Services Oriented Storage Solutions

Executive Summary

With the introduction of Application Optimized Storage, Hitachi Data Systems delivered a revolutionary solution framework enabling organizations to closely align their storage infrastructure with their unique business requirements. Services Oriented Storage is the next generation of Application Optimized Storage introducing new levels of virtualization, management, and application support for businesses small and large. While Application Optimized Storage focused primarily on optimizing Hitachi storage systems to serve multiple application requirements concurrently, Services Oriented Storage greatly enhances the platform by introducing the following:

- Enhanced storage services enabling heterogeneous storage systems to interact and work in concert to optimize performance, protection, and availability.
- Support for file, archive, and content services enabling organizations to leverage a single platform for all their application requirements, not just block-based applications.

This enables organizations to leverage single universal platform for storage and to take an efficient, process oriented, approach to storage, rather than the current, piece meal, task oriented approach which leads to needless redundancies, oversubscription of storage resources, management inefficiencies, and compliance exposures.

The Promise of Storage Area Networks Alternate = A Services Oriented Software Architecture Delivers the Unfulfilled Promises of SANs

Fibre Channel, Storage Area Networks were introduced in the late 1990's to eliminate the islands of direct attached storage. It promised to consolidate storage and centralize management of storage and data resources. The assumption was that this consolidation and centralization would lead to better utilization of storage capacity which was then about 20 to 30%. In the more than 10 years since its introduction, SANs have enabled more servers to attach to larger and larger capacity storage arrays, and Storage Area Management tools have been developed to map the resources in a large heterogeneous SAN. However, when we look at the utilization of storage today, more than 10 years after the introduction of SAN, utilization in many cases is still around 20 to 30%. The only difference now is that instead of 100's of TBs in many large accounts, we see PBs in these accounts. There are customers with 4 PB of storage where 3PB are not being used!

Tony Asaro, of ESG identifies this as a failure of SANs to network storage. He points out that SANs provides a network of host servers to storage but it does not network storage systems to other storage systems …"aside from being on the same network, individual storage systems do not, in any way, interact with each other. They do not work in concert, but rather separately: individually; discretely; and therefore inefficiently."

The Roots of Application Optimized Storage Alternate = Services Oriented Storage Solutions are built on Storage Controller Based Virtualization

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Comment [JM1]: I think this whole paper should be reworked with a front end that sets up the "SOA for Storage" as defined by the ITCentrix paper. Also the company should talk about it's SOS architecture which enables the SOS solutions and not just jump into SOSS. The whole point of SOA is to provide a platform that offers services on an as needed basis as Vellante and company described so well in their paper. Hitachi should be focused on providing storage services in the world's first "SOS architecture" on your new "SOS [software] platform" to application developers on an as needed basis. This is the ultimate connection of the Hitachi [controller based] virtualization vision of long ago to the SOA architecture of the future. SOS is Hitachi's first software platform and should make it's "storage services" available through ESBs to enterprises developing SOAs, just like application vendors will be exposing their applicatino services through ESBs and FileNet / IBM, Documentum etc expose their Content services to the enterprise app developer. Hitachi is ahead on the vision at this point and it would be a shame not to drive the stake in the … [1]

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Comment [JM4]: This is the key problem that SOSS solves and the competitors do not.

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Comment [JM5]: This section really talks about Hitachi's unique storage controller based virtualization app … [5]

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1. Virtualization Within a Storage System Provides Storage Services Within a Hardware Platform

Recognizing this problem Hitachi introduced a storage controller with the ability to network storage resources within a storage system. In 2000 Hitachi delivered the Lightning 9900 storage array which introduced a cross-bar switch enabling the ability to dynamically change storage configurations within its global cache. Logical Disk Volumes within the storage array could work in concert, to deliver optimum performance and availability to host applications. The addition of virtual storage ports increased the connectivity of each fibre channel storage port to 128 virtual ports, each with its own dedicated address space, so that applications that shared the same storage port could be secure from data leakage or data corruption from each other. Multiple applications, residing on different platforms like mainframes, Unix, Linux, Windows, and Novell, could share the same storage array, and use different RAID protection, different performance disks, and set different priorities on port access. Not only was the Lightning 9900 able to optimize storage for multiple applications simultaneously it could also dynamically change the storage configuration as the requirements of the application changed. This enabled customers to massively consolidate and optimize their infrastructure while greatly reducing cost, complexity, and management.

