

Lab Review

Hitachi Adaptable Modular Storage with Microsoft Exchange Server 2010

Simply Scalable, Easy to Manage, Enterprise Class Midrange Storage

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ESG Lab Reports

The goal of ESG Lab reports is to educate IT professionals about emerging technologies and products in the storage, data management and information security industries. ESG Lab reports are not meant to replace the evaluation process that should be conducted before making purchasing decisions, but rather to provide insight into these emerging technologies. Our objective is to go over some of the more valuable feature/functions of products, show how they can be used to solve real customer problems and identify any areas needing improvement. ESG Lab's expert third-party perspective is based on our own hands-on testing as well as on interviews with customers who use these products in production environments. This ESG Lab report was sponsored by Hitachi Data Systems.

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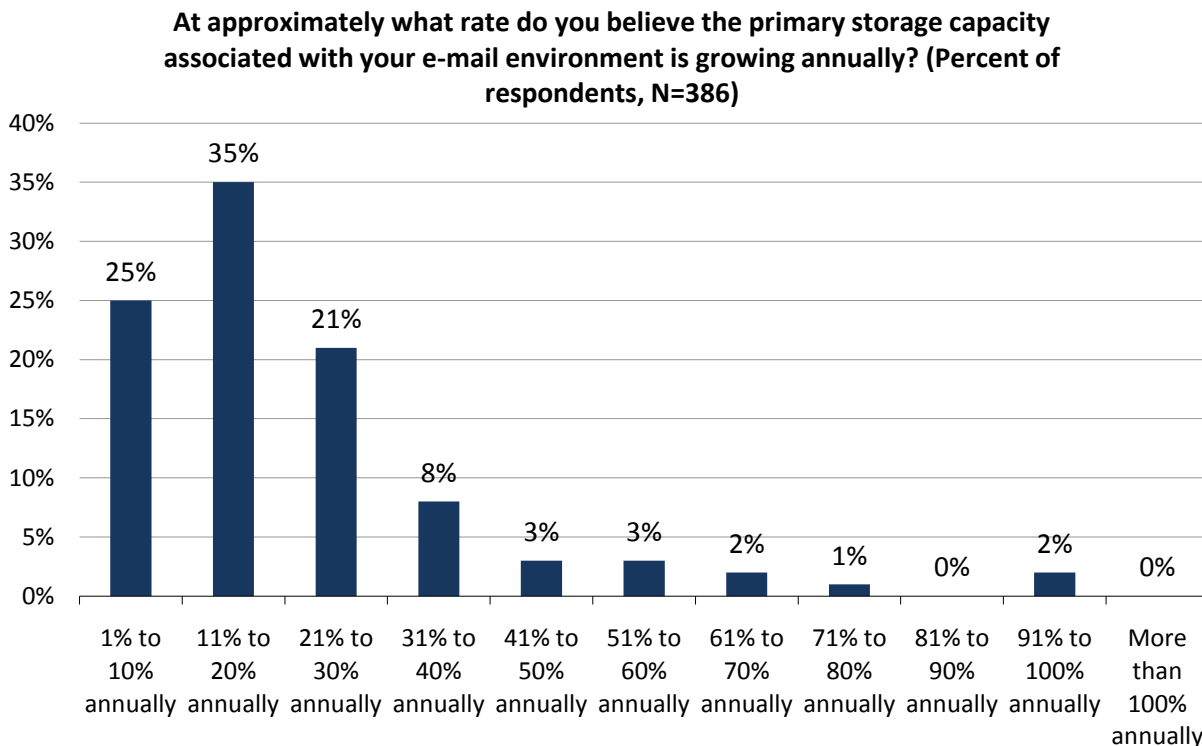
Introduction

This ESG Lab Review analyzes the operational efficiency (scalability, reliability, availability, and performance) of the [Hitachi](#) Adaptable Modular Storage 2000 family in real-world, mission-critical environments. Hitachi demonstrated excellent results both in the Microsoft Exchange Solution Reviewed Program (ESRP) and through the Storage Performance Council SPC-1 benchmark; these results were audited and analyzed to validate the tangible business value offered by the Hitachi Adaptable Modular Storage 2000 family systems.

Background

ESG asked IT managers to share the growth rate of their production email data year over year, and found that 75% of users reported greater than 10% annual growth while 40% of respondents reported 20% or higher growth in email capacity, as seen in Figure 1.¹ Interestingly, the highest growth rates were reported by sites supporting the largest numbers of users and the highest installed capacity, 58% of organizations with 25TB of installed email capacity reported 20% or higher annual growth. A 20% annual growth rate represents a doubling of capacity every four years.

