

Usability Comparison White Paper: EMC VNX versus NetApp FAS

April 2011



Twenty Years Experience In
Technical Evaluation

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1.0 Executive Summary

This report represents an evaluation of two leading unified storage offerings, EMC VNX and NetApp FAS. The purpose of this usability study is to provide storage administrators and IT management with practical information related to the manageability of each solution in a context of several very common and critical use-case scenarios. The study results show that while they each offer a full range of management features, EMC VNX with Unisphere v1.1 provides users with significant advantages over NetApp FAS's System Manager v1.1, FilerView, and NetApp CLI combined.

Our analysis demonstrated the superiority of EMC VNX in the following critical areas:

Criteria	EMC Advantage	NetApp Disadvantage
Unified Storage Management	EMC Unisphere provides a single, intuitive interface for managing across all of the use-case scenarios we tested	Management of NetApp FAS was a fragmented experience requiring the use of two GUIs and the NetApp CLI

Unified management is important: Unified management makes the role of storage administrators far less tedious, enabling them to keep pace with data growth and more strategically manage critical business information.

Criteria	EMC Advantage	NetApp Disadvantage
VMware Awareness	Integration between EMC and VMware enables administrators to view the relationship between VNX storage and specific virtual machines; this view is available to storage managers via Unisphere and to VMware administrators via vCenter	NetApp provides some level of visibility into FAS storage from vCenter, but it does not offer any mapping of VMs from FAS System Manager, FilerView, or the NetApp CLI; mapping of these relationships is a time-consuming, manual, error-prone process

VMware awareness is important: Understanding the relationship between physical and virtual infrastructure enables storage and VMware administrators to ensure performance expectations are met and to resolve issues quickly, and is critical to effective infrastructure planning and private cloud deployments.

Criteria	EMC Advantage	NetApp Disadvantage
Automated Storage Tiering	EMC allows users to auto-tier data using EMC VNX; service levels for storage cost and performance are automatically managed per the policies set in Unisphere	NetApp does not support this automated functionality and therefore requires tiering to be managed manually, increasing complexity and management cost

Automated storage tiering is important: Automated storage tiering ensures that data is stored on the media type providing the right service level for both performance and cost. This is critical to driving down costs even as organizations continue to create and store more data.

EMC realizes that there are some areas where EMC VNX and Unisphere could be even better. For example, CIFS/NFS share creation requires a number of steps to accomplish, utilizing the wizard-based method. Though this task is performed infrequently, it could be simplified. EMC agrees with this and is working to improve the overall solution.

For customers wanting to implement a virtualized infrastructure, improve overall storage efficiency, and drive down management costs, the EMC VNX series with Unisphere is the superior choice over NetApp FAS with System Manager.

2.0 Objective of the Study

The primary objective of the project was to perform a comparison study of usability of EMC's midrange storage management suite, Unisphere, against NetApp's array management software, System Manager, and to document the results in a white paper. EMC requested an objective assessment and was open to finding opportunities for improvement.

3.0 Project Scope

The project scope was limited to the execution of tasks that would:

- Explore the ease of multiprotocol provisioning, including thin provisioning and storage pooling.
- Evaluate the flexibility and efficiency features such as auto-tiering, compression, dedupe, and dynamic LUN migration.
- Investigate the Virtual Machine (VM) management and awareness to effectively administer the storage allocated to virtual environments.
- Assess general manageability features such as usability, reporting capabilities, and support features.

4.0 Methodology

To attain our objective, we performed a hands-on evaluation of both the environments. The specific steps employed using this approach included:

- We set up and configured hardware and software systems from NetApp in our lab. EMC personnel provided basic setup of the EMC VNX system at their facility, where it was remotely accessed by Strategic Focus engineers. The NetApp and VNX systems were similarly configured with a variety of disk types and speeds.
- We developed a test plan in collaboration with the EMC team to fit the project scope.
- We configured the landscape to execute the tests on each of the two systems per the test plan.
- We captured metrics in the form of number of clicks and steps required to execute each task.
- We also captured the tester's experience, in particular the key features or lack thereof in the execution of each task.
- Results from this exercise formed the foundation of this usability report.

5.0 Test Results and Analysis

5.1 Storage Provisioning of File and Block Storage Comparison

The primary advantages of EMC Unisphere over NetApp System Manager for high priority storage provisioning tasks can be summarized as follows:

- **Deciding where to provision new storage:** EMC has a superior automated graphical interface and requires six fewer clicks than NetApp.
- **Creating storage pools with multiple tiers:** Unisphere has superior flexibility and requires three fewer clicks for creating pools with multiple tiers than NetApp does for a single tier. NetApp does not support storage pools with multiple tiers of disk.
- **Creating LUNs and file systems:** Unisphere creates multiple LUNs simultaneously, eliminating the need for repeated manual processes. In addition, EMC Unisphere enables the user to set file level retention policies when file systems are created.
- **Determining available space:** Unisphere displays comprehensive information in an intuitive dashboard eliminating the need for manual computation and navigation.

