



Global Distributed Storage Engineering

EMC Symmetrix Enginuity 5772 Release Notes

GDSE-07023-RN

Release Notes Document

1.0

1. Version Control

Version	Date	Author	Reviewed	Comments
0.1	12/20/07	Guy Shimabuku Quang Le	Ludwig Derodel	Peer Review
0.2	01/08/08	Guy Shimabuku Quang Le	Global Stakeholders:	RFC
1.0	1/25/08	Guy Shimabuku Quang Le		Release to Production

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3. Contact

Please address any comments or questions regarding the information contained in this document via email to the “*GT Global Distributed Storage Engineering” distribution list or alternatively to gdse@citi.com.

4. Latest Versions

It is recommended that the latest version of the document be used from the GDSE website <http://engineering.citigroup.net/gdse/>. Newer versions may include certification on additional platforms, or comments on issues discovered after deployment.

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6. Introduction:

6.1 Intended Audience:

This internal Citigroup document is intended for technical personnel with a background in Storage Area Networks (SAN) and server operations.

6.2 Document Scope:

Enginuity 5772 presents many new features and functionalities for the Symmetrix DMX-3 and DMX-4 arrays. This document focuses on the new data protection schemes, device tiering and array security; while, verifying the compatibility of the Symmetrix DMX-4 array and Solutions Enabler 6.4.2 with Enginuity 5772. SRDF features and operations will be covered in a separate document.

6.3 Enginuity Introduction:

Enginuity is the Storage Operating Environment (SOE) for the Symmetrix DMX series storage array. Enginuity is a multi-tasking SOE that provides the intelligence for each module within the array, thereby ensuring I/O flow and integrity of information through the different components of the Symmetrix system. Enginuity provides the following services for the Symmetrix DMX array:

- Managing system resources to optimize performance across all I/O requirements.
- Enabling system availability through fault monitoring/detection and error correction capabilities.
- Offering the foundation for specific software features available through EMC's disaster recovery, business continuance, and storage management software.
- Providing functional services for EMC storage application software.
- Prioritizing tasks for basic system maintenance, I/O processing and application processing.
- Providing uniform access through APIs for internal calls.
- Providing an external interface to allow integration with other software providers and independent software vendors.

6.4 Enginuity 5772 Introduction:

In 2007, EMC announced the general availability for Enginuity 5772 with enhanced security, optimized performance and improved data protection. The features and functionalities of Enginuity 5772 fall into four categories: scalability/resiliency features, priority controls, information-centric security and base functionality:

6.4.1 Scalability/Resiliency Features

- Improved data availability and resiliency with RAID 6 support, available in 6+2 (6 data + 2 parity stripes) or 14+2 (14 data and 2 parity stripes) configurations. RAID 6 achieves a high level of resiliency by protecting data in the event of a second drive failure within the RAID group. This report will concentrate on RAID 6 14+2, which provides the best balance of performance and capacity.
- Support for RAID 6, RAID 5 and mirror devices co-existing on the same DMX-3/4 array. This document focuses on RAID 6 14+2, RAID 5 7+1 and mirror meta devices contained within the same array.

6.4.2 Priority Controls

- Symmetrix Priority Controls (SPC) provides flexible regulation of host application I/O by assigning a priority level to a device or device group. SPC uses Priority Service Time (PST) levels to determine the potential I/O delay per device or device group. PST supports 16 Quality-of-Service (QoS) levels, with 1 being the highest throughput and 16 being the lowest.

6.4.3 Information-Centric Security

Solutions Enabler 6.4.2 along with the 5772 microcode for the DMX-3 and DMX-4 storage platforms has new and improved security features of which were tested in this project:

- Role-based access control will now be available and configurable using the symauth utility.
- New and improved audit logging capabilities in 5772 code will enable the logging of any user configuration changes that are traceable to the user making the change.
- The use of the daemon storevntd that runs on the SE server will enable audit logs to be gathered and exported to eTrust for log

consolidation and reconciliation. The storevntd will also be able to monitor the storage array for any alerts and store them locally on the SE server in a file.

- ECC integration was also tested for reporting and alerting capabilities.
- SANscreen integration was tested for change monitoring.
- Changes to symacl entries for the above functionality.
- SE software installation package for new installations and upgrades

6.4.4 Base Functionality

- Ability to monitor device and element status, display configurations, provision devices and manipulate the bin file through Solutions Enabler and Configuration Manager commands and processes.

7. Summary Conclusions:

7.1 Scalability/Resiliency Features

RAID 6 encoding protects against data loss if one or two drives fail or if unrecoverable read errors occur within the rank. EMC utilizes an evenodd encoding algorithm to create horizontal and diagonal parity stripes within each rank:

- RAID 6 14+2 utilizing 61.3GB devices (largest single device supported on the Symmetrix) on 146GB and 300GB disks and RAID 5 7+1 on 300GB disk shows the highest overall I/O performance.

Disk hyper size for a 61.3GB RAID 6 14+2 device is 4390MB versus 2470MB for a 34.5GB device. A disk hyper size of 2470MB creates 116 disk hypers on a 300GB disk, while a 4390MB disk hyper creates 65. disk hypers on a 300GB disk. The EMC DMX Product Guide recommends a maximum of 160 disk hypers per physical drive for RDF frames, and EMC Engineering recommends a maximum of 56 volumes on a physical drive for optimum manageability and performance.

- RAID 6, RAID 5 and mirror devices shows similar throughput in the sequential I/O test.

- RAID 6 61.3GB devices shows a 9% higher level of throughput than RAID 5 34.5GB devices for random I/O.
- Simultaneous support of mirrored, RAID 5 and RAID 6 devices within the same DMX-3 frame.

7.2 Priority Controls

Symmetrix Priority Service Time (PST) operation provides Quality-of-Service (QoS) levels for a device or group of devices. PST allows the user to view or change the QoS service levels of selected devices from 1 (highest throughput) through 16 (lowest throughput):

- The delta between PST QoS levels of 1 and 16, average 11-12% less throughput performance for level 16, with the highest delta of 21% occurring in the 4KB -16KB transaction size.
- EMC defaults the QoS priority for each device to the highest QoS level of 1 for the entire frame, therefore making it difficult to configure a device requiring a higher priority than the default level.

7.3 Information-Centric Security

The following new security features have been tested and certified with SE 6.4.2 and 5772 code for use within Citi:

- Symauth – Symmetrix role-based access control.
- Storeventd – Audit logging and alerting.
- ECC Integration – Reporting and central alerting.
- SANscreen Integration – Change monitoring.
- eTrust integration – Log consolidation/reconciliation. A solution is still being tested but is coming soon.

7.4 Base Functionality

Solutions Enabler (SE) 6.4.2.3 is required to display and manage the new 5772 microcode capabilities and features:

- Mirror, RAID 5 and RAID 6 devices is managed in a consistent manner.

7.5 Primary Issues Encountered:

7.5.1 DMSP Failure

According to the log messages, 100% of the DMSP operations is failing with a persistent hard error status on an active Symmetrix array. EMC attributes the DMSP failure to the Service Processor being unable to communicate with or trying to communicate with a non-existent array. EMC resolves this issue by removing and rebuilding the access database located on the Service Processor followed by a reboot.

7.5.2 Configuration Manager Commit Process Fails

Configuration Manager commit procedure for creating or converting a device fails when requesting Symmetrix resource information. This failure is evident when the commit process is queued while resource information on the array is being requested. Failure to acknowledge this commit process request causes Configuration Manager to abort this procedure and timeout alerts are generated. At this juncture, Configuration Manager appears to be hung, and a session termination request generates Symmwin timeout alert messages. However, Configuration Manager verify command (symconfigure –sid verify) completes successfully indicating that Configuration Manager is operational. EMC attributes this error to Symmwin on the Service Processor hanging causing the communication failure between Configuration Manager and the array; however, this doesn't explain why the "symconfigure –sid verify" command completes successfully. EMC recommends rebooting the Service Processor to fix this issue.

7.5.3 SRDF Director Locking Failure

When initiating an SRDF full establish, the devices hangs with an "in progress" state. According to EMC Engineering, hanging of the RDF establish is caused by unprocessed tracks locking the Director and offlining the RA port. When the Director tries to release the I/O a miscommunication occurs in the CDI layer leaving the I/O unprocessed. These unprocessed I/O results in tracks remaining locked on the Director, causing the SRDF establish process appearance of being hung. EMC resolves this issue by VTOC'ing the RA port.

8. Scalability and Resiliency

8.1 Introduction:

RAID 6 devices utilizes dual distributed parity to protect against data loss if one or two drives fail or unrecoverable bit errors occur within the rank. EMC utilizes an evenodd encoding algorithm to create horizontal and diagonal parities stripes within each rank. RAID 6 14+2 provides a level of data protection 70-145 times greater than that of RAID 5 7+1 devices within a DMX-3/4 array (see [Appendix B, RAID 6 Reliability](#)).

Engenuity 5772 simultaneously supports mirror, RAID 5 and RAID 6 data protection schemes within the DMX-3/4 frame. Previous versions of Engenuity supported only two data protection schemes, mirrored and RAID 5.

8.2 Test Methodology:

The DMX storage array can be broken down into four basic sub-systems: channel directors, global memory, disk directors and disks. The global memory or cache engine is the common link between the sub-systems since all I/O's are processed from cache. Therefore, observing the cache operation provides an insight into how the array is performing during a throughput test. Likewise, minimizing the effects of caching provides a good view of how the backend (e.g. disk director, disk adapter and disk) of the array performs.

Storage arrays utilize a prefetch algorithm with the simple goal of requesting tracks of data far enough in advance to be readily available in cache if the application needs it. The prefetch algorithm accomplishes this by directing the backend directors to load specific tracks to cache ahead of the current access. Prefetching has three possible outcomes: "true positive" where a prefetch block turns out to be needed (cache hit), "false positive" where a prefetched block is not needed after all, and "false negative" where a block that was needed is not prefetched (cache miss).

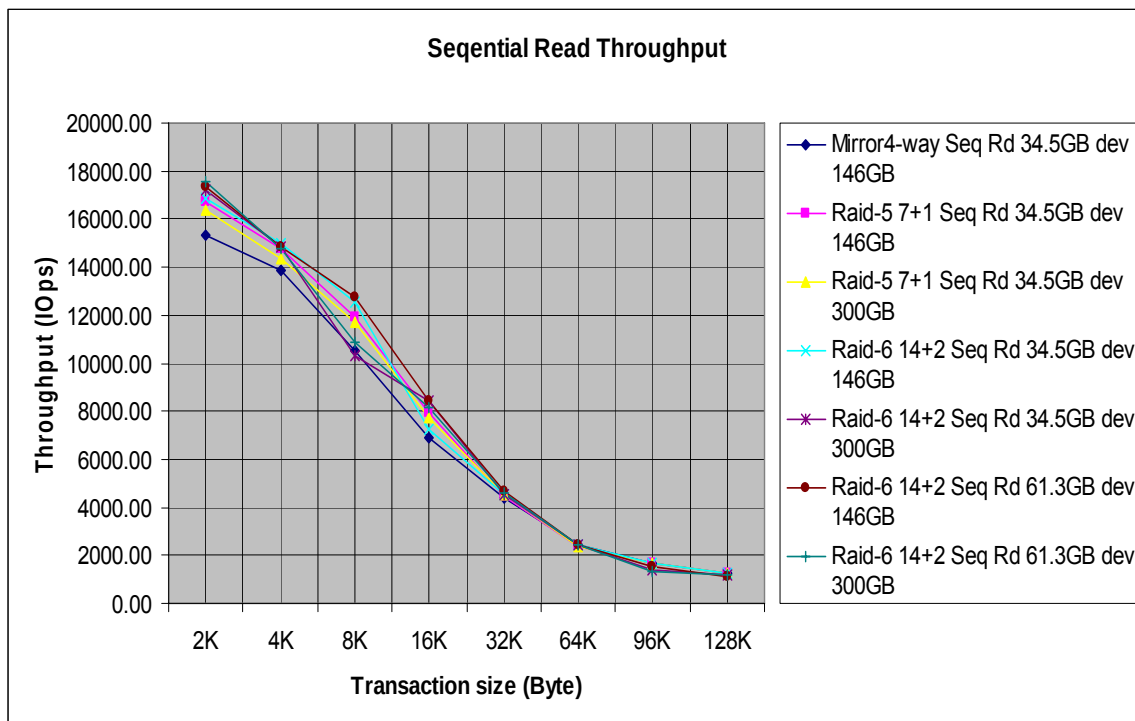
The DMX series utilizes an adaptive prefetch to limit cache pollution, thereby reducing the number of "false positives" and "false negatives" that occur with random I/O. This is achieved by dynamically adjusting the number of prefetch tracks read ahead into cache based upon the success/failure ratio of the previous prefetch tasks. With random I/O, adaptive prefetch may reduce the number of prefetch tasks or may even cease the prefetch tasks altogether. Removing the beneficial affects of the prefetch algorithm provides the best vantage point into observing the performance of the array. Once the array is in this position, the

read transactions must obtain the requested information from the physical drive. Therefore, the read transaction must transverse all four sub-systems of the array providing an end-to-end performance view.

The commonly referred to four-corners test will be used to extrapolate the throughput performance capabilities of the DMX-3 running Enginuity microcode version 5772. The four-corner test suite determines performance by varying the I/O transaction size, ratio of sequential/random request, ratio of the read/write request and queue depth.

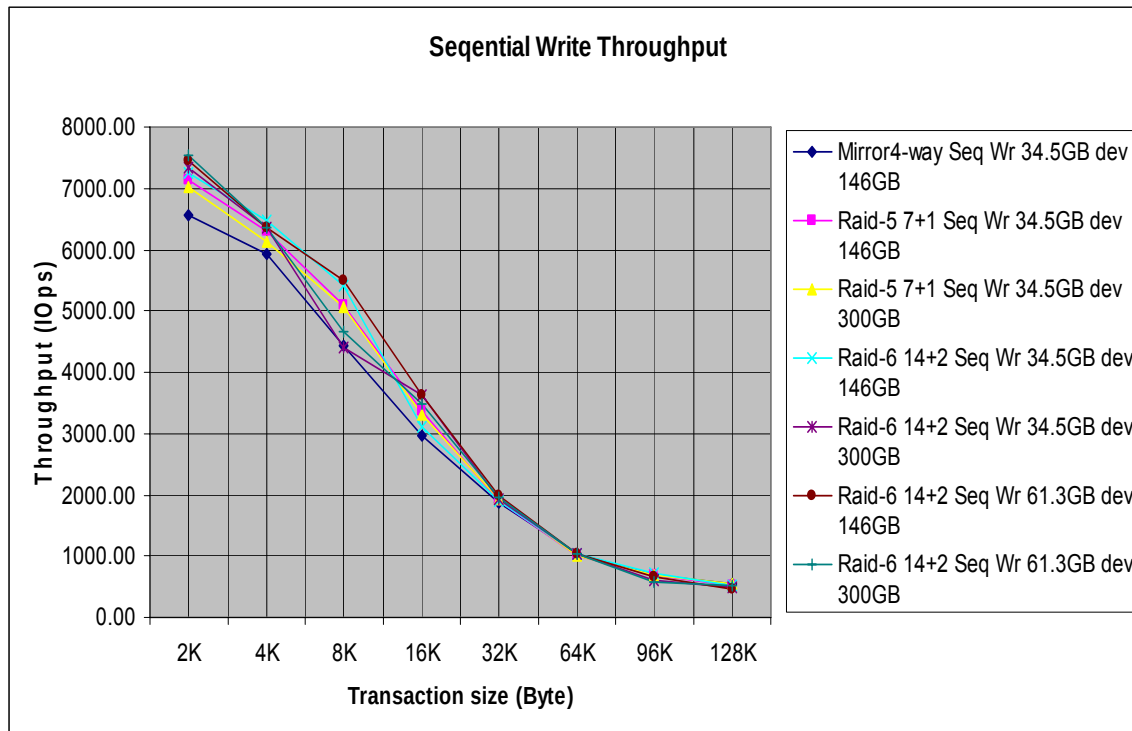
8.3 Sequential I/O Throughput Performance Test Results:

The sequential throughput test provided the best performance numbers, due to the prefetch algorithm's high ratio of true positives.



Key Observations:

- Average sequential read throughput for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 7043 IOps.
- Average sequential read throughput for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 7630 IOps.
- Average sequential read throughput for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 7492 IOps.
- Average sequential read throughput for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 7680 IOps.
- Average sequential read throughput for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 7525 IOps.
- Average sequential read throughput for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 7886 IOps.
- Average sequential read throughput for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 7621 IOps.
- The symmetry of each plot shows the consistency at which the array processes sequential transactions from cache.
- RAID 6 14+2 on 61.3GB devices with 146GB 15K disks depicts the highest sequential read throughput between 2K and 8K transactions of 14979 IOps.
- RAID 6 14+2 on 34.5GB devices with 300GB 15K disks depicts the highest sequential read throughput between 16K and 64K transactions of 5171 IOps.



