Flash Storage for Virtualization for Dummies
A Wiley Brand

Learn to:
• Overcome storage issues
• Fix the I/O blender problem
• Balance capacity and performance optimization

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tegile

Brian Underdahl
About Tegile Systems

Tegile Systems is pioneering a new generation of intelligent flash arrays that balance performance, capacity, features and price for virtual desktop and database applications. With Tegile’s line of all-flash and hybrid storage arrays, the company is redefining the traditional approach to storage by providing a family of arrays that accelerate business critical enterprise applications and allow customers to significantly consolidate mixed workloads in virtualized environments.

Tegile’s patented IntelliFlash™ technology accelerates performance and enables inline deduplication and compression of data so each array has a usable capacity far greater than its raw capacity. Tegile’s award-winning solutions enable customers to better address the requirements of virtualization, virtual desktop integration and database integration than any other offerings. Featuring both NAS and SAN connectivity, Tegile arrays are easy-to-use, fully redundant and highly scalable. They come complete with built-in snapshot, remote-replication, near-instant recovery, onsite or offsite failover, and VM-aware features. Additional information is available at www.tegile.com. Follow Tegile on Twitter @tegile.
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**Business Development**

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Introduction

Organizations are virtualizing server and desktop resources more aggressively than ever, which dramatically changes the performance demands on storage. As more physical server resources are moved to a virtualized environment, the data path into shared storage becomes more unpredictable, driving the demand for agile storage systems even higher. The result of this performance demand is a significant challenge, especially for organizations who haven’t evaluated how flash technologies can alleviate these storage challenges.

About This Book

Flash Storage for Virtualization For Dummies, Tegile Special Edition, introduces you to the options flash technology offers to meet the increasing demands on storage created by virtualization. This book is about solving your organization’s storage needs without putting up with poorer performance and greatly increased operational costs induced by legacy hard drive–based systems.

In these pages, you discover how to get more bang for your buck by applying flash technology to your modernized infrastructure.

In this book, you also find solutions from Tegile Systems — all flash arrays and hybrid storage systems that allows you to balance the performance optimization of solid-state drives and the capacity efficiency of hard disk drives in a single architecture.
Icons Used in This Book

This book uses the following icons to call your attention to information that you may find helpful in particular ways.

The information in paragraphs marked by the Remember icon is important and therefore repeated for emphasis.

The Tip icon indicates extra-helpful information.

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Where to Go from Here

Hey, it’s your book, so dive in anywhere. No, seriously. You can thumb through the book anywhere you like, skipping around here and there. Or, you can read it straight through from front to back, if you prefer. Either way, you can go back to it at any time you want.
Chapter 1

Understanding the Challenges

In This Chapter

▶ Comprehending the I/O Blender
▶ Understanding the server issues
▶ Considering desktops

As servers continue to get virtualized and new desktop virtualization programs are launched, organizations face many challenges in addressing those needs. Storage is often the biggest bottleneck to performance. Simply adding more and more hard disk drive (HDD) spindles without considering the cost and efficiencies isn’t a sustainable answer for most companies.

This chapter takes a look at the challenges you face when you try to balance competing forces that can seem to be incompatible.

Understanding the I/O Blender

Meeting the challenge of increased demand for storage may sound simple on the surface, but in reality, you need to be aware of a number of competing factors. Besides the need for additional capacity, you also need
to consider costs and required performance levels that are more challenging in a virtualized environment. Creating the proper balance between these varying interests requires an understanding of how your system is used and what this usage means in terms of the mix of I/O (input/output) levels you need to support. As you deploy more virtual machine instances, the highly random and mixed I/O for each of the virtual machines compete for storage resources — which leads to unpredictable performance. Many call this I/O Blender effect.

Traditionally, increased demand for storage capacity of performance has been addressed by adding hard disk drives and software, causing storage arrays to become complex (think redundant array of independent disks [RAID] groups, path management, and so on), bloated, and unnecessarily expensive. While the basic architecture of enterprise storage arrays has changed little over the past 25 years, the way organizations use that storage has changed. IT organizations are increasingly consolidating their compute and storage infrastructure by using virtualization technology and cloud-based applications that can be shared by thousands of simultaneous users, therefore changing I/O patterns radically.