Table 5-1 shows the EMC advantage over NetApp in the tasks that were executed and the tester's experience in terms of what functions and features contributed to this advantage.

Table 5-1: Storage Feature Comparisons

#	Task	Frequency of Use	EMC Strength (+) or Weakness (-)	NetApp Strength (+) or Weakness (-)
1	Determining where to provision 450 GB of new storage	High	<ul style="list-style-type: none"> + No dependency to create LUN; the building blocks to create a LUN can be created as part of LUN creation which reduces the cycle time; this is not possible in NetApp + Graphical storage info provides easy understanding of where storage is available for provisioning + Six fewer clicks 	<ul style="list-style-type: none"> - In order to create a new LUN, a FlexVol volume and aggregate need to be created prior to LUN creation because the administrator will not be able to create the desired aggregate as part of the wizard - The GUI provides the storage space (used, allocated, and raw) at individual components (disks, aggregates, volumes, LUNs) details, but requires manual computation to figure out where to put the new storage element. Lacks a graphical representation or drill-through feature
2	Creating storage pools with multiple tiers on EMC vs. required static tiers on NetApp	High	<ul style="list-style-type: none"> + Storage administrators can immediately provision storage pools and RAID groups with no prerequisite requirements + EMC provides administrators flexibility to create pools while creating the LUN + EMC natively supports 	<ul style="list-style-type: none"> - Zeroing out disks while provisioning storage takes considerable time and as such needs to be done as a prerequisite if the aggregate is re-built - There is no option to create pools while creating a LUN. Pools need to be created prior to

			<p>aggregation of differing tiers of disks in a single storage pool</p> <p>+ Three fewer clicks</p>	<p>creating a LUN</p> <p>- NetApp requires prerequisites to enable the multiple tier from the console (either logging in from FilerView or from a terminal connected to the subsystem)</p>
3	Creating a LUN and file system	High	<p>+ Multiple LUNS of the same type can be created during a single instantiation</p> <p>+ Capable of setting file-level retention during NFS export creation</p> <p>- Eight more clicks</p>	<p>- Creating multiple LUNs of the same type requires manually repeating the process for each of the LUNs that is required</p> <p>- No support for file-level retention during NFS export creation</p>
4	Thin provisioning	Medium	<p>+ Thin provisioned LUN is available once a Storage Pool is created</p> <p>- Three more clicks</p>	<p>- Thin provisioning requires both an aggregate and a flex volume to be created before the thin LUN can be provisioned</p>
5	Creation of CIFS and NFS servers	Low	<p>- CIFS/NFS requires a number of steps to accomplish utilizing the wizard-based method</p> <p>+ Provides more functionality, such as the ability to set up multiple CIFS servers on a single controller to provide more flexibility and scalability to customers</p> <p>- Nine more clicks</p>	<p>+ The CIFS/NFS creation process is measurably faster</p> <p>- NetApp supports only a single CIFS server on a filer unless MultiStore is configured; this would require the MultiStore license and extensive additional configuration</p>
6	Growing storage elements (LUNs and file systems)	Medium	No measurable difference	No measurable difference
7	Determine how much usable space is available on both systems	High	<p>+ Usable storage can be viewed on the rich interactive graphical dashboard; this shows RAW space available, free Storage Pool space, and free RAID Group space in different portlets</p> <p>+ Three fewer clicks</p>	<p>- Space availability in the array needs manual computation and requires the user to browse various components (disks, aggregates, volumes, and LUNs) to arrive at a numerical value</p>

5.2 Efficiency and Flexibility Features Comparison

The primary advantages of Unisphere over System Manager for medium and high-priority efficiency and flexibility features can be summarized as follows:

- Setting up snapshots and schedules:** EMC provides the ability to schedule snapshots at the time of creation directly from the wizard. NetApp requires a two-step approach—creation and scheduling use different interfaces. Dealing with the complexities of multiple management interfaces is unproductive when compared to the centralized management capabilities of EMC Unisphere.
- Leveraging storage tiering:** EMC allows a storage administrator to auto-tier at the array, Pool, and LUN level. Service levels for storage cost and performance are automatically

managed per the policies set in Unisphere. NetApp does not support this functionality and requires tiering to be managed manually by the administrator, increasing complexity and management cost.

- **Dynamic LUN migration:** Unisphere enables a storage administrator to move running workloads to another LUN with no down time. NetApp offers similar functionality, but requires a separate command line tool (“DataMotion”) to provide this capability.
- **Determine available space:** Unisphere displays comprehensive information in an intuitive dashboard eliminating the need for manual computation and navigation.

Table 5-2 shows the EMC advantage over NetApp in the tasks that were executed and the tester’s experience in terms of what functions and features contributed to this advantage.