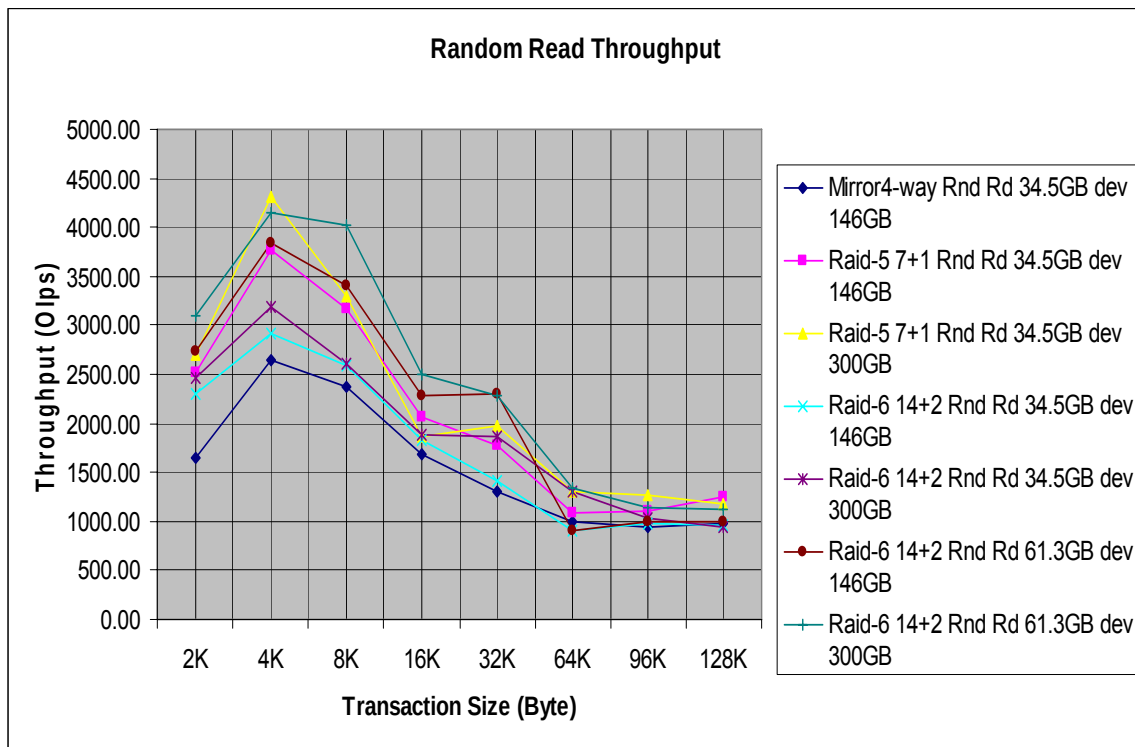
Key Observations:

- Average sequential write throughput for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 3006 IOPS.
- Average sequential write throughput for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 3258 IOPS.
- Average sequential write throughput for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 3210 IOPS.
- Average sequential write throughput for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 3301 IOPS.
- Average sequential write throughput for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 3222 IOPS.
- Average sequential write throughput for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 3385 IOPS.
- Average sequential write throughput for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 3267 IOPS.
- The symmetry of each plot shows the consistency at which the array processes sequential transactions from cache.

- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks depicted the highest sequential write throughput between 2K and 8K transactions of 6433 IOps.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks depicted the highest sequential write throughput between 16K and 64K transactions of 2333 IOps.

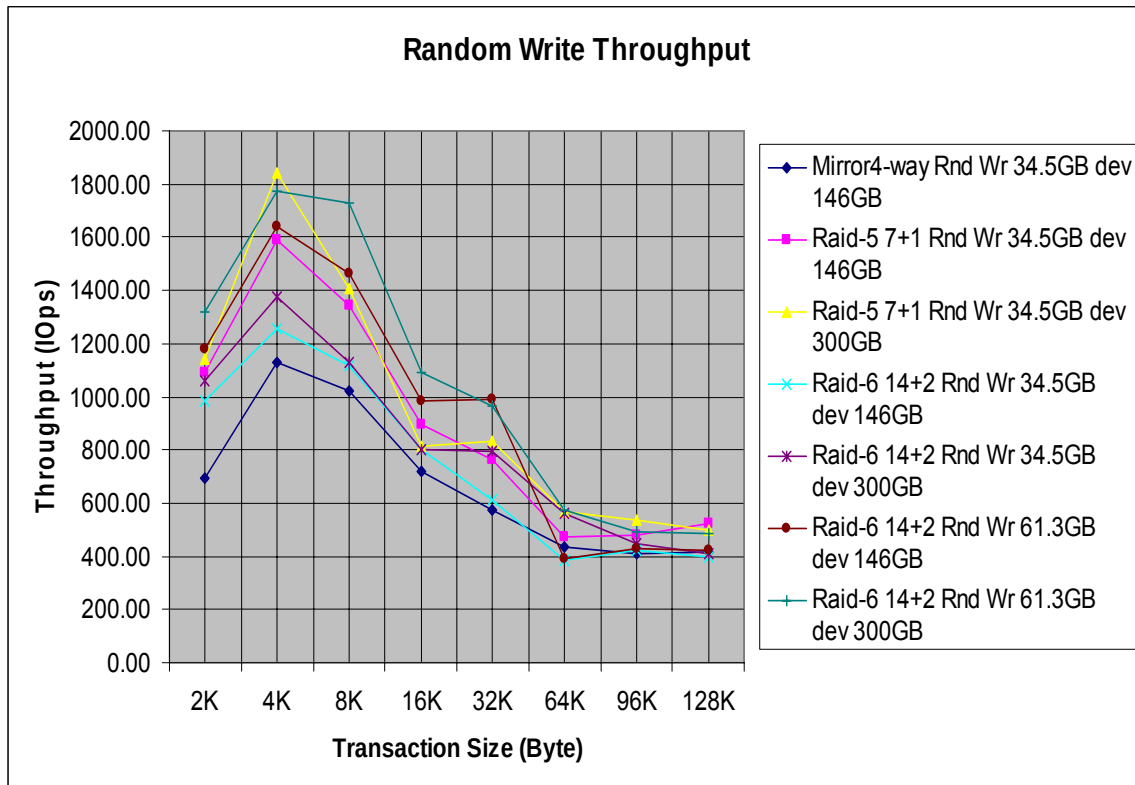
8.4 Random I/O Throughput Performance Test Results:

Random transactions are the most difficult for an array to process, due to retrieving the requested data from the physical disk while the request remains in a hold status. Random I/O removes much of the cache I/O enhancement abilities of the array, therefore providing a backend performance perspective of the array.



Key Observations:

- Average random read throughput for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 1572 IOps.
- Average random read throughput for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 2091 IOps.
- Average random read throughput for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 2237 IOps.
- Average random read throughput for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 1735 IOps.
- Average random read throughput for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 1913 IOps.
- Average random read throughput for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 2148 IOps.
- Average random read throughput for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 2457 IOps.
- Each plot shows similar shape with a peak magnitude at 4KB transactions.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random read throughput between 2K and 8K transactions of 3754 IOps.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random read throughput between 16K and 64K transactions of 2039 IOps.



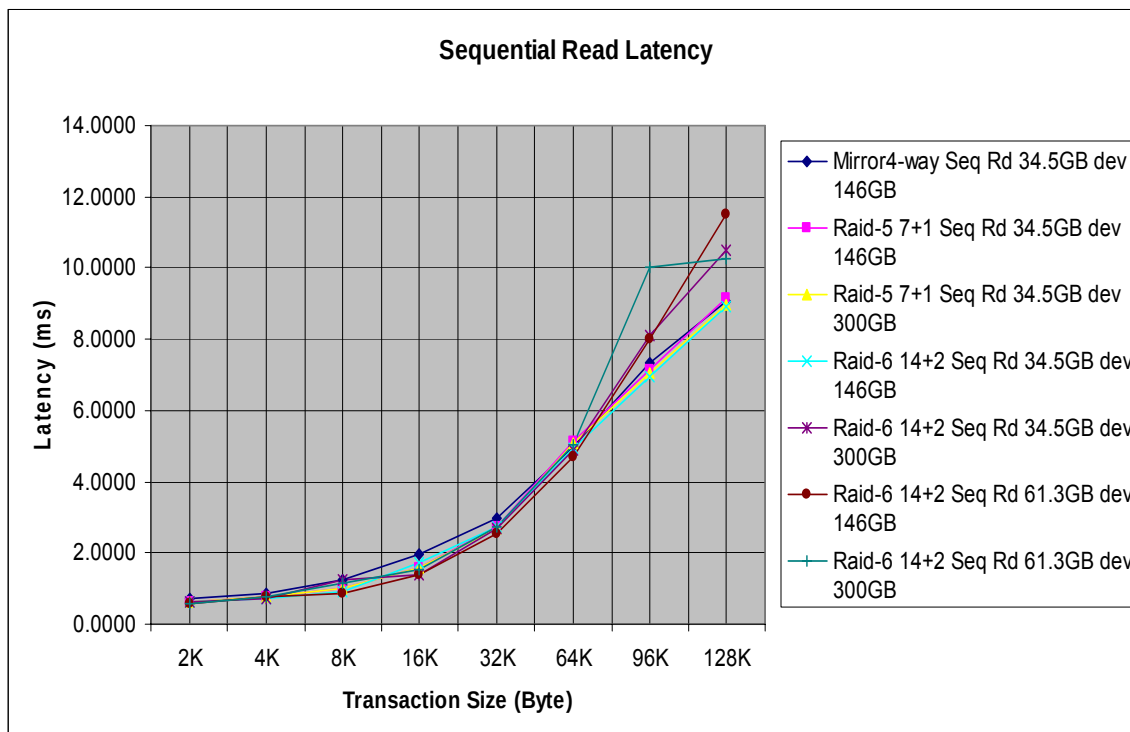
Key Observations:

- Average random write throughput for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 674 IOPS.
- Average random write throughput for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 895 IOPS.
- Average random write throughput for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 955 IOPS.
- Average random write throughput for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 746 IOPS.
- Average random write throughput for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 821 IOPS.
- Average random write throughput for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 938 IOPS.
- Average random write throughput for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 1053 IOPS.
- Each plot shows similar shape with a peak magnitude at 4KB transactions.

- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random write throughput between 2K and 8K transactions of 1607 IOps.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random write throughput between 16K and 64K transactions of 875 IOps.

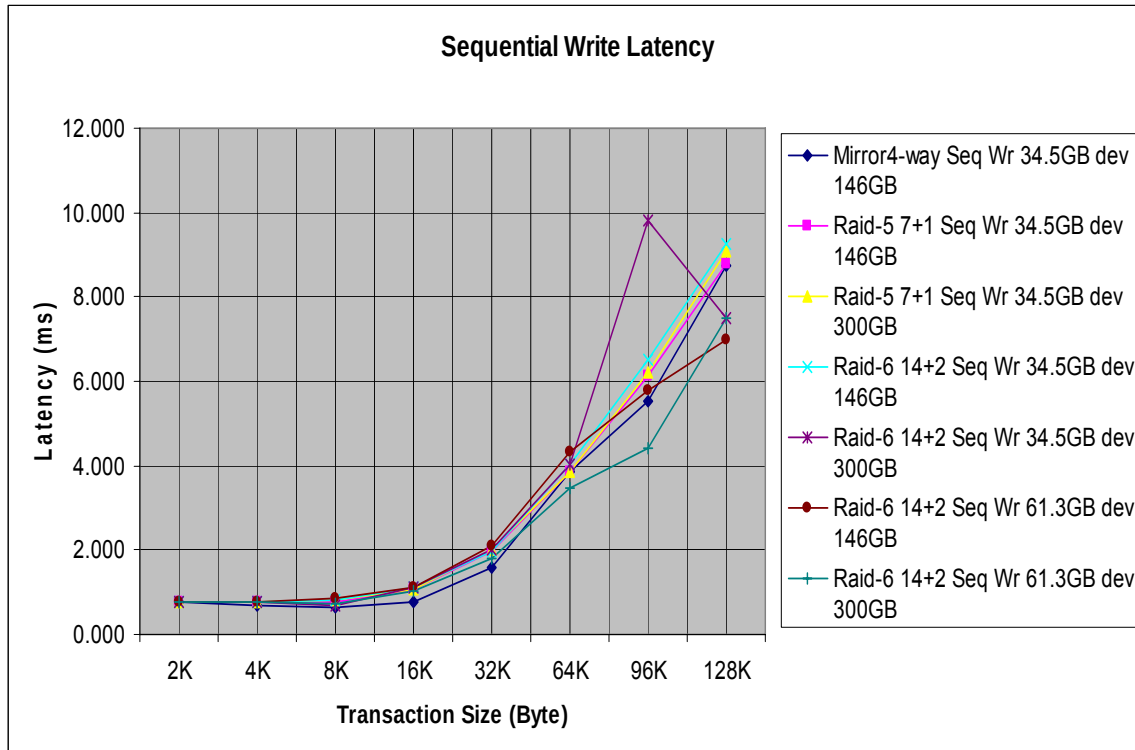
8.5 Response Time Performance Test Results:

Response time is measured from the initiation to the completion of the I/O operation. In this evaluation, response times are measured for each of the test volumes independently and then grouped and averaged by transaction size. The DMX utilizes the fast write technique, where once the write I/O is written to cache, the array notifies the host that the write operation is complete and the data is asynchronously sent to the physical drives.



Key Observations:

- Average sequential read latency for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 3.639ms.
- Average sequential read latency for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 3.513ms.
- Average sequential read latency for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 3.472ms.
- Average sequential read latency for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 3.432ms.
- Average sequential read latency for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 3.773ms.
- Average sequential read latency for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 3.797ms.
- Average sequential read latency for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 3.999ms.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the lowest sequential read latency between 2K and 8K transactions of 0.742ms.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the lowest sequential write latency between 16K and 64K transactions of 2.887ms.

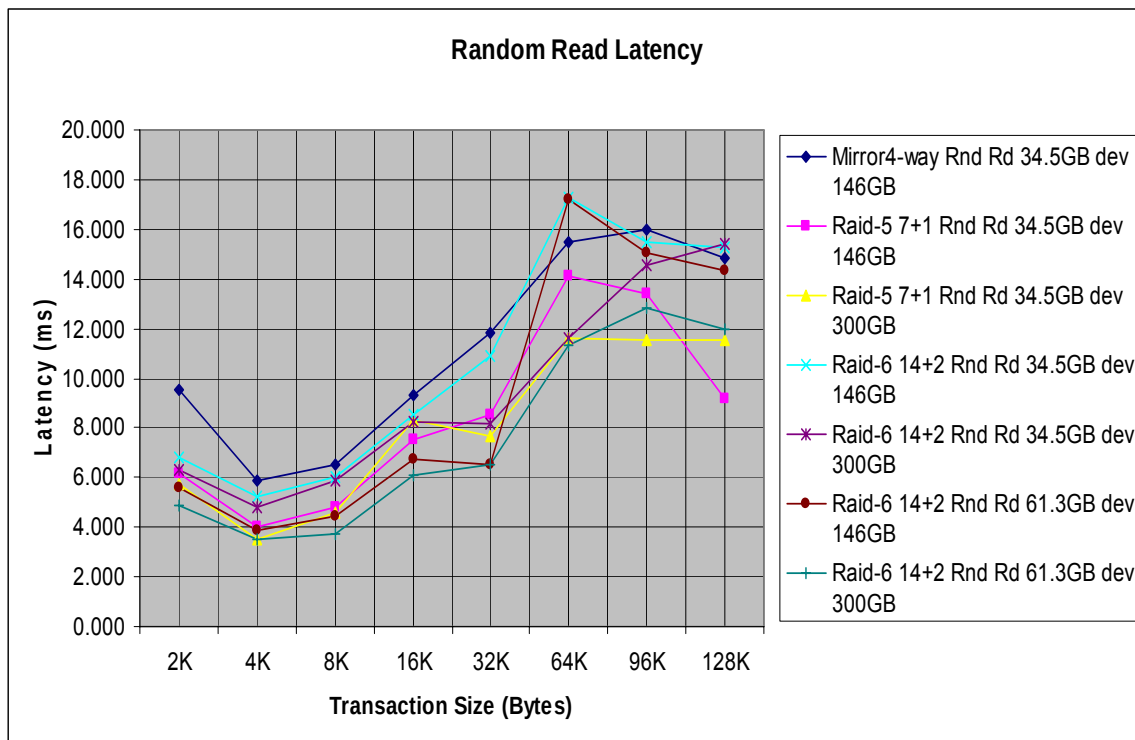


Key Observations:

- Average sequential write latency for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 2.830ms.
- Average sequential write latency for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 3.012ms.
- Average sequential write latency for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 3.079ms.
- Average sequential write latency for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 3.154ms.
- Average sequential write latency for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 3.340ms.
- Average sequential write latency for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 2.829ms.
- Average sequential write latency for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 2.562ms.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the lowest sequential write latency between 2K and 8K transactions of 0.696ms.

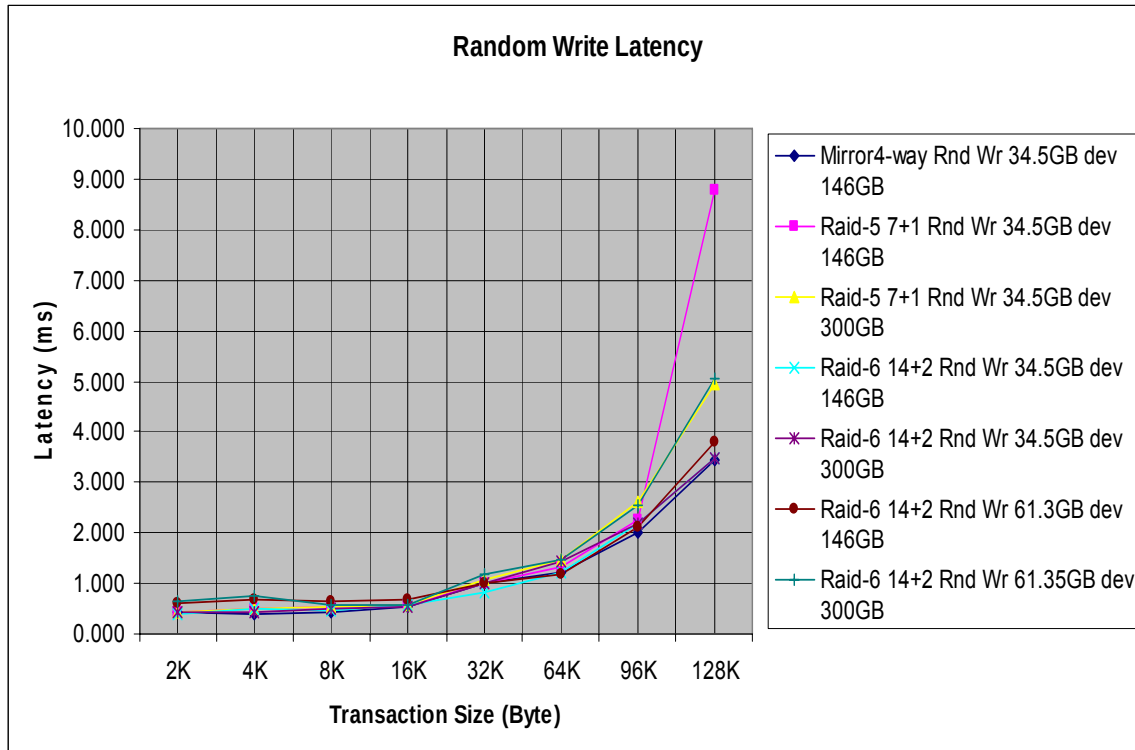
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the lowest sequential write latency between 16K and 64K transactions of 2.085ms.

