A Perfect Fit:

IBM XIV® Storage System with VMware® for Optimized Storage-Server Virtualization

White Paper | February 2011 update

(Original version published October 2010)

Questions? Contact us, at:
askxiv@us.ibm.com

For more information:
www.xivstorage.com
xiv on www.ibm.com

Contents

Executive Summary

This paper discusses the many challenges of a total virtualized solution in light of the integration of virtualized servers and virtualized storage. It reviews the complementary technologies of the VMware and IBM XIV® Storage System environments, while highlighting IBM XIV features that address the different issues. Real-world use cases provided at the end of the document illustrate IBM XIV server-storage virtualization success and benefits. After reading this paper, you will have a clear understanding of the different factors involved in achieving an effective virtual environment and how to address them using the IBM XIV Storage System.

Introduction

Today's virtualization technology is transforming business. Whether the virtualization goal is to consolidate servers, centralize services, implement disaster recovery, set up remote or thin client desktops, or create clouds for optimized resource use or new revenue streams, companies are increasingly virtualizing their environments.

Organizations often deploy server virtualization in the hope of gaining economies of scale in consolidating underutilized resources to a new platform. It's important to remember that storage is the chief component underlying an enterprise IT system; therefore, equally crucial to a server virtualization scenario. Many who have implemented server virtualization but neglected to take storage into account find themselves facing common challenges of uneven resource sharing, and of performance and reliability degradation.

So what is the right storage for achieving a complete, complementary virtualized infrastructure? What storage system features will make the most of a virtualized server environment?

The IBM XIV® Storage System, with its next-generation grid architecture, automated load balancing, and exceptional ease of management, provides best-in-class virtual enterprise storage for virtual servers. IBM XIV reduces the overall footprint of the storage architecture as VMware reduces the server infrastructure. IBM XIV end-to-end support for VMware solutions, including vSphere and vCenter, provides hotspot-free server-storage performance, optimal resource use, and an on-demand storage infrastructure that enables

the simplified growth key to meeting enterprise virtualization goals. Together, IBM XIV and VMware provide the best consolidation, performance, resilience, and usability for virtual infrastructures.

IBM Gold Alliance Partnership with VMware

IBM and VMware have a Global Alliance Partnership—the highest level of VMware partnership. The largest OEM partner with VMware, IBM has more VMware-certified solutions than any other storage vendor. In the context of its elite VMware Technology Alliance Partner (TAP) relationship, IBM collaborates with VMware on ongoing strategic, functional, and engineering levels.

As part of this leading partnership, IBM XIV provides end-to-end support for VMware—including vSphere, Site Recovery Manager, and **vStorage API for Array Integration** (VAAI)—with ongoing support for VMware virtualization solutions as they evolve and are developed. Specifically, IBM XIV works in concert with the following VMware products:

- vSphere™ ESX
- vSphere Hypervisor (ESXi)
- vCenter
- vSphere vMotion

IBM XIV system leverages the VMware strategic technology partnership to provide robust solutions and release them quickly, for customer benefit. Along with other IBM storage platforms, the XIV system is installed at VMware's Reference Architecture Lab and other VMware engineering development labs, where it is used for early testing of new VMware product release features. Among other VMware product projects, IBM XIV took part in the development and testing of VMware ESX 4.1.

IBM XIV engineering teams have ongoing access to VMware co-development programs – developer forums and a comprehensive set of developer resources such as toolkits, source code, and application program interfaces; this access translates to excellent virtualization value for customers.

Fully Virtualized IBM XIV Enterprise Storage

Delivering the performance, availability, and scalability that enterprises require for their most critical applications, at exceptionally low total cost of ownership, the IBM XIV Storage System has been architected by listening to enterprise customers and their needs.