Table 5-2: Efficiency and Flexibility Comparison

#	Task	Frequency of Use	EMC Strength (+) or Weakness (-)	NetApp Strength (+) or Weakness (-)
1	Setting up snapshots and schedules at 8 a.m., 12 p.m., 4 p.m., and 8 p.m.	Medium	+ Snapshots schedule can be set up during initial configuration + Five fewer clicks	- Snapshots schedule can be set up only after the volume has been created in System Manager
2	Enabling dedupe\compress (efficiency of usable storage after (1) formatting and then (2) dedupe and compression)	Medium	+ Storage administrator has granular control over LUN dedupe vs. LUN compression - Five more clicks	+ When both compression and dedupe are enabled on the same volume, the data is first compressed and then deduplicated
3	Leveraging storage tiering (EMC FAST VP vs. manual tiering on NetApp)	High	+ Auto-tiering is available at the array, Pool, and LUN level + Automated migration makes leveraging appropriate storage tiers much more effective for a storage administrator + Administrators can schedule the best time(s) to allow tiering to occur	- Auto tiering is not supported - Manual tiering is time consuming and requires planning and administrative overhead
4	Dynamic LUN Migration—movement of a LUN that hosts a running workload	Medium	+ Administrator can move a running workload with no downtime + Administrator can set priority of LUN migration to minimize performance impact	- LUN migration is not supported, however, Online Volume (which contains various LUNs) migration is supported using DataMotion

5.3 VMware Management Comparison

The primary advantages of EMC over NetApp for medium and high priority VMware management tasks can be summarized as follows:

- **VMware awareness from within the storage console:** EMC Unisphere provides the administrator with the ability to view what VMs reside on LUNs, Storage Groups, and NFS. This functionality is not available with NetApp. Understanding the storage relationship between physical and virtual is critical to ensure optimal system performance. With NetApp, mapping this relationship is a time-consuming, error-prone manual process.
- **Array awareness within VMware vCenter:** EMC Virtual Storage Integrator provides a set of plug-ins that allows the VMware administrator to have VM-level granularity for compression, deduplication, and cloning. NetApp only provides deduplication at the volume level, requiring administrators to dedicate a volume per VM to get that granularity.

The combination of VM awareness in Unisphere and VNX awareness in vCenter means that the storage administrator and VMware administrator both have full visibility into relationships between physical and virtual resources in their own familiar interfaces.

Table 5-3 shows the EMC advantage over NetApp in the tasks that were executed and the tester’s experience in terms of which functions and features contributed to this advantage.

Table 5-3: VMware Awareness/Management Comparison

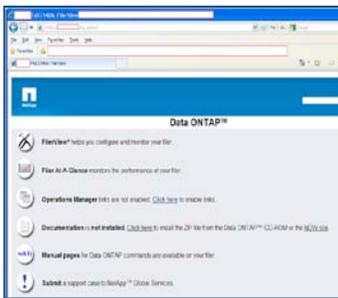
#	Task	Frequency of Use	EMC Strength (+) or Weakness (-)	NetApp Strength (+) or Weakness (-)
1	VMware awareness from within the storage console	High	<ul style="list-style-type: none"> + Simple and direct integration into vSphere + Shows what VM guests reside on LUNs. 	- Not available in NetApp
2	EMC Virtual Storage Integrator vs. NetApp storage plug-ins deduping/compress individual VMs	Medium	<ul style="list-style-type: none"> + Allow individual VM compression + Allow individual VM dedupe + Allow VM cloning + Direct integration into the array 	<ul style="list-style-type: none"> - NetApp only enables dedupe at the volume level - NetApp storage management tools do not provide management awareness into vCenter

5.4 General Management Features Comparison

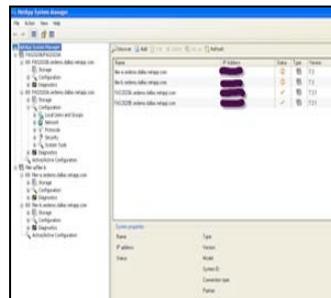
EMC Unisphere provides a simple, integrated experience for managing existing EMC CLARiON, EMC Celerra, and EMC VNX family storage systems through both a storage and VMware lens. It is designed to provide simplicity, flexibility, and automation—key requirements for the journey to the private cloud. The screenshot below shows a high-level overview of the **Unisphere interface**.



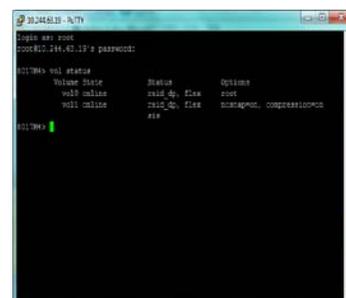
NetApp System Manager is a relatively new Windows-only NetApp MMC release that provides partial functionality for managing NetApp FAS systems. System Manager requires a Windows host. To manage all tasks that were tested on the system, Strategic Focus also needed to use two other interfaces offered by NetApp. The first, FilerView, has long been NetApp’s web-based UI along with the Command Line Interface (CLI). Screenshots of all NetApp tools used in this study are shown.



