Introduction

In today’s challenging data center environments, storage systems must supply continuous data availability, high input/output (I/O) performance and advanced functionality. When purchasing new data storage, such capabilities are frequently hard to evaluate due to the expense and time it takes. As a result, many data centers rely on industry benchmarks or other reports to gauge storage performance and study product specifications to rate system functionality.

In this regard, HP® has recently submitted their newest midrange HP 3PAR StoreServ 7400 for a Microsoft Exchange Solution Reviewed Program (ESRP) test run. HP documented the results of the test and posted them online for examination. To better understand this report, we analyze the performance of all mid-tier ESRP trials below, comparing HP 3PAR StoreServ 7400 to similar storage systems from other vendors.

Although ESRP testing stresses storage to reveal system peak I/O performance, Microsoft never intended it to be used as a benchmark. Also, due to the high adoption of Exchange in IT organizations, many storage vendors supply ESRP results as an aid to help customers plan their email storage configurations.

With this relative abundance of vendor submissions and ESRP’s ability to drive maximum system I/O, examining ESRP results can provide a rich trove of verifiable storage performance information. Nonetheless, the extensive parameterization of ESRP testing makes comparing storage performance a complex undertaking.

Another issue that confounds analysis is that ESRP submissions span a wide extent of mailbox counts. In fact, for the category of over 5,000 email users published by Microsoft on their website, the range is from 5,800 to 140,000 email users. As this encompasses mid-tier to high-end enterprise class storage, the analysis in this paper is restricted to a field of between 40,000 to 60,000 mailboxes, representing just midrange storage systems. For this range of mailboxes, there are fifteen ESRP submissions, eleven of which represent current products that are assessed herein.

Microsoft Exchange 2010

Microsoft continues to improve Exchange to increase email performance by minimizing I/O requirements. For instance, Exchange 2010 (E2010) reduced I/O activity by increasing mailbox size and simplified database replication by introducing Data Availability Groups (DAGs)

A DAG is a set of email databases and log files. Each DAG database can be active or copies of active databases. The passive database copies provide email services only during an outage and are kept up-to-date by shipping log files between mailbox servers and applying updates. While the introduction of DAGs caused considerable excitement for storage administrators, the increased I/O capabilities of E2010 probably did the most to expand storage options for Exchange deployments.

Exchange 2010 ESRP testing
ESRP uses the Jetstress test program to simulate log file I/O and email processing against active databases. In E2010, many multi-site configurations have at least two sets of mailbox servers and storage systems, one set for each site. As ESRP assumes that the two sites are similar to the one another, Jetstress only has to exercise one set of servers and storage to demonstrate peak system performance.

HP 3PAR StoreServ 7400 Storage
The HP 3PAR StoreServ 7400 comes with 2- or 4-mesh (cluster controller) nodes and supports up to 64 GB of DRAM cache, twenty-four 8 Gbps FC ports or eight 10 GbE iSCSI ports with a maximum of 480 SAS drives (in the 4-mesh node configuration). In the largest offering, the storage system can have up to 864 TB of raw storage.

Besides HP 3PAR StoreServ 7400, the HP 3PAR StoreServ family includes HP 3PAR StoreServ 10000 enterprise class storage and HP 3PAR StoreServ 7200 system for small to mid-tier data center environments. Specifically, the

- **HP 3PAR StoreServ 10000** supports more cluster nodes, storage drives and cache memory than HP 3PAR StoreServ 7400 with substantially higher I/O performance, and
- **HP 3PAR StoreServ 7200** offers fewer nodes, drives and cache with less I/O performance.

The HP 3PAR StoreServ family offers more hardware differences than just those indicated above. For more information please refer to product specifications available online.2

HP 3PAR StoreServ software functionality is common across the product family. Some of these shared advanced features include:

- **Thin provisioning** – with HP 3PAR StoreServ Thin Built In™ ASIC, the system only consumes storage capacity when needed and any resulting surplus can be used to host other data.
- **Autonomic storage tiering** – with HP 3PAR StoreServ Adaptive Optimization and optional SAS SSDs, the system moves highly active sub-LUN data to SSDs while keeping less active data on spinning disks to improve system performance.
- **Non-disruptive workload rebalancing** – with HP 3PAR StoreServ Dynamic Optimization, the system moves data within its storage volumes to reliably re-balance I/O activity, non-disruptively with a single click.