IBM XIV provides:

- A smart **"autonomic" virtualized grid architecture** that features automated data distribution, unique caching, and other innovations to distribute data across the entire system evenly at all times, eliminating hotspots
- An **intuitive management interface**—one of the best in the industry—designed to eliminate complexity and revolutionize the ease and speed with which storage is managed
- **High reliability and data availability** via active-active N+1 redundancy of all key components, partition mirroring, unique self healing, rapid rebuild times, and non-disruptive upgrades
- **Unmatched total cost of ownership** and environment-friendly attributes, with dramatic efficiencies in capacity, power, and space
- Consistent **enterprise-level performance** through massive parallelism, disk utilization, unique caching mechanisms, and optimal load balancing
- A built-in feature set that comes as standard with the product, including **snapshots, thin provisioning, a migration tool,** and **asynchronous and synchronous mirroring**

The IBM XIV Storage System is open and integrated. A modular system, it is available in partial to full (27 to 161 TB) configurations, based on 1 TB or 2 TB disk drives. All configurations include full software functionality. The system's modular nature enables transparent, no-impact scalability, in on-demand increments. With no manual data migration or performance tuning required, organizations benefit from simple capacity growth with little to no storage administration. IBM XIV provides cache, processors, disks, and connectivity in every module: all resources are augmented with every increase in capacity, further enabling organizations to grow capacity without complexity.

Additional innovations inherent in the IBM XIV system include:

- A **single-tier** platform for all application needs, avoiding the need for RAID and other storage management technologies
- A complete system, with no additional software licensing or price escalations

- A revolutionary system built of industry-standard components
- High resilience that reduces recovery time for a failed 1 TB disk drive to an average of 30 minutes, while maintaining performance and service levels
- A solution designed to reduce complexity and management overhead, and to minimize exposure to human error by reducing manual intervention
- Optimized use of capacity
- Minimized physical points of failure, readying the enterprise for cloud services and high quality of service levels.

These IBM XIV system features and benefits make a storage landscape smarter and more agile while reducing its capital and operating expenses.

VMware Virtualization Solutions

VMware virtualization solutions apply the power and resources of a single physical computer dynamically and concurrently across multiple operating environments to provide multiple virtual systems. The elastic, self-managed virtual VMware infrastructure delivers flexibility and agility while maintaining system control. The results are dramatic:

- Major reductions in system management
- Higher resource and application availability
- Maximum consolidation to reduce data center footprint
- Ease of use
- Increased resilience
- Streamlined deployment and configuration processes
- Continuous and automatic virtual machine optimization
- Reduced costs

By providing its technology partners with a standard set of integration APIs, VMware enables its partners to control, deliver, and complement VMware value through their own offerings.

Why IBM XIV is a Perfect Fit with VMware

IBM XIV Storage provides best-in-class virtual enterprise storage for virtual servers. The combination of its optimal use of resources and hotspot-free server-storage performance make for exceptional synergy with the VMware server infrastructure and products. IBM XIV successfully leverages VMware APIs to deliver a complete solution for virtualization. Tight integration with VAAI, SRM, vSphere, and vCenter allow for simple configuration, resilience (snapshots and mirroring), and management.

Some 70% of IBM XIV customers are also VMware customers, in various stages of integrating server-storage environments. Numerous customer results across a variety of industries demonstrate measureable ROI from their combined IBM XIV – VMware deployments.

Instant storage provisioning

IBM XIV can provision storage in less time than it takes to provision a virtual machine. This means that high availability storage can be instantly available to new virtual machines, while ensuring optimal load balancing throughout the storage array. Instant provisioning promotes high responsiveness, saves configuration time, and upholds outstanding performance.

Storage designed to optimize virtual servers

Typically, customers deploy server virtualization hoping to gain economies of scale from consolidating underutilized resources on a new platform. All too often they don't take into account the storage that underlies their enterprise IT systems. The resulting challenges show themselves quickly as resources are unevenly shared, performance degrades, and reliability suffers.

By using IBM XIV as the cornerstone storage platform in the VMware-based architecture, customers can address the whole picture and achieve a complete virtualization solution. IBM XIV's inherent architecture lends itself perfectly to optimized server-storage environments for maximal benefit from both technologies. Several native IBM XIV features, detailed in the following sections, bring particular value to the dynamic system environments typically demanded by VMware virtualization.

Top performance: randomization, caching, and I/O optimization

In VMware environments, as the number of virtual machines per VMware ESX server grows, random storage access increases. In conventional storage solutions, an increase in random storage access typically results in degraded system performance.