FilerView



System Manager



Command Line Interface

The primary advantages of Unisphere over System Manager for high-priority general management tasks can be summarized as follows:

- Customization of views:** EMC Unisphere’s dashboard and view customization makes system management straightforward even for relatively new administrators. This can be attributed to the interface consistency across all levels of configuration, and its user-friendly wizard-driven tools. In contrast, NetApp System Manager has limited functionality to customize views and no dashboard support.
- Managing the physical system:** Unisphere renders the physical components of the array in great detail, including the ability to "blink" the lights. This helps administrators to precisely understand what is needed when any type of physical management is required, including hardware locations within the array. NetApp System Manager provides only textual information for the physical components.
- Alerting and reporting:** Reporting is easy, highly customizable and very extensive within Unisphere. The reports allow the administrator to understand and demonstrate a number of

key performance indicators relevant to the array and the business. NetApp provides limited reporting capabilities (FilerView only), and they are not customizable.

Table 5-4 shows the EMC advantage over NetApp in the tasks that were executed and the tester's experience in terms of what functions and features contributed to this advantage.

Table 5-4: General Management Comparison

#	Task	Frequency of Use	EMC Strength (+) or Weakness (-)	NetApp Strength (+) or Weakness (-)
1	Customization of views within the UI	High	<ul style="list-style-type: none"> + 18 different portlet options + Provides ability to add new portlets and customize them based on business needs within the Unisphere interface + UnisphereV is a browser-based GUI with zero install requirement - Two more clicks 	<ul style="list-style-type: none"> - System Manager has the ability to customize the view, but it is very limited; the ability to create new views is not supported - System Manager is a fat Windows client that requires installation on every computer from where the storage is managed + FilerView is a browser-based GUI
2	Understanding/managing the physical system from the UI (ease of understanding physical aspects of each system)	High	<ul style="list-style-type: none"> + Shows graphical representation of all physical hardware; administrator can see graphical representation of SPS, Storage Processor, LCC, disks, etc., in an array + Drill-down view of hardware + Allows administrator to know how to easily troubleshoot physical issues + One fewer click 	<ul style="list-style-type: none"> - Doesn't provide physical insight of any of the array components
3	Support and support community—opening tickets and collaboration with community	Medium	<ul style="list-style-type: none"> + All support is available from a single Unisphere interface; including manuals, vendor support, user collaboration + Alerts/notification can be viewed with recommendations to resolve the problem + Software download alerts and the ability to update/upgrade within the tool using a global account are supported in EMC + The ability to customize an install or troubleshooting document using the EMC Procedure Generator is provided 	<ul style="list-style-type: none"> + System Manager provides the mechanism to trigger an autosupport report to NetApp CS + FilerView provides a link to log in to support portal + Collaboration with user community is managed in a separate portal - The support is not unified and not as sophisticated when compared to EMC, for example, in the areas of Procedure Generator and software update management - The "NOW" account is managed separately for downloads and updates

4	Altering and reporting: determining the health of the array	High	+ Unisphere reporting is easy to build, use, and export using a wizard; about 25 delivered reports are available in the fault summary, profile, servers, configuration, and storage applications categories	- Reporting is limited in System Manager and can't be customized or exported
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6.0 Conclusions

EMC's key technological differentiators over NetApp such as FAST VP (Fully Automated Storage Tiering for Virtual Pools), dynamic LUN migration, storage management awareness from within the storage console, virtual storage integration, and unified management console gives the company's solution greater usability over its competition. In addition, Unisphere is a web-browser-based centralized graphical user interface that enables administrators to achieve higher productivity with features such as dashboard and reporting customization with drilldown capabilities.

In our view, EMC is clearly the better choice for customers seeking an enterprise storage solution, because it empowers their storage administrators to perform their jobs more efficiently with minimal administrative overhead resulting in increased productivity.

Appendix A: Test Configuration

Table A: Test Configurations of EMC and NetApp Storage Management Systems

	NetApp	EMC
Storage System	Model FAS3070	VNX5300
Software	OnTap Version 8.0.1 7 mode NetApp System Manager, Version 1.1R1 (1.1.0.464)	VNX-Block-Operating-Environment 05.31.000.4.01 Unisphere v1.1
Disk Drives	14 * 273.54 FC 10K RPM Hard Drives 14 * 268.4 FC 15K RPM Hard Drives 13 * 268.11 ATA 5400 RPM Hard Drives 1 * 268.11 ATA 7200 RPM Hard Drives Total Disks - 42	25 * x 273 GB SAS Hard Drives DAE 0:0 19 * x 273 GB SAS Hard Drives DAE 0:1 10 * 2 TB NL SAS DAE 0:2 4 * 100 GB SATA FLASH DAE 0:2 1 x 546 GB SAS DAE 0:2

Appendix B: Detailed Metrics Test Data

Table B1: Storage Provisioning of File and Block Storage Test Data

#	Tasks	EMC Clicks	NetApp Clicks	Variance (EMC Clicks–NetApp Clicks)
1	Determining where to provision new storage	6	12	-6
2	Creating storage pools with multiple tiers vs. static tiers on NetApp	9	12	-3
3	Creating LUNs and file systems	21	13	8
4	Thin provisioning	23	20	3
5	Creation of CIFS and NFS servers	43	24	19
6	Growing storage elements	8	7	1
7	Determine how much usable space is "available by default" on both systems	1	4	-3

The following table identifies the tasks that were conducted, describing not only why they are important to the storage administrator, but also the level of importance of each task based on the frequency of its execution. A task that is likely to be executed several times during the course of a week is assigned **“High”** in frequency and considered very important. Tasks executed several times during the course of a month, but not necessarily every week, are assigned a **“Medium”** level of frequency. Those tasks that are executed infrequently, perhaps a few times in a year, are assigned a **“Low”** frequency. This type of rating helps the customer to put the test results in their proper perspective in the selection of the right storage product by not assigning too much importance to functionalities and features that may be infrequently used.