Random read latency provides a good view to the backend performance of the array. High random read requests nullify the pre-fetch capabilities of the array, requiring the array to retrieve the data from the physical drives while the read request remains in a hold status. Therefore, random reads will usually provide the highest latency values. Random writes will be acknowledged by the fast write procedure; however, the randomness will likely increase the probability of short writes. Short writes are defined as a write to a drive that is less than one sector in size; therefore, requiring the array to read the remaining data from the sector into cache to calculate the Cyclic Redundancy Check (CRC). This procedure generates an additional I/O per backend destage to fetch the remaining data to run against the CRC algorithm. A high number of short writes taxes the available array resources.



Key Observations:

- Average random read latency for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 11.165ms.
- Average random read latency for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 8.461ms.
- Average random read latency for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 8.066ms.
- Average random read latency for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 10.678ms.
- Average random read latency for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 9.377ms.
- Average random read latency for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 9.211ms.
- Average random read latency for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 7.617ms.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the lowest random read latency between 2K and 8K transactions of 4.044 ms.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the lowest random write latency between 16K and 64K transactions of 7.999ms.



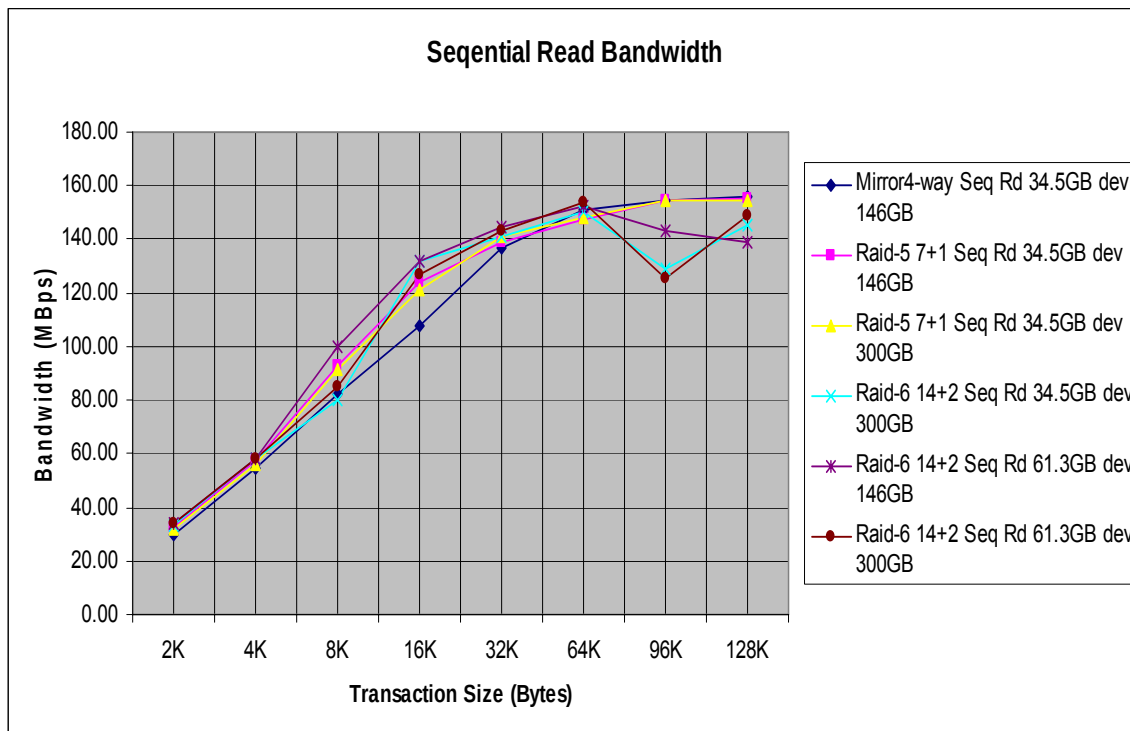
Key Observations:

- Average random write latency for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 1.183ms.
- Average random write latency for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 1.193ms.
- Average random write latency for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 1.519ms.
- Average random write latency for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 1.205ms.
- Average random write latency for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 1.253ms.
- Average random write latency for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 1.336ms.
- Average random write latency for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 1.606ms.
- 4-way mirror devices at 34.5GB on 146GB 15K RPM disk depicts the lowest random write latency between 2K and 8K transactions of 0.422ms.

- 4-way mirror devices at 34.5GB on 146GB 15K RPM disk depicts the lowest random write latency between 16K and 64K transactions of 0.921ms.

8.6 Bandwidth Utilization

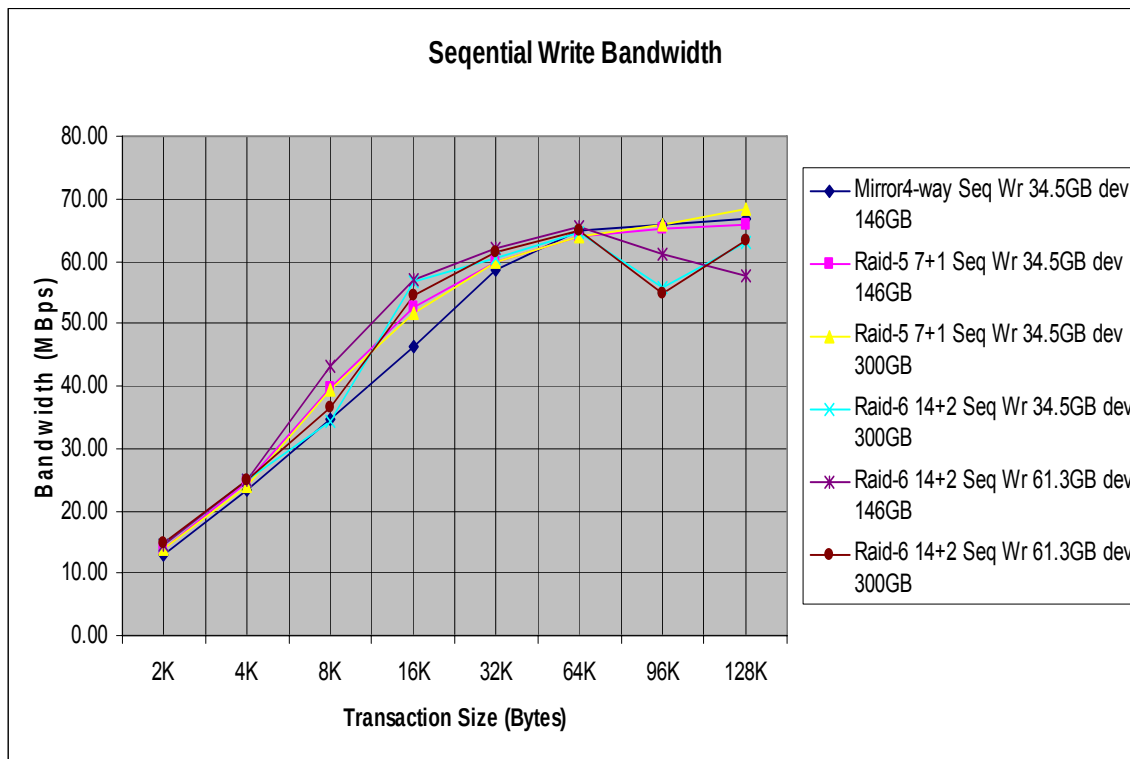
Bandwidth utilization is the average number of megabyte read and written per second averaged over the length of the test.



Key Observations:

- Average sequential read bandwidth utilization for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 109MBps.
- Average sequential read bandwidth utilization for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 112MBps.
- Average sequential read bandwidth utilization for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 112MBps.
- Average sequential read bandwidth utilization for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 112MBps.

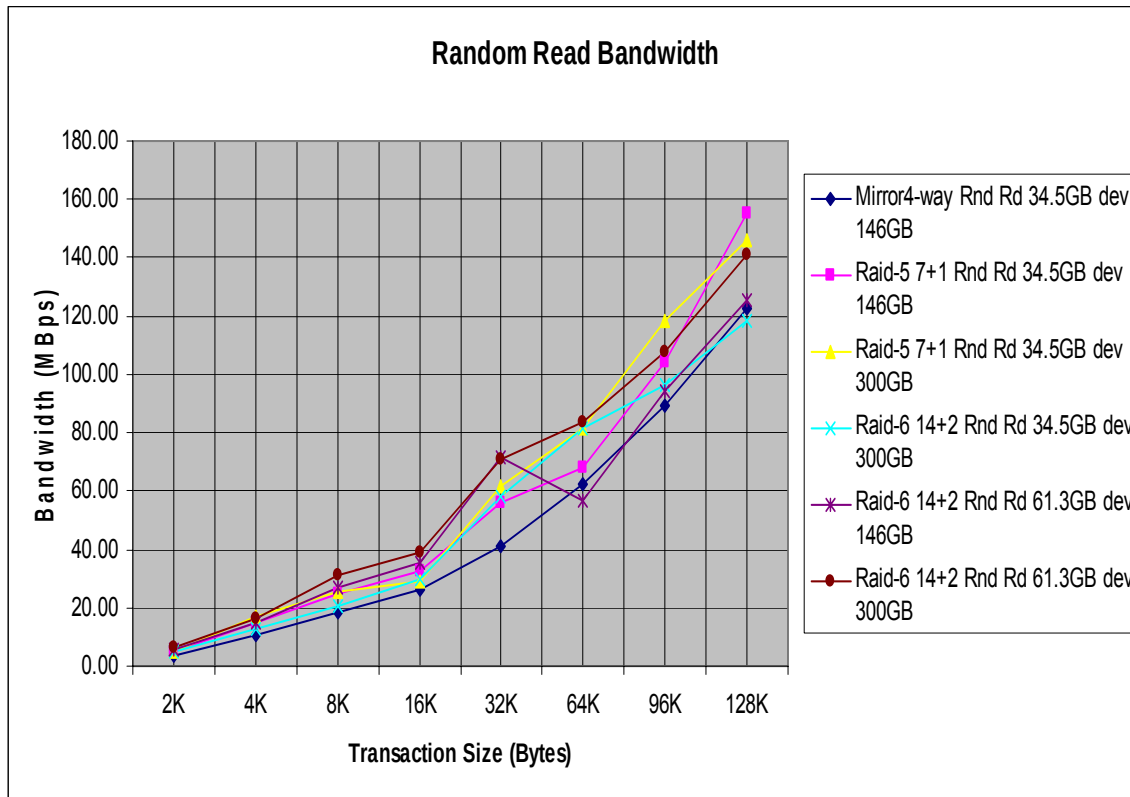
- Average sequential read bandwidth utilization for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 108MBps.
- Average sequential read bandwidth utilization for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 112MBps.
- Average sequential read bandwidth utilization for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 109MBps.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the highest sequential read bandwidth utilization between 2K and 8K transactions of 63.9MBps.
- RAID 6 14+2 34.5GB devices on 146GB 15K RPM disk depicts the highest sequential write bandwidth utilization between 16K and 64K transactions of 151MBps.



Key Observations:

- Average sequential write bandwidth utilization for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 46MBps.

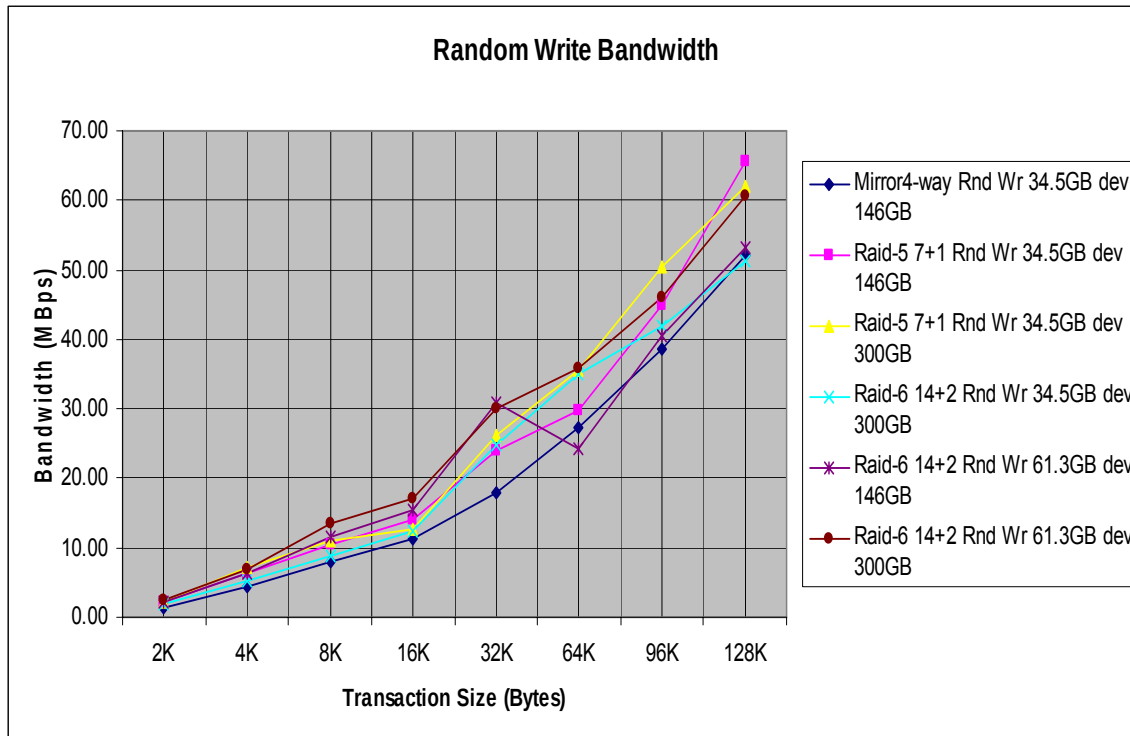
- Average sequential write bandwidth utilization for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 48MBps.
- Average sequential write bandwidth utilization for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 48MBps.
- Average sequential write bandwidth utilization for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 48MBps.
- Average sequential write bandwidth utilization for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 46MBps.
- Average sequential write bandwidth utilization for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 48MBps.
- Average sequential write bandwidth utilization for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 46MBps.
- RAID 6 14+2 61.3GB devices on 146GB 15K RPM disk depicts the highest sequential write bandwidth utilization between 2K and 8K transactions of 27.4MBps.
- RAID 6 14+2 34.5GB devices on 146GB 15K RPM disk depicts the highest sequential write bandwidth utilization between 16K and 64K transactions of 143MBps.



Key Observations:

- Average random write bandwidth utilization for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 46MBps.
- Average random write bandwidth utilization for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 43MBps.
- Average random write bandwidth utilization for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 60MBps.
- Average random write bandwidth utilization for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 48MBps.
- Average random write bandwidth utilization for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 52MBps.
- Average random write bandwidth utilization for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 53MBps.
- Average random write bandwidth utilization for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 62MBps.

- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random write bandwidth utilization between 2K and 8K transactions of 17.9MBps.
- RAID 6 14+2 34.5GB devices on 300GB 15K RPM disk depicts the highest random write bandwidth utilization between 16K and 64K transactions of 55.1MBps.



Key Observations:

- Average random write bandwidth utilization for 4-way mirror devices at 34.5GB on 146GB 15K RPM disks, is 20MBps.
- Average random write bandwidth utilization for RAID 5 7+1 34.5GB devices on 146GB 15K RPM disks, is 18MBps.
- Average random write bandwidth utilization for RAID 5 7+1 34.5GB devices on 300GB 15K RPM disks, is 25MBps.
- Average random write bandwidth utilization for RAID 6 14+2 34.5GB devices on 146GB 15K RPM disks, is 22MBps.
- Average random write bandwidth utilization for RAID 6 14+2 34.5GB devices on 300GB 15K RPM disks, is 22MBps.

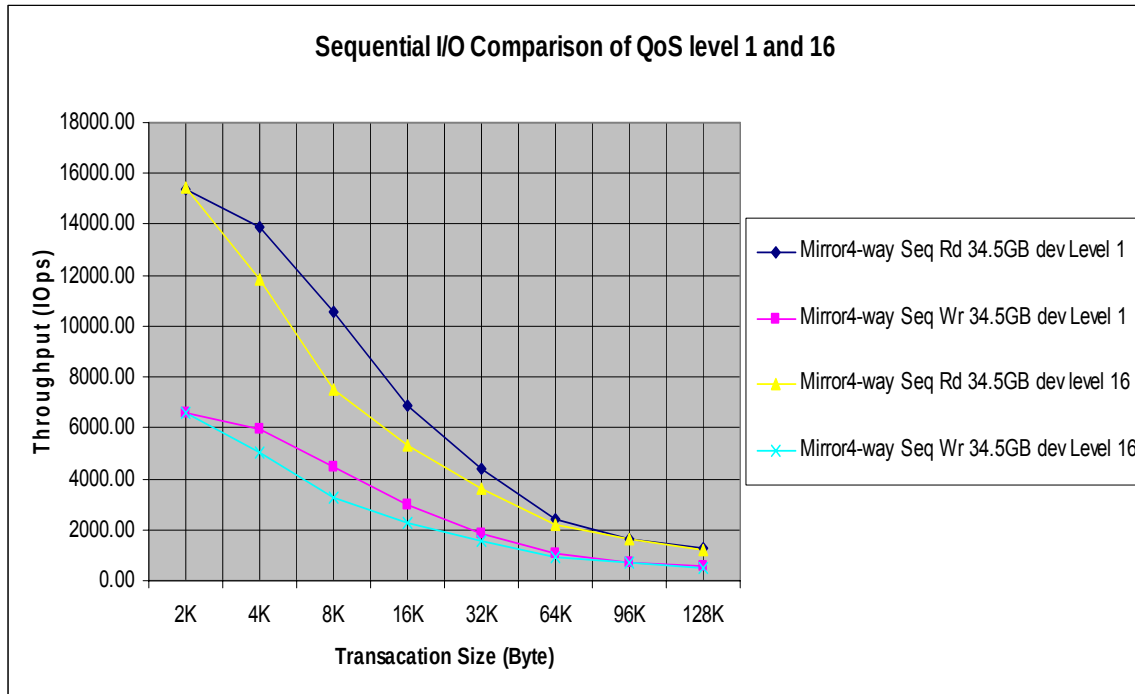
- Average random write bandwidth utilization for RAID 6 14+2 61.3GB devices on 146GB 15K RPM disks, is 23MBps.
- Average random write bandwidth utilization for RAID 6 14+2 61.3GB devices on 300GB 15K RPM disks, is 26MBps.
- RAID 6 14+2 61.3GB devices on 300GB 15K RPM disk depicts the highest random write bandwidth utilization between 2K and 8K transactions of 7.6MBps.
- RAID 6 14+2 34.5GB devices on 146GB 15K RPM disk depicts the highest random write bandwidth utilization between 16K and 64K transactions of 23.7MBps.