IBM XIV storage system arrays are fully and automatically distributed, with random I/O optimized, advanced caching algorithms, and ideal I/O levels. This dramatically reduces random seek times—offering granular and efficient caching, leading to powerful performance for consolidated environments. For more information on IBM XIV's superior performance, see the IBM XIV "Performance Reinvented" White Paper.

Figure 1: Traditional storage – The application determines if reads/writes are random or sequential.

Unparalleled consolidation and virtual machine utilization

Consolidation to reduce data center footprint for corporate infrastructure is a key value of virtualization. IBM XIV Storage promotes maximized throughput, preventing hotspots and performance bottlenecks typical of traditional storage environments. IBM XIV's abundant points of connectivity support large numbers of virtual machines at any time, with no negative performance impact.

In a conventional RAID-based storage system, the LUNs managed by the Virtual Machine File System (VMFS) are typically dedicated to a fixed number of spindles. This means that as virtualization environments grow or the requirements change, the underlying storage cannot automatically adjust without complex manual intervention that takes the system out of production for prolonged periods of time.

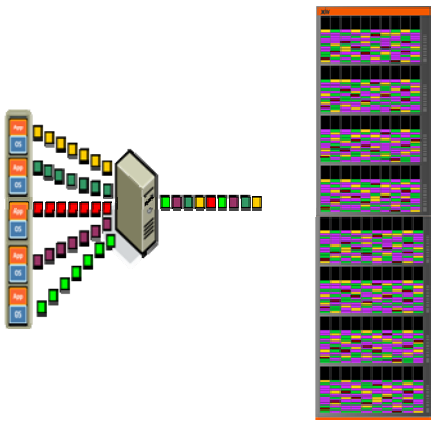

Figure 2: IBM XIV - Distributes datastores equally across the system, optimizing it for random read/write access.

With the IBM XIV architecture, datastores are completely distributed across every spindle in the system, allowing changes in performance or application requirements to be managed without manual adjustment. The flexibility and resource utilization of the IBM XIV storage system provides ideal load balance—without consuming major server resources or degrading volume utilization. This strategic approach helps IBM XIV achieve ultimate consolidation levels and maximize virtual machines per ESX server.

Dynamically prevents disk hotspots

Disk hotspots can create bottlenecks that prevent users from achieving the maximum consolidation possible for their ESX servers. Typical dedicated-spindle storage cannot adjust automatically to dynamic conditions as virtualization environments scale. In peak volume situations, such as during VM reboots, traditional storage cannot handle the immediate simultaneous demand generated. The result is a spike in hotspots and performance degradation while VMs are queued up and waiting for disk service.

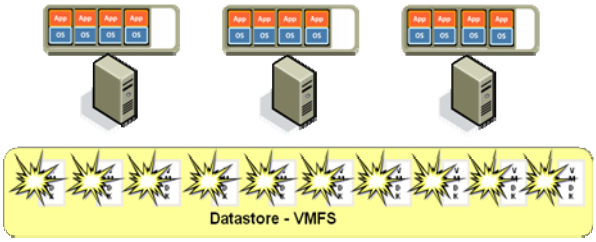

Figure 3: Traditional storage - The infrastructure cannot handle peak demand.

In addition, server hotspots that are not addressed at the core of the problem are just relocated to another virtual machine location or "offloaded" to the storage environment, which must then resolve the problem.

With IBM XIV, the ESX guest operating datastores are randomized across all disks, providing exceptional load balancing and performance optimization. The sophisticated IBM XIV architecture eliminates the problem of storage hotspots that originate at the server level.

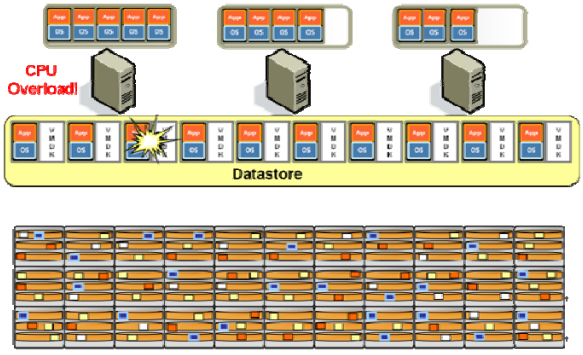

Figure 4: IBM XIV storage - The system already accommodates peak demand through optimized distribution.