Figure 1. Email Data Growth



Source: Enterprise Strategy Group, 2010.

IT managers are being challenged to satisfy this growth in e-mail data while addressing the host of IT concerns that come with it. Mission-critical Exchange environments demand easily manageable systems with predictably scalable performance, enterprise class availability, and rock solid reliability.

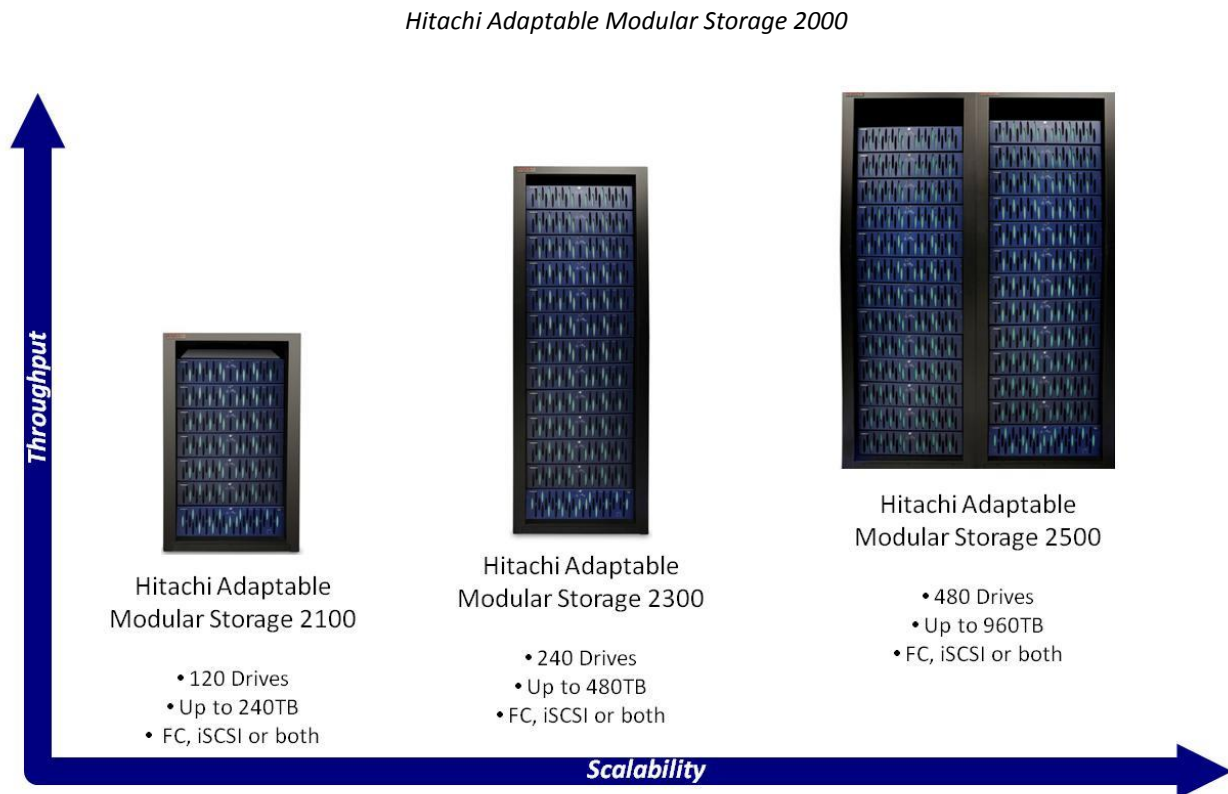
Hitachi Adaptable Modular Storage 2000 Family

Hitachi Data Systems has focused on customer priorities with its Hitachi Adaptable Modular Storage 2000 family of next-generation midrange storage systems. In particular, Hitachi is to be commended for its comprehensive testing

¹ Source: ESG Research Report, [E-mail Archiving Market Trends](#), May 2010.

on Exchange 2010 which is published on Microsoft's ESRP 3.0 website.² Hitachi has tested 10 configurations ranging from 5,400 mailboxes all the way up to a 100,800 mailbox configuration, the largest number of mailboxes validated on the ESRP 3.0 site to date. These flexible, midrange storage systems are designed to address the most crucial performance, scalability, and availability challenges faced by storage and IT managers supporting mission critical Microsoft Exchange environments. Hitachi Adaptable Modular Storage 2000 family systems can start small and scale up to 960 TB in a single storage system, as shown in Figure 2. Performance of the Adaptable Modular Storage 2000 family has increased dramatically over the previous generation, and all systems support Fibre Channel and iSCSI host connections.