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**HP 3PAR 7400 ESRP PERFORMANCE RESULTS**

- **Scale-out design** – with HP 3PAR StoreServ innovative mesh architecture, the system can dramatically increase its I/O performance by adding more cluster or mesh nodes.
- **Secure multi-tenancy** – with HP 3PAR StoreServ sophisticated partitioning, the system can divide storage resources and dedicate them to specific clients to provide more predictable performance.
- **Data mobility** – with HP 3PAR StoreServ Peer Motion, a group of HP 3PAR StoreServ systems can work together to migrate customer data across multiple storage systems within a data center.

In addition, the newly introduced EVA Online Migration is available on the HP 3PAR StoreServ family. This service offers an easy process to migrate EVA data to HP 3PAR StoreServ systems.

**The ESRP Test Configuration**

**HP 3PAR StoreServ 7400 configuration**

The recent HP ESRP submission used the following storage configuration:

- 2-mesh nodes with 32 GB of DRAM cache (8 GB control and 8 GB data cache per node),
- 216-2 TB, 7200 RPM, NL-SAS disk drives in a single RAID 1 group (data mirroring),
- 12-8 Gbps FC host ports, and
- 13-fully provisioned HP 3PAR StoreServ VVols presented to each Exchange server (12 database/log LUNs and 1 restore LUN per server) for a total of 78 VVols.
Microsoft Exchange configuration

The Jetstress Exchange parameters used by the HP 3PAR StoreServ 7400 ESRP run included:

- 2 GB mailbox size,
- 60,000 mailboxes,
- 833 mailboxes per database,
- 0.14 I/Os/second (IOPS) per user mailbox,
- 2-DAGs, and
- Background database maintenance.

The Jetstress execution environment was comprised of

- 6-Exchange mailbox servers supporting the two DAGs at the Disaster Recovery Site,
- Each mailbox server was configured to manage 12 active databases, and
- Each mailbox server consisted of an HP Proliant BL460c Gen8 BladeSystem server connected to the storage with 2-8 Gbps FC links.

Exchange Performance Metrics

Using the 40,000 to 60,000 mailbox range described earlier, we extracted several performance metrics from ESRP reports and derived others from additional information that was supplied. Several of the more important ones included:

- **Database read and write transfers per second**, an ESRP reported parameter measuring the normal storage database I/O activity associated with receiving, reading, writing and sending emails using Exchange. IT staff often use this metric to estimate the number of emails that can be processed by a storage system over time. This metric is summed across all databases and all mailbox servers accessing a storage system.

- **Database transfers per second per disk spindle**, a computed value normalizing database transaction performance over the number of disk drives configured for a storage system. ESRP test runs often employ different numbers of disk spindles. Even for the 40,000 to 60,000 range of mailbox reports reviewed here, the number of drives used in disk-only submissions varied from 120 to 252.

- **Normalized database read and write transfers per second**, another computed value, similar to the above but measuring normalized IO activity over 1000 mailboxes and providing a measure which can be used to predict how a system might perform for smaller or larger Exchange configurations. Administrators can estimate how different environments will perform with the storage system using this metric.

- **Log playback time**, an ESRP reported parameter measuring the average time to process/playback a 1 MB log file against a passive email database. Unlike the above
Database transfers per second

Comparing the reported ESRP results for the database transfers per second, the HP 3PAR StoreServ 7400 configuration clearly outperformed the other midrange storage submissions as seen in Figure 1. The HP 3PAR StoreServ 7400 achieved over 7K read database transfers and over 4K write database transfers per second for a total of just under 11.6K transactions per second. This remarkable performance bested the other systems from all the other major manufacturers with similar Exchange configurations.

Only the hybrid, flash-disk storage system (ranked number two in Figure 1) from another vendor came even close to HP 3PAR StoreServ 7400 database transaction performance. Typically, flash storage costs much more than disk storage for the same capacity. Even though ESRP reports do not provide pricing information, it is possible that this hybrid storage system cost more than the disk-only storage on this chart.