Quite simply, different types of usage place very different I/O performance demands on your storage systems. Consider two different scenarios that illustrate this point in a virtual desktop environment:

✔ **Call center workers:** In a typical call center, you may have hundreds or even thousands of users who all use identical applications on a desktop PC or thin client. Users have little or no opportunity to customize their display, and their individual systems use very little I/O overhead in
transferring data to and from each workstation. When you put all these together, though, the load can create storage challenges that directly impact user experience and customer satisfaction.

- **Knowledge workers:** Users who need to use many different applications throughout the workday and whose value to the organization is based on creativity need fast access to a wide variety of applications and data at random times. Clearly this type of system access demands much higher I/O performance in order to maintain worker productivity levels. Infrastructure performance directly impacts these workers’ productivity.

Although these examples only show the extremes of I/O performance demands, they do demonstrate that you need to understand the differences in system usage before you can make useful choices in storage system arrays. With lower I/O demands, the first example wouldn’t require nearly the I/O performance of the second example, so the balance of capacity and performance needed for the two examples is quite different.

**Examining Server Virtualization Challenges**

Delivering IT services today isn’t what it used to be. Server virtualization has revolutionized application services while massive data growth continues to challenge
infrastructure and operational processes. It’s little surprise that recent research shows that increased use of server virtualization remains a top priority for many organizations.

Server virtualization is a process that allocates resources on a physical computer to different applications or users, so that each virtual server functions as though it was an actual computer — rather than multiple isolated physical servers hosting each application. Users are unaware of the physical location or even the identity of the actual physical servers. In most cases users aren’t even aware that their applications are running on virtual servers. Server virtualization leads to increased operating efficiency because fewer physical components are needed to handle the demand for individual servers.

Server virtualization creates challenges by combining mixed workloads that stress storage systems. In a successful server virtualization installation, you must provide for many different needs such as block and file storage, high performance of throughput and I/O while maintaining low latency, high availability, data protection, fast restores, long-term retention, and so on. Addressing all these needs usually means deploying and managing a number of different purpose built storage systems, while keeping up with capacity growth. These requirements drive up both equipment and operational costs and are part of the challenge you face in successfully implementing server virtualization. There must be a better way.
Looking at Desktop Virtualization Challenges

Virtual Desktop Infrastructure (VDI) is a growing trend aimed at reducing costs and administrative overhead while improving reliability and security of users’ desktops. Successful VDI implementations require several factors, including reasonable costs and good performance from users’ perspectives.

Desktop virtualization is a process that separates the desktop environment that users see from the physical hardware. In effect, users see a desktop and applications that are running on a server rather than on a PC. One big advantage to desktop virtualization is that less powerful (and often less expensive) devices are needed at each workstation.

Achieving performance for virtual desktops while maintaining costs at levels similar to traditional desktops requires careful planning and architecture as well as an understanding of how to optimize the most commonly encountered bottleneck — storage.

Storage is often cited as the item most often responsible for performance success or failure. Storage generally also has the largest impact on total costs. Achieving good cost and performance levels requires a storage architecture optimized for VDI. The issues relating to storage can be categorized into three areas:
✓ **Storage capacity:** The requirements for VDI storage have a significant impact on the choice of a system. For example, the use of layered images can dramatically reduce the real storage requirement by keeping only one copy of common data. Other technologies such as thin provisioning, deduplication, and other features may have an impact as well (see Chapter 3 for additional information on these features).

✓ **Storage performance requirements:** The specific mix of VDI desktop types and usage patterns (think boot and login storms) determine how many I/Os per second are required and how performance scales with the number of concurrently used virtual desktops.