Figure 2. The Hitachi Adaptable Modular Storage 2000 Family



The Adaptable Modular Storage 2000 family is designed to address the dynamic needs of IT in support of mission- and business-critical applications like Exchange 2010 and provide a combination of critical features and functionality not found in other midrange storage systems or direct attached storage.

- **Symmetric, active/active controllers**—Hardware load balancing and server native multipathing optimally spread I/O workload across storage resources. No separate software to buy, install, or maintain.
- **Hitachi Dynamic Provisioning (HDP) with wide striping**: Removes the requirement to stripe multiple raid groups together and manage performance manually. Wide striping has a smoothing effect on performance and allows virtual volumes to leverage the performance of all drives in the pool. Automatic workload leveling increases resilience to workload fluctuations by addressing bottlenecks proactively.
- **Hitachi Data Protection Suite with SnapProtect**: Manages snapshot protection across multiple arrays and applications, with support for Exchange, SQL Server, Oracle, and SAP. Automates dynamic, online, non-disruptive migration of recovery copies across storage tiers using pre-configured policies.

The balance of this report presents the results of ESG Lab testing and analysis of the attributes of the Hitachi Adaptable Modular Storage 2000 family of storage solutions with a focus on real-world application performance in Microsoft Exchange 2010 environments.

² <http://technet.microsoft.com/en-us/exchange/ff182054.aspx>

ESG Lab Analysis

ESG Lab’s assessment of the capabilities of the Hitachi Adaptable Modular Storage 2000 family began with hands-on testing of an Adaptable Modular Storage 2300 system at Hitachi Data Systems corporate headquarters in Santa Clara, California. Recently published ESRP and SPC performance benchmark results for Adaptable Modular Storage 2100, 2300, and 2500 storage systems were audited and analyzed.