2. Virtualization Between Storage Systems Provides Storage Services to all Externally Attached Storage Systems

Moving from an Array to a Platform

While Application Optimized Storage was able to network storage in Hitachi storage arrays, it was apparent that networking of storage resources had to extend beyond individual storage systems. In 2004, Hitachi introduced the Universal Storage Platform (USP) providing the capability to connect, or network, external, heterogeneous, storage systems including Hitachi and non-Hitachi arrays through standard Fibre Channel port connections each of which were now virtualized to 1024 virtual ports. This not only provided the ability to connect tens of thousands of heterogeneous host applications, it also provided the ability to network thousands of heterogeneous storage systems together into a common platform of logical, virtual volumes.

While much of the early adoption of Application Optimized Storage focused on virtualization as a tool to migrate volumes from old arrays to new, organizations have come to realize the cost, performance, protection, and management benefits of deploying tiered storage infrastructures leveraging heterogeneous storage assets and the common services offered by Services Oriented Storage including virtual ports, logical partitioning, provisioning, mirroring, replication, and volume migration.

So, today while other storage virtualization solutions continue to focus on simple volume pooling offering limited value to customers, Hitachi's Services Oriented Storage Solutions, enabled by our storage controller-based virtualization technology have evolved

well beyond basic pooling to provide intelligent tiered storage based upon common management, data mobility, data protection, and provisioning. This capability of virtualized storage systems interacting and working in concert to optimize performance, protection, availability and cost is unique within the industry and can only be accomplished by Hitachi's purpose built, multiprocessor storage platform, supported by a large dynamic global cache, and a rich menu of storage and data services.

The Value of Data and Content

Much of the traditional focus of storage has been around structured data (e.g. databases, transactional data, and data warehouses). However, structured data only comprises ~20% of all data. The other 80% is comprised of unstructured (e.g. objects and files) and semi-structured data (e.g. email) and this unstructured data is growing at close to 10x the rate of structured data. A recent study from the Enterprise Strategy Group estimates there is close to 2,250 PB's of unstructured data growing to 20,000 PB in 2010. Furthermore, <5% of this unstructured data is currently being managed by a content management system and most of the data is dormant after 90 days.

Organizations have come to realize that the understanding all data and content is critical to a comprehensive storage strategy. For example, file attributes help classify data, content attributes (metadata) enables additional levels of classification, and the content inside files enables text searching. A key attribute of a storage platform, therefore, must be its ability to support all data types (structured, semi-structured, and unstructured) and application types (volume and file based) and provide a common set of services for management, protection, archiving, and search.

So, while the focus of Application Optimized Storage was primarily on providing storage services to externally attached storage, Services Oriented Storage expands the capability to storage applications servers supporting file and content applications. Application servers including content archive, backup, virtual tape libraries, nearline storage and high performance NAS all focus on files and content and all have traditionally required their own storage creating islands of storage and complexity of management.

With Services Oriented Storage Hitachi centralizes all storage, data, and content services offloading the workload from the application services enabling them to concentrate on their application services while also greatly reducing the overall complexity of the storage infrastructure. This is somewhat analogous to SOA, Services Oriented Architecture, where applications can re-use common modules like billing, and not have to rewrite them for every application.

Architecture Summary

As we have described throughout this paper, Services Oriented Storage is a business-centric framework enabling organizations to closely align their storage infrastructure with their business requirements.

