FalconStor®

THE VALUE OF STORAGE VIRTUALIZATION

A WHITE PAPER

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ABSTRACT

Virtualization has become a buzzword in technology circles, but what exactly it is—and what it is not—have been variously and vaguely defined. This white paper addresses the specific topic of storage virtualization. Storage virtualization is defined, its benefits presented, and its features detailed within the context of related issues in storage networking.

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WHAT STORAGE VIRTUALIZATION IS AND IS NOT

Storage virtualization is not

Simple storage virtualization has been with us as long as we have had storage to mask the physical aspects of the storage systems in use from the operating system and provide greater flexibility. Early systems used disk partitioning of a single physical disk to create multiple logical (read virtual) disks. RAID arrays took this the other direction and used an aggregation of multiple physical disks to create a single logical disk (which might be further carved into logical volumes).

Simple partitioning and data striping technologies, hardware mirroring or RAID by an individual storage device vendor are NOT what the current industry is referring to regarding "storage virtualization". Simply using someone else's disk behind your controller is also not virtualization. Common disk and array controllers have always done this. Nevertheless, some manufacturers are now blurring virtualization with the functionality of their new RAID controllers, which accepts reconfiguration commands from a metadata manager.

Storage virtualization is

Today's storage virtualization goes a level higher than an individual controller device. Storage virtualization can be seen as an Abstraction Layer that provides additional benefits. It includes the aggregation of multiple physical storage devices across various storage fabrics and interface protocols (such as SCSI, iSCSI, or Fibre Channel inc. FCoE) into a single virtual storage pool. The creation and provisioning of virtual storage volumes, appearing as locally attached logical devices to their host server, can be performed from a centralized console.

When an administrator at a centralized console allocates storage from the virtual pool to an application server, the server is forced into thinking that an actual block-level SCSI storage device has been physically plugged into it. So that is how it appears on the list of devices attached to the server. Complete Storage Virtualization is like a shield that protects application servers from being affected by the heterogeneous (if not out-and-out chaotic) storage world of fabrics, protocols, arrays, mixed disks, storage controllers, NICs, HBAs, and tape drives that are operating behind the scenes.

Storage virtualization is valuable when

To be truly valuable, in addition to unifying management of storage resources, an advanced storage virtualization solution should come as part of an industrial-strength storage infrastructure package offering maximum freedom of choice in all areas. The complete solution should be based on open standards, making it independent of device vendors and interfaces, connectivity protocols, and operating system (OS) platforms.

Virtualization is best offered in conjunction with cutting-edge storage management features, such as high availability, automatic failover, snapshot, mirroring, replication, and accelerated backup and recovery. Application-specific optimization capabilities should exist, such as the ability to offload host server tasks like replication and backup. Plus, the solution should be reliable, scalable, secure, easy to deploy and use, and cost-effective.

Sound like a tall order? Yes, but it is not impossible. A sophisticated software solution can achieve these results.

TECHNOLOGY'S MAGIC POTION

Virtualization is valuable because it makes everyone happy, which equates with a healthy bottom line. For enterprises, the bottom line is that virtualization saves money and helps make money. For systems operators, the benefit is the light at the end of their workload tunnel. Moreover, for end-users, the boon is the ability to remain blissfully unaware of what's going on behind the scenes while reliably having someplace to dump their data.

Below is a collection of notable reasons why a superior virtualization solution substantially increases return on investment (ROI) and reduces total cost of ownership (TCO) of the total storage network infrastructure.

Reduces managerial and administrative overhead

Virtualization makes IT administrators happy. A storage infrastructure that employs virtualization is considerably easier for IT administrators to manage, while saving them a great deal of time and effort. Instead of expending huge chunks of time on hardware modifications—physically attaching, moving around, and configuring devices—they can effortlessly assign, unassign, or reassign virtual volumes from a central location. Not only does this leave administrators with more time to do all of the other things on their plate, it saves enterprises resources as fewer IT staff members are needed to manage much larger amounts of storage.