✓ **Administrative activities:** Administrative activities include what actions are needed, or at least useful, in various traditional functions such as provisioning (adding a new virtual desktop), backup, restore, virus scanning, security, and so on. You want to examine each of these issues, looking at how they’re currently handled, who’s responsible for each issue, and how these responsibilities should change with VDI.
In This Chapter

▶ Introducing server-based flash storage
▶ Understanding all-flash-based arrays
▶ Seeing the benefits of tiered arrays
▶ Considering a hybrid array

Network storage arrays have traditionally been comprised of a bunch of hard disk drives. Over the years those drives have become faster, physically smaller, higher capacity, and less expensive. Even so, hard disk drives increasingly fall short in delivering the performance and energy efficiency required in today’s high-demand computing environments.

This chapter takes a look at a technology that offers a higher performance and more efficient alternative to hard disk drive arrays: solid state drives — flash memory-based SSDs. You see how flash storage provides some real advantages and how some vendors create a blend of flash and traditional disk-based storage that address the performance, efficiency, and cost issues in a balanced solution.
Getting to Know Server-Based Flash

Server-based flash has two kinds of solutions. The first is a flash device that’s designed into a PCI Express form factor to fit into a standard expansion slot in a server. The second is a flash based solid state drive that can fit in to a typical drive slot. Server-based flash can function as a cache in the server or as persistent storage, allowing the server to essentially have extremely fast access to data. Putting high-performance storage directly in the server reduces latency because the server doesn’t have to access data on an external storage network. Server-based flash is high-performance, direct-attached storage.

Server-based flash is often used for frequently accessed data. Some examples of this usage are database indexes or whole databases. In these use cases, data access latency reduction can be as much as 90 percent. Both server vendors and some storage vendors offer server-based flash solutions. While it’s excellent for databases, server-based flash is considerably more expensive than other solutions and has many management challenges, such as high availability and resource sharing across a pool of servers.

Understanding All-Flash Arrays

Flash memory-based SSDs are significantly faster than hard disk drives and this makes SSDs much better at
delivering the performance required for today’s data centers. At the component level, a solid state drive with a standard Serial Attached SCSI (SAS) interface promises performance many times the promised IOPS of hard disks.

On the other hand, SSDs have a higher cost compared to hard disk drives of the same capacity. Although the cost of SSDs is falling, so is the cost of hard disk drives, which maintains hard disk drives’ status as the best value for large scale storage capacity.

All-flash arrays are great at delivering very high IOPS at low latency. However, all data does not need to reside on an all-flash array. Cost, performance and capacity are all major considerations in a storage system investment.

**Going to Tiered Arrays**

Some legacy vendors address the need for more balance between performance and capacity by using data tiering approaches — a means of assigning different types of data to different types of storage media in an array. In a tiered array, you may have a small amount of relatively costly SSD-based storage that handles extremely performance sensitive data, a middle ground tier using high performance disk drives, and a much larger pool of low cost hard disk drive-based storage for less critical data. Depending on the organization’s needs, there could be three or more tiers of storage categories.
Managing tiered storage can quickly become a data management nightmare. The process can be automated to a degree by using software, but the management process continues as an ongoing task.

Storage administrators must understand that data movement across tiers steals storage CPU and data path resources away from handling I/O from production applications. This creates tiering windows, similar to backup windows, that rarely meet the agility needs of the business.

Tiered storage arrays provide different levels of performance for the different categories of data, but sweeping the array for hot/cold data takes time and resources.

Introducing Hybrid Arrays

If you’re looking for a solution to the cost and performance equation, an answer that offers higher performance, better capacity, and helps keep costs in check is hybrid arrays. Hybrid architectures use fast SSDs and/or dynamic random access memory (DRAM) to cache in-demand data and uses less expensive hard disk drives for low-cost capacity. The result is a faster, high-capacity array at a reasonable price. Using a cache-based design addresses the agility problem data tiering imposes.

Hybrid arrays make sense for organizations that need arrays that balance performance, capacity, and cost. However, on its own the hybrid architecture doesn’t necessarily fulfill all the expectations you may have of a new generation of storage. To meet those
expectations, the hybrid array also needs to incorporate a number of advanced features like advanced data protection, compression, deduplication and flexible connectivity.