9. Quality-of-Service Performance:

Engenuity 5772 enables the Symmetrix array to manage device priority controls within a single system by implementing Symmetrix Priority Controls (SPC). SPC provides prioritization for an individual device or group of devices through setting the Priority Service Time (PST) with 16 QoS levels (1 highest – 16 lowest priority). PST prioritizes the device or device group by increasing or decreasing the potential I/O delay.

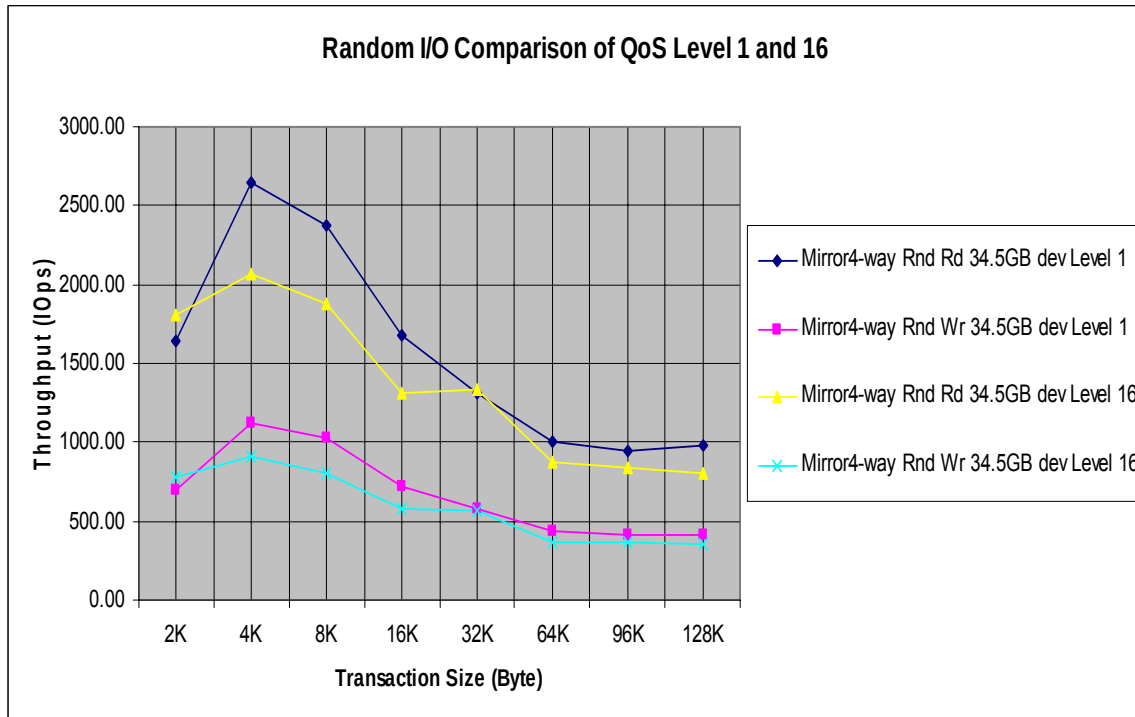
PST testing depicts a 12% difference for sequential reads and writes between devices with PST levels of 1 and 16, an 11.5% difference for random reads and writes. For transactions sizes of 4KB-16KB, sequential reads and writes shows a 22% difference and 21.7% for random reads and writes between PST levels of 1 and 16.

EMC defaults the QoS priority for each device to the highest QoS level of 1 for the entire frame, therefore making it difficult to configure a device with a higher priority than the default level. Since the QoS levels are relative to each other, EMC should set the array default level at 8, providing an option to set the QoS levels higher or lower than the default.



Key Observations:

- 8KB transaction shows the highest level of throughput attenuation of 24% for sequential and random I/O.
- 2KB transaction shows a 5.75% higher throughput for PST level 16 as compared to level 1.



Key Observations:

- Highest attenuation for level 16 occurred at transaction sizes 4KB-16KB which averaged 21.7%.
- Transactions sizes 2KB and 32KB-128KB shows an average level 16 attenuation of 5.9%.

10. Degraded Mode Performance

RAID 6 degrade mode is attained when a physical disk failure occurs within the RAID group, and double-degrade mode is when two disk fails within a RAID group. In degraded mode RAID 6 functions similar to RAID 5 with a single parity stripe.

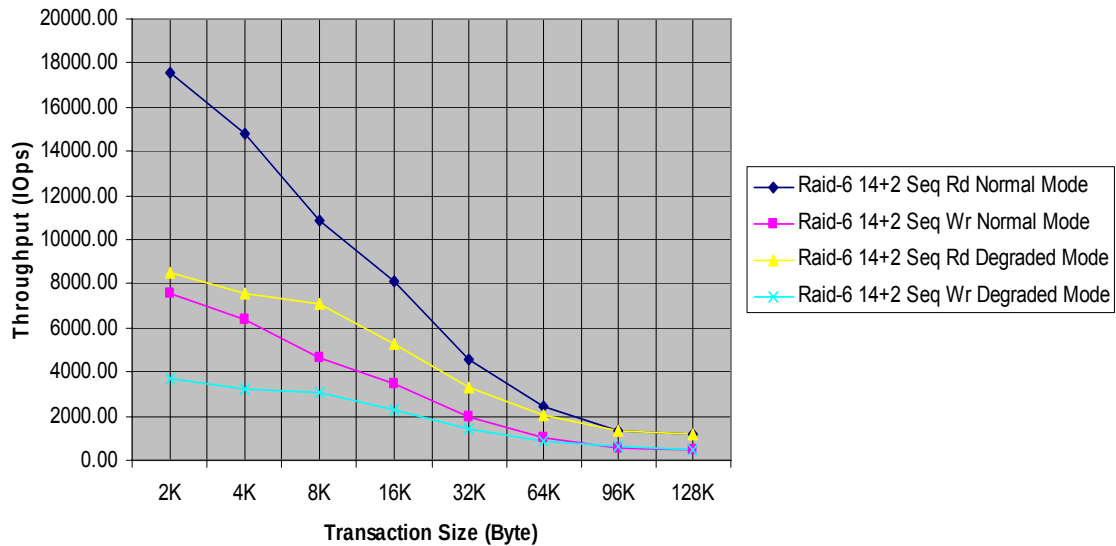
The test results indicates that degraded mode RAID 6 61.3GB devices on 300GB disk shows 40% lower throughput for sequential I/O and 30% lower throughput for random I/O as compared to normal device operation. RAID 6 34.5GB devices on 300GB disks, shows 38% lower sequential I/O and 15% lower

random I/O in comparing degraded and normal mode operation. In comparing RAID 5 7+1 34.5GB devices on 300GB disks with RAID 6 14+2 34.5GB devices on 300GB disk in degrade mode, RAID 5 shows 48% higher sequential I/O throughput and 35% higher throughput for random I/O. The resulting values indicates the degrade mode severely affects performance of the RAID 6 group. In addition, RAID 6 takes on the profile of RAID 5 group in degraded mode with a single parity stripe; however, RAID 5 in normal mode show higher performance than RAID 6 in degraded mode.

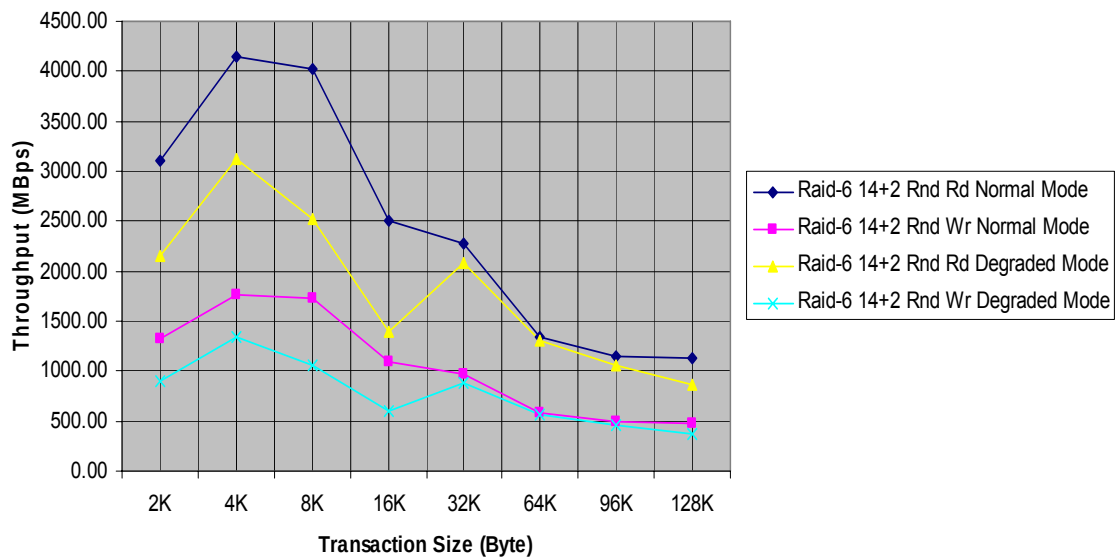
RAID 6 degraded mode simulation was achieved through logically disabling a single disk in the RAID group. Following the disabling of the disk, the disk was VTOC'd then re-enabled to simulate a drive replacement. The duration to rebuild the disk and return the RAID group to normal operation averaged 4.16 hours, which corresponds to the 3.51 hours calculated for MTTR (recognition and replacement time equal zero). Disk rebuild times depend on many factors such as disk type, disk size, bus speed, application load and hot sparing if utilized. A standard rule-of-thumb, the RAID 6 will take 10% longer to rebuild as a RAID 5 device with the same number of data stripes.

RAID 6 double-degraded mode was not evaluated. According to EMC, double-degraded mode uses a cache construct, which is a backend physical consistency table that separates the logical and physical representations of the device. The consistency table is very small in structure, using one bit of information for each track within the slice including the parity tracks to indicate whether the track is consistent within the RAID group. Reconstruction of the data on a replaced disk, depends if there is sufficient data on a horizontal stripe to complete the reconstruction; otherwise, the diagonal parity is used to reconstruct the data. When two disks require re-reconstruction, the rebuilds occur serially where first disk will complete before starting the rebuild on the second disk.

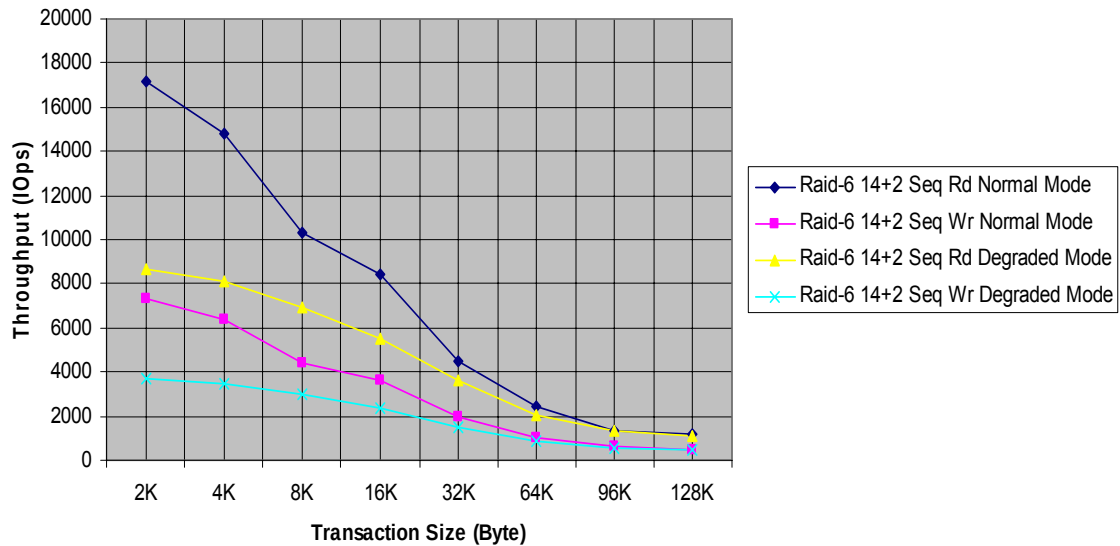
Raid-6 61.3GB Device 300GB Disk w/ Sequential I/O



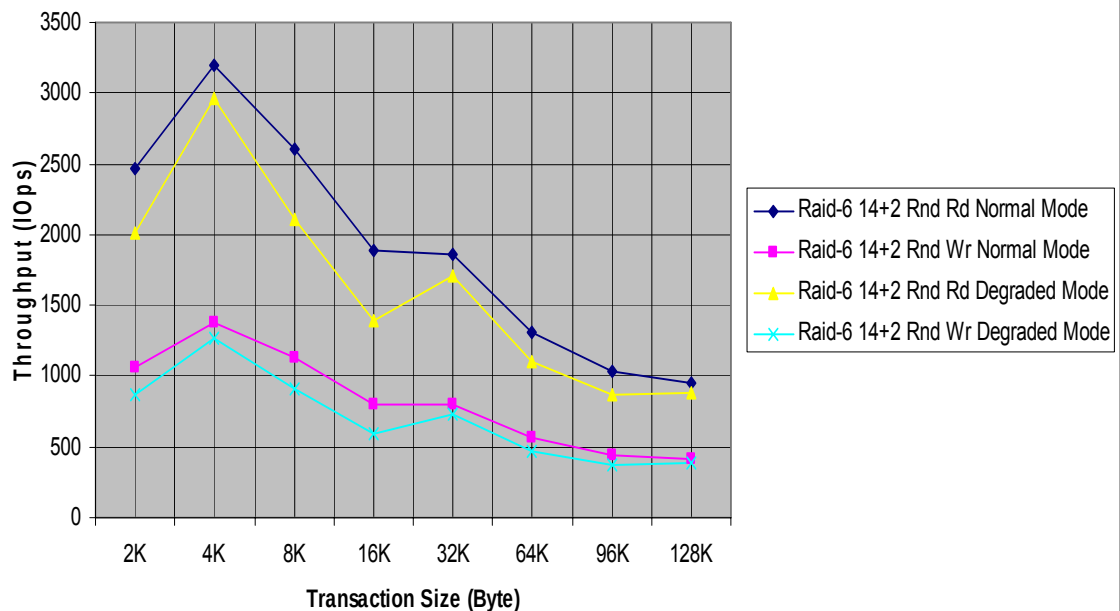
Raid-6 61.3 Device 300GB Disk w/ Random I/O



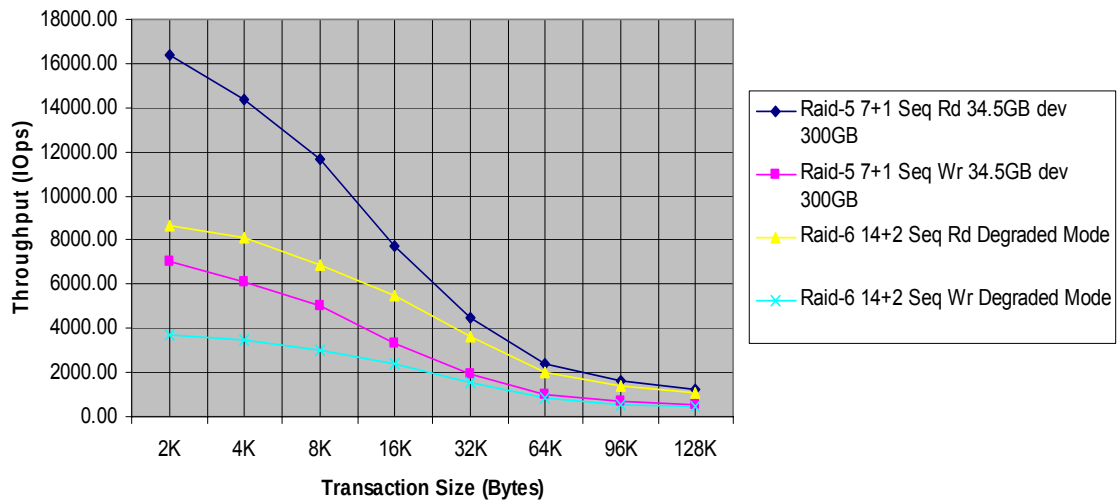
Raid-6 34.5GB Device 300GB Disk w/ Sequential I/O