Enables interoperability with storage hardware

Another key benefit of virtualization is interoperability. Masking the complexity of various vendors' storage solutions ideally creates an environment where every disk subsystem appears the same to the host server. The actual disk subsystem behind the virtual image can be anything. In virtualized storage architecture, enterprises can purchase their storage knowing that they can plug it in to start working. No complex and time-consuming configurations—or a total lack of interoperability—thus significantly decreasing their investment and increasing financial return.

Virtualization can keep enterprises immune to becoming captive to a specific vendor or proprietary technology and a higher initial and recurring cost. Because virtualized storage is agnostic with respect to vendors and technology, IT administrators are given the freedom to choose the best solution for their organization. Encouraging healthy competition in the storage appliance industry, bringing added benefits over time in the form of technological advances and fine-tunings.

Enables efficient allocation of storage resources

Since virtual volumes can span across multiple physical device boundaries, a virtualized storage environment maximizes storage utilization, helping to avoid idle or unused storage space. Administrators can allocate more storage instantly where it is being used or is almost used up, and less storage where it is unneeded. The immediate effect leads to preventing the common practice of over-allocating storage in an attempt to prevent running out of space, or the equally common under-allocation—and its associated panicked race to buy and allocate more storage. Virtualization enables administrators to respond immediately, rationally, to changing storage needs. In advanced solutions, the response can even be instant—the system can be configured to monitor itself and add storage capacity automatically when pre-defined thresholds are reached. All of this opens the way for future storage purchases to be chosen from a plethora of available solutions, resulting in better price and capabilities. A practical virtualization solution likewise ensures that all existing and future storage capacities can be fully integrated, realized, and presented in a simple manner and managed with ease as a single virtual volume.

Allows easy, effective management of storage network/devices

A virtualized approach makes it much easier to add and maintain storage devices. An advanced solution applies an intuitive GUI to visualize storage and then assign and manipulate it as needed. Furthermore, dynamic modification of access permissions to virtual volumes can be performed on the fly. Online and transparent migration of storage devices allows maintenance and upgrade of storage devices without shutting down applications.

Supports remote data access, backup, mirroring, replication

A value-adding storage virtualization solution also enables IT administrators to create backups and mirror space on disks configured virtually anywhere in the system, or across IP networks. It enables disaster recovery (DR) services such as replication of data across IP to a remote site and rapid data and system recovery services such as bare metal recovery and online/near line disk-based backups. Easing the administration for the local SAN managers, since they can remain at their central location, and benefits the entire enterprise, since it makes critical data inexpensively available outside a geographically local area. Also, it ensures that a business can continue operating in the event of damage or loss of a primary data set.

Ensures business continuity

Virtualization allows for rapid storage growth and reconfiguration, without the downtime that an expansion, usually, entails. Virtualization is a vital advantage for today's enterprises, which are increasingly running in fast-paced 24x7x365 modes. Volumes of storage can be allocated to application servers on the fly, without interrupting operation.

In order to truly assure business continuity, an advanced virtualization solution should make it possible to safeguard against all possible single points of failure on storage devices, server hardware, networking hardware, and even complete site failure due to disaster. In an age when businesses cannot operate without access to their data, less downtime and disaster protection translate into higher returns for enterprises.

In order to prevent failure of storage systems, the solution should enable mirroring of virtual drives, within and across cabinets, even if they are made by different vendors, and across any distance. For a defense against server hardware failure, an advanced virtualization solution should support high availability configurations, enabling full redundancy throughout the entire data path so that there is no single point of failure. Lastly, to protect against site failure from a variety of disasters, the solution should support remote replication of virtual drives to keep an extra set of data off-site.

Facilitates fast data access

For purposes, a virtualized volume mimics an actual physical device. However, a superior virtualization solution succeeds at generating virtual drives that far surpass their physical cousins in speed and functionality. In this way, virtualization can significantly improve the performance of a storage network. Speedy access to data is a critical benchmark for modern enterprises whose customers want products fast and demand answers now.

Virtualization, in combination with other functionalities, can be particularly beneficial when performing tape backups. Virtual volumes can be staged on disks and later backed up to tapes, thus offloading I/O and processing cycles from the application server. For example, by leveraging delta-based snapshot technology and/or virtual tape library (VTL) technology, both of which are provided by FalconStor Software, truly LAN-free/server-less/windowless backups become a reality.

