A second and often simultaneous approach, at least when database performance is the issue, has been for enterprises to invest millions of dollars to improve the efficiency of their SQL statements. But while tuning SQL can result in performance improvements, even the best SQL cannot make up for poor storage I/O, which is often where the real problem lies.

Flash Ahead: Leveraging IBM® FlashSystem™ to Dramatically Improve Application Performance and Data Center Economics

In fact, in many cases it is storage-side performance, not processor speed or insufficient memory, which is the principal cause of application performance issues.

When the CPU has to wait on information from storage, time and resources are wasted. And due to 20 years of exponential growth in terms of raw CPU processing power, those waits have become longer and longer. Put simply, the processing capabilities of today’s CPUs far outstrip the speed at which hard disk drives (HDDs) can deliver data to them. The massive performance gap is felt most painfully by database servers, which typically carry out far more I/O transactions than other systems. The result is that superfast processors and massive amounts of bandwidth are often wasted because HDDs take several milliseconds – an eternity for modern CPUs – to access and retrieve requested data. And when servers wait on storage, users wait on servers. This is the real problem with I/O wait time.
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

The difficulty is one of basic physics. While data moves through solid state components and the network at the speed of energy through a circuit – essentially, at the speed of light – hard drives move mechanically, relying on physical movement around a rotating platter to access information. Hence, although they are extremely reliable devices and have established themselves as the workhorses of information storage, when it comes to data delivery speeds, HDDs are the weak link in the chain.

The Problem with Traditional “Fixes” for HDD Latency

There are work-arounds to HDD-induced latency issues, such as adding disks to JBOD (just a bunch of disks) or RAID (redundant array of independent disks). By increasing the number of disks, the I/O from a database can be spread across more physical devices. Unfortunately, this approach has been shown to have a trivial impact on decreasing the HDD bottleneck.

Another approach is to move frequently accessed files to their own disks. But while this will deliver the best I/O performance available from a single hard drive, the I/O capability of such a drive is very limited. At best, a single hard drive can deliver 300 I/Os per second (IOPS), which is several orders of magnitude lower than the I/O performance needed to close the gap.

A final approach in using traditional HDDs is to move from a JBOD to a RAID implementation. Such a move will provide additional performance, particularly when a high-volume cache controller is used in front of the disk drives to stripe storage across multiple disks. But to reach the high IOPS necessary to meet user demand, the number of hard disk drives required can easily become prohibitive along several dimensions, including cost, space requirements and weight.
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

**The Solution: All-Flash Storage Systems**

Because of the performance gap between server speeds and HDD storage systems, a gap that is particularly acute when it impacts business-critical applications, there has been a growing need for a new, faster type of storage.

**Enter Flash Storage**

Flash storage systems are solid state devices designed to solve the problem of I/O wait time by offering orders-of-magnitude-faster access times and lower-latency I/O transactions per second than a hard disk drive. These storage systems can either complement or replace traditional hard disk arrays in many business-critical applications, including ERP systems, transactional databases and analytical applications such as BI. And because of new technology and improved economics, it is now possible to build storage systems based entirely on flash memory.

Flash storage systems can either complement or replace traditional hard disk arrays in many business-critical applications, including ERP systems, transactional databases and analytical applications such as BI.

Strictly speaking, a solid state disk (SSD) is any storage device that does not rely on mechanical parts to input and output data. However, SSD has come to mean a form-factor solid state device meant to take the place of an existing HDD. Flash storage should not be confused with form-factor technology. Form-factor SSDs use traditional infrastructure connections and controllers that
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

Flash storage systems are designed from the flash chip up, using fast FPGA controller technology to minimize latency and maximize bandwidth.

The latest flash storage systems minimize I/O wait time by delivering access times that are 250 times faster than HDDs (0.2 milliseconds versus 5). And because of the faster access times, flash storage systems can deliver 1,333 times more IOPS than a hard disk drive (more than 400,000 IOPS versus 300). These improvements can result in a dramatic decrease in storage-driven latency.

The IBM FlashSystem™ Family

IBM views flash as a strategic and critical form of storage technology and is committed to being at the forefront of all-flash storage development. (This commitment was evident in October 2012 when IBM acquired Texas Memory Systems [TMS], a world-class designer of high-performance, high-durability flash-based storage.)