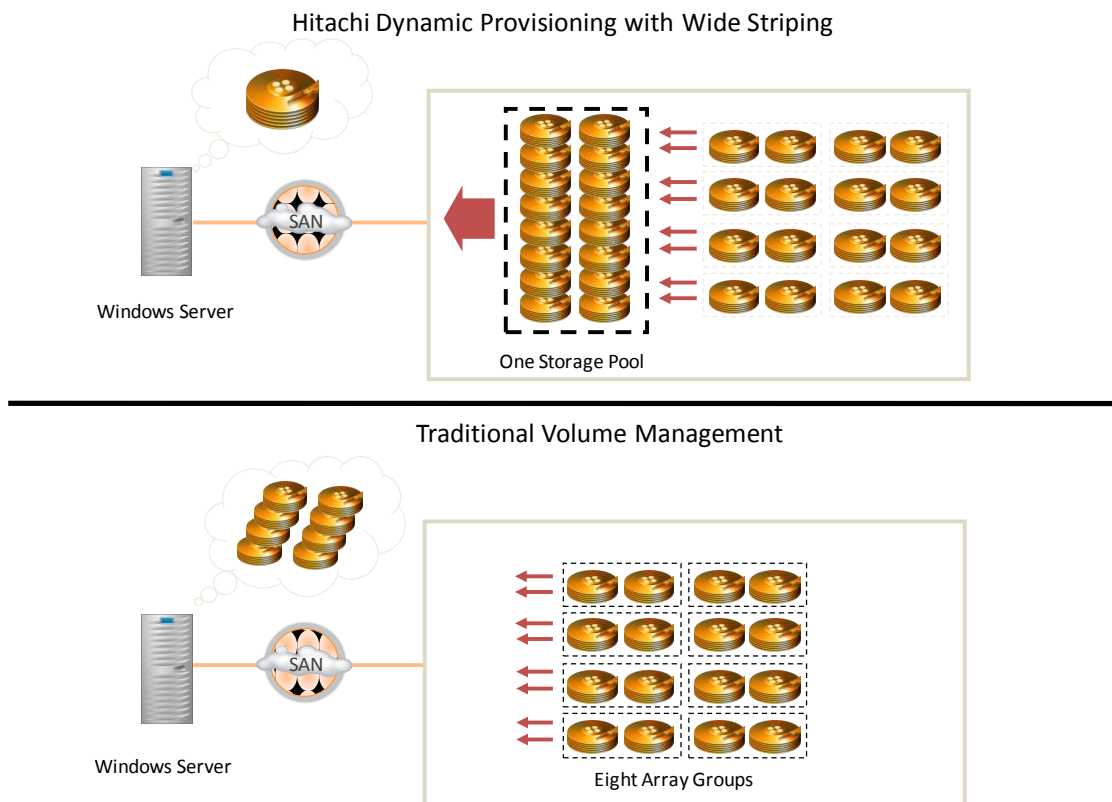
Enterprise Class Features

The Adaptable Modular Storage 2000 family systems are midrange storage systems with a unique combination of enterprise class features and midrange storage efficiencies. Hitachi Dynamic Provisioning (HDP), symmetric active-active controllers, dynamic load balancing, and a cost-efficient SAS back end come together to provide a storage system that behaves like an enterprise class array as it provides integrated and automated front-to-back IO load balancing.

Mechanically spinning hard drives are the slowest link in the storage performance chain. The implementation of additional drives behind each application volume enables more work to be done in parallel. This is particularly true for massively interactive applications like e-mail systems. Storage administrators have been using host-based volume management software for years to make multiple LUNS appear to an application as a single disk volume. HDP volumes defined over a wide-striped pool of drives can be used to achieve the same performance benefits with less administrative overhead.

Figure 3 compares traditional volume management to HDP with wide striping. In the traditional methodology, if an application needs more performance than a single device can provide, large numbers of individual devices need to be mapped to the server, regardless of the capacity requirements of the application, and the administrator must stripe them together to allow the application to see them as one logical device. Using HDP, an administrator places a large number of drives into a pool, and can create thin provisioned volumes from that pool, consuming only the capacity needed by each application, while providing the full performance of all disks in the pool.

Figure 3. Hitachi Dynamic Provisioning with Wide Striping



ESG Lab Testing

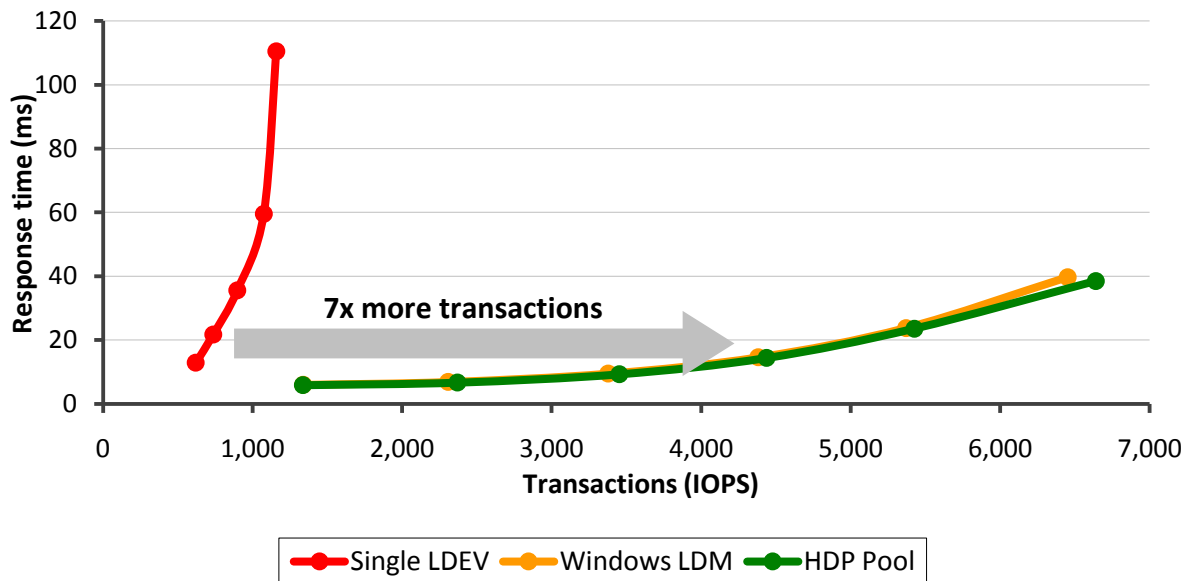
ESG Lab evaluated the effect of HDP with wide striping in the Adaptable Modular Storage system with a single Windows server attached to an AMS 2300 using one 4Gb Fibre Channel HBA. Iometer was used to generate traffic to three different types of LUN:

- A single Hitachi LUN defined over a single RAID group
- A single Windows Logical Disk Manager (LDM) volume defined over eight RAID groups
- A single Hitachi HDP volume defined over eight RAID groups

The workload used for this test was 100 percent random, 75 percent reads and an 8 KB block size. Thirty-two 146 GB 15K RPM SAS disk drives were configured as eight RAID groups (2+2)³. Multiple tests were performed on each configuration, using a range of active I/O threads between eight and 256.