Benefits summary

Virtualization greatly enhances the capabilities of storage administrators; whose ability to manage storage with a comprehensive virtualization and storage services tool set drives down storage administration costs significantly. A storage virtualization solution eases the task and cost of storage capacity planning. It allows usage of heterogeneous storage, empowering enterprises to leverage their current infrastructure and to make future purchases based on the best choices available rather than being tied to homogeneous proprietary storage offerings.

Virtualization makes the implementation of enterprise-wide storage management a dream come true. It can provide enterprise-wide manageability, allowing storage systems to be constantly available and scalable to meet future needs. It allows easy storage space reallocation with minimal impact to application servers, diminishing downtime and allowing enterprises to do business at optimum intensity, 24x7. Virtualization is also fundamental to enabling business continuity functionality, such as mirroring and remote backup.

With proper implementation, storage virtualization can yield tremendous cost savings and other vital benefits to today's enterprises.

THE CASE FOR VIRTUALIZATION

The wild world of SAN and NAS

In response to the need to warehouse and manage the ever-flourishing jungles of mission critical data, many enterprises have either already implemented a SAN or are considering doing so. A caveat: there is a high degree of complexity inherent in the implementation and subsequent maintenance of a typical SAN solution. There is a variety of reasons for this. The point to remember is that even though basic storage devices may be getting cheaper, complexity is expensive.

Another challenge to the designing of a storage network is posed by the existence of NAS as a storage alternative. Which should a company choose? A SAN or NAS? Alternatively, both a SAN and NAS? Each addresses a different need and exercises a different approach to storage management. Though the advantages and disadvantages of SAN and NAS are still debated in technology circles and by vendors, the fact is that both are needed in corporate data centers.

Complicating matters further, the original separation of abilities between SANs and NAS, such as block- level access and file-level access, respectively, is becoming blurred as the capabilities of storage appliances continue to be enhanced. As a result, an enterprise may invest a tremendous amount in one solution, only to find that another solution might have been better in some way, e.g., more versatile. Only by then it is too late: resources have already been spent. Furthermore, the chosen solution is likely to be incapable of being integrated with any other solution. In these ways, enterprises often find themselves locked into one vendor's proprietary solution, which may be less appropriate to their needs, less technologically advanced, and more expensive than an alternative solution. Alternatively, they end up with several different storage solutions that need to be managed separately and require more of the storage administrators' already limited time. Additionally, IT staff is required to have first-hand knowledge of several different devices and modes of connectivity.

One thing is certain: SAN and NAS storage solutions are, usually, costly and complex to design, implement, and integrate. In addition to these factors, the continual investment in maintaining such solutions is substantial. For each vendor's specific solution, specialized technical knowledge is required to manage it. Future expansion would necessitate the purchase of proprietary storage appliances and use of the same method of connectivity, even if alternative methods have developed.

These factors have generated a huge demand for a method of managing multiple storage solutions that not only has a unifying and simplifying effect on storage management, but is more cost effective over the long term.

Is simpler cheaper? How can you simplify and speed up both storage provisioning and data access while reducing costs? By using a virtualization solution that is capable of unifying SAN and NAS provisioning and management under one umbrella. The key is to implement a solution that delivers all the benefits of virtualization while reducing administrative overhead, instead of introducing new policies, procedures, and costly devices.

BUYER BEWARE

Virtualization alone doesn't cut it

It is not enough to simply enable a virtualization process. The true value of virtualization can only be realized within a full-featured, future-proof storage solution that leverages current IT infrastructure. Additionally, one that provides not just virtualization, but top performance (fast data storage and access), ease of use, unified SAN and NAS management, seamless and simple integration of host-based systems (i.e. servers with direct-attached storage [DAS]), virtualization across cabinets, and seamless support of heterogeneous storage environments. A solution that offers total freedom of choice in device vendors, interfaces, connectivity, platforms, and protocols can achieve this.

