IBM XIV® Storage System:

Ease of Management Reinvented

White Paper

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info@xivstorage.com

www.xivstorage.com

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Introduction

Managing a storage system has become a costly and complicated task. The direct labor cost associated with its management is increasing. In addition, organizations incur hidden indirect costs due to slow responsiveness, ineffective utilization, and inflexibility.

This paper discusses how the IBM XIV Storage System's revolutionary built-in virtualization architecture provides a way to drastically reduce the costs of managing storage systems. The XIV system's ease of management offers much to an organization:

- Much simpler storage management, resulting in less work and, hence, less expense
- An easy to learn and use system, eliminating the need for highly skilled, experienced storage managers with specific expertise in the existing system
- Faster and better responsiveness to needs, including provisioning of volumes, snapshots, and mapping
- Elimination of performance issues and the constant need for system monitoring
- Elimination of the "orphaned storage" phenomenon, resulting in better use of the capital investment

Understanding the Difficulties behind Storage Management

To understand the solution to storage management problems, we first need to understand why managing traditional storage is so difficult. Essentially, the problem is rooted in the fact that traditional storage requires manual intervention to exploit a system's resources. This paradigm of the need for manual planning and tuning surfaces in many ways:

- **Allocation of logical volumes on physical disk drives.** This is the biggest hurdle in managing storage systems today. The system administrator needs to make a conscious decision regarding how to group disk drives and how to provision logical volumes from these groups. The process is tedious and lengthy, taking much management time, and inevitably results in some storage space left unused (thus effectively increasing the system's unit cost) and an unacceptable response time to provisioning requests.

- **Performance tuning.** One of the most important qualities of a centralized storage system, especially a tier-1 system, is its ability to provide consistently high performance levels. With traditional systems, attaining such performance levels is not simple. To get full return on the investment, one must undertake manual tasks to ensure that the system's components are fully and equally utilized. Practically, this means that someone must continually review performance statistics, analyze system performance, isolate hot spots, and migrate volumes between disk drives. Each time a new volume is provisioned, the size of a volume changes, new capacity is added, or application access patterns change, one has to make sure that the new configuration provides the required performance levels. The effort is never-ending, and invariably produces only partial success.

- **Performance vs. space resource allocation**. With traditional storage systems, when allocating resources to applications or groups of applications, the storage administrator allocates units of shelves or disk drives. Assigning shelves or drives gives the host applications more capacity and better performance. However, unfortunately, the performance and capacity requirements are not aligned. A typical archiving application, for example, might need a large amount of the system's capacity but only a fraction of the system's performance. With traditional storage architecture, the de-coupling of the allocation of performance and capacity is almost impossible and, in any case, extremely difficult.

- **Snapshot management.** Creating and using snapshots is an essential component of any centralized storage environment today. Unfortunately, storage administration teams must handle snapshot creation with great caution. Traditional storage systems provide either differential snapshots or full copies. Differential snapshots reduce performance levels and, hence, cannot be used without paying attention to a system's performance and needs. On the other hand, full copies are created through a complex process that needs to be coordinated with the application. In either case, creating and using snapshots requires the attention of highly skilled storage management experts.

- **HSM and ILM.** One of today's common answers to sky-rocketing storage prices is Hierarchal Storage Management (HSM) and Information Lifecycle Management (ILM). These buzzwords actually refer to a range of solutions that involve classifying data into several categories of importance. Each such category is served by a different storage solution, with its own range of costs and capabilities. The classifying of data is sometimes done using several different storage platforms (most commonly tier-1 and tier-2 systems) and provisioning different categories of data to the different platforms.

  Another solution is to have one system that contains several types of disks of different cost and performance levels. A third approach is to use virtualization solutions that present multiple tiers of storage as one system. Regardless of the solution, the bottom-line is always the same: *administrators have to monitor performance, classify volumes, and migrate volumes between storage tiers*.