The strategic use of IBM FlashSystem can help make businesses more agile and analytics driven by providing up-to-the-minute analytics based on real-time data, not yesterday’s news. It transforms the data center environment and helps consolidate resources to gain the most from business processes and critical applications. The FlashSystem family also enhances system resiliency without sacrificing performance or usable capacity.
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

FlashSystem storage systems deliver over 500,000 read IOPS with less than 100 microseconds of latency and provide up to 24 TB of usable data storage in just 1U of rack space. They also offer enterprise-level availability and reliability with no single point of failure, multiple layers of data correction, chip redundancy or redundant hot swap components.

IBM FlashSystem products are designed to deliver the lowest latency and the highest IOPS in the market today at a very economical price point. They can be used as Tier 0 storage for solutions with SVC (IBM System Storage® SAN Volume Controller) storage virtualization platform, and they are especially useful when cooling, low-power consumption and small footprint are key to accelerating business-critical applications.

**Economic Benefits of IBM FlashSystem**

In addition to their technical advantages, all-flash storage systems also offer a number of economic benefits as compared to traditional HDD systems. For example, storage licensing costs for IBM FlashSystem are 50% lower than they are for HDD systems.

In addition, because of a much smaller footprint and higher storage density, IBM FlashSystem implementations reduce floor space significantly. (As noted above, with an all-flash solution, 24 terabytes of addressable, high-availability storage fit into a 1U form factor [with one petabyte in a single rack].)

All-flash solutions also use far less energy than comparable HDD systems, reducing energy costs by as much as 75%.

i. Software licensing costs are 50% lower with IBM FlashSystem compared to HDD

ii. IBM FlashSystem reduces floor space significantly and generates energy savings of as much as 75% as compared to HDD

iii. Operational support costs with flash are 35% lower than with HDD

iv. Total storage solution cost for an all-flash system is 31% less than it is for an all-HDD solution
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

Getting the most from flash requires using it strategically to maximize the technology’s effectiveness and cost efficiencies. Not all applications require an all-flash solution; but many do, and they are often those most critical to your business. Knowing which should be moved to an all-flash environment, and which would be served best by a traditional HDD solution or a hybrid of the two technologies, will pay off in improved application performance, end-user satisfaction and TCO for your overall storage solution.

Not all applications require an all-flash solution; but many do, and they are often those most critical to your business.

Most application performance issues result from high-volume, concurrent, and often highly complex, queries against your database. Once you conclude that your system is experiencing I/O subsystem problems, the next step is to determine which components of your database are experiencing the highest I/O and in turn causing I/O wait time.

In some cases, entire databases should have all of their files moved to flash storage. These include databases with a history of high concurrent access, as well as those with frequent random access to all of the database tables (which makes it virtually impossible to identify a subset of most-frequently accessed files).
In Business, Timing Is Everything – Especially for Business-Critical Applications

The Challenge (Hint: It’s NOT Processor Speed)

The Solution: All-Flash Storage Systems

Getting Started with Flash

Small and midsize databases are also good candidates for moving to an all-flash environment, because the economics of such a move – especially when compared to the cost of buying RAID systems – are attractive. The same is also true of large, read-intensive databases.

Most application performance issues result from high-volume, concurrent, and often highly complex, queries against your database.

For additional suggestions tied specifically to Oracle® database performance with IBM FlashSystem, see reference (vi) under “Additional Resources.”

Other considerations, such as space limitations and soaring energy costs due to massive arrays of HDDs, might also prompt a move to flash. For details, see the case studies listed in the following section.
Additional Resources