While many storage vendors may claim to have business-centric strategies only Hitachi can deliver because Service Oriented Storage is the only strategy built upon a dynamic, flexible platform of integrated storage services enabling customers to optimize storage infrastructure while reducing cost and complexity. The architecture is both powerful and simple:
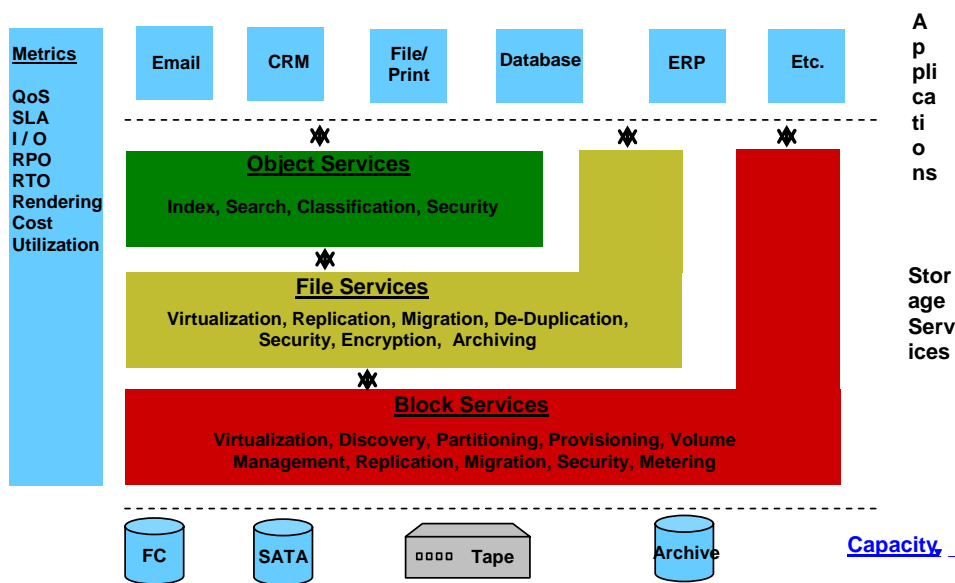
In Figure X you can see that the Services Oriented Storage is comprised of an integrated stack of services including:

- Block Services – which include volume virtualization, discovery, provisioning, partitioning, volume management, replication, migration, security, and metering
- File Services – which include file virtualization, replication, migration, security, encryption, and archiving
- Object Services – which include content services including index, search, classification, and security

All of these services are used individually or collectively to optimize the storage infrastructure to meet the necessary application storage requirements based upon metrics including I/O, service-level-agreements, Quality-of-Service, Recovery Time and Recovery Point Objectives (RTO and RPO), and retention. Most importantly, the unique value of Services Oriented Storage is the ability to leverage all of these services on a single, integrated storage platform, managed by a common management interface.

Some Examples

All Services Oriented Storage Solutions are built using some combination of the block, file, and content services of the Service Oriented Storage architecture. Some examples include:

Storage Resource Management – Service Oriented Storage starts with a comprehensive approach to storage management. To manage heterogeneous storage effectively requires highly scalable management software built around a services; Hitachi Storage Services Manager software services enable organizations to monitor, visually render, administer their SAN as a whole, including storage, switches, hosts, and applications from multiple vendors, and provide chargeback based on the resources used..

Tuning Manager - Services have to be measureable. Hitachi Tuning Manager software gathers detailed information regarding capacity and performance utilization, provides a history for modeling projections for future requirements, and provide alerts based upon high water marks.

Tiered Storage Manager – Services should be managed by policies. The Hitachi Universal Storage Platform (USP) and Network Storage Controller (NSC) offer advanced virtualization services which enable the automated movement of migration groups across storage tiers, based upon policies that are triggered by time or events, to reduce costs and improve efficiencies.

NAS - The Hitachi High-performance NAS Platform, powered by BlueArc®, is an advanced NAS solution comprised of file-based services that offers exceptional performance, scalability, and an advanced file virtualization framework working in concert with the USP and NSC block services..