Criteria for choosing a SAN virtualization solution

Tip: If a solution cannot leverage an enterprise's current network infrastructure or the IT staff's knowledge, does not enable the seamless integration of a heterogeneous storage environment, does not have the ability to provision storage resources as SAN and/or NAS, and cannot integrate machines that have DAS (which most organizations still have around), it is probably time to look for a different solution.

The key is to find a solution that enables virtualization within a unified mechanism, while simultaneously facilitating rapid sharing of stored data, and maximizing ROI on current and future infrastructure purchases. In this matter, not all storage solutions are created equal. The storage market warrants a highly sophisticated, high performance, vendor-neutral solution that works with all management tools, reporting utilities, and maintenance procedures.

Selection criteria for a vendor's virtualization solution should include performance, scalability, high availability, and the cost of installation and maintenance. Additional concerns include ease-of-use and the manufacturer's or vendor's plans for the future (i.e., their support of emerging standards). Heavy overhead becomes an issue with solutions that preclude those in charge of the IT treasure chest from making a more cost-effective decision in the future, or limit them to a proprietary technology. In an ever-changing market, this is undesirable.

The real challenge in setting selection criteria is figuring out what an enterprise's business-specific needs are. Factors such as bandwidth, response time, and required physical connections must be determined. Available support staff and technical competency also play critical roles.

Simultaneously, many companies are struggling to disentangle themselves from proprietary vendor-specific environments, many IT professionals have come to the realization that true virtualization enables the recognition and control of many different vendors' storage devices.

When selecting a virtualization solution, enterprises must choose the solution that offers the most value to their organization. Unfortunately, this is not always apparent.. Virtualization solutions on the market today focus almost solely on the presentation of multiple physical devices to the host servers as logical virtual volumes. The two additional facets that create a truly comprehensive solution should not be overlooked: connectivity and application optimization. As was explained earlier, freedom of connectivity allows for the integration of storage devices and free expansion of the storage network. Application optimization allows for the offloading of host server tasks like snapshot and backup for faster data throughput.

Questions to ask before selecting a solution include:
- Is the solution a hardware and software solution that will require extensive matrix testing across all equipment?
- If a hardware solution, what industry support is there for such hardware?
- Does it require a "black box" which is based upon a proprietary, vendor-specific operating system?

Formerly, virtualization was thought of as functioning only within a Fibre Channel (FC) SAN. Today's business needs dictate that storage be dynamically accessible both within and across SANs. A comprehensive virtualization solution should also include the ability to connect virtualized volumes across IP as well as FC. The solution should also allow the seamless incorporation and management of NAS devices. Usually, this is the point of demarcation for most virtualization solutions on the market today. They provide virtualization within a SAN only and do not accommodate NAS devices. Negating one of the most important aspects of storage virtualization: presentation of storage and data outside the SAN.

FalconStor rises to the challenge

While bearing the aforementioned concerns in mind, a close look at the performance capabilities of the FalconStor® Network Storage Server (NSS) solution puts everything in focus. FalconStor NSS not only cuts costs by optimizing usage and management of the storage the hardware an enterprise already has, it improves performance, too. A 'zero-memory-copy' algorithm passes data through a FalconStor NSS appliance with minimal processing and without reliance on caching data in memory. Practical benchmark tests show better performance through FalconStor NSS than directly attaching storage to each server.

For businesses whose data is mandated to remain on physical storage, FalconStor NSS offers a unique Storage Service Enabler option that allows these machines to be incorporated seamlessly into a FalconStor NSS-managed storage network without being virtualized, but rather as service-enabled devices (SEDs). SEDs can immediately take advantage of all FalconStor NSS business continuity and DR capabilities.

Lowering costs is the name of the game

In order to extend SAN connectivity, the device is needed to serve as a bridge between a distance-limited FC network and the boundless IP-based network. While certain solutions on the market today can extend the distance limitations imposed by FC, they are costly and complicated both to implement and to maintain.

There is a cost-effective and simple alternative: FalconStor NSS, which fully supports SAN connectivity across IP via iSCSI. FalconStor NSS leverages the ubiquitous IP infrastructure, allowing for standard networking devices to be utilized for presentation of the virtual volumes derived from the SAN storage to a wide community of application servers. It also allows the management of these virtual volumes by a readily available pool of IP-familiar personnel.