Strategic load balancing

IBM XIV automatically balances load, actively allocating it evenly across all spindles at all times, providing hotspot-free storage. VMware's Storage vMotion offers the option of manually moving virtual disks non-disruptively to a disk system, one at a time. To meet specific needs, users can invoke vMotion to move data to separate, physical IBM XIV systems.

High availability and resilience

Virtual environments are tied to physical disk volumes that, in traditional systems, are supported by RAID groups. A failure of one or more disks often causes a slowdown or unplanned maintenance outage as the RAID system recovers the lost data and adds a cold

spare to the system. It can take from hours to days to recover the data and resume the previous level of performance.

With IBM XIV, because data is evenly distributed across the storage array, disk failure does not adversely affect system performance; a 1TB disk drive rebuild typically takes 30 minutes or less, with negligible performance impact.

Upward scalability

With the highly modular IBM XIV, virtual system scaling to support larger capacities and higher levels of performance is as simple as adding additional modules. There is no need to stop the production environment; additional resources can be brought online non-disruptively, in real-time. Many IBM XIV customers are running 10,000+ virtual servers within a single environment – many of these customers leveraged IBM XIV's easy scaling feature to grow much smaller virtual server schemes to large-scale virtual infrastructures. With IBM XIV, each addition of a new module increases not only capacity but also cache, processors, and number of connections, yielding continually balanced performance benefits in addition to scalability.

Optimizing multipathing

Native IBM XIV multipathing architecture works in concert with VMware out of the box, with no need for plug-ins, modifications, or workarounds. Optimal path availability and native load balancing on IBM XIV help boost performance in the VMware environment.

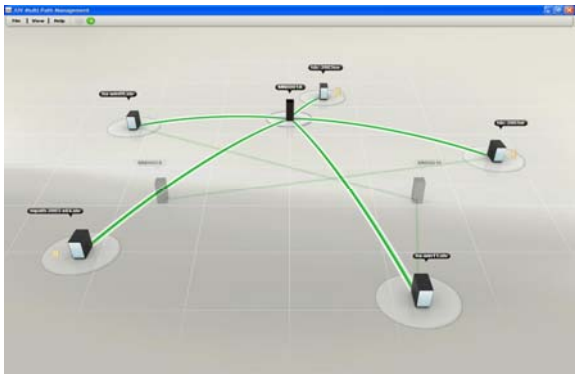

Figure 5: Easy-to-navigate IBM XIV MPIO Management Console

The IBM XIV MPIO Management Console is a GUI-based tool that enables simplified management, monitoring, and viewing of the VMware-based multipath environment. Functions such as load balancing policy can be centrally controlled for immediate system optimization.

Highly efficient snapshots

The IBM XIV approach to snapshots brings several advantages to VMware users.

Unlike traditional storage, IBM XIV does not require dedicated space to be reserved for snapshots and imposes no artificial limitation on spindle space.

With IBM XIV running on VMware, incremental snapshots perform well since data blocks are already optimally distributed and configured. Snapshots taken on IBM XIV storage systems are nearly instantaneous, with little to no impact on performance. IBM XIV production LUNs are not compromised when snapshots are in use, eliminating the traditional need for disk-intensive snapshot clones. This means that the storage capacity required for snapshots is exponentially lower than for traditional storage.

The IBM XIV architecture is ideal for VMware-based development and test environments which require extensive snapshots, and multiple test data and software versions. IBM XIV's snapshot space efficiencies and its snap-of-snap capabilities also help make systems massively scalable.

A new benchmark in thin allocation

IBM XIV inherently allocates data "thinly" — that is, physical capacity is used only when actually written to — so as to ensure that space allocation facilitates rather than hinders virtualization agility. Moreover, IBM XIV offers built-in thin provisioning: administrators decide whether to "thick provision" or "thin provision" on a pool-by-pool basis. VMware administrators can leverage this capability to create volumes that are larger than the storage pool, avoiding unnecessary management overhead. Unique to IBM XIV, and making administrating volumes that much easier, is that thin provisioning takes place in the same environment, not on separate disks, and so has no impact on snapshots or other activities, and requires no special construct or volumes.