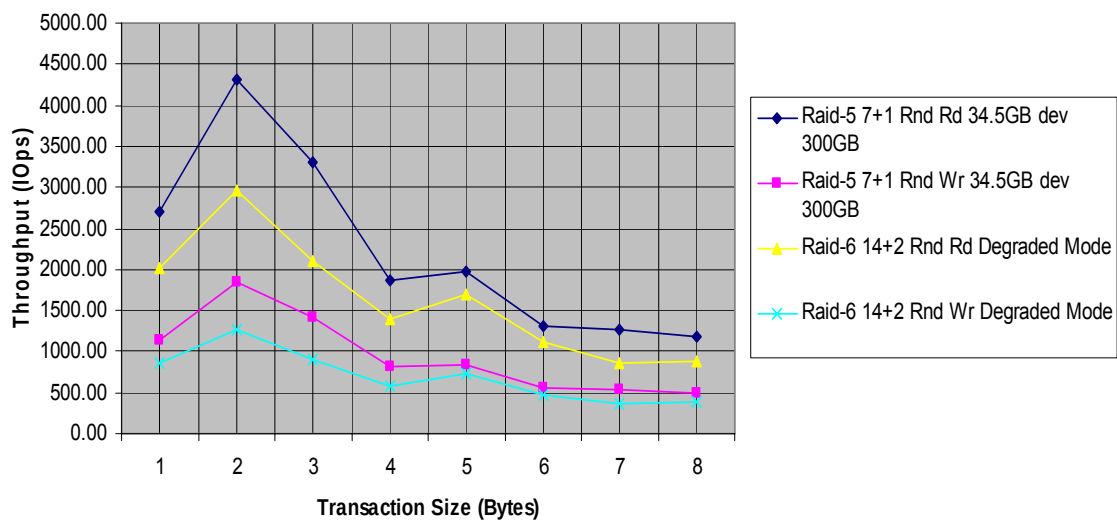
Raid-6 34.5GB Device 300GB Disk w/ Random I/O



**Raid-5 34.5GB Devices vs. Raid-6 34.5GB Devices Degraded Mode on 300GB
Disks w/ Sequential I/O**



**Raid-5 34.5GB Devices vs. Raid-6 34.5 Devices Degraded Mode on 300GB Disks
w/ Random I/O**



11. Base Functionality

Determine the capability of Solution Enabler 6.4.2 to administrate and manage the DMX-4 array with Enginuity 5772:

11.1 Test Results:

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
1.0.0.0	Device depiction		CLI		Pass	"symdev show" proper list the capacity of the devices. Request the number of stripes and parity members be shown.
1.0.0.1	Device list with cylinder capacity		CLI		Pass	"symdev list -cyl" proper list the cylinder capacity of the devices.
1.0.0.2	Device list specifying data protection type		CLI		Pass	"symdev list -RAID5/6 - protection m+x"
1.0.0.3	List device inventory		CLI		Pass	"symdev -sid list - inventory"
1.0.0.4	List device by disk group		CLI		Pass	" symdev -sid list - disk_group 03"
1.0.0.5	Verify Microcode Level		CLI		Pass	"symconfigure -sid list -v"
1.0.0.6	Verify freespace in bytes and cylinders		CLI		Pass	"symconfigure -sid list - fresspace -units MB/cyl, depicts the amount of free space available on the frame.
1.0.0.7	Verify configuration manager status		CLI		Pass	"symconfigure -sid verify"
1.0.0.8	Verify capacity on back-end directors		CLI		Pass	"symdev -sid list -da all - space -cyl"
1.0.0.9	Verify disk hyper maximum value		CLI		Pass	"symcfg -sid list -v"
1.0.1.10	Listing drive capacity in		CLI		Pass	"symdisk -sid 919 list", "symdisk -sid 919 list -cyl"

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
	cylinders					
1.0.2.1	Listing drive capacity in bytes		CLI		Pass	"symdisk -sid 919 list"
1.0.2.2	List drive information by disk group		CLI		Pass	"symdisk -sid list -by_diskgroup"
1.0.2.3	Listing devices on a particular FA port with LUN ID's		CLI		Pass	"symcfg -sid -FA -p list -address"
1.0.2.4	Host device inquiry		CLI		Pass	"syminq"
1.0.2.5	Display Symmetrix configuration database information		CLI		Pass	"symcfg -sid -db"
1.0.2.6	Verbose list of Symmetrix configuration		CLI		Pass	"symcfg -sid list -v"
1.0.2.7	Display all Symmetrix directors		CLI		Pass	"symcfg -sid -dir all list"
1.0.2.8	Listing devices by FA port		CLI		Pass	"symcfg -sid -dir all list -address"
1.0.2.9	Listing host to Symmetrix connections with capacities		CLI		Pass	"symcfg -sid list -connections -capacity"
1.0.2.10	Listing devices without port assignments		CLI		Pass	"symdev -sid list -noport"
1.0.2.11	Listing Symmetrix locks		CLI		Pass	"symcfg -lockn all list"
1.0.3.1	List Symmetrix daemons		CLI		Pass	"stordaemon list"
1.0.3.2	Symmetrix daemon shutdown		CLI		Pass	"stordaemon shutdown all"
1.0.3.3	Symmetrix daemon startup		CLI		Pass	"stordaemon start"

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
1.0.3.4	Display Symmetrix code level RAID 5 availability		CLI		Pass	"symconfigure list -v"
1.0.3.5	Display cabinet status		CLI		Pass	"symcfg -sid list -env_data"
1.0.4.1	Create RAID 6 device from available free from a specific disk group		CLI		Pass	Configuration manager to create multiple RAID 6 devices from freespace: create dev count=3, size=36828, emulation=FBA, onfig=RAID 6, data_member_count=14, mvs_ssid=0000, disk_group=5;
1.0.4.2	RAID 6 Metavolume device creation		CLI		Pass	configuration manager to create RAID 5 metavolume: form meta from dev 02E3 config=Striped, stripe_size=1920; add dev 02E4:02E5 to meta 02E3, protect_data=FALSE;
1.0.4.3	Metavolume device dissolve		CLI		Pass	configuration manager to dissolve metavolume: dissolve meta dev 02E3;
1.0.4.4	Port mapping of devices		CLI		Pass	configuration manager to map metavolume to front-end pair: map dev 02E3 to dir 7A:0 lun=074; map dev 02E3 to dir 10B:0 lun=074;
1.0.4.4	Port unmapping of devices		CLI		Pass	configuration manager to remove metavolume from front-end ports: unmap dev 02E3 from dir 7A:0; unmap dev 02E3 from dir 10B:0;
1.0.4.4	Removal of one device from		CLI		Pass	Removing a device from a stripped metavolume

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
	striped meta-volume					should not be allowed. Error message: Striped META device membership cannot be modified Device 02E5 generated the failure
1.0.4.5	Set maximum disk hyper value		CLI		Fail	"set symmetrix max_hypers_per_disk=160;" EMC recommends that disk hypers be limited to 160 for RDF frames.
1.0.5.1	Symmetrix device group rename		CLI		Fail	symdg rename <orig_name> <new_name>
1.0.5.2	List channel director device assignments		CLI		Pass	symmaskdb -sid list assignment -dev xx:yy
1.0.6.1	List log records		CLI		Pass	symaudit -sid list
1.0.6.2	List finite number of log records		CLI		Pass	symaudit -sid list -last_n 5
1.0.6.3	Show detail individual log record		CLI		Pass	symaudit -sid list -v -record_number XXXX
1.0.7.1	Backup VCMDDB		CLI		Pass	symmaskdb -sid -file <filename> backup
1.0.7.2	List devices assigned to a wwn in the backup file		CLI		Pass	symmaskdb -file list devs - wwn
1.0.7.3	Display channel adapter location of the specified device		CLI		Pass	symmaskdb -file <filename> list database
1.0.7.4	Display device and FA assignment					Symmaskdb -sid list assignment -dev xxx:xxx
1.0.7.5	Display channel adapter and device size and type assigned to a particular host		CLI		Pass	symmaskdb -sid -host <hostname> list capacity

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
1.0.7.6	Restore VCMDB		CLI		Pass	symmaskdb -sid -file restore
1.0.7.7	List connectivity by hosts		CLI		Pass	symcfg list -connections -sorthosts
1.0.7.8	List Symmetrix hosts by application ID		CLI		Pass	symcfg list -application
1.0.7.9	Lists the FA/WWN information		CLI		Pass	symcfg list -sid -FA all
1.0.7.10	Lists the RA/WWN information		CLI		Pass	symcfg list -sid -RA all
1.0.7.11	Show available LUN ID's per channel adapter		CLI		Pass	symcfg -sid list -available -address-sa -p
1.0.7.12	Show symm dev address per channel adapter		CLI		Pass	symcfg -sid -fa -p list -address
1.0.7.13	Offline and online an FA port		CLI		Pass Condition	symcfg -sid -SA -p offline symcfg -sid -SA -p online Note: both ports 0 & 1 need to be offline for symcfg to display the FA as offline.
10.0.7.14	Display RA group connected in RDF fabric		CLI		Pass	symcfg -sid 3110 list -RA 8D -switch
1.0.8.1	List gatekeeper and DB semaphores		CLI		Pass	Symcfg list -semaphores
1.0.8.2	Log file creation		CLI		Pass	View symapi log files
1.0.8.3	Initialize masking database		CLI		Pass	Symmaskdb -sid -file init

Item #	Storage Management	Date	GUI Or CLI	Size and Qty	Pass Fail	Comments
1.0.8.4	Rebuild masking database		CLI		Pass	Remove exiting database then rediscover attached arrays
1.0.8.5	Disable/Enable a range of devices		CLI		Pass	Symdg create <testgrp> Symld -g testgrp addall dev - range xxx:xxx -sid Symld -g testgrp not_ready Symld -g testgrp ready Symdg -force delete testgrp
1.0.8.6	List device inventory		CLI		Pass	Symdev -sid list -inventory
1.0.8.7	Display configured network services		CLI		Pass	Symcfg list -services
1.0.9.1	Display cache status		CLI		Pass	Symstat -type cache -i -c -sid -sa all
1.0.9.2	Display LRU status		CLI		Pass	Symstat -type cache -lru all -i -c -sid
1.0.9.3	Display prefetch status		CLI		Pass	Symstat -type prefetch -i -c -sid -da all
1.0.9.4	Display memory status		CLI		Pass	symstat -sid -i 5 -c 5 -type memio
1.0.9.5	Display disk status		CLI		Pass	symstat -sid -i 5 -c 5 -type disk -disk 2a,c,all
1.0.9.6	Display HBA, WWN and connect FA ports from host		CLI		Pass	symmask list hba
1.0.9.7	Display number of memory boards and size		CLI		Pass	Symcfg -sid list -memory
10.0.9.8	Depict individual disk profile and hypers		CLI		Pass	symdisk -sid show 16b,c,06
10.0.9.9	Depict available spare disks		CLI		Pass	symdisk -sid list -hotspares

12. Access Security

With the new security features introduced in SE 6.4 and 5x72 code, the following changes will take effect for Citi's management practices for the Symmetrix:

Function	Current Solution	New Solution
Audit Logging	Powerbroker is used for audit logging.	Symauth will be used to create user roles (Admin, SecurityAdmin, StorageAdmin, Monitor, and Auditor) for each user on the SE server that will be managing/monitoring the storage array. The symaudit log on the symmetrix will capture any configuration changes issued by any user. The storeventd daemon which runs on the SE server will need to be configured to poll the Symmetrix and gather the symaudit logs and events and store them in a file locally on the SE server. These logs can then be exported to the eTrust server.
Role Based Access Control	Powerbroker is used to manage user permissions to the Symmetrix.	Users on the SE server will need to have a symauth role mapped to their user ID (SOE ID). Once the necessary symauth entries are created, symauth should be enabled and users will be limited to actions respective to their symauth role. Powerbroker will no longer be needed to issue SE commands.
ECC	ECC is used for reporting and alerting.	ECC will still be used for reporting and alerting. The ECC storage agent server will need to be added to the AdminGrp accgroup in symacl and a symauth entry will need to be created for the ECC storage agent server's root user and assigned the StorageAdmin role.

SANscreen	SANscreen will be used for monitoring, analyzing, and validating changes in the SAN.	SANscreen will still be used for monitoring, analyzing, and validating changes in the SAN. SANscreen will continue to use the SYMAPI server on the SE server. The user "D:\NT AUTHORITY\SYSTEM" should be entered in the symauth list.
Vendor Access	ESRS is used for remote access. RSA software is used for secure local access.	No change.
Symacl	Syamcl should be enabled to control management access to the Symmetrix for a limited set of hosts.	The Symmetrix service processor will need to be added as a host in the AdminGrp. Contact EMC to get the unique ID of the service processor.

13. Issues Encountered

13.1 Dynamic Mirror Service Policy Failure

Symptom:

The log file depicts Dynamic Mirror Service Policy (DMSP) with external hard error status.

Description:

According to the log messages, 100% of the DMSP operations is failing with a persistent hard error status. EMC concludes that failure of the DMSP service is caused when the Service Processor is unable to communicate with or trying to communicate with a non-existent array. EMC resolves this issue by removing and rebuilding the access database on the Service Processor followed by a reboot.

Summary:

According to EMC, DMSP improves backend disk performance is by 20-30% for disk containing RAID-10 devices. This is achieved through collecting statistics on spindle rotation and head movement and uses adaptive algorithms to balance the load among all of Symmetrix backend components and minimize the seek time spent on the physical drives. DMSP toggles between interleave and split service policies:

Interleave Service Policy — Shares the read operations of the mirrored pair by reading tracks from both disk devices in an alternating method, a number of tracks from M1, and a number of tracks from M2. Interleave is designed to achieve maximum throughput.

Split Service Policy — is designed to minimize head movement by assigning disk requests to either the M1 or the M2 logical volume but not both.

One of the new architectural changes with Enginuity 5772, is that DMSP operates on the Service processor, where previous versions ran internally on array Directors. According to EMC, DMSP runs with SQL Server on the service processor, whereby relieving the Directors from processing the DMSP and SQL services. EMC believes this architecture change enhances the robustness of the total system, and if the Service Processor dies or loses communication with the array, this service is transferred to Director 1A or 2A.

The direction of EMC to place more of the service processing burden for the array on the Service Processor is a questionable architectural change. The Service Processor contains no active or passive hardware redundancy, and is simply a laptop within the array system cabinet. It is difficult to envision why EMC has selected this direction without upgrading and hardening of the hardware and communication links on the Service Processor.

EMC DMSP Overview:

The Symmetrix DMSP is a feature of the adaptive algorithms in the Symmetrix architecture that improves the performance of read operations in mirrored and Business Continuance Volume (BCV) environments. The improved system performance is a result of the Symmetrix system balancing the load between physical disk drives and disk directors, and minimizing actuator movement.

To achieve this improved performance, the Symmetrix system measures and tracks I/O activities of logical volumes (including business continuous volumes), physical volumes, and disk directors (FEBE board back-end function). Utilizing these measurements, the Symmetrix system directs read operations for mirrored data to the appropriate mirror resulting in the best overall performance of the Symmetrix system. As the access patterns and workloads change, the dynamic algorithm analyzes the new workloads and adjusts the service policies as needed.

Additional Information:

Log File:

```
[user=D:NT AUTHORITY\SYSTEM] [host=HK190100919] [actid=SEf0b60e3bca]
[appid=DMSPServer
] [aud-cls=Base] [aud-act=PhoneHome] [aud-num=4689] = 100 percent of DMSP OE
operations failed with external hard error status.
This is more than the threshold of 25 percent in 4 hours.
Changing the status to persistent error.
: Operations failed too many times, threshold was reached.
[fmt=symaud] [date=2007-11-07T19:54:16] [symid=000190100919] [orig=SE] [user=D:NT
AUTHORITY\SYSTEM] [host=HK190100919] [actid=SEf0b60e3bca] [appid=DMSPServer
] [aud-cls=Base] [aud-act=PhoneHome] [aud-num=4690] = 100 percent of DMSP OE
operations failed with external hard error status.
This is more than the threshold of 25 percent in 4 hours.
Changing the status to persistent error.
: Operations failed too many times, threshold was reached.
[fmt=symaud] [date=2007-11-07T19:54:19] [symid=000190100919] [orig=SE] [user=D:NT
AUTHORITY\SYSTEM] [host=HK190100919] [actid=SEf0b60e3bca] [appid=DMSPServer
] [aud-cls=Base] [aud-act=PhoneHome] [aud-num=4691] = 100 percent of DMSP OE
operations failed with external hard error status.
This is more than the threshold of 25 percent in 4 hours.
Changing the status to persistent error.
: Operations failed too many times, threshold was reached.
```

13.2 Configuration Manager Commit Process Fails

Symptoms:

Creating or converting a device successfully completes the preview and prepare process and fails on the commit process.

Error Description:

Configuration Manager commit procedure for creating or converting a device fails when requesting Symmetrix resource information. This failure starts when the commit process is queued while resource information on the array is being requested, and when the request times out Configuration Manager tries to abort the change request. At this juncture, Configuration Manager appears to be hung, and a session termination request generates Symmwin timeout errors. However, following the commit process failure, configuration manager is still able to successfully respond to the “symconfigure –sid verify” command. EMC attributes

this error to Symmwin on the Service Processor hanging causing the communication failure between Configuration Manager and the array; however, this doesn't explain why the "symconfigure verify" command completes successfully.