Table B1a: Storage Comparison Tasks

#	Task	Frequency of Use	Why the Task is Important
1	Determining where to provision 450 GB of new storage	High	The administrator must frequently allocate storage for new applications; this can be time consuming and error prone if not done properly, and the cost of doing it incorrectly can be high in terms of performance, scalability, cost, and on-going maintenance of the application; appropriate provisioning of storage can save money and defer a storage purchase and other associated costs until a later date; this deferred purchase often results in lower costs and excess capacity that can be used for new projects
2	Creating storage pools with multiple tiers vs. static tiers on NetApp	High	By implementing a blending of several tiers of storage in a single storage pool, organizations can overcome some key data management challenges such as: <ul style="list-style-type: none"> • Increased storage requirements placed on (expensive) primary storage while secondary storage remains underutilized • Inability to easily optimize placement of data on different types of storage based on its relative business value
3	Creating LUNs and file systems	High	Storage is presented to the servers (where the business applications are hosted) in terms of LUNs; the LUNs are mapped to the file systems to segregate the application data for better performance, security, scalability, data, and maintenance efficiency; how long or how complex this process is directly impacts the productivity of IT staff
4	Thin provisioning	Medium	By allowing as-needed provisioning and space reclamation, thin provisioning can result in better storage utilization and smaller capital expenditures on storage infrastructure
5	Creation of CIFS and NFS servers (NAS)	Low	To support NFS and CIFS protocols which are intended to provide an open cross-platform mechanism for client systems to request file systems over a network
6	Growing storage elements	Medium	Dynamic LUN and file system expansion allows business/applications to work non-disruptively and helps minimize the need for storage maintenance
7	Determine how much usable space is available "by default" on both systems	High	This is important to IT staff for three reasons: <ol style="list-style-type: none"> 1. To help determine how well the applications are using the storage thereby measuring total cost ownership 2. To help forecast for future data 3. To accommodate new storage provisioning requests for new applications deployments

Table B2: Efficiency and Flexibility Feature Test Data

#	Tasks	EMC Clicks	NetApp Clicks	Variance (EMC Clicks–NetApp Clicks)
1	Setting up snapshots and schedules	10	15	-5
2	Enabling dedupe\compress (efficiency of usable storage after (1) formatting and then (2) dedupe and compression)	15	10	5
3	Leveraging storage tiering (EMC FAST VP vs. manual tiering on NetApp)	16	NA	Not Meaningful
4	Dynamic LUN Migration—movement of a LUN that hosts a running workload	22	NA	Not Meaningful

Table B2a: Efficiency and Flexibility Tasks

#	Task	Frequency of Use	Why the task is Important
1	Setting up snapshots and schedules at 8 a.m., 12 p.m., 4 p.m., and 8 p.m.	Medium	<p>Snapshots enable IT staff to protect and quickly revert data to previous versions, often in the event of user error</p> <p>IT staff schedules snapshots to run at specific times of the day, usually every day; the ease with which this can be done can be a major contributor to the efficiency, reliability, and availability of the data stored on the array</p>
2	Enabling dedupe\compression (efficiency of usable storage after (1) formatting and then (2) dedupe and compression)	Medium	Dedupe and compression on a storage array can directly save the company money by driving down the amount of RAW storage required to support the business
3	Leveraging storage tiering (EMC FAST VP vs. manual tiering on NetApp)	High	Allowing the system to dynamically move sub-LUN and sub file system data to appropriately tier of disks to handle workloads on an automated basis drives high-end storage costs down by saving the company money on the storage costs; this process utilizes fast and dense disks much more efficiently compared to relying on manual macro-level data movement that often requires movement of entire LUNs and file systems
4	Dynamic LUN Migration—movement of a LUN that hosts a running workload	Medium	This allows an administrator to dynamically move LUNs to new types of disks or RAID levels if needed while maintaining system uptime

Table B3: VMware Awareness/Management Comparison Test Data

#	Tasks	EMC Clicks	NetApp Clicks	Variance (EMC Clicks–NetApp Clicks)
1	Storage management awareness from within the storage console on EMC vs. NetApp; Unisphere integrates into vCenter; how does NetApp do it	9	NA	Not Meaningful
2	EMC Virtual Storage Integrator vs. NetApp storage plug-ins deduping/compress individual VMs	17	NA	Not Meaningful