Virtual Tape - Virtual Tape Library Solutions by Hitachi Data Systems enables storage managers to obtain all the benefits of backing up to disk without changing established backup policies or procedures. The integrated suite of storage services creates a "virtual" tape library that appears to the backup application as one or more real tape libraries. Replacing slow tapes with high-speed disk, enables customers to increase backup/recovery performance, optimize their storage infrastructure, and achieve their business resilience objectives. Virtual tape libraries can utilize the USP/NSC services for tiered storage and remote vaulting

Data Protection - The Hitachi Data Protection Suite, powered by CommVault®, is a unified data management solution that significantly automates and simplifies key operational and administrative data and storage management tasks which leverage the storage services of the USP/NSC for replication and rapid recovery . This comprehensive solution including backup and recovery, disaster recovery, replication, hierarchical storage management (HSM), archiving, and compliance, is ideal for mid-size organizations.

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Archiving - The Hitachi Content Archive Platform solution allows organizations to satisfy regulatory and corporate governance mandates and provides rapid access to archived data when needed. The solution delivers automated policy management to ensure content authenticity, retention, and integrity while also supporting robust discovery capabilities through integrated indexing, search, and retrieve features.

A Unique Strategy

While other vendors may offer individual pieces of the puzzle no one except Hitachi offers an integrated strategy of block, file, and content services providing intelligent tiered storage, common management, data protection, and performance optimization. In addition, Hitachi's strategy in numerous ways:

- Hitachi is the only leading storage company that can scale from very small to very large with a storage approach using a 'single pane of glass' management strategy.

- Hitachi's Universal Storage Platform and Network Storage Controller architecture are the only leading products in the market that manage heterogeneous storage assets.

- Hitachi's best-in-class virtualization capability is based on an architecture with a single point of control. This enables storage services to be presented as a unified whole, managed by a powerful back-end storage and data services capable of moving data between heterogeneous storage tiers with 100% certainty of success.

Solutions for Smaller Organizations

Most small and mid-size companies face the same challenges as large organizations (cost, compliance, efficiency, risk) just on a smaller scale, and they need the same kind of solutions enterprise customers do. So, Services Oriented Storage Solutions are designed for organizations small and large.

Specifically, the Hitachi Universal Storage Platform VR, a rack mounted version of the USP is designed specifically for smaller organizations enabling them to leverage all the benefits of Services Oriented Storage.

For small businesses which are less likely to have a SAN with multiple storage systems, Hitachi offers virtualization in a box solutions with our modular Adaptable Modular Storage systems. These solutions focus on simplicity and include block and file services including virtual storage ports for safe multi-tenancy, dynamic cache partitioning for QoS, customizable cache block sizes for optimization of data base or streaming applications, dynamic multi-tiering for data life cycle management, and replication for business continuance. Like all Service Oriented Solutions, Hitachi solutions for smaller businesses can be managed using a common management interface.

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SOSS Summary

Since the introduction of Application Optimized Storage, Hitachi Data Systems has had a singular focus on delivering storage solutions enabling organizations to closely align their storage infrastructure with their business applications' requirements. Services Oriented Storage represents the next generation of Application Optimized Storage introducing new levels of virtualization, management, and application support for businesses small and large.

By delivering on this promise Hitachi enables organizations to leverage a single universal platform for storage and to take an efficient, process oriented, approach to storage, rather than the current, piece meal, task oriented approach which leads to needless redundancies, oversubscription of storage resources, management inefficiencies, and compliance exposures.

Page 1: [1] Comment [JM1]	Jim McBurney	4/7/2009 10:59:00 AM

I think this whole paper should be reworked with a front end that sets up the "SOA for Storage" as defined by the ITCentrix paper. Also the company should talk about it's SOS architecture which enables the SOS solutions and not just jump into SOSS. The whole point of SOA is to provide a platform that offers services on an as needed basis as Vellante and company described so well in their paper. Hitachi should be focused on providing storage services in the world's first "SOS architecture" on your new "SOS [software] platform" to application developers on an as needed basis. This is the ultimate connection of the Hitachi [controller based] virtualization vision of long ago to the SOA architecture of the future. SOS is Hitachi's first software platform and should make it's "storage services" available through ESBs to enterprises developing SOAs, just like application vendors will be exposing their applicatino services through ESBs and FileNet / IBM, Documentum etc expose their Content services to the enterprise app developer. Hitachi is ahead on the vision at this point and it would be a shame not to drive the stake in the heart of EMC on this one since they don't have external storage support or the controller based virtualization that will simplify so much the job of the application developer. This moves the company from a "storage sale" to an "application developer SOA sale." Jim Bahn and company should be just absolutely delighted. EMC can't compete with the story and ITCentrix hit the nail on the head when they say 'The biggest risk of this strategy for Hitachi is not making the concept tangible. HITACHI'S SOFTWARE DEVELOPMENT PLANS TO EXPOSE SERVICES TO APP DEVELOPERS IS WHAT WILL MAKE THE CONCEPT TANGIBLE.