The way a vendor implements a particular feature can vary widely. Simply saying that a feature exists in a product is no guarantee that you’ll obtain the full set of benefits you might expect.

To more fully understand how different types of storage arrays compare, consider these key points:

✔ Hard disk drive arrays have the lowest cost per GB, but expanding their capacity by simply adding more drives adds complexity without addressing key performance issues.

✔ All flash storage arrays are expensive, but may allow you to consolidate workloads, analyze the business and accelerate your transactions, leading to higher revenues.

✔ Tiered arrays offer a balance between the expense of all flash arrays and hard disk arrays, but can be much more complex to manage and provide inconsistent performance levels to different applications.

✔ Hybrid arrays can provide the best balance between costs and performance, but implementation of important advanced features can vary widely between different vendors.
Chapter 3

Taking a Closer Look at Flash Storage for Virtualization

In This Chapter
▶ Reducing redundant data
▶ Using unified protocols
▶ Getting better performance
▶ Making storage more efficient
▶ Applying data protection

In this chapter, you take a look at how hybrid storage arrays combined with the right set of advanced features can provide the solution your organization deserves. One example, Tegile’s intelligent flash arrays, is discussed to show how this solution is designed to provide the features you need.

Using In-line Data Reduction
Hybrid storage arrays use a combination of dynamic random-access memory (DRAM), SSDs and hard disk drives, to provide the best mix of performance and capacity (see Chapter 2). Although SSDs can operate
many times faster than traditional hard disk drives, SSDs are currently more expensive than their mechanical counterparts. This cost difference dictates that you make wise use of the space on a system’s SSDs in order to keep the array’s cost under control.

One very effective means of making the best use of available storage is to store as little redundant data as possible through a process known as de-duplication. Essentially, de-duplication separates the information being stored into two parts — the actual data and metadata (which is information about what the data is and where it is stored). By separating the storage of data from the metadata, the same data only needs to be stored once, and the metadata tells the system how to find that data no matter how many different applications may need it.

A very good example would be the way server virtualization uses several instances of the same operating system image to run different virtual machines on the same server. With in-line deduplication, these several OS instances can be created for their individual purposes, but only a single instance of the OS is stored in the array. Caching this single instance of the OS image in a fast storage media, greatly improves the performance for all users.

In addition to de-duplication, data storage requirements can often be reduced significantly by compressing the data so it occupies less space. Unfortunately, the performance of legacy arrays is significantly impacted by de-duplication and compression processes.
Because of the performance penalties often associated with de-duplication and compression, many storage vendors only apply these technologies off-line, rather than in real-time. But Tegile’s patented IntelliFlash technology addresses the performance penalty associated with de-duplication and compression allowing both data reduction technologies to be applied to all data throughout the array, not just near-line or backup storage.

**Applying Unified (NAS/SAN) Protocols**

Flexibility and agility are key elements in a virtualized environment. New applications and use cases must be provisioned in hours, not months. This need introduces a huge sense of infrastructure unpredictability. IT decision makers must ensure the best level of flexibility in their virtualized infrastructure to absorb this unpredictability. Unified storage systems that can communicate over both block and file protocols offer this superior flexibility.

Instead of limited or proprietary protocol systems, you need the flexibility to choose the optimal connectivity protocol from a unified storage system that works with your existing infrastructure. Tegile’s intelligent flash arrays easily fit into existing enterprise storage environments without server-side agents so they can work alongside or replace your EMC, Dell, IBM, NetApp, HP, Hitachi or other arrays. Both *storage area network* (SAN) and *network attached storage* (NAS) deployments are supported by the intelligent flash arrays. Additionally, standard file-level protocols allow the numerous applications to share the same Tegile storage array.
Improving Performance

Performance of your storage array is a critical element in a virtualized environment. You need an array that can manage higher volumes of simultaneous transactions and additional concurrent users.