Table B3a: VMware Awareness/Management Tasks

#	Task	Frequency of Use	Why the Task is Important
1	Storage management awareness from within the storage console on EMC vs. NetApp. Unisphere integrates into vCenter; how does System Manager do it	High	This provides a storage administrator the ability to have insight into the specific manner that VMs are distributed among LUNs in an array
2	EMC Virtual Storage Integrator vs. NetApp storage plug-ins deduping/compress individual VMs	Medium	This gives a virtualization administrator the ability to have direct integration into a storage array; a virtualization administrator can enable individual guest VM compression /deduplication directly from vSphere onto an array

Table B4: General Management Comparison Test Data

#	Tasks	EMC Clicks	NetApp Clicks	Variance (EMC Clicks–NetApp Clicks)
1	Customization of views within the UI	6	4	2
2	Understanding/managing the physical system from the UI (ease of understanding physical aspects of each system)	2	3	-1
3	Support and support community—opening tickets and collaboration with community	NA	NA	Not Meaningful
4	Altering and reporting: -Determining the health of the array	6	6	0
5	Simplicity of failing over of NAS, failover of SAN	7	Not done due to HW constraints	Not Meaningful

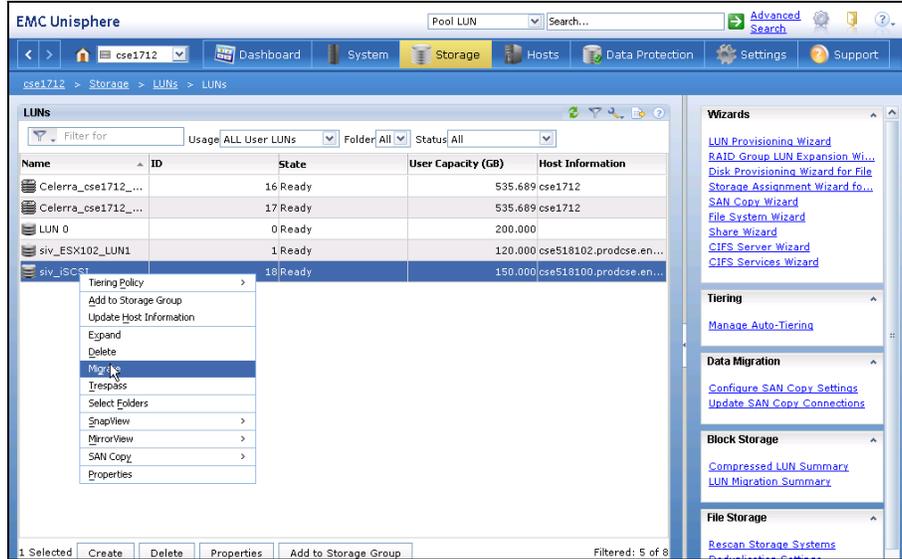
Table B4a: General Management Tasks

#	Task	Frequency of Use	Why the Task is Important
1	Customization of views within the UI	High	The administrator is able to customize the look and feel of the array's UI to meet the specific needs to the administrator to better support the business; these different portlets are able to give an administrator details that he/she finds important
2	Understanding/managing the physical system from the storage UI (ease of understanding the physical aspects of each system)	High	This allows the administrator to completely understand what is physically occurring on the array and to be able to identify and address these issues quickly and efficiently, helping to maintain system stability
3	Support and support community—opening tickets and collaboration with community	Medium	This enables an administrator to work with other storage admin professionals and vendor support staff on system best practices, problem resolution, and system fixes; this needs to be readily available to ensure IT staff has access to the resources necessary to effectively support an array
4	Altering and reporting: Determining the health of the array	High	Automated system alerting is essential to ensuring administrators and/or vendor support is aware of system issues; these alerts allow the appropriate groups to quickly address issues ensuring system availability and integrity
5	Simplicity of failing over of NAS, failover of SAN	Medium	The ability to move workloads between storage processors on an as-needed basis allows an administrator to perform required system maintenance on an array while maintaining enterprise level SLAs; this also allows an administrator to move workloads as needed to improve system performance if needed