Consequences of Management Difficulties

The most direct and evident consequence of all these management hurdles is the financial cost of maintaining large teams of highly skilled (and hence costly) professionals.

But this is not the end of the story, since the impact of hard-to-manage systems goes much beyond the need to allocate more budget:

- Skilled storage professionals are not always easy to find. So even if a budget for their salary has been allocated, storage teams tend to be understaffed, causing the service level to be much less than expected.
- The storage team's responsiveness does not meet the organization's needs. It takes too much time to provision storage space, solve performance problems, and provide snapshot and backup solutions, slowing down IT efforts overall.
- As a side effect of the lack of responsiveness, users over-specify storage demand to reduce their dependence on IT, thus effectively increasing storage capital costs.
- As a result of ever-existing allocation limitations, some storage capacity remains orphaned (unused), increasing real storage capital and power costs.

XIV Breakthroughs

The IBM XIV Storage System provides a new approach to how storage is managed, making life much easier for storage administrators, while providing better service to the end user. This is possible due to several architectural breakthroughs, described in this section.

Built-in Virtualization

The XIV system's virtualization scheme completely obviates the traditional storage administration task of laying out logical volumes on physical disk drives. When a new volume is defined, the system automatically thin-slices the volume into 1 MB stripes and uses a pseudo-random algorithm to randomly assign each stripe to a disk on a module.

XIV's virtualized architecture provides the following advantages:

- All disk drives are equally loaded, making optimal use of all system resources
- When new disk drives are added to the system, a small part of the data stored on each disk drive is migrated to the newly added drives. This is a background process, transparent to the hosts and storage administrators.
- Storage administrators are spared the need to plan and implement the layout of the volume on specific disk drives
- All space on the system can be used; the traditional phenomenon of *orphaned space* is completely avoided
- A volume can always be resized, without any limitation

Thin Provisioning

Thin provisioning is an enormous cost-saving feature with regard to equipment, power, and space expenditures. The XIV system is inherently thin provisioned, with actual disk space capacity allocated only when written to the first time. This approach allows system administrators to allocate large logical capacity at the time the volume is provisioned, with the actual installation of additional physical capacity only when and if needed.

For storage administrators, the XIV implementation of thin provisioning brings numerous advantages:

- The XIV system eliminates the need, during thin provisioning, to constantly resize volumes when applications demand more space. In traditional systems, such resizing is typically needed and is often a complex operation involving application downtime, host reconfiguration, and application and backup configuration.
- The XIV system allows the definition of thin provisioning policy per storage pool. For example, critical applications can get their own dedicated space with no thin provisioning, while non-critical applications can be thin provisioned. This gives the administrator the ability to use thin provisioning without risking the availability of critical applications.

Snapshot Architecture

The IBM XIV Storage System provides a revolutionary snapshot architecture, whose many features include: the ability to create a snapshot instantly, define a writable snapshot, define a practically unlimited number of snapshots, and support high performance production environments with snapshots.

For storage administrators, these capabilities mean:

- Simpler backup procedures, due in part to the ability to create a snapshot instantly
- Simple and easy testing of new environments and configuration, due in part to writable snapshots

XIV System Management

The XIV system provides outstanding ease of management, delivered through technological breakthroughs that offer an entirely new, virtualized approach to storage system management, and a powerful set of features that make daily administration easier, more efficient, and more effective.

Innovative Concept

The XIV system is based on many technological breakthroughs designed to impact positively on ease of management.

One such breakthrough is the XIV scheme for spanning volumes across physical disk drives. When a new volume is defined, the XIV system splits the volume into 1 MB units and applies a pseudo-random algorithm that assigns each such unit to a different disk on a different module.

This revolutionary approach to volume distribution provides the best of all worlds:

- **Built-in virtualization.** The storage administrator does not need to decide on which disks drives or modules a certain volume will reside. Rather, the XIV system performs these decisions automatically and optimally.
- **Optimal performance.** The pseudo-random distribution ensures that all disk drives are equally utilized, regardless of usage patterns. This ensures — and without manual configuration or tuning — that full performance resources are in use at all times.