Because performance is such a critical element, it’s important to understand your options. For example, Tegile’s intelligent flash arrays are up to seven times faster than standard arrays. Tegile’s arrays incorporate large amounts of memory and SSD optimization to provide high performance. These intelligent flash arrays also provide on-the-fly de-duplication, compression, fast snapshots and instantaneous restores. In virtualized environments, you can easily manage more hypervisors and offset the disruptive impact of VDI boot storms — large numbers of users starting their systems and booting a system image at the same time, such as the beginning of a call center shift — all at a fraction of the cost of legacy arrays.

Increasing Capacity Efficiency

Efficient use of storage capacity enables you to do more within the same space. This type of efficiency makes better use of your server rack space, cuts energy usage, and reduces equipment expense.

Not all storage arrays are equally efficient in how they store data. But the usable capacity of a Tegile intelligent flash array is up to five times its raw capacity allowing you to store more data per unit of rack space. Built using enterprise class SSDs and HDDs in standard server chassis, Tegile’s intelligent flash arrays consumes far less than half the size of most current
storage arrays, reducing data center space and power consumption.

Tegile intelligent flash arrays support in-line compression and block level de-duplication of all data before it’s written to disk instead of the typical post-processing batch job that’s done after all the raw data is written to disk and used in other arrays. This in-line processing uses high performance CPUs and ensures that the in-line compression and de-duplication doesn’t add any latency to the transaction.

Virtualized environments inherently have a lot of duplicate data. The Tegile intelligent flash array is able to detect duplicate blocks of data and avoid writing these duplicate blocks of data to disk. This not only saves disk space but also improves throughput speeds because the data doesn’t have to be written to disk every time another instance is created.

Protecting Data

No matter the application, your data always is far more valuable to your organization than any of the hardware components in your system. Protecting your data is one of the most important functions of any storage array.

Your storage array needs to provide automatic protection for your data. Tegile’s intelligent flash arrays keep your applications online and protect you better than standard arrays because they come complete with unlimited automatic snapshots, clones and replication features. Automatic snapshots and clones can be scheduled differently for each volume. You can elect to back up critical virtual machines more frequently than less
critical ones to save space and improve performance. Being VM-aware, Tegile’s IntelliFlash instant restore capabilities allow you to immediately roll back one machine or all machines to a previous state should the need arise. Additionally, the array’s automated replication feature backs-up only the data that’s changed, so even remote backups require less network bandwidth, hardware and administration.

In addition, Tegile’s intelligent flash arrays protect your data because they are architected with no single point of failure and automatic fail-over capabilities. These arrays include dual hot-swappable controllers, dual power supplies and hot drive spares for hardware failure protection.
In This Chapter

▶ Helping speed medical care delivery
▶ Going back to school with a flash storage array

Descriptions of the technology and product features are certainly useful in introducing a subject like flash and hybrid storage arrays, but sometimes seeing concrete examples helps you gain a better understanding of the actual value of technology and features. In this chapter, you see a couple of examples that show how Tegile’s storage arrays benefited a medical services firm and a school district.

Using Virtualization to Support Medical Care

Oklahoma Heart Hospital is a physician-owned facility that brings world-class medical expertise and compassion to the care of every patient, to ensure a patient-centered care experience that delivers better outcomes. As the nation’s first all-digital hospital,
Oklahoma Heart Hospital saves valuable time for patients by making information readily available to doctors and nurses. X-rays, lab results, vital signs and medications are right at the caregivers’ fingertips. This approach has helped the hospital achieve a ranking in the top 1 percent nationally for patient satisfaction.

Oklahoma Heart Hospital has embraced virtualization to support its mission-critical applications. With a traditional tiered storage model in place, Oklahoma Heart Hospital wanted to evaluate new options that would allow faster boot times and quicker reads to benefit its Citrix XenDesktop VDI environment.

With speed and performance being the main criteria required in building its new storage infrastructure, the IT staff at Oklahoma Heart Hospital began to look for the fastest, highest-performing SAN hardware available.