To learn more about all-flash storage and the IBM FlashSystem family, visit the following:

i. Flash Storage Website:
   ibm.com/systems/storage/flash/

ii. Video: “Real World Perspectives on IBM Flash Storage”
    http://www.youtube.com/watch?v=AxeNyssFPhs

iii. Video: “Flash Ahead with IBM”
    http://www.youtube.com/watch?v=EzpgK-eUL-E

iv. Video: “What Happens in a Flash: the Answer”
    http://www.youtube.com/watch?v=HXlSptFiyY

v. Video: “Flash Storage vs. Disk Storage”
    www.youtube.com/watch?v=jq8jklbKFy0

vi. Video: “Flash Storage Is the Tipping Point”
    www.youtube.com/watch?v=2OjeDw6mk


viii. “Flash or SSD: Why and When to Use IBM FlashSystem”

ix. “Benefits of IBM FlashSystem in a VDI Environment”

dx. “Best Practices with SVC and FlashSystem 820”

xi. Solution Guide: “IBM FlashSystem in OLAP Database Environments”

xii. Case Study: “Rathbone Brothers Plc Runs Billion-Dollar Business on Flash Storage”

xiii. Case Study: “Sprint Drives 45 Times Performance Improvement: Transforming Customer Service with Ultra-Fast Flash Storage from IBM”
Appendix: Some Additional Technical Details on Flash and IBM FlashSystem

All-flash storage systems offer higher capacity than do any earlier forms of memory storage. This is because all-flash storage systems do not require additional batteries to allow flushing of the DDR cache during power outages; nor do they include large amounts of expensive DDR memory. Instead, a small amount of DDR is used to act as buffering for the flash for writes and to act as a metadata repository during operation. Small batteries are used to provide electricity during loss-of-power situations to allow the flush of the small cache and metadata areas to flash. With IBM FlashSystem, 24 terabytes of addressable, highly-available storage fit into a 1U form factor.

IBM® FlashSystem™ uses only the highest-quality flash available: single level cell (SLC) and enterprise multilevel cell (eMLC). Most solid state devices (SSDs) utilize less-reliable, lower-endurance consumer-grade MLC flash. eMLC flash has 10 times the life of MLC technology; SLC flash has 33 times the working life of MLC technology. MLC flash has a lifetime of 3,000 write operations per flash storage cell location (designated as p/e cycles), while eMLC has 30,000 and SLC, over 100,000.

FlashSystem family offer multiple layers of data protection (ECC, Variable Strip RAID, and 2D Flash RAID) to avoid unplanned outages and provide enterprise reliability. To view the technical product guide for the FlashSystem family, please visit IBM FlashSystem 720 and IBM FlashSystem 820 (http://www.redbooks.ibm.com/abstracts/tips1003.html#specifications) and IBM FlashSystem 710 and IBM FlashSystem 810 (http://www.redbooks.ibm.com/abstracts/tips1002.html)
Flash Ahead: Leveraging IBM® FlashSystem™ to Dramatically Improve Application Performance and Data Center Economics

IBM commissioned, paid for, and assisted with this eBook.

© Copyright IBM Corporation 2013

IBM Global Services Route 100
Somers, NY 10589 U.S.A.

Produced in the United States of America June 2013
All Rights Reserved

IBM may not offer the products, features or services discussed in this document in all countries. The information may be subject to change without notice.

Consult your local IBM business contact for information on the products, features and services available in your area.

All statements regarding IBM future directions and intent are subject to change or withdrawal without notice and represent goals and objectives only.

IBM, the IBM logo, ibm.com, Smarter Planet, the planet icon and IBM Flash Systems are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries or both. If these and other IBM trademarked terms are marked on their first occurrence in this information with a trademark symbol (® or TM), these symbols indicate U.S. registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. Other product and service names might be trademarks of IBM or other companies. A current list of IBM trademarks is available on the web at “Copyright and trademark information” at ibm.com/legal/copytrade.shtml

References in this publication to IBM products and services do not imply that IBM intends to make them available in all countries in which IBM operates. Product data has been reviewed for accuracy as of the date of initial publication. Product data is subject to change without notice. Any statements regarding IBM’s future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only. IBM products are warranted according to the terms and conditions of the agreements (e.g., IBM Customer Agreement, Statement of Limited Warranty, International Program License Agreement, etc.) under which they are provided.

The customer is responsible for ensuring compliance with legal requirements. It is the customer’s sole responsibility to obtain advice of competent legal counsel as to the identification and interpretation of any relevant laws and regulatory requirements that may affect the customer’s business and any actions the customer may need to take to comply with such laws. IBM does not provide legal advice or represent or warrant that its services or products will ensure that the customer is in compliance with any law or regulation.