With FalconStor NSS, all of the potential cost-savings introduced by the implementation of a virtualization solution are realized. In particular, the savings are staggering in terms of lower managerial and administrative overhead. In a virtual storage environment, FalconStor NSS applies an intuitive Java-based GUI to visualize storage and then assigns and manipulates it as necessary; one administrator can potentially manage an infinite amount of data with ease, instead of managing individual systems in a non-virtualized setting.

Furthermore, dynamic modification of access permissions to virtual volumes can be performed on the fly. Online and transparent migration of storage devices allows maintenance and upgrade of storage devices without shutting down applications. The least amount of downtime equals higher returns.

Access security gets a boost with IPStor
Even when the focus is intra-SAN only, FalconStor NSS has specific advantages.

The problem: In order to accomplish such tasks as flow analysis and snapshots, some metadata solutions must insert themselves into the data path. In short, they pop in-band and out-of-band. These metadata servers must also interface with the FC switches in order to properly map paths between the application server(s) and the storage devices. Accomplished by either standardizing on a specific switch manufacturer (in essence becoming homogenous) or turning off all zoning and LUN masking in the switch. Turning off zoning and LUN masking at the switch opens up a security issue with FC. Many low-level utilities can then potentially scan all attached storage since it is now open through the switch.
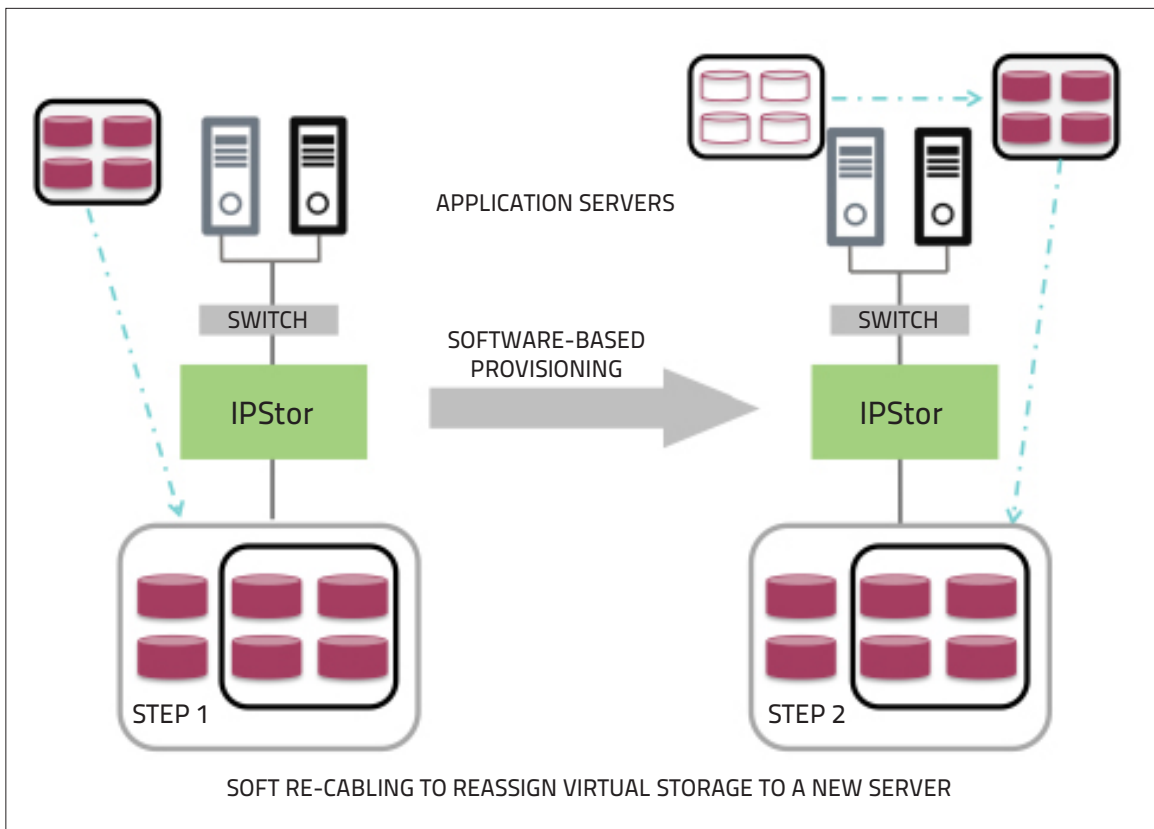
True security cannot be realized unless there is end-to-end intelligence. Certain metadata solutions accomplish this by dictating intelligent adapters be installed in both the servers and storage devices. An intrusive approach and often results in a large compatibility test matrix.