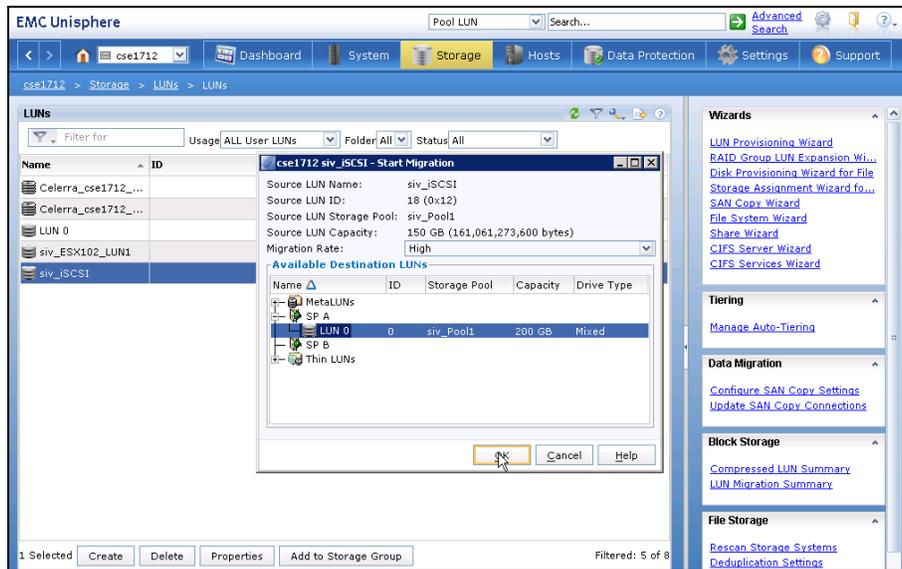
Appendix C: Online LUN Migration

EMC online LUN migration using Unisphere:

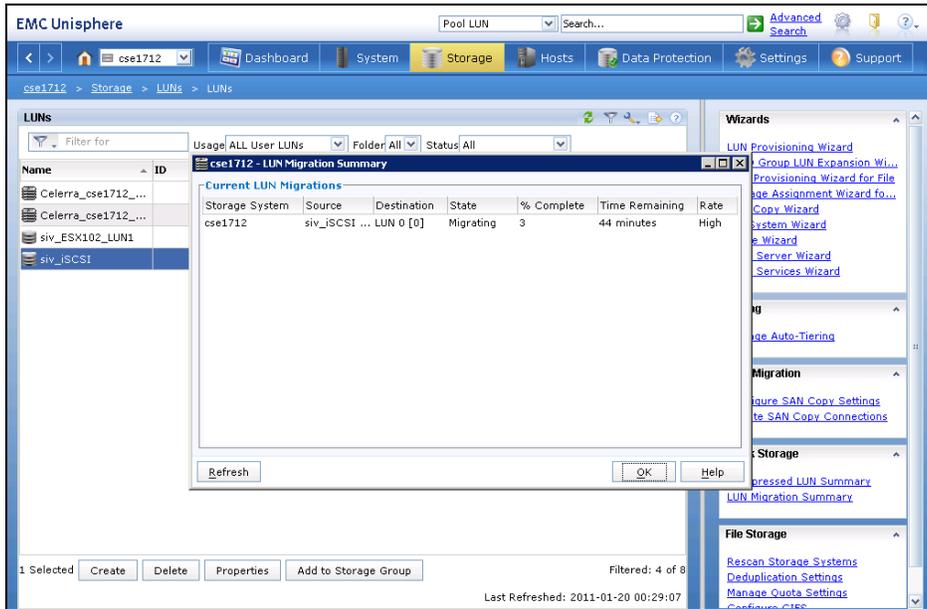
1. Choose by right clicking on the LUN to migrate, using browser-based Unisphere GUI.



2. Choose the destination LUN from the list available.

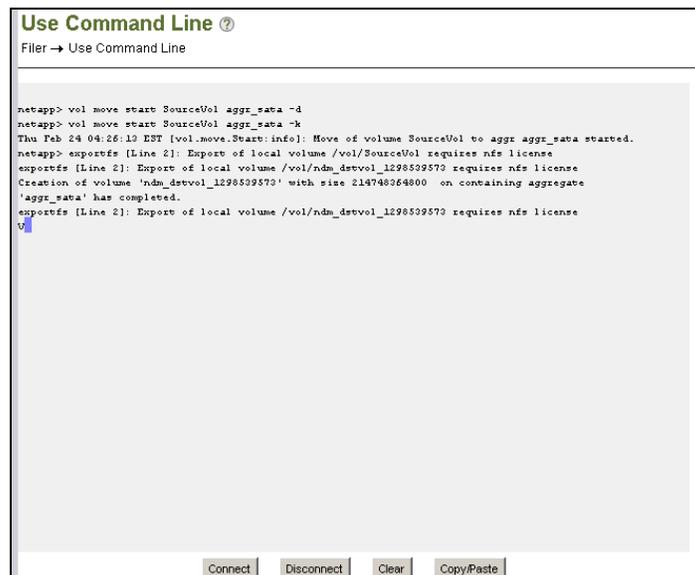


3. Monitor the migration using the “LUN Migration Summary” from the right pane.

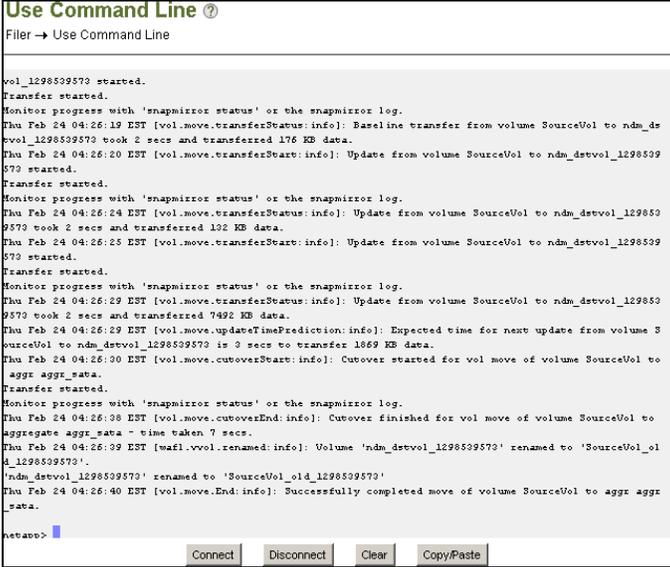


NetApp online volume migration using DataMotion (LUN migration is not supported):

1. Log in to the console using FilerView (or terminal) and type the “move” command. The source and destination volume names containing the LUN must be noted, probably from the “System Manager,” in advance, and the administrator has to manually type-in.