Streamlining system deployment

The VMware-based provisioning of operating systems and applications can be achieved easily by simply copying a standard VMware template virtual machine to a new virtual machine. Since IBM XIV storage can be activated and assigned almost instantly, new applications can be deployed in the virtual environment in a matter of minutes, with a few mouse clicks, rather than hours or days as with conventional storage products.

Simplified management

Server virtualization tends to add complexity in storage configuration and tuning. The IBM XIV Storage System avoids this potential additional intricacy and overhead, offering a tremendously flexible solution with extremely low configuration and maintenance requirements. IBM XIV's self-tuning and single-tier architecture eliminates the need for RAID group definitions and management.

Ease of use

The entire IBM XIV approach to storage and intuitive management interface simplify storage planning, deployment, administration, and maintenance in VMware environments. For more information on IBM XIV ease of use, view the IBM XIV website.

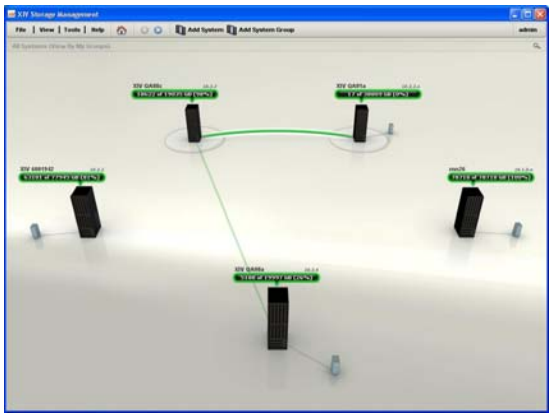

Figure 6: Easy-to-use IBM XIV Management Console: Remote mirroring status display

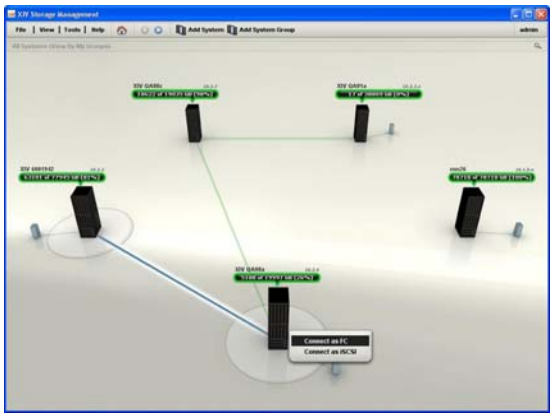

Figure 7: Easy-to-use IBM XIV Management Console: Connecting between mirrored systems

IBM XIV Feature Integration with VMware

The IBM XIV – VMware integration encompasses support at the server-storage management and communication levels, optimizing server virtualization functionality and accelerating overall system performance in the most demanding enterprise-scale environments. The overall value of the IBM XIV integration serves to:

- Simplify the total solution thereby reducing risk, cost and complexity of the total virtual solution
- Ensure vital production resources are available when needed at the performance level required by the enterprise

Storage management integration

IBM XIV leverages the range of interoperability features provided by VMware, including:

- **VMware Virtual Center Console Plug-in** - For automated viewing and management functionality
- **vStorage API for Array Integration (VAAI)** - Support for IBM XIV Storage to communicate directly with VMware for common storage tasks
- **VMware vCenter™ Site Recovery Manager (SRM)** - For intelligent, reliable system recovery

Storage viewer enhances and streamlines storage management

The IBM XIV Management Console for VMware vCenter integrates IBM XIV storage with the VMware management console to enable more efficient management of VMware components residing on IBM XIV storage. The service queries the VMware and IBM XIV systems for information, which is then used to generate the appropriate views, accessible to the VMware vSphere Client.

The IBM XIV Management Console for VMware vCenter provides detailed information on the underlying IBM XIV volumes, such as LUN name, size, and free space. VMware ESX server and guest OS-level mapping offer transparency that streamlines storage management and control.