Resolution:

EMC attributes this error to the MSWindows based operating system on the Service Processor hanging. However, this does not explain why the Configuration Manager verify command completes successfully following the commit process failure. EMC fixed this issue by rebooting the Service Processor; whereby, resetting Symmwin and the Configuration Manager application. EMC had no reasonable explanation as to the root cause of the Service Processor hanging, they iterated that the service processor is Windows base and may need to be rebooted periodically as indicated in their written response below:

This issue arises from time to time and there is no real way to troubleshoot it from my end, other than to restart symmwin. Every now and then the windows process hangs and timeouts occur. – EMC Technical Support

Additional Notes:

Example: Converting an R5 to a R5 BCV device fails at the commit stage:

```
root@sangs7(/user/home/gs96899/scripts)# symconfigure -sid 3110 -f conv-r5-bcv preview -v
```

```
Execute a symconfigure operation for symmetrix '000190103110' (y/[n]) ? y
```

A Configuration Change operation is in progress. Please wait...

```
Establishing a configuration change session.....Established.
```

```
Processing symmetrix 000190103110
```

```
{
  convert dev 0076 to BCV+R-5, RAIDset=false;
}
```

```
Performing Access checks.....Allowed.
```

```
Checking Device Reservations.....Allowed.
```

```
Submitting configuration changes.....Submitted
```

```
Locking devices.....Locked.
```

```
Validating configuration changes.....Validated.
```

```
Closing configuration change request.....Closed.
```

```
Terminating the configuration change session.....Done.
```

The configuration change session has completed successfully.

```
root@sangs7(/user/home/gs96899/scripts)# conv-r5-bcv prepare -v -nop
```

<

A Configuration Change operation is in progress. Please wait...

```
Establishing a configuration change session.....Established.
Processing symmetrix 000190103110
```

```
{
  convert dev 0076 to BCV+R-5, RAIDset=false;
}
```

```
Performing Access checks.....Allowed.
Checking Device Reservations.....Allowed.
Submitting configuration changes.....Submitted
Locking devices.....Locked.
Validating configuration changes.....Validated.
Initiating PREPARE of configuration changes.....Prepared.
Closing configuration change request.....Closed.
Terminating the configuration change session.....Done.
```

The configuration change session has completed successfully.

```
root@sangs7(/user/home/gs96899/scripts)# symconfigure -sid 3110 -f conv-r5-bcv commit -v ->
```

A Configuration Change operation is in progress. Please wait...

```
Establishing a configuration change session.....Established.
Processing symmetrix 000190103110
```

```
{
  convert dev 0076 to BCV+R-5, RAIDset=false;
}
```

```
Performing Access checks.....Allowed.
Checking Device Reservations.....Allowed.
Submitting configuration changes.....Submitted
Locking devices.....Locked.
Validating configuration changes.....Validated.
Initiating PREPARE of configuration changes.....Prepared.
Initiating COMMIT of configuration changes.....Queued.
COMMIT requesting required resources.....No Progress.
```

Error occurred while Committing
The SymConfigChangeControl COMMIT failed. Please see the SYMAPI log file for more information

```
Closing configuration change request.....Closed.
Terminating the configuration change session.....Failed.
```

The configuration server processing timed out

The configuration change session has failed.

```
root@sangs7(/usr/emc/API/symapi/log)# symconfigure -sid 3110 verify
```

A Configuration Change Verification is in progress. Please wait...

A Configuration Change operation is in progress. Please wait...

```
Establishing a configuration change session.....Established.
Verifying configuration.....Verified.
Terminating the configuration change session.....Done.
```

The configuration verification session has succeeded.

Log file:

```
12/05/2007 11:07:31.533 7092 1 EMC:SYMCONFIGURE iCfgChgSessionStart
Starting a local CfgChg session for SID 000190103110, symapi V6.4-845 (2.3) ucode 5
772
12/05/2007 11:07:53.577 7092 Establishing session with Local cfg svr (0001901
03110)...Established.
12/05/2007 11:07:54.524 7092 {
12/05/2007 11:07:54.525 7092 convert dev 0076 to BCV+R-5, RAIDset=false;
12/05/2007 11:07:54.525 7092 }
12/05/2007 11:08:01.997 7092 Submitting configuration changes.....
.....Submitted
12/05/2007 11:08:16.587 7092 Validating configuration changes.....
.....Validated
12/05/2007 11:08:30.127 7092 Closing configuration change request.....
.....Closed.
12/05/2007 11:08:41.057 7092 Terminating session with configuration server....
.....Done.
12/05/2007 11:08:44.174 986 9 EMC:EVTdaemon SymDiscover()
Function start
12/05/2007 11:08:45.141 986 9 EMC:EVTdaemon SymDiscover()
Function complete.
12/05/2007 11:08:59.052 7103 1 EMC:SYMCONFIGURE iCfgChgSessionStart
Starting a local CfgChg session for SID 000190103110, symapi V6.4-845 (2.3) ucode 5
772
12/05/2007 11:09:19.827 7103 Establishing session with Local cfg svr (0001901
03110)...Established.
12/05/2007 11:09:20.752 7103 {
12/05/2007 11:09:20.753 7103 convert dev 0076 to BCV+R-5, RAIDset=false;
12/05/2007 11:09:20.753 7103 }
12/05/2007 11:09:28.229 7103 Submitting configuration changes.....
.....Submitted
12/05/2007 11:09:41.787 7103 Validating configuration changes.....
.....Validated
12/05/2007 11:09:41.804 7103 Initiating PREPARE of configuration changes.....
.....Prepared.
12/05/2007 11:09:55.340 7103 Closing configuration change request.....
.....Closed.
```

```

12/05/2007 11:10:06.299 7103 Terminating session with configuration server....
.....Done.
12/05/2007 11:13:35.389 7116 1 EMC:SYMCONFIGURE iCfgChgSessionStart
Starting a local CfgChg session for SID 000190103110, symapi V6.4-845 (2.3) ucode 5
772
12/05/2007 11:14:02.507 7116 Establishing session with Local cfg srvr (0001901
03110)...Established.
12/05/2007 11:14:03.419 7116 {
12/05/2007 11:14:03.421 7116 convert dev 0076 to BCV+R-5, RAIDset=false;
12/05/2007 11:14:03.421 7116 }
12/05/2007 11:14:10.897 7116 Submitting configuration changes.....
.....Submitted
12/05/2007 11:14:24.457 7116 Validating configuration changes.....
.....Validated
12/05/2007 11:14:24.474 7116 Initiating PREPARE of configuration changes.....
.....Prepared.
12/05/2007 11:15:07.326 7116 Initiating COMMIT of configuration changes.....
.....Queued.
12/05/2007 11:15:23.563 4257 17 EMC:ECC emcSymLoadDiskInfo_s
PSCrdfstatetbl_9250_01. sts: SYSCALL_NON_ZERO_RC, order 17: SYSCR_REMOTE_FAILED S
ID: 000190100919
12/05/2007 11:15:26.218 986 9 EMC:EVTdaemon emcSymGetFailedDiskl
PSCHyprdyinfo_9204_02. sts: SYSCALL_NON_ZERO_RC, order 17: SYSCR_REMOTE_FAILED SI
D: 000190100919
12/05/2007 11:21:04.726 7116 COMMIT requesting required resources.....
.....NoProgress.
12/05/2007 11:21:13.217 7116 Step 001 of 024 steps.....
.....Executing.

Abort initiated:
12/05/2007 11:21:27.146 7116 1 EMC:SYMCONFIGURE cfgShutDownScript
SWS_ABORT_SYMPL_SCRIPT succeeded.
12/05/2007 11:21:46.107 7116 1 EMC:SYMCONFIGURE cfgShutDownScript
SWS_ABORT_SYMPL_SCRIPT succeeded.
12/05/2007 11:22:06.077 7116 1 EMC:SYMCONFIGURE cfgShutDownScript
SWS_ABORT_SYMPL_SCRIPT succeeded.
12/05/2007 11:22:06.077 7116 Closing configuration change request.....
.....Closed.

SWRS timeout =
12/05/2007 11:22:39.851 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:22:39.851 7116 1 EMC:SYMCONFIGURE SymConfigChangeSessi
Retrying...
12/05/2007 11:23:11.537 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:23:11.537 7116 1 EMC:SYMCONFIGURE SymConfigChangeSessi
Retrying...
12/05/2007 11:23:49.287 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:23:49.287 7116 1 EMC:SYMCONFIGURE SymConfigChangeSessi
Retrying...
12/05/2007 11:24:25.494 986 9 EMC:EVTdaemon SymDiscover()
Function start
12/05/2007 11:24:29.056 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:24:29.057 7116 1 EMC:SYMCONFIGURE SymConfigChangeSessi
Retrying...

```

```

12/05/2007 11:24:59.737 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:24:59.737 7116 1 EMC:SYMCONFIGURE SymConfigChangeSessi
Retrying...
12/05/2007 11:25:01.743 7116 Terminating session with configuration server....
.....Failed.
12/05/2007 11:25:01.743 7116 1 EMC:SYMCONFIGURE iCfgChgSessionEnd
Attempt cancel session failed
12/05/2007 11:25:01.744 7116 1 EMC:SYMCONFIGURE cfgLogSymmwinError
SymConfigChangeSessionEnd call to silsw_DoSymmWinService for SWS_CONFIG_CANCEL_SESSION failed with
code: SWRS_TIMEOUT
12/05/2007 11:25:11.326 986 9 EMC:EVTdaemon SymDiscover()
Function complete.
12/05/2007 11:25:56.112 4257 11982 EMC:ECC emcSymGetFailedDiskI
PSCHyprdyinfo_9204_02. sts: SYSCALL_NON_ZERO_RC, order 17: SYSCR_REMOTE_FAILED SID: 000190100919

```

13.3 SRDF Director Locking Failure

Symptom:

When initiating an RDF full establish, the devices remains in an “in progress” state without completing the full establish process.

Issue Description:

According to EMC Engineering, hanging of the RDF establish is caused by unprocessed tracks locking the RDF Director. When the RDF Director tries to release the I/O a miscommunication occurs in the CDI layer leaving the I/O unprocessed. These unprocessed I/O results in tracks remaining locked on the Director, causing the SRDF establish process appearance of being hung.

Fix:

EMC engineering has acknowledge an intermittent issue with the RA hanging and has provided the following process to clear this error:

1. Take Director in question offline.
2. Check E8 on all affected tracks to make sure the Director lock has cleared.
3. If all locks are cleared on all the tracks, verify that the write pendngs are now showing invalids on the m3 position. If they are not invalid, generate a F3R2 to set them invalid on the M3.
If the locks do not get cleared go to step 5.
4. IML the Director in question and verify the errors subside.
5. If IML fails contact EMC engineering.

The fix as proposed by EMC is initiated through the Service Processor and requires an outage on one or more Directors. GDSE concludes this fix as unacceptable, and requires EMC to resolve this issue by preventative measures.

Status:

EMC Engineering has created fix 36323 that removes unprocessed I/O from the channel director preventing the RA from hanging. This fix is incorporated into Enginuity package (Epack) 6513 and must be installed on each frame running 5772 microcode, until such time the fix is incorporated into a 5772 release. EMC estimates at a 5772 release that incorporates fix 36323 will be available at the end of 1Q08.

Additional Information:

With the RA in a hung state, the SRDF full establish remains in an "In Progress" state:

```
symrdf -g DG60 est -full
```

```
Execute an RDF 'Full Establish' operation for device
group 'DG60' (y/[n]) ? y
```

```
An RDF 'Full Establish' operation execution is
in progress for device group 'DG60'. Please wait...
```

```
Write Disable device(s) on RA at target (R2).....Done.
Suspend RDF link(s).....Done.
Mark target (R2) devices for full copy from source (R1)...Started.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
Devices: 0139-014C in (0919,060)..... In Progress.
```

The log file shows the RDF group failure in **blue** the channel director instability in **red**:

```
[fmt=symaud] [date=2007-12-07T16:41:35] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919]
[actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud
-act=] [aud-num=13503] = User issued inline command to director 08D: Interrogating disk and device details
[fmt=symaud] [date=2007-12-07T16:42:07] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919]
[actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud
-act=] [aud-num=13504] = User issued inline command to director 08D: Interrogating disk and device details
[fmt=symaud] [date=2007-12-07T16:42:57] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919]
[actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud
-act=] [aud-num=13505] = User issued inline command to director 08D: Interrogating disk and device details
[fmt=symaud] [date=2007-12-07T16:44:08] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919]
[actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud
-act=] [aud-num=13506] = User issued inline command to director 08D: Interrogating disk and device details
[fmt=symaud] [date=2007-12-07T17:12:05] [symid=000190100919] [orig=SE] [user=D:NT AUTHORITY\SYSTEM]
[host=sangs6] [actid=SE09ecb44f29] [appid=SANSscreen] [aud
-cls=Security] [aud-act=Denied] [aud-num=13507] = Access Denied for User D:NT AUTHORITY\SYSTEM, access
VLOGIX (minimum necessary Role: Storage Administrator)
[fmt=symaud] [date=2007-12-07T17:52:06] [symid=000190100919] [orig=SE] [user=D:NT AUTHORITY\SYSTEM]
[host=sangs6] [actid=SEc03019d35c] [appid=SANSscreen] [aud
-cls=Security] [aud-act=Denied] [aud-num=13508] = Access Denied for User D:NT AUTHORITY\SYSTEM, access
VLOGIX
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:12] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:33] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:13] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:14] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:25] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:15] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:16] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:17] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:35] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:18] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:19] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:20] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:21] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:22] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:24] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:26] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:27] [sev=warning] = Single SRDF
link in an RDF group is not operational.
[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:32] [symid=000190103110] [SRDF-grp:28] [sev=warning] = Single SRDF
link in an RDF group is not operational.
```

[illegible]

[fmt=evt] [evtid=1064] [date=2007-12-07T18:00:21] [symid=000190100919] [SRDF-grp:70] [sev=minor] = No SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1080] [date=2007-12-07T18:00:21] [symid=000190100919] [SRDF-grp:16] [sev=warning] = Single SRDF link in an RDF group is not operational.

[fmt=evt] [evtid=1200] [date=2007-12-07T18:01:17] [symid=000190100919] [Device:0069] [sev=warning] = Device state has changed to Online [Degraded].

[fmt=evt] [evtid=1203] [date=2007-12-07T18:01:17] [symid=000190100919] [Port:RF-8D:0] [sev=warning] = Port state has changed to Offline.

[fmt=evt] [evtid=1202] [date=2007-12-07T18:01:17] [symid=000190100919] [Director:RF-8D] [sev=warning] = Director state has changed to Offline [Degraded].

[fmt=symaud] [date=2007-12-07T18:00:21] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud-act=] [aud-num=13509] = User issued inline command to director 08D: Setting a director offline

[fmt=evt] [evtid=1250] [date=2007-12-07T18:01:39] [sev=info] = Base Daemon detected a change in Symmetrix topology.

[fmt=evt] [evtid=1200] [date=2007-12-07T18:02:21] [symid=000190103110] [Device:0069] [sev=warning] = Device state has changed to Online [Degraded].

[fmt=evt] [evtid=1117] [date=2007-12-07T18:04:22] [symid=000190100919] [Director:RF-8D] [sev=fatal] = Director not responding.

[fmt=symaud] [date=2007-12-07T18:04:21] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud-act=] [aud-num=13510] = User issued inline command to director 08D: Single director IML

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:70] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:70] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:2] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:11] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:11] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:52] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:52] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:60] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:60] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:12] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:12] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:13] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:13] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:14] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190103110] [SRDF-grp:14] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:21] [symid=000190103110] [SRDF-grp:15] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:21] [symid=000190103110] [SRDF-grp:15] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:21] [symid=000190103110] [SRDF-grp:16] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:21] [symid=000190103110] [SRDF-grp:16] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:21] [symid=000190103110] [SRDF-grp:56] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:31] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:32] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:32] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:33] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:33] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:34] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:34] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:35] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:19] [symid=000190100919] [SRDF-grp:35] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190100919] [SRDF-grp:36] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190100919] [SRDF-grp:36] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1081] [date=2007-12-07T18:06:20] [symid=000190100919] [SRDF-grp:37] [sev=info] = Single SRDF link in an RDF group is now operational.

[fmt=evt] [evtid=1065] [date=2007-12-07T18:06:20] [symid=000190100919] [SRDF-grp:37] [sev=info] = All SRDF links in an RDF group are operational.

[fmt=evt] [evtid=1200] [date=2007-12-07T18:06:28] [symid=000190100919] [Device:0069] [sev=normal] = Device state has changed to Online.

[fmt=evt] [evtid=1203] [date=2007-12-07T18:06:28] [symid=000190100919] [Port:RF-8D:0] [sev=normal] = Port state has changed to Online.

[fmt=evt] [evtid=1202] [date=2007-12-07T18:06:28] [symid=000190100919] [Director:RF-8D] [sev=normal] = Director state has changed to Online.

[fmt=symaud] [date=2007-12-07T18:06:17] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud-act=] [aud-num=13511] = User issued inline command to director 08D: Setting a director online

[fmt=evt] [evtid=1200] [date=2007-12-07T18:07:29] [symid=000190103110] [Device:0069] [sev=normal] = Device state has changed to Online.

[fmt=evt] [evtid=1080] [date=2007-12-07T18:06:30] [symid=000190100919] [SRDF-grp:34] [sev=warning] = Single SRDF link in an RDF group is not operational.

[fmt=symaud] [date=2007-12-07T18:07:09] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=SW_INL_0553] [appid=SPCM] [aud-cls=Recovery] [aud-act=] [aud-num=13512] = User issued inline command to director 08D: Interrogating disk and device details

[fmt=evt] [evtid=1250] [date=2007-12-07T18:17:19] [sev=info] = Base Daemon detected a change in Symmetrix topology.

[fmt=evt] [evtid=1201] [date=2007-12-07T18:17:47] [symid=000190103110] [sev=normal] = Array state has changed to Online.

[fmt=evt] [evtid=1201] [date=2007-12-07T18:17:47] [symid=000190103110] [sev=warning] = Array state has changed to Online [Degraded].

[fmt=symaud] [date=2007-12-07T18:21:17] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=SW_INL_9D8F] [appid=SPCM] [aud-cls=Recovery] [aud-act=] [aud-num=13513] = User issued inline command to director 01A: Interrogating disk and device details

[fmt=symaud] [date=2007-12-07T18:32:07] [symid=000190100919] [orig=SE] [user=D:NT AUTHORITY\SYSTEM] [host=sangs6] [actid=SEab2294916d] [appid=SANSscreen] [aud-cls=Security] [aud-act=Denied] [aud-num=13514] = Access Denied for User D:NT AUTHORITY\SYSTEM, access VLOGIX (minimum necessary Role: Storage Administrator)

[fmt=symaud] [date=2007-12-07T18:45:29] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=] [appid=Symmwin] [aud-cls=Security] [aud-act=Log out] [aud-num=13515] = Logout: User 167 logged out of application Symmwin.

[fmt=symaud] [date=2007-12-07T18:45:34] [symid=000190100919] [orig=SW] [user=167] [host=HK190100919] [actid=] [appid=EMCRemote] [aud-cls=Security] [aud-act=D isconnect] [aud-num=13516] = Disconnect: Remote user 167 disconnected.