- **Automatic and optimal usage of new capacity.** When new storage capacity is installed, the XIV system automatically migrates a small part of the contents in each of the existing modules to the newly installed modules. By the end of the migration process (which takes only hours), all volumes in the system will be distributed equally over all the modules, old and new, in the system. Once the new capacity is installed, the system provides better performance for all applications, with no need for administrator decisions or manual tuning.
- **No orphaned space.** The XIV system never has orphaned space – a space that cannot be assigned to volumes. This XIV characteristic further ensures full utilization of all system resources.
- **Storage pools.** Storage pools provide a simple resource allocation scheme, limiting the total space consumption of volumes and snapshots for specific needs.
- **Flexible snapshot architecture.** The XIV system supports differential snapshots and requires practically zero time to create a snapshot, take a snapshot of a snapshot, etc. The flexible architecture makes snapshot-related tasks simple, easy, and fast, while empowering administrators with a rich set of snapshot features.
- **Thin provisioning.** XIV's implementation of thin provisioning makes management simpler by eliminating the need to constantly resize volumes.

Management Features – Doing More with Less Effort

The XIV system offers storage administrators a rich set of management features, allowing simple and powerful management characterized by the ability to do more with less effort.

Key XIV management capabilities and their benefits appear in greater detail below.

Volume management

The XIV concept of volume management is an innovative approach that optimizes use of capacity while avoiding hotspots and other pitfalls of traditional volume management. With the XIV system, one can:

- Create a volume with a single command, simply by specifying its size. No need for layout management, performance optimization, or other such tasks
- Resize volumes without limitation, **even while IOs are being processed**

Benefit: *Simple and immediate provisioning without the typical administrative overhead of planning, performance tuning, and the like.*

Pool management

The concept of storage pools calls for partitioning the system and controlling volume and snapshot space consumption per application or department. With the XIV system, one can:

- Define storage pools for allocating storage resources for a group of volumes
- Define storage pools as pure logical entities unrelated to a physical entity, such as a disk or module
- Resize storage pools instantly, without limitation
- Move volumes between storage pools instantly, without limitation

Benefit: *Simple resource allocation for different needs, without limitation or association with the physical structure*

Snapshot management

XIV snapshot management is enabled by a powerful architecture and algorithms that allow almost unlimited flexibility in snapshot creation while minimizing snapshot overhead. With the XIV system, one can:

- Create snapshots instantly, with a single CLI command, and no need for a complex split and copy process
- Take near-unlimited number of snapshots
- Use consistency groups to take consistent snapshots of multiple volumes concurrently
- Define snapshots as writable, for easy testing of new versions or configurations
- Take snapshots of writable snapshots
- Restore a volume from a writable snapshot
- Overwrite the contents of a snapshot with a volume's existing contents, allowing backup servers to run a new backup without a system-level rescan process
- Manage the priority of snapshot deletion, so as to ensure the correct behavior when running out of storage space

Benefit: *Simple writing and maintaining of backup procedures, simple testing of new environments.*

Thin provisioning

XIV thin provisioning flexibly optimizes existing capacity and allows "thick to thin" migration of existing volumes from a non-XIV system. With the XIV system one can:

- Define a logical volume size that is decoupled from the physical resources

- Implement thin provisioning per storage pool
- Monitor usage statistics and receive notifications

Benefit: *The ability to save costs by deferring the purchase of physical capacity until it is absolutely needed; consequently also enables organizations to buy the latest capacity densities available on the market at that time*

Event notification

The XIV system empowers storage administrators with full and flexible control over event alerts. With the XIV system, one can:

- Easily configure the notification of any system event
- Send messages via Email, SNMP traps or SMS
- Use powerful rules to control which users are notified of which events: send different notifications to different destinations based on type or severity
- Enable users to override the thresholds that cause notifications
- Set up the system to send notifications continuously to the same users or a broader distribution list, until the problem is resolved
- Use powerful wizards, even without prior training, to define any configuration