Offloading tasks to IBM XIV boosts performance and scalability

IBM XIV leverages VAAI to take on storage-related tasks that were previously performed by VMware. Transferring the processing burden dramatically reduces performance overhead; speeds processing; frees up VMware for more mission-critical tasks, such as adding applications; simplifies management; and positions the virtual environment for additional capacity and scalability. When hardware acceleration is enabled with IBM XIV, operations like VM provisioning, VM cloning, VM migration, and thin storage provisioning complete dramatically faster, and with minimal impact on the ESX server, increasing scalability.

IBM XIV uses the following key application program interfaces to achieve the above levels of integration and related benefits:

- **Full Copy** – Divests copy operations from VMware ESX to the IBM XIV storage array. This feature allows for rapid movement of data by off-loading block level copy, move and snapshot operations to the IBM XIV Storage System. It also

enables VM deployment by VM cloning and storage cloning at the block level within and across LUNS. Benefits include expedited copy operations, minimized host processing/resource allocation, reduced network traffic, and considerable boosts in system performance.

- **Block Zeroing** – Offloads repetitive block-level write operations within virtual machine disks to IBM XIV, such as zeroing blocks. This feature improves efficiency, reduces server workload, and improves server performance. Space reclamation and thin provisioning allocation are more effective with this feature. Support for VAAI Block Zeroing allows VMware to better leverage IBM XIV architecture and gain overall dramatic performance improvements with VM provisioning and on-demand VM provisioning—when VMware typically zero-fills a large amount of storage space. Block Zeroing allows the VMware host to save bandwidth and communicate faster by minimizing the amount of actual data sent over the path to IBM XIV. Similarly it allows IBM XIV to minimize its own internal bandwidth consumption and virtually apply the write much faster.
- **Hardware Assisted Locking** – Intelligently relegates resource reservation down to the selected block level instead of the LUN, significantly reducing SCSI reservation contentions, lowering storage resource latency and enabling parallel storage processing—particularly in enterprise environments where LUNs are more likely to be used by multiple applications or processes at once.

Site recovery management

IBM XIV Storage is designed to work in concert with VMware Site Recovery Manager (SRM) for robust recovery—from planning, to testing, and failover.

Synchronized recovery with VMware

The IBM XIV Storage system coordinates recovery activities with SRM, taking full advantage of VMware's Storage Replication Adaptor (SRA) for open systems. For example, IBM XIV provides detailed storage topology information so SRM can determine which volumes failover during a VMware ESX server to

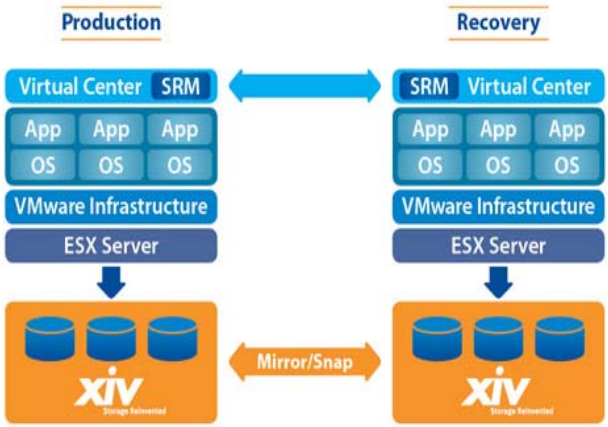

Figure 8: IBM XIV disaster recovery infrastructure

outage.

Flexible failover scenarios

The XIV system supports a broad spectrum of failover scenarios and infrastructure components, making storage management nearly invisible during recovery.

Both SRM and IBM XIV automate disaster recovery workflows, working together to pre-program the disaster recovery response. Failover activities, such as breaking the mirror upon error, reversing roles, and mounting target LUNs at the recovery site facilitate successful failover.

Recovery testing environment

IBM XIV Storage System capabilities promote easy recovery testing, such as providing an isolated cluster-based testing environment that does not impact the live cluster. The IBM XIV architecture is ideal for VMware-based development and test environments which require heavy snapshotting and multiple test data and software versions. IBM XIV's snapshotting space efficiency and its snap-of-snap capabilities make systems massively scalable.

IBM XIV Solutions for VMware

IBM XIV offers end-to-end solutions in virtualized enterprise VMware environments, from the most simple to the most complex.