The solution: when a FalconStor NSS appliance is located between the host application server(s) and the storage devices, true end-to-end intelligence and complete security can be maintained. Low-level scan utilities are prevented from spoofing storage devices. Public Key Infrastructure (PKI) is also used to maintain host server security. A shared secret key is established when a host server is configured and attached to a virtual volume. Ensuring only that particular client can access its corresponding virtual volume assignments.

Security-conscious users can also appreciate FalconStor's commitment to furnishing cutting-edge access security. FalconStor NSS provides strict built-in authorization policies to ensure that unauthorized users do not gain access to storage resources on an IPStor storage network. Security for the management console is the same for all connectivity types. The solution's console provides centralized access control to the storage network, possible as a result of the aggregation and virtualization of storage resources. Only an authenticated administrator is permitted to manage physical devices, create and manage virtual drives, define storage management policies, perform end-to-end diagnostics, and generate reports. IPStor is also the industry's only storage solution to utilize a key-based authentication process to create a supplementary shield against snooping and spoofing.

Soft re-cabling

The FalconStor NSS virtualized storage model also allows for soft re-cabling of hosts: the ability to logically re-deploy storage from one host to another without moving any physical cables. All re-assignments are handled by the software, with a simple point and click functionality. For example, an existing data set residing on virtual storage can be switched from a test server to a production server in seconds via software reassignment. This methodology is far simpler than the complex FC switch reconfigurations and zoning topologies, usually, understood as soft re-cabling.

APPLICATION SERVERS

SWITCH

SOFTWARE-BASED PROVISIONING

IPStor

SWITCH

IPStor

STEP 1

STEP 2

SOFT RE-CABLING TO REASSIGN VIRTUAL STORAGE TO A NEW SERVER

FalconStor NSS-managed soft re-cabling greatly simplifies storage administration by providing a software-only means to move storage from one server to another.

High Availability (HA)

High Availability (HA) is also high on the wish list of enterprises. Leveraging failover functionality, FalconStor NSS can be deployed in a two-node, symmetric, or asymmetric cluster configuration, where two appliances are configured to monitor each other's health. Should one fail, the other automatically assumes the failed appliance's workload. The DynaPath®

option maintains consistent connectivity between application servers and the appliances via sophisticated multi-pathing and load balancing mechanisms. These are a few of the integral parts of this advanced virtualization solution's robust support of high availability configurations, with full redundancy throughout the entire data path so that there is no single point of failure. Mirroring can also be set up between the clustered FalconStor NSS appliances and their attached storage devices. This results in a highly redundant virtual storage solution with continuous availability.

FalconStor NSS offers the freedom of choice in device vendors, interfaces, connectivity, platforms, and protocols. Enterprises are empowered to virtualize across drive, cabinet, protocol, and vendor boundaries with just-in-time (Capacity-On-Demand™) space management.

Platform independent
FalconStor NSS is platform independent. The software itself runs on either a standard SUSE Linux server (which means that its platform is open and has substantial and growing support from the technology industry) or on a Sun Solaris platform. However, FalconStor NSS is not based upon any proprietary operating system, as are many of the solutions on the market today. Future expansion and additional functionality, therefore, remain open. Furthermore, FalconStor NSS integrates with Microsoft Windows, Solaris, Linux, HP-UX, and IBM AIX, and is continually being developed to support even more client server OS possibilities.