2. The progress can be monitored from the console with the old-school approach.



```
Use Command Line
Filer -> Use Command Line

vol_1298539573 started.
Transfer started.
Monitor progress with 'snapmirror status' or the snapmirror log.
Thu Feb 24 04:26:19 EST [vol.move.transferStatus:info]: Baseline transfer from volume SourceVol to ndm_dstvol_1298539573 took 2 secs and transferred 176 KB data.
Thu Feb 24 04:26:20 EST [vol.move.transferStart:info]: Update from volume SourceVol to ndm_dstvol_1298539573 started.
Transfer started.
Monitor progress with 'snapmirror status' or the snapmirror log.
Thu Feb 24 04:26:24 EST [vol.move.transferStatus:info]: Update from volume SourceVol to ndm_dstvol_1298539573 took 2 secs and transferred 132 KB data.
Thu Feb 24 04:26:25 EST [vol.move.transferStart:info]: Update from volume SourceVol to ndm_dstvol_1298539573 started.
Transfer started.
Monitor progress with 'snapmirror status' or the snapmirror log.
Thu Feb 24 04:26:29 EST [vol.move.transferStatus:info]: Update from volume SourceVol to ndm_dstvol_1298539573 took 2 secs and transferred 7492 KB data.
Thu Feb 24 04:26:29 EST [vol.move.updateTimePrediction:info]: Expected time for next update from volume SourceVol to ndm_dstvol_1298539573 is 3 secs to transfer 1869 KB data.
Thu Feb 24 04:26:30 EST [vol.move.cutoverStart:info]: Cutover started for vol move of volume SourceVol to aggr_aggr_sata.
Transfer started.
Monitor progress with 'snapmirror status' or the snapmirror log.
Thu Feb 24 04:26:38 EST [vol.move.cutoverEnd:info]: Cutover finished for vol move of volume SourceVol to aggregate aggr_sata - time taken 7 secs.
Thu Feb 24 04:26:39 EST [waf1.vvol.renamed:info]: Volume 'ndm_dstvol_1298539573' renamed to 'SourceVol_01_1298539573'.
'ndm_dstvol_1298539573' renamed to 'SourceVol_01_1298539573'
Thu Feb 24 04:26:40 EST [vol.move.End:info]: Successfully completed move of volume SourceVol to aggr_aggr_sata.

netapp>
```

Appendix D: About Strategic Focus

Strategic Focus, founded in 1986, is a business strategy-consulting firm focused on creative problem solving with out-of-the-box thinking. Strategic Management methodologies as well as a variety of market research techniques within the enterprise software and services space are used. In addition to expertise in using traditional approaches such as customer interviews and phone surveys to help its clients address strategic and competitive issues, the company complements these methods with hands-on evaluations of enterprise software products in its own laboratory.

The core competencies of the firm may be summarized as follows:

- Use of Business Strategy Development along with supporting market research and the Balanced Score Card methodologies to help client companies increase their penetration within the mid and enterprise software vertical market segments. This may include:
- Understanding customer requirements, customer experience, software, and vendor selection criteria, as well as competitive analysis via phone interviews in the USA, Europe, and Japan
 - Market segmentation, analysis, positioning, value proposition, and sizing of market opportunities
 - Scenario planning—including understanding strategies of the competition and forecasting future moves
 - Partner analysis and development
 - Developing strategies to target the competitor's customer base
 - Case studies as sales collateral to compare and contrast customer experience between the vendor and its competition
 - TCO and ROI studies
- Hands-on technical competitive evaluation of all of the major domains of the enterprise software and services market in our own laboratory by software engineers. We are pioneers in this space, starting in 1993—long before other research firms. Our reports are used for competitive analysis, product improvements, and product planning, as well as for developing sales collateral.

The company has domain expertise in the following areas: Portals, CRM, ERP, Open Source, Storage, Development Tools, BPM, BI Tools, SOA Middleware, Application Servers, RSS Feed Servers, Electronic Forms, Databases, J2EE and Database Application Performance Management Tools, Enterprise Application Integration, Backup and Restore software, Web Services, Mobile Solutions, and other emerging market segments. Strategic Focus has conducted numerous projects over the years in all of these areas.

For additional information, please contact Jay Prakash, President, Strategic Focus, by phone at 408-568-3993 or by e-mail at jay@strategicfocus.com.