Reliable disaster recovery

IBM XIV and VMware work hand-in-glove for solid planning, precise setup, thorough testing, and quick, accurate, low-risk recovery.

The cornerstone of the virtualized disaster recovery infrastructure is IBM XIV integration with VMware SRM. Beginning with initial configuration, IBM XIV and VMware are synchronized; storage information is shared between the virtual server and storage environments. Failover planning and recovery testing help minimize downtime and impact on production.

Simple failover management

"One button" initiates and runs failover in VMware environments to accelerate recovery and eliminate manual steps.

Resilient recovery

IBM XIV disaster recovery functionality through VMware SRM helps promote swift return to operations in sync with VMware.

The XIV system's database resiliency features, such as mailbox resiliency, provide automatic monitoring and database-level recovery from database, server, or network failure.

Business continuity

IBM XIV promotes optimal business operations in dynamic VMware environments with high-availability storage. IBM XIV's business continuity solutions incorporate the complete storage-related IT architecture:

Support for redundant, fault-tolerant clustering

By leveraging VAAI and vMotion, IBM XIV supports effective VMware cluster management. IBM XIV uses SRM to promote fault tolerance and optimize uptime.

Self-healing storage

Data stored on IBM XIV is automatically checked for integrity. Should a disk go down, the system automatically and transparently rebuilds the faulty disk while maintaining consistent performance.

Consistently high performance

The system performs well, particularly during peak demand periods, by preventing storage hotspots amid changes in virtual machine load.

Proven solutions for mission-critical applications

IBM XIV storage systems support all major enterprise applications running on virtual servers within VMware. Even the most resource-intensive applications: SAP®, Microsoft Exchange, Oracle®, and SAS® have been proven to achieve significant improvements in application performance with IBM XIV in VMware environments. Despite the high levels of random I/O workload that these applications demand, IBM XIV's massive parallel storage architecture and automatic load balancing succeed in preventing bottlenecks and maintain high performance levels.

Portfolios of applications with mixed workloads (heavy throughput or transaction-based workload) perform well on IBM XIV storage, without system-slowing resource contention.

Virtualized application deployments on IBM XIV Storage are performed in a fraction of the time of traditional storage products; with IBM XIV, adding volumes and assigning them to servers takes a few minutes, instead of hours or days.

Cloud computing

IBM XIV provides an expansive architecture to support virtualized cloud computing, including:

- **Promoting extensive scalability** – Minimizes storage I/O overhead to the VMware server, enabling servers to apply more processing power to mission-critical processes.
- **Supporting optimal performance** – Minimizes latency and resource conflicts at the LUN and storage block level. Minimizes I/Os of repetitive write operations and unused storage space.
- **Promoting agility** – Offers immediate storage provisioning, simple storage movement, minimized processing overhead, and maximized shared resources
- **Achieves unprecedented economies of scale** - With IBM XIV, virtualized enterprises can achieve ideal levels of physical server density while ensuring optimal service, secure data segregation, performance, reliability, and availability. Providers of IT-as-a-service and other multi-tenancy services have much to benefit from VMware consolidation on IBM XIV storage.

Select IBM XIV VMware References

Many VMware customers worldwide are enjoying—and reporting on!—the native server-storage virtualization benefits of IBM XIV, including:

- Bank Leumi (Finance)
- Bourse de Luxembourg (Finance) – Video available in: English; French; German
- COSVI (Insurance) – Video available in: English; Spanish
- Euronics (Retail) – Video available in: English; German
- nui (IT Services)
- OCH Regional Medical Center (Healthcare)
- Vinci PLC (Construction) – Video available in: English

*Links require Internet connectivity: To read the **case study**, just click on the company name; to see the **video**, just click on the language of your choice.*

Conclusion

IBM XIV Storage, perhaps more than any other enterprise storage system on the market, offers exceptional business value to VMware users through compelling strategic solutions for complex, dynamic virtualized environments. IBM XIV Storage, with its inherent design and partnership-fortified tight end-to-end VMware interoperability, provides the perfect virtualized storage complement to VMware platforms.

Users of both solutions gain server-storage virtualization primed for whatever business endeavor comes next, while reducing the risk, cost, and complexity of storing and managing their most important asset: data.