14. Appendix A: Symmetrix Security

Function	Test	Expected Results	Actual Results	Pass / Fail	Notes
SE software installation	Verify that the SE software package available on stealth installs correctly for Solaris 8/10 and HP-UX 11.11 hosts.	SE should install successfully for both installs and upgrades.	SE installed successfully for both Solaris and HP-UX	Pass	
Role based administration	Verify that SE roles have the correct permissions.	SE roles should be limited to their specified permissions.			
Monitor Role - Able to perform read-only (passive) operations on a Symmetrix array excluding the ability to read the audit log or Access Control definitions.	Read-only commands should execute.				
	Symacl	All symacl commands should fail.	Command failed as expected	Pass	The error, "The caller is not authorized to perform the requested operation" was returned.
	Symapierr	Command should execute.	Command translates error codes.	Pass	
	Symapisrv	This command should fail.	Tried to stop the symapi daemon. Command failed as expected.	Pass	The error, "User not authorized to perform operation" was returned.
	Symaudit	This command should fail.	Command failed as expected	Pass	The error, "The caller is not authorized to perform the requested operation" was returned.

	Symauth	Only read-only symauth commands should be successful.	List users commands successful. Remove user command failed. Results as expected. Failed attempts at modifying user commands were recorded in the symaudit log.	Pass	The error, "The caller is not authorized to perform the requested operation" was returned when attempting to execute the command file that would remove user role mappings.
	Symbcv	Only read-only symbcv commands should be successful.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	
	Symcfg	Only read-only symcfg commands should be successful.	The list command was successful. Configuration command failed as expected.	Pass	Configuration attempts failed with error: Read or Read/Write permission/access not present. The monitor user should not have write permissions to the symapi_db.bin file.
	Symcg	Only read-only symcg commands should be successful.	The list command was successful. Configuration command failed as expected with error: Read or Read/Write permission/access not present	Pass	
	Symchg	Only read-only symchg commands should be successful.	Read and config commands failed. Read commands failed with error: The caller is not authorized to perform the requested operation.	Fail	The monitor role should be able to view symchg sessions.
	Symcli	symcli commands don't change the configuration so of the system so all commands should be successful.	Commands successful.	Pass	

	Symclone	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symconfigure	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symdev	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symdg	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	
	Symdisk	Symdisk commands are not used for configuration so all symdisk commands should be successful	Symdisk commands were successful.	Pass	
	Symdrv	Symdrv commands are not used for configuration so all symdrv commands should be successful.	Symdrv commands were successful.	Pass	

	Symevent	Symevent commands are not used for configuration so all symevent commands should be successful.	Symevent commands were successful.	Pass	
	Symgate	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symhost	Symhost commands are not used for configuration so all symhost commands should be successful.	Symhost commands were successful.	Pass	
	Symhostfs	Symhostfs commands are not used for configuration so all symhostfs commands should be successful.	Symhostfs commands were successful.	Pass	
	Syminq	Syminq commands are not used for configuration so all syminq commands should be successful.	Syminq commands were successful.	Pass	
	Symld	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	

	SymImf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Unable to write to EMC license database file	Pass	
	Symmask	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symmaskdb	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symmir	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symptmz	Only read-only commands should allowed.	Configuration and read commands failed with error: Read or Read/Write permission/access not present	Partial Pass	The monitoring role should be able to view symptmz information
	Sympd	Sympd commands are not used for configuration so all sympd commands should be successful.	Symevent commands were successful.	Pass	

	Symqos	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symrdf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symstat	Symstat commands are not used for configuration so all symstat commands should be successful.	Symstat commands were successful.	Pass	
Storage Admin Role - Able to perform all management (active, or control,) operations on a Symmetrix array and modify GNS group definitions in addition to all Monitor operations.					

	Symacl	The 'storage admin' role should not be able to issue symacl commands.	Error: The caller is not authorized to perform the requested operation	Pass	This works as advertised in the Solutions Enabler product. Citi would like to have the storage admin and not the security admin control symacl. This enhancement will be explored with EMC. Storevntd log entry is needs more detail: Access Denied for User H:sangs6\root, access ADMIN (minimum necessary Role: Security Administrator)
	Symapierr	Command should execute.	Command translates error codes.	Pass	
	Symapisrv	Command should execute	Symapisrv stopped and started successfully	Pass	
	Symaudit	Should be able to view but not modify the symaudit log.	This user is unable to issue any symaudit commands. Error: The caller is not authorized to perform the requested operation	Fail	The Storage Admin role should have the capability to view the symaudit events.
	Symauth	Should be able to view but not modify SE user information.	The user was able to view SE user information but was not able to modify it as expected.	Pass	
	Symbcv	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symcfg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symcg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	

	Symchg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	If no symchg sessions were created, an error results when trying to issue the command 'symchg list - sessions.' Error: Could not open the '/var/symapi/db/symchg_db.bin' file to list the marked objects.
	Symcli	'symcli' commands don't change the configuration so of the system so all commands should be successful.	Commands successful.	Pass	
	Symclone	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symconfigure	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symdev	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symdg	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symdisk	Symdisk commands are not used for configuration so all symdisk commands should be successful	Symdisk commands were successful.	Pass	
	Symdrv	Symdrv commands are not used for configuration so all symdrv commands should be successful	Symdrv commands were successful.	Pass	

	Symevent	Symevent commands are not used for configuration so all symevent commands should be successful.	Symevent commands were successful.	Pass	
	Symgate	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symhost	Symhost commands are not used for configuration so all symhost commands should be successful.	Symhost commands were successful.	Pass	
	Symhostfs	Symhostfs commands are not used for configuration so all symhostfs commands should be successful.	Symhostfs commands were successful.	Pass	
	Syminq	Syminq commands are not used for configuration so all syminq commands should be successful.	Syminq commands were successful.	Pass	
	Symld	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symlmf	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_licenses.dat file.
	Symmask	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_db.bin file

	Symmaskdb	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_db.bin file.
	Symmir	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symoptmz	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Sympd	Sympd commands are not used for configuration so all sympd commands should be successful.	Symevent commands were successful.	Pass	
	Symqos	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symrdf	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symstat	Symstat commands are not used for configuration so all symstat commands should be successful.	Symstat commands were successful.	Pass	
Admin Role - Able to perform all operations on a Symmetrix array, including security operations in addition to all Monitor operations.					
	Symacl	Symacl commands should be successful.	Symacl commands successful.	Pass	Events were recorded in the storevntd.
	Symapierr	Command should execute.	Command translates error codes.	Pass	

	Symapisrv	Command should execute	Symapisrv stopped and started successfully	Pass	
	Symaudit	Command should execute.	Command executed successfully	Pass	
	Symauth	Should be able to view and modify SE user information.	Commands executed successfully.	Pass	
	Symbcv	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symcfg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symcg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symchg	Read and config commands should be successful.	Both read and config commands were successful.	Pass	If no symchg sessions were created, an error results when trying to issue the command 'symchg list - sessions.' Error: Could not open the '/var/symapi/db/symchg_db.bin' file to list the marked objects.
	Symcli	'symcli' commands don't change the configuration so of the system so all commands should be successful.	Commands successful.	Pass	
	Symclone	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symconfigure	Read and config commands should be successful.	Both read and config commands were successful.	Pass	
	Symdev	Read and config commands should be successful.	Both read and config commands were successful.	Pass	

	Symdg	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symdisk	Symdisk commands are not used for configuration so all symdisk commands should be successful	Symdisk commands were successful.	Pass	
	Symdrv	Symdrv commands are not used for configuration so all symdrv commands should be successful	Symdrv commands were successful.	Pass	
	Symevent	Symevent commands are not used for configuration so all symevent commands should be successful.	Symevent commands were successful.	Pass	
	Symgate	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symhost	Symhost commands are not used for configuration so all symhost commands should be successful.	Symhost commands were successful.	Pass	
	Symhostfs	Symhostfs commands are not used for configuration so all symhostfs commands should be successful.	Symhostfs commands were successful.	Pass	

	Syminq	Syminq commands are not used for configuration so all syminq commands should be successful.	Syminq commands were successful.	Pass	
	Symld	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symlmf	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_licenses.dat file.
	Symmask	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_db.bin file
	Symmaskdb	Read and config commands should be successful.	Read and config command were successful.	Pass	User must have read/write permissions to the symapi_db.bin file.
	Symmir	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symoptmz	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Sympd	Sympd commands are not used for configuration so all sympd commands should be successful.	Symevent commands were successful.	Pass	
	Symqos	Read and config commands should be successful.	Read and config command were successful.	Pass	
	Symrdf	Read and config commands should be successful.	Read and config command were successful.	Pass	

	Symstat	Symstat commands are not used for configuration so all symstat commands should be successful.	Symstat commands were successful.	Pass	
Security Admin Role - Able to perform security operations (symaudit, symacl, symauth) on a Symmetrix array in addition to all Monitor operations.					
	Symacl	Symacl commands should be successful.	Symacl commands successful.	Pass	Events were recorded in the storevntd.
	Symapierr	Command should execute.	Command translates error codes.	Pass	
	Symapisrv	This command should fail.	Tried to stop the symapi daemon. Command failed as expected.	Pass	The error, "User not authorized to perform operation" was returned.
	Symaudit	Command should execute.	Command executed successfully	Pass	
	Symauth	Should be able to view and modify SE user information.	Commands executed successfully.	Pass	
	Symbcv	Only read-only symbcv commands should be successful.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	

	Symcfg	Only read-only symcfg commands should be successful.	The list command was successful. Configuration command failed as expected.	Pass	Configuration attempts failed with error: Read or Read/Write permission/access not present. The security admin should not have write permissions to the symapi_db.bin file.
	Symcg	Only read-only symcg commands should be successful.	The list command was successful. Configuration command failed as expected with error: Read or Read/Write permission/access not present	Pass	
	Symchg	Only read-only symchg commands should be successful.	Read and config commands failed. Read commands failed with error: The caller is not authorized to perform the requested operation.	Pass	The security administrator doesn't need to view this information.
	Symcli	'symcli' commands don't change the configuration so of the system so all commands should be succussful.	Commands successful.	Pass	
	Symclone	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symconfigure	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	

	Symdev	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symdg	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	
	Symdisk	Symdisk commands are not used for configuration so all symdisk commands should be successful	Symdisk commands were successful.	Pass	
	Symdrv	Symdrv commands are not used for configuration so all symdrv commands should be successful	Symdrv commands were successful.	Pass	
	Symevent	Symevent commands are not used for configuration so all symevent commands should be successful.	Symevent commands were successful.	Pass	
	Symgate	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	

	Symhost	Symhost commands are not used for configuration so all symhost commands should be successful.	Symhost commands were successful.	Pass	
	Symhostfs	Symhostfs commands are not used for configuration so all symhostfs commands should be successful.	Symhostfs commands were successful.	Pass	
	Syminq	Syminq commands are not used for configuration so all syminq commands should be successful.	Syminq commands were successful.	Pass	
	Symld	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	SymImf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Unable to write to EMC license database file	Pass	
	Symmash	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	

	Symmaskdb	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symmir	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symoptmz	No configuration commands should be allowed.	Configuration and read commands failed with error: Read or Read/Write permission/access not present	Pass	
	Sympd	Sympd commands are not used for configuration so all sympd commands should be successful.	Symevent commands were successful.	Pass	
	Symqos	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symrdf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	

	Symstat	Symstat commands are not used for configuration so all symstat commands should be successful.	Symstat commands were successful.	Pass	
Auditor Role - Grants the ability to view, but not modify, security settings for a Symmetrix array (including reading the audit log, symacl list, and symauth) in addition to all Monitor operations. This is the minimum role required to view the Symmetrix audit log.					
	Symacl	The 'auditor' role should not be able to issue symacl commands.	Read-only commands successful. Config command return the error: The caller is not authorized to perform the requested operation	Pass	Storevntd log entry needs more detail: Access Denied for User H:sangs6\auditor, access ADMIN (minimum necessary Role: Security Administrator)
	Symapierr	Command should execute.	Command translates error codes.	Pass	
	Symapisrv	This command should fail.	Tried to stop the symapi daemon. Command failed as expected.	Pass	The error, "User not authorized to perform operation" was returned.
	Symaudit	Command should execute.	Command executed successfully	Pass	
	Symauth	Should be able to view but not modify SE user information.	The user was able to view SE user information but was not able to modify it as expected.	Pass	

	Symbcv	Only read-only symbcv commands should be successful.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	
	Symcfg	Only read-only symcfg commands should be successful.	The list command was successful. Configuration command failed as expected.	Pass	Configuration attempts failed with error: Read or Read/Write permission/access not present. The auditor should not have write permissions to the symapi_db.bin file.
	Symcg	Only read-only symcg commands should be successful.	The list command was successful. Configuration command failed as expected with error: Read or Read/Write permission/access not present	Pass	
	Symchg	Only read-only symchg commands should be successful.	Read and config commands failed. Read commands failed with error: The caller is not authorized to perform the requested operation.	Pass	The auditor doesn't need to view this information.
	Symcli	'symcli' commands don't change the configuration so of the system so all commands should be successful.	Commands successful.	Pass	
	Symclone	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	

	Symconfigure	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symdev	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symdg	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation.	Pass	
	Symdisk	Symdisk commands are not used for configuration so all symdisk commands should be successful	Symdisk commands were successful.	Pass	
	Symdrv	Symdrv commands are not used for configuration so all symdrv commands should be successful	Symdrv commands were successful.	Pass	
	Symevent	Symevent commands are not used for configuration so all symevent commands should be successful.	Symevent commands were successful.	Pass	

	Symgate	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symhost	Symhost commands are not used for configuration so all symhost commands should be successful.	Symhost commands were successful.	Pass	
	Symhostfs	Symhostfs commands are not used for configuration so all symhostfs commands should be successful.	Symhostfs commands were successful.	Pass	
	Syminq	Syminq commands are not used for configuration so all syminq commands should be successful.	Syminq commands were successful.	Pass	
	Symld	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symlmf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Unable to write to EMC license database file	Pass	

	Symmask	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symmaskdb	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	
	Symmir	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symoptmz	No configuration commands should be allowed.	Configuration and read commands failed with error: Read or Read/Write permission/access not present	Pass	
	Sympd	Sympd commands are not used for configuration so all sympd commands should be successful.	Symevent commands were successful.	Pass	
	Symqos	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: The caller is not authorized to perform the requested operation	Pass	

	Symrdf	Only read-only commands should be allowed.	Read-only commands successful. Configuration commands failed with error: Read or Read/Write permission/access not present	Pass	
	Symstat	Symstat commands are not used for configuration so all symstat commands should be successful.	Symstat commands were successful.	Pass	
symaudit	Verify that configuration changes are logged in the symaudit logs	Configuration changes should appear in the symaudit logs and sent to the file specified in the configuration of the storevntd.	Configuration changes were logged correctly and were sent to the symevents.log0/1 file on the SE server.	Pass	The file that the storevntd uses to record the symaudit logs is specified in the daemon_options file on the SE server.
eTrust	Verify that symaudit logs are imported into eTrust.	Symaudit logs should be imported into eTrust for log reconciliation.	<i>TBD</i>	<i>TBD</i>	<i>TBD</i>

SANScreen	Verify SANScreen functionality	SANScreen should be able to discover to the storage array.	SANScreen was able to discover after symauth entries were created for the SANScreen server.	Pass	SANScreen was able to connect to the storage array using the symapi server on the SE server. A user "D:NT AUTHORITY\SYSTEM" was created in symauth with the Monitor role. There is an error message that appears in the symapi log stating, "User Authorization Failure for User D:NT AUTHORITY\SYSTEM -- 'VLOGIX' rights not present (minimum necessary role: Storage Administrator) (SID 000190100919)." SANScreen still appeared to function properly despite the error.
ECC	Verify ECC functionality	ECC should be able to monitor the storage array.	ECC was able to discover the symmetrix with the appropriate symacl and symauth entries.	Pass	The symauth entry must give the ecc server's root user the role of StorageAdmin.
Vendor Remote Access	Verify that EMC can log into the Symmetrix using ESRS.	EMC should be able to use ESRS to log into the service processor	EMC was able to log into the service processor via ESRS.	Pass	EMC login was logged in the symaudit logs as well as any inline configuration actions they issued to the Symmetrix.
Vendor Local Access	Verify that EMC can connect locally on the Symmetrix.	EMC should be able to log into the service processor of the Symmetrix.	EMC logged into the Symmetrix successfully utilizing RSA software to give them a one time token at login.	Pass	

15. Appendix B: RAID 6 Reliability

Predicting data storage reliability can often be confusing due to the large numbers used by vendors to describe their products reliability. For many storage administrators the Mean Time Between Failure (MTBF) value of an individual

drive is represents the reliability of the entire frame. The MTBF values provided by vendors represents a statistical approximation of how long a set of devices should last before failure. This approximation is derived by estimating the MTBF of individual components on the device mixed with reliability experiences with similar products. Therefore, MTBF values can be useful by the marketing department to compare individual devices, however it is not valuable at predicting the reliability of a series of devices on the backend of a storage array.

A practical method to predict the overall reliability of the disks in an array is the Mean Time To Data Loss (MTTDL) calculation. MTTDL calculates the probability that data will be lost by the frame using a number of metrics: 1) MTBF, 2) Mean Time To Replace (MTTR), 3) total number of disks in the array, 4) number of data/parity volumes in the RAID group and 5) sector error rates. The higher the MTTDL value the less likely a failure will occur.

In RAID 5 and RAID 6 structures, losing one drive over the total number of parity drive(s) will cause the RAID group to fail. Therefore, losing 2 drives in a RAID 5 group or 3 drives in a RAID 6 group will cause a failure of the RAID group an in-turn loss of data with in the volume. This type of failure can be calculated using the Mean Time to Data Loss due to disk failure (MTTDL-DF) formula. A second method where data loss occurs, is caused by bit error(s) when the RAID group is in a degraded (failed drive(s)) or in a rebuilding mode (replacement of failed drive(s)). This type of calculation uses the Mean Time to Data Loss due to bit errors (MTTDL-BER) formula.