Connectivity protocol independent
FalconStor NSS is connectivity protocol independent. It robustly and natively supports FC SAN, IP, iSCSI, FCoE, and HTTPS.

Vendor neutral and interface independent
FalconStor NSS is vendor neutral and interface independent with respect to storage devices. It fully supports and makes sense of heterogeneous storage environments. As noted, storage devices have different performance characteristics. FalconStor NSS incorporates a feature that reports a device's throughput capabilities so that proper grouping of storage devices into virtual volumes can be achieved. Statistical analysis of data flow can then be routinely monitored for saturation and capacity planning. FalconStor NSS generates a storage pool to which physical storage can be added without affecting the existing logical allocation of resources.

When a storage administrator creates virtual volumes, read/write permissions can be applied, and assignments of SAN and/or NAS resources can be made to the appropriate hosts. Volumes can also be dynamically added, removed, mirrored, and the permissions can be altered.

Since permission is given at the volume level, file formats are no longer an issue. That is left to client operating systems to manage. Complementary with other vendors' file management solutions, FalconStor NSS does not interfere with file system access.

An enterprise-level SAN virtualization solution
A sophisticated virtualization solution can yield tremendous value for an organization, playing a major role in business continuity, increased ROI, and lower TCO of storage infrastructure. However, it cannot accomplish this without being a part of a complete, open, high-performance storage infrastructure solution that also offers excellent data security. A software solution can accomplish the requisite level of flexibility and feature-richness, unlike a pure hardware solution, especially if it is highly advanced software and based on open standards.

FalconStor NSS meets and exceeds these criteria. This proven, top-performance solution includes virtualization functionality in an easy-to-use package combining speed, security, reliability, interoperability, and scalability – while enabling all the latest data management features and performance enhancers.

Mission-critical FalconStor NSS capabilities include:

- TimeMark® snapshots, synchronous and asynchronous mirroring, and WAN-optimized replication provide rapid data recovery to any point in time and reliable DR functionality for business continuity.
- Application-aware snapshot agents minimize quiesce time during backups and other snapshot-based operations (TimeMark, replication, etc.) and ensure transactional integrity/consistency of databases and message stores for fast recovery times. Agents are available for IBM DB2, Microsoft SQL Server, Oracle, Sybase, IBM Lotus Notes/Domino, Microsoft Exchange, Microsoft VSS, and many file systems.
- Storage provisioning occurs in a just-in-time fashion with Capacity-on-Demand (COD). To sustain business operations, COD monitors disk space consumption at the application appliance and proactively ensures constant availability of storage. COD can free up disk space by compressing infrequently used files and/or relocating them to an overflow storage pool. If necessary, COD can expand the file system to meet the storage needs of the application in real time, without user intervention.
- DynaPath maximizes data availability for FalconStor NSS storage systems and provides peak performance across the SAN. Performing FC and iSCSI HBA load balancing and delivering transparent failover, and fail-back services that create parallel active storage paths to transparently reroute server traffic without interruption in the event of a storage network problem.
- ZeroImpact™ Backup and HyperTrac™ Backup Accelerator, plus tight integration with the industry-leading FalconStor® Virtual Tape Library (VTL) solution, eliminate the backup window and render backups highly reliable and efficient.

FalconStor NSS enables organizations to maximize utilization of their current IT infrastructure. FalconStor NSS is based upon a non-proprietary operating system that is open and allows for not only storage virtualization, but also storage over IP (via the industry standard iSCSI) or FC. It allows for application optimization such as the offloading of host server tasks like replication and backup. To ensure that FalconStor NSS remains future-proof, FalconStor developers are committed to staying on top of and integrating advanced technologies.

The proven and flexible FalconStor NSS storage virtualization solution brings tremendous value to organizations in an increasingly network-centric and data-centric market. It is also an immensely practical and commonsense partner to virtual machine solutions that virtualize and consolidate servers, such as VMware technology. In addition to the cost savings, it generates as a result of its deployment; FalconStor NSS is also cost-effective to deploy which helps IT organizations stay ahead of their storage needs.

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