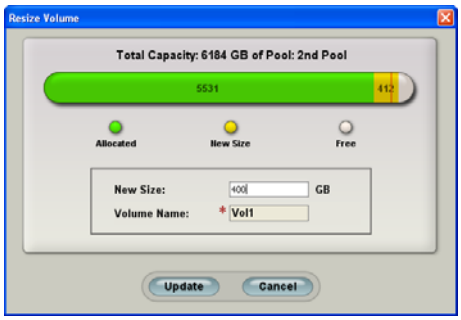
Benefit: *Powerful and easy-to-configure mechanism for notification of any system event, built to enable optimal monitoring and responsiveness*

Simple graphical user interface (GUI)

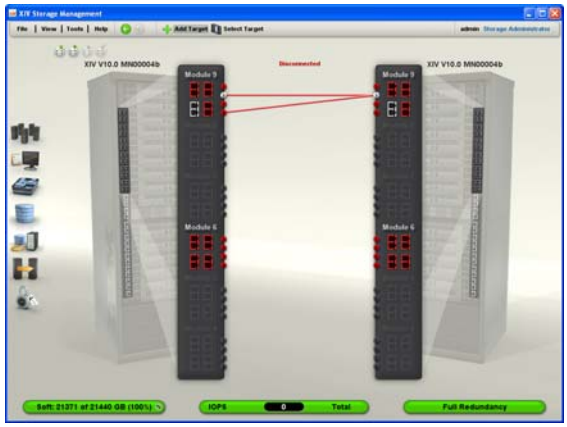
The XIV system provides an outstandingly pleasant and straightforward user experience, in large part thanks to an easy-to-use graphical interface (GUI) to all system functionality. Users work with the GUI to:

- Define volumes and hosts, map volumes, create snapshots, and manage consistency groups and storage pools – all these operations can be performed in minutes, practically without prior training.
- View the status of one or more XIV systems, identifying easily the state of each
- View performance statistics, analyze performance bottlenecks, and identify the reasons for any performance problem
- View event history through various filters
- Manage the event notification scheme, define email servers, SNMP managers, and email-to-SMS gateways, with full control over message syntax and content
- View host FC connectivity, identifying configuration problems and verifying multipath connectivity.

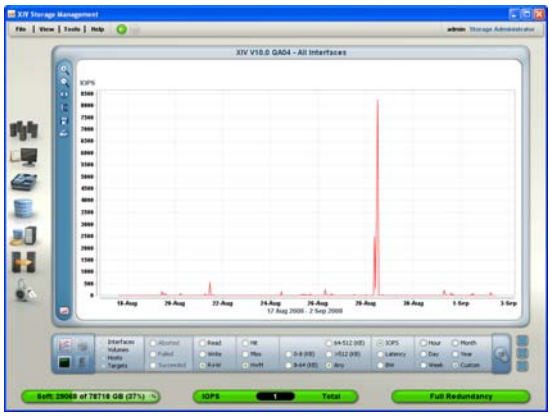
Benefit: *Easy-to-use, graphics-based interface for full system management, making administrator tasks simple and swift, and improving responsiveness to system needs and users*



Resizing volumes



Host connectivity



Performance statistics

Figure: The breakthrough XIV GUI dramatically improves ease of management for enterprise storage administrators

Summary

As described above, the XIV system overcomes the typical complexities of traditional storage systems through exceptional ease of management, implemented through:

- Several XIV architectural breakthroughs, including with regard to virtualization, thin provisioning, and snapshot creation
- A paradigm shift in system management, in which system transparency and “ease of use” are key, delivered via a highly responsive graphical user interface

The resulting benefits to IT users and their organizations include reduced administrative overhead, optimized use of storage resources, greater responsiveness to end-users, and reduced costs overall.