Summary Results of Reliability Calculations:

1. For a DMX-3 4500 equipped with 300GB 10K RPM drives, RAID 6 14+2 shows a MTTDL-DF that is 145 times greater than RAID 5 7+1 and 20 times greater than mirror devices. (note: higher MTTDL value equates to a lower probability of failure)
2. For a DMX-3 4500 equipped with 300GB 15K RPM drives, RAID 6 14+2 shows a MTTDL-DF that is 228 times greater than RAID 5 7+1 and 33 times greater than mirror devices.
3. For a DMX-3 4500 equipped with 300GB 10K RPM drives, RAID 6 14+2 shows a MTTDL-BER that is 1465 times greater than RAID 5 7+1 and 211 times greater than mirror devices.

4. For a DMX-3 4500 equipped with 300GB 15K RPM drives, RAID 6 14+2 shows a MTDDL-BER that is 2297 times greater than RAID 5 7+1 and 330 times greater than mirror devices.
5. For a DMX-3 4500 equipped with 500GB 7200 RPM drives, RAID 6 14+2 shows a MTDDL-BER that is 1128 times greater than RAID 5 7+1.

Conclusion:

- RAID 6 shows higher MTDDL-DF and MTDDL-BER values than RAID 5 or mirror devices regardless of drive type.
- RAID 6 14+2 with 300GB 15K drives provides the best balance of reliability and capacity.
- RAID 5 on SATA drives presents MTDDL-BER of less than half a year.

Summary Results:

Reliability: DMX-3 4500 frame with 960 300GB 10K RPM drives	MTTR High I/O (hr)	MTTR Low I/O (hr)	MTDDL disk fail High I/O (yr)	MTDDL disk fail Low I/O (yr)	MTDDL bit error High I/O (yr)	MTDDL bit error Low I/O (yr)
RAID 5 7+1	3.2	6.56	1040	507	9.99	9.99
RAID 6 14+2	3.2	6.56	151,632	36,036	14,632	7159
Mirror	3.2	6.65	7,278	3,548	69.4	69.4

Reliability: DMX-3 4500 frame with 960 300GB 15K RPM drives	MTTR High I/O (hr)	MTTR Low I/O (hr)	MTDDL disk fail High I/O (yr)	MTDDL disk fail Low I/O (yr)	MTDDL bit error High I/O (yr)	MTDDL bit error Low I/O (yr)
RAID 5 7+1	2.05	3.51	1624	949	9.99	9.99
RAID 6 14+2	2.05	3.51	370,196	126,257	22,945	13,400
Mirror	2.05	3.51	11,372	6641	69.4	69.4

Reliability: DMX-3 4500 frame with 960 500GB 7.2K RPM SATA drives	MTTR High I/O (hr)	MTDDL disk fail (yr)	MTDDL bit error (yr)
RAID 5 7+1	4.06	601	0.58

RAID 6 14+2	4.06	59,217	654
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References:

P. Chen, E. Lee, G. Gibson, R. Katz, D. Petterson: RAID: High-Performance, Reliable Secondary Storage. ACMComputing Surveys

16. Appendix C: Summary Performance Test:

Symmetrix DMX-4 Engenuity 5772 Sequential/Random Read and Write I/O Throughput

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
Mirror4-way Seq Rd 34.5GB dev 146GB	15354.48	13888.75	10530.49	6893.02	4375.07	2411.16	1651.49	1246.85	7043.91	5598.03
Mirror4-way Seq Wr 34.5GB dev 146GB	6571.18	5934.65	4429.61	2970.64	1874.07	1038.01	702.83	534.79	3006.97	2386.90
Mirror4-way Rnd Rd 34.5GB dev 146GB	1643.05	2646.92	2373.86	1677.59	1306.28	1000.45	950.17	981.93	1572.53	648.82
Mirror4-way Rnd Wr 34.5GB dev 146GB	691.88	1126.49	1022.11	717.00	573.72	435.37	412.66	417.65	674.61	274.93
RAID 5 7+1 Seq Rd 34.5GB dev 146GB	16737.41	14752.30	11912.45	7957.71	4442.00	2353.36	1645.74	1241.89	7630.36	6173.03
RAID 5 7+1 Seq Wr 34.5GB dev 146GB	7147.95	6305.83	5096.35	3366.13	1910.61	1021.53	696.08	525.40	3258.73	2636.56
RAID 5 7+1 Rnd Rd 34.5GB dev 146GB	2513.88	3763.21	3167.02	2063.93	1782.32	1089.85	1113.32	1241.89	2091.93	993.41
RAID 5 7+1 Rnd Wr 34.5GB dev 146GB	1092.04	1591.39	1340.97	892.87	766.52	474.48	479.22	525.40	895.36	418.42
RAID 5 7+1 Seq Rd 34.5GB dev 300GB	16349.70	14377.47	11685.07	7748.95	4515.25	2375.23	1651.37	1233.56	7492.07	5998.09
RAID 5 7+1 Seq Wr 34.5GB dev 300GB	7018.61	6119.98	5050.48	3312.24	1918.26	1021.03	700.53	546.75	3210.99	2569.65
RAID 5 7+1 Rnd Rd 34.5GB dev 300GB	2704.00	4313.62	3300.60	1872.78	1969.50	1301.92	1264.67	1170.58	2237.21	1122.69
RAID 5 7+1 Rnd Wr 34.5GB dev 300GB	1142.96	1841.07	1409.74	815.66	834.37	568.01	538.01	495.29	955.64	477.52
RAID 6 14+2 Seq Rd 34.5GB dev 146GB	16834.16	14993.52	12546.18	7263.22	4516.51	2404.25	1641.05	1244.10	7680.37	6289.11
RAID 6 14+2 Seq Wr 34.5GB dev 146GB	7260.11	6482.78	5403.01	3095.71	1907.30	1027.88	707.33	529.30	3301.67	2719.71
RAID 6 14+2 Rnd Rd 34.5GB dev 146GB	2298.74	2925.71	2581.66	1826.29	1420.53	900.00	975.50	955.04	1735.43	796.61
RAID 6 14+2 Rnd Wr 34.5GB dev 146GB	981.86	1253.59	1118.65	804.12	609.33	382.12	422.71	399.49	746.48	344.59
RAID 6 14+2 Seq Rd 34.5GB dev 300GB	17186.82	14810.99	10287.01	8457.60	4514.33	2408.93	1373.92	1163.48	7525.39	6193.06
RAID 6 14+2 Seq Wr 34.5GB dev 300GB	7350.24	6353.93	4390.64	3618.97	1934.21	1034.26	593.85	503.50	3222.45	2648.90
RAID 6 14+2 Rnd Rd 34.5GB dev 300GB	2469.26	3196.39	2611.19	1885.45	1860.64	1305.66	1031.49	943.98	1913.01	804.66
RAID 6 14+2 Rnd Wr 34.5GB dev 300GB	1058.14	1374.18	1128.57	802.19	794.11	560.98	446.86	409.36	821.80	345.37

Throughput in IOps

Con't

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
RAID 6 14+2 Seq Rd 61.3GB dev 146GB	17341.02	14816.62	12781.14	8436.70	4635.87	2441.57	1528.79	1110.24	7886.49	6416.80
RAID 6 14+2 Seq Wr 61.3GB dev 146GB	7446.96	6350.35	5503.70	3639.48	1981.49	1049.19	650.36	462.06	3385.45	2759.25
RAID 6 14+2 Rnd Rd 61.3GB dev 146GB	2740.84	3836.61	3406.66	2284.60	2300.99	903.79	1002.00	1001.42	2184.61	1133.54
RAID 6 14+2 Rnd Wr 61.3GB dev 146GB	1182.51	1640.52	1464.07	982.10	987.70	389.34	431.97	425.79	938.00	486.08
RAID 6 14+2 Seq Rd 61.3GB dev 300GB	17591.52	14789.34	10891.52	8122.05	4584.53	2464.85	1339.03	1188.26	7621.39	6306.38
RAID 6 14+2 Seq Wr 61.3GB dev 300GB	7541.17	6355.41	4674.00	3481.17	1961.49	1036.61	585.49	506.12	3267.68	2707.77
RAID 6 14+2 Rnd Rd 61.3GB dev 300GB	3102.28	4145.45	4016.06	2507.50	2274.86	1335.54	1149.23	1129.52	2457.55	1222.63
RAID 6 14+2 Rnd Wr 61.3GB dev 300GB	1320.79	1773.21	1729.11	1088.74	962.76	573.90	491.88	484.69	1053.13	524.31

Symmetrix DMX-4 Enginuity 5772 Sequential/Random Read and Write Latency

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
Mirror4-way Seq Rd 34.5GB dev 146GB	0.717	0.855	1.243	1.977	2.973	4.963	7.328	9.058	3.639	3.162
Mirror4-way Seq Wr 34.5GB dev 146GB	0.751	0.687	0.649	0.790	1.589	3.874	5.536	8.762	2.830	2.999
Mirror4-way Rnd Rd 34.5GB dev 146GB	9.555	5.869	6.545	9.301	11.803	15.455	15.965	14.827	11.165	3.977
Mirror4-way Rnd Wr 34.5GB dev 146GB	0.420	0.404	0.442	0.541	1.001	1.222	1.997	3.439	1.183	1.065
RAID 5 7+1 Seq Rd 34.5GB dev 146GB	0.630	0.756	1.003	1.563	2.750	5.115	7.127	9.162	3.513	3.254
RAID 5 7+1 Seq Wr 34.5GB dev 146GB	0.754	0.761	0.788	1.050	1.967	3.861	6.124	8.788	3.012	3.019
RAID 5 7+1 Rnd Rd 34.5GB dev 146GB	6.176	4.027	4.817	7.491	8.532	14.100	13.387	9.162	8.461	3.697
RAID 5 7+1 Rnd Wr 34.5GB dev 146GB	0.420	0.519	0.546	0.580	1.020	1.320	2.272	8.788	1.933	2.838
RAID 5 7+1 Seq Rd 34.5GB dev 300GB	0.638	0.775	1.019	1.597	2.686	5.067	7.046	8.947	3.472	3.179
RAID 5 7+1 Seq Wr 34.5GB dev 300GB	0.785	0.787	0.803	1.082	2.012	3.872	6.223	9.067	3.079	3.098
RAID 5 7+1 Rnd Rd 34.5GB dev 300GB	5.734	3.483	4.619	8.290	7.669	11.643	11.526	11.565	8.066	3.285
RAID 5 7+1 Rnd Wr 34.5GB dev 300GB	0.417	0.519	0.521	0.573	1.063	1.468	2.631	4.958	1.519	1.576

Latency in ms

Con't

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
RAID 6 14+2 Seq Rd 34.5GB dev 146GB	0.618	0.729	0.920	1.727	2.711	4.927	6.929	8.896	3.432	3.146
RAID 6 14+2 Seq Wr 34.5GB dev 146GB	0.761	0.773	0.818	1.098	1.962	4.033	6.525	9.262	3.154	3.206
RAID 6 14+2 Rnd Rd 34.5GB dev 146GB	6.783	5.247	5.992	8.509	10.908	17.245	15.451	15.287	10.678	4.759
RAID 6 14+2 Rnd Wr 34.5GB dev 146GB	0.405	0.498	0.466	0.564	0.818	1.230	2.177	3.480	1.205	1.094
RAID 6 14+2 Seq Rd 34.5GB dev 300GB	0.604	0.740	1.256	1.404	2.678	4.897	8.122	10.483	3.773	3.734
RAID 6 14+2 Seq Wr 34.5GB dev 300GB	0.756	0.785	0.695	1.132	2.012	4.030	9.807	7.504	3.340	3.515
RAID 6 14+2 Rnd Rd 34.5GB dev 300GB	6.293	4.811	5.904	8.248	8.159	11.631	14.549	15.425	9.377	4.028
RAID 6 14+2 Rnd Wr 34.5GB dev 300GB	0.426	0.429	0.501	0.552	1.000	1.441	2.201	3.475	1.253	1.093
RAID 6 14+2 Seq Rd 61.3GB dev 146GB	0.592	0.752	0.882	1.413	2.551	4.697	7.991	11.495	3.797	4.017
RAID 6 14+2 Seq Wr 61.3GB dev 146GB	0.760	0.757	0.850	1.112	2.089	4.311	5.781	6.973	2.829	2.509
RAID 6 14+2 Rnd Rd 61.3GB dev 146GB	5.568	3.873	4.422	6.707	6.516	17.191	15.048	14.359	9.211	5.378
RAID 6 14+2 Rnd Wr 61.3GB dev 146GB	0.615	0.683	0.628	0.681	1.010	1.168	2.117	3.790	1.336	1.111
RAID 6 14+2 Seq Rd 61.3GB dev 300GB	0.573	0.749	1.150	1.520	2.718	5.024	10.000	10.259	3.999	4.044
RAID 6 14+2 Seq Wr 61.3GB dev 300GB	0.777	0.767	0.732	1.043	1.792	3.459	4.406	7.519	2.562	2.433
RAID 6 14+2 Rnd Rd 61.3GB dev 300GB	4.878	3.527	3.728	6.121	6.533	11.344	12.821	11.986	7.617	3.833
RAID 6 14+2 Rnd Wr 61.35GB dev 300GB	0.648	0.767	0.587	0.590	1.166	1.471	2.555	5.061	1.606	1.547

Symmetrix DMX-4 Enginuity 5772 Sequential/Random Read and Write Bandwidth Test

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
Mirror4-way Seq Rd 34.5GB dev 146GB	29.99	54.25	82.27	107.70	136.72	150.70	154.83	155.86	109.04	48.93
Mirror4-way Seq Wr 34.5GB dev 146GB	12.83	23.18	34.61	46.42	58.56	64.88	65.89	66.85	46.65	21.02
Mirror4-way Rnd Rd 34.5GB dev 146GB	3.21	10.34	18.55	26.21	40.82	62.53	89.08	122.74	46.68	41.90
Mirror4-way Rnd Wr 34.5GB dev 146GB	1.35	4.40	7.99	11.20	17.93	27.21	38.69	52.21	20.12	17.95

Bandwidth in MBps

Con't

DMX3 Transaction*	2K	4K	8K	16K	32K	64K	96K	128K	Average	Std Dev
RAID 5 7+1 Seq Rd 34.5GB dev 146GB	32.69	57.63	93.07	124.34	138.81	147.08	154.29	155.24	112.89	46.84
RAID 5 7+1 Seq Wr 34.5GB dev 146GB	13.96	24.63	39.82	52.60	59.71	63.85	65.26	65.67	48.19	19.97
RAID 5 7+1 Rnd Rd 34.5GB dev 146GB	4.91	14.70	24.74	32.25	55.70	68.12	104.37	155.24	43.54	34.78
RAID 5 7+1 Rnd Wr 34.5GB dev 146GB	2.13	6.22	10.48	13.95	23.95	29.65	44.93	65.67	18.76	15.03
RAID 5 7+1 Seq Rd 34.5GB dev 300GB	31.93	56.16	91.29	121.08	141.10	148.45	154.82	154.19	112.38	47.55
RAID 5 7+1 Seq Wr 34.5GB dev 300GB	13.71	23.91	39.46	51.75	59.95	63.81	65.67	68.34	48.33	20.57
RAID 5 7+1 Rnd Rd 34.5GB dev 300GB	5.28	16.85	25.79	29.26	61.55	81.37	118.56	146.32	60.62	51.14
RAID 5 7+1 Rnd Wr 34.5GB dev 300GB	2.23	7.19	11.01	12.74	26.07	35.50	50.44	61.91	25.89	21.70
RAID 6 14+2 Seq Rd 34.5GB dev 146GB	32.88	58.57	98.02	113.49	141.14	150.27	153.85	155.51	112.96	46.70
RAID 6 14+2 Seq Wr 34.5GB dev 146GB	14.18	25.32	42.21	48.37	59.60	64.24	66.31	66.16	48.30	19.84
RAID 6 14+2 Rnd Rd 34.5GB dev 146GB	4.49	11.43	20.17	41.10	44.39	56.25	91.45	119.38	48.58	39.85
RAID 6 14+2 Rnd Wr 34.5GB dev 146GB	1.92	4.90	8.74	28.54	19.04	23.88	39.63	49.94	22.07	16.98
RAID 6 14+2 Seq Rd 34.5GB dev 300GB	33.57	57.86	80.37	132.15	141.07	150.56	128.80	145.44	108.73	44.94
RAID 6 14+2 Seq Wr 34.5GB dev 300GB	14.36	24.82	34.30	56.55	60.44	64.64	55.67	62.94	46.72	19.39
RAID 6 14+2 Rnd Rd 34.5GB dev 300GB	4.82	12.49	20.40	29.46	58.15	81.60	96.70	118.00	52.70	42.36
RAID 6 14+2 Rnd Wr 34.5GB dev 300GB	2.07	5.37	8.82	12.53	24.82	35.06	41.89	51.17	22.72	18.36
RAID 6 14+2 Seq Rd 61.3GB dev 146GB	33.87	57.88	99.85	131.82	144.87	152.60	143.32	138.78	112.87	44.71
RAID 6 14+2 Seq Wr 61.3GB dev 146GB	14.54	24.81	43.00	56.87	61.92	65.57	60.97	57.76	48.18	19.00
RAID 6 14+2 Rnd Rd 61.3GB dev 146GB	5.35	14.99	26.61	35.70	71.91	56.49	93.94	125.18	53.77	41.34
RAID 6 14+2 Rnd Wr 61.3GB dev 146GB	2.31	6.41	11.44	15.35	30.87	24.33	40.50	53.22	23.05	17.64
RAID 6 14+2 Seq Rd 61.3GB dev 300GB	34.36	57.77	85.09	126.91	143.27	154.05	125.53	148.53	109.44	44.92
RAID 6 14+2 Seq Wr 61.3GB dev 300GB	14.73	24.83	36.52	54.39	61.30	64.79	54.89	63.27	46.84	19.07
RAID 6 14+2 Rnd Rd 61.3GB dev 300GB	6.06	16.19	31.38	39.18	71.09	83.47	107.74	141.19	62.04	47.20
RAID 6 14+2 Rnd Wr 61.3GB dev 300GB	2.58	6.93	13.51	17.01	30.09	35.87	46.11	60.59	26.59	20.22