Oklahoma Heart Hospital brought in the best-performing solutions with the largest amounts of flash from major storage vendors to run real-world tests in the hospital’s production environment to measure, compare and decide which would be the best fit. Results were recorded and evaluated against each other. After evaluating all of the solutions, Oklahoma Heart Hospital decided to implement a Tegile All-Flash Array, which delivers maximum performance, high density, and compelling economics.

Tegile supports the Citrix virtualization environment for Oklahoma Heart Hospital’s main facilities with plans to replicate snapshots to a satellite campus. Currently, the hospital hosts more than 300 Citrix XenApp Servers and hundreds of virtual apps and VDI desktops, as well as mock and training environments. As additional doctors, nurses and staff commit to VDI, the hospital expects to roll out to 1,500 desktops.
Making the Grade in Desktop Virtualization

School District 27J provides educational services to approximately 16,000 students in Colorado. The staff and educators work to ensure that all students have the knowledge, skills, and attitudes needed for present and future competence and success. As part of this commitment, the district sought to create an online computing environment that leveraged a virtual desktop infrastructure, ensuring that teachers had access to their district resources at all times, which allowed them to fully support students both inside and outside the classroom.

The district launched its virtual desktop infrastructure (VDI) environment with a 100-desktop pilot program with the expectation that it would later scale to 800 desktops. As the system went live on the first day of the school year, the resulting boot storm from teachers logging in crashed the backend of the infrastructure — the SAN was undersized and basically wasn’t going to work.

The CIO of the school district scurried for other storage options that could quickly overcome the hardware failure. After looking at other solutions that could take up to 30 days to deliver, the district needed help sooner and decided on Tegile Systems.

Tegile assessed the needs of the district quickly and implemented a solution in the middle of the outage. Tegile delivered the hybrid solution within days of placing the order.
School District 27J currently has implemented two Tegile units to support its 866 virtual desktops. Desktop delivery times that were initially measured in hours now only take 14 seconds. With its built-in compression and de-duplication features, the school district reduced the 13.5 TB of storage utilized on one storage pool to only 8 TB, and the units’ performance enhancements have convinced staff that they can successfully accelerate their 3-year plan for offering VDI from teachers to libraries to students.
To help make sure that you understand the key issues regarding flash-based and hybrid storage arrays, this chapter gives you ten things you really need to know about flash storage:

1. Virtualization creates an I/O blender problem for storage. See Chapter 1 for more info.
2. Legacy storage doesn’t operate well in virtualized environments. Flip back to Chapter 1 for more information.
3. Flash is a key technology that can fix the I/O blender problem. See Chapter 2 for more discussion on this topic.
4. Flash used as a tier in a legacy storage system isn’t the best way to fix the I/O blender problem. Head to Chapter 2 for more info.
5. All-flash arrays are really fast but are extremely expensive when viewed in a cost versus capacity basis. Look at Chapter 2 for more on this topic.

6. Data reduction technologies such as de-duplication and compression help resolve the cost premium that flash carries. Chapter 3 covers this in more detail.

7. Flash used as a cache in front of spinning disk masks their long latency. Chapter 3 gives you more about this subject.

8. Hybrid arrays balance the age-old tension between capacity and performance optimization of storage. In Chapter 3, you find out more about hybrid arrays.

9. Unified arrays that offer many protocols provide excellent flexibility. Check out Chapter 3 for a more detailed discussion.

10. Storage that balances capacity and performance optimization while eliminating management headaches is considered best in class. Chapter 3 has more information on this topic.
Meet the increasing demands on storage created by virtualization

This book introduces you to the options flash technology offers you to meet your ever-growing storage needs. You discover how to get more bang for your buck by applying flash technology to your modernized infrastructure and start solving your organization’s storage needs without putting up with poor performance and greatly increased operational costs.

- **Understand the I/O blender** — unsramble those radically mixed I/O patterns
- **Get a grip on server issues** — examine server virtualization challenges
- **Discover a hybrid system solution** — check into Tegile’s method of storage

Open the book and find:

- Flash storage alternatives
- Ways to make storage more efficient
- How to protect your data
- Ten facts about flash storage

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