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to to a heterogenous storage environment through the use of virtualization and consolidated management tools that address enterprise, mid market, and SMB storage environments.

Page 1: [3] Comment [JM2]	Jim McBurney	4/7/2009 10:59:00 AM

This paragraph has got to be one of the most important talking points for SOSS -namely that "SOSS Delivers the Unfufilled Promises of SANs". To me, the heading [as is] started to makes this section too easy to skim over, since it sounded [in conjunction with the next heading] like a historical riview. I didn't realize the huge news until the Tony Asaro comments in the final sentence of this section. I think the heading should be changed and the quote highlighted to punch up this key talking point.

Page 1: [4] Comment [JM3]	Jim McBurney	4/7/2009 10:59:00 AM

The paper had a strong start but I lost some credibility with the use of theses low numbers for utilization. I think making a relative statement instead of using exact utlization numbers is better or to at least acknowlege that some progress has been made.

Page 1: [5] Comment [JM5]	Jim McBurney	4/7/2009 10:59:00 AM

This section really talks about Hitachi's unique storage controller based virtualization approach as described in the Hu Yosihda paper some years back. It is ONLY with this building block external storage can be networked. In addition this is the most efficient way to develop a SOS architecture since the USP V controller becomes logical place to "expose" the "storage services" and is analogous to the Enterprise Services {Storage] Bus in the SOA analogy. I think the message here should be that "Services Oriented Storage Solutions are built on Storage Controller Based Virtualization.

Page 2: [6] Comment [JM7]	Jim McBurney	4/7/2009 10:59:00 AM

I think the company needs to be very clear on terms here since platform has different meanings to hardware and software people. A software platform typically means software structure with APIs to access it and a SOA means that there are defined APIs to access a "service". So this phraseology in the headline becomes critically important to the company story which needs to clearly encompass SOA from a software architecture view since the very term SOSS and SOS architecture implies that Hitachi is heading toward "exposing" it's "storage services" to enterprise SOA software architectures. It is my opinion that since SOA is the hottest buzzword in enterprise software its not possible to implement anything called SOSS without addressing how it fits into the SOAs being developed today. Although SOA has met its share of road bumps in implementation, it is clearly the only promise of implementing true enterprise application that failed so badly in the 1990s.

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Storage Platform and External Attach

the high end Lightning 9900 storage system and the modular, dual controller, Thunder storage system and move logical volumes move between them with a product called HiCopy. This proved successful, so in September of 2004 Hitachi announced the Universal Storage Platform (USP) which was able to extend this capability to attach external, heterogeneous, storage systems through standard Fibre Channel port connections each of which were now virtualized to 1024 virtual ports.

. It provided the ability to connect external storage to the USP through standard FC ports and virtualize them by presenting their logical volumes through the USP's internal cache as USP virtual volumes.

As USP virtual volumes, the external storage volumes inherit all the existing storage and data services of the USP

 (the new name for CruiseControl), virtual ports, Logical partitioning, and all the provisioning capabilities of AOS.