Figure 1 Top 10 ESRP v3.0 DB transfers/second for 40K to 60K mailboxes
Database transactions per second per spindle

This measure normalizes storage transaction processing by using the spindle or drive count as the divisor. In this computed metric shown in Figure 2, HP 3PAR StoreServ 7400 again performed admirably by placing number one at ~54 database transfers per second per spindle against comparable configurations. Hybrid SSD-disk based systems were specifically excluded from this measure because the performance of flash augmented storage is not readily comparable on a per drive basis to disk-only systems.

Also, the HP 3PAR StoreServ 7400 and a majority of the other submissions used 7200 RPM disk drives, but there were at least two storage systems on this chart which took advantage of faster 10 KRPM disks. It is interesting to note that even with its slower drives the HP 3PAR StoreServ came in at the top of this ranking.

As discussed previously, disk drive counts vary considerably across ESRP submissions. However, one can use this measure to help understand how storage systems would perform under different drive configurations for other Exchange environments.

Figure 2 Top ESRP v3.0 Total database transfers per second per disk spindle
Given the performance advantage of the HP 3PAR StoreServ Storage shown above, it was not surprising that it still remained one of the top two performers in the normalized database transfers per second metric as shown in Figure 3. This metric was derived by taking transaction performance over the number of mailboxes and multiplying this by 1,000, to provide a predictive value per 1,000 mailboxes. This predictor could be less reliable for configurations with vastly different mailbox counts, particularly those with more mailboxes exceeding the capabilities of the current systems. Nevertheless, the HP 3PAR StoreServ 7400 ~ 193 database transfer rate per second per 1,000 mailboxes provides a sound value for making at least initial comparisons and may be especially relevant for Exchange configurations that don’t substantially diverge from the one tested.

![Top 10 ESRP V3.0 normalized (1K mailboxes) database transfers per second, for from 40K to 60K mailboxes as of 27Feb2013](image)

Figure 3 Top 10 ESRP v3.0 Database transfers per second per 1,000 mailboxes
Log Playback Time

Under the log playback time metric shown in Figure 4, the HP 3PAR StoreServ 7400 configuration was once again a good top ten performer. Its average time to playback a 1-MB log was just under 2.4 seconds. When one ignores the number one ranked hybrid SSD-disk drive storage system in Figure 3, the HP 3PAR StoreServ 7400 was only ½ second behind the leading disk-only storage.

This criterion is sometimes overlooked as customers are often focused on other measures like the more widely known database read and write transfers per second. However, log playback may provide a better metric of unconstrained performance because it is not influenced by the vendor supplied Jetstress IOPS parameter. That is, log playback measures the execution time of database transaction playback at the fastest possible rate that the underlying storage can achieve concurrent with ongoing email processing transaction activity.

Figure 4 Top 10 ESRP v3.0 Log playback time for 40K to 60K mailboxes
Summary

In short, the HP 3PAR StoreServ 7400 performed very well in comparison to the other ESRP submissions for midrange storage, specifically ranking first place for two out of four measures and reasonably well in the remainder. Furthermore, scaling HP 3PAR StoreServ 7400 performance above this point cannot be guaranteed, but as it only used two controllers and 216-disk drives there appears ample headroom to increase I/O capabilities, where needed. As a matter of fact, the HP 3PAR StoreServ 7400 can support double the controllers, DRAM cache and more than double the disk drives used in this ESRP run.

Since the HP 3PAR StoreServ 7400 demonstrated such great performance under ESRP’s mixed workloads, this system should perform splendidly for most mid-tier data center application environments. That the HP 3PAR StoreServ 7400 ESRP submission was not close to its maximum configuration also signifies it has the potential to tackle even larger IT operations. Indeed, given the performance advantages displayed by HP 3PAR StoreServ 7400 in its ESRP run and the excellent advanced functionality available from HP 3PAR StoreServ, most customers will be pleasantly surprised by this new midrange system, especially if they currently utilize this class of storage from other vendors.

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