I think this first paragraph should not be deleted since it is a very important message and deserves a clear illustration to show how Hitachi "storage services" can be provided to applications that access information on either the USP per se or externally attached storage systems. This one illustration would be a very impactfuly way to communicate all the messages that have been built up thus far. It make the following points:

1. Controller virtualization benefits within the USP system
2. Controller virtualization between the USP and other storage systems
3. The Hitachi Controller as the logical interface to the enterprise service bus [ESB] in SOA terms
4. In this way Hitachi can provide complete storage services to enterprise application developers and publish the service [fragments] to the registry over time. This is a huge advantage to any enterprise developing and SOA for future application development
5. The Hitachi controller based virtualization gives the company a huge leg up on competition since it makes it so much easier for the enterprise software developers to write new applications that call the Hitachi storage services. This will take more manual work out of the hands of storage administrators and make it automatic in the software development process.
6. Can you imagine programmers wanting to deal with "independent storage services" from all the storage vendors OR just from Hitachi? Whereas I think the company should continue to promote an SOS architecture as a good thing, it should clearly explain that it is BEST IMPLEMENTED when the storage service [fragements] that are called by applications are standardized on those offered by the Hitachi.

Service Oriented Storage Solutions

With controller based virtualization and the ability to map our storage services to external storage systems, we have moved beyond AOS. We now provide Services Oriented Storage Solutions (SOSS), providing centrally managed storage services like replication to externally attached storage systems

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This capability was extended to the mid market through the introduction of the Network Storage Controller, the NSC. In order to avoid confusion with network based virtualization systems that are limited to volume pooling, the NSC is being re-branded to be the USP Modular, to more correctly describe it as a USP for the modular, midrange market. It can provide all the services of the USP but is packaged and priced for the mid market with a reduced set of processors and cache boards.

For the SMB market which is less likely to have a SAN with multiple storage systems, we provide virtualization in a box with the modular AMS Storage System. While this system can not virtualize external storage, it has virtual storage ports with separate address spaces for each port for safe multi-tenancy, dynamic cache partitioning for QoS, customizable cache block sizes for optimization of data base or streaming applications, dynamic multi-tiering for data life cycle management, and replication for business continuance. It has a rich menu of storage services for storage application servers like NAS, Virtual tape Libraries, and Archive Systems..

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In recent years we have seen the proliferation of servers which address storage applications like

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of these storage application servers

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. Creating and managing their own storage services in many cases limits their ability to scale their application services.

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associated with storage services and e

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which they can then scale to new levels.

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In the case of active archive applications we have added storage services to ingest meta data and objects, search and retrieve objects, fingerprint for immutability, refresh over technology generations, and scrub data when it is no longer needed.

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Key to the success of Services Oriented Storage Solutions are tools to monitor, meter, and manage the services from a common management interface. The metrics for services need to be expressed and measured in terms of services, like SLA and QoS. Recovery services need to be measured in Recovery Time and Recovery Point Objectives (RTO and RPO).

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SOSS Proof Points

By connecting behind a USP a modular storage system that does not have the ability to do distance replication for business continuance, can utilized the Hitachi Universal Replicator to replicate volumes to the other side of the world.

BlueArc is a High Performance NAS server that used to have its own storage system. By connecting to the USP, it has the ability to use the high performance capability of the USP architecture and dynamically move storage pools to different tiers of storage.

Diligent is a Virtual Tape Library that has an industry leading de-duplication capability. It used to have its own storage system, but now it attaches to the USP and uses the USP's virtualization to move libraries to tiers of storage and electronically vault data to remote protection facilities. Combined with Diligent de-duplication, we can de-dup a 250 GB Library down to 10TB and create the equivalent of the 250TB Library in a location thousands of miles away simply by replicating 10TB of de-dup data.

The Hitachi Data Protection Suite, powered by CommVault®, is a unified data management solution that significantly automates and simplifies key operational and administrative data and storage management tasks. Each module—backup and recovery, disaster recovery, replication, hierarchical storage management (HSM), archiving, compliance, storage resource management, remote office data protection, and IT service management—can be deployed individually and leverages storage services with in the USP.

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SOSS Services

AOS optimized provisioning for application requirements
Mirroring as many as 9 different copies in 9 different locations
Migration of volumes across tiers of storage with out disruption to the application
Policy management for movement of volumes
Synchronous and asynchronous replication of migration groups
Copy on write for fast recovery
VSS providers for non disruptive snapshots.

SOSS Architecture