Figure 4 shows the median results for each test.

Figure 4. HDP with Wide Striping Performance



What the Numbers Mean

- Wide striped volumes over eight array groups can do significantly more in-parallel work than a LUN configured over one array group. For example, the HDP volume with eight times as many drives as the LDEV performed seen times more transactions at a response time of 15 milliseconds or less.
- Wide striped volumes not only process more work in parallel, but they also do it faster. For example, the response time of the HDP volume was 118 percent faster than the single LUN at the first data point on the curve.
- While both the HDP and Windows LDM volumes showed similar, much improved performance and response times over the single RAID group, it should be noted that the volume created using the Windows Logical Disk Manager consumed the total capacity of all 32 drives, or more than 2 Terabytes while the HDP volume was thin provisioned and consumed only the capacity assigned to it.

³ The diagram depicts 16 instead of 32 drives for simplicity.

Why This Matters

ESG has found that performance, scalability, complexity, and cost were consistently among the top storage challenges reported by IT professionals and managers.⁴ A major challenge with both direct attached storage and midrange storage systems in Exchange environments has been the administrative effort required to manage scalability and performance. With traditional midrange storage systems, administrators must carefully map servers to resources to avoid bottlenecks and balance the load evenly. With DAS, administrators are limited by the number of drives that can be attached to a single server, which can be a very inefficient use of powerful server resources.

With architectural enhancements, enterprise class Wide Striping, and load balancing technology, ESG Lab has verified that the Hitachi Adaptable Modular Storage 2000 family can cost-effectively provide easy-to-configure storage for mission-critical applications with excellent performance. ESG Lab validated that the Adaptable Modular Storage 2000 family was able to stripe data across a large number of disk drives while efficiently allocating capacity using HDP. This improved performance significantly while reducing administrative effort. In combination with active-active load balancing, HDP significantly reduced performance management tasks.

Microsoft ESRP 3.0

The Microsoft Exchange Solution Reviewed Program (ESRP) is designed to facilitate third party storage testing and solution publishing for Exchange Server. Microsoft Gold Certified or Certified Storage Partners use the ESRP framework to test their storage solutions in the context of a Microsoft Exchange deployment. The programs combine a storage testing harness (Jetstress) with publishing guidelines. Manufacturers use the ESRP framework to test storage solutions and then submit results to Microsoft for review with approved solution results getting posted on the Microsoft Exchange ESRP website.⁵ ESRP version 3.0 focuses on Exchange 2010 and Microsoft provides specific recommendations regarding Exchange database size, IO profiles, mailboxes per server, and mailbox size. Hitachi's submissions align and comply with all of Microsoft's recommendations.

Figure 5. Exchange Simulation Configuration

Number of Exchange mailboxes simulated	100,800
Number of database availability groups (DAGs)	16
Number of servers per DAG	2
Number of active mailboxes per server	6,300
Number of databases per host	5
Number of copies per database	2
Number of mailboxes per database	1,260
Simulated profile: I/Os per second per mailbox (IOPS, include 20% headroom)	0.12
Database LU size	1750GB
Log LU size	175GB
Total database size for performance testing	100,800GB

The publishing guidelines require vendors to be quite specific as to the server, storage, and Exchange configurations tested. In addition to the Exchange Simulation data shown in Figure 5, the level of detail reported includes detailed configuration and layout of the disk array tested and the details of the Exchange deployment being simulated.

⁴ Source: ESG Research Report, *Enterprise Storage Systems Survey*, November 2008.

⁵ <http://technet.microsoft.com/en-us/exchange/ff182054.aspx>

ESRP differs from standard IO generation benchmarking suites in three important ways. First, it employs the Jetstress utility to create real Exchange traffic that runs against real Exchange databases—with logging and file attachments—exactly as in the real world. Second, the testing is designed to measure both the performance and the reliability of a given solution. The performance test runs for two hours while the reliability test runs for 24 hours, and both tests must run without exceeding a prescribed disk latency threshold (20 milliseconds). A reliability test is performed to check for database and log corruption at the end of the run. Finally, ESRP is focused on producing recommendations from vendors for configuring and deploying Exchange 2010 on their solutions.

Microsoft has made significant changes to Exchange 2010, greatly reducing disk IO requirements, which not only increases the number of mailboxes that can be supported by each disk in a solution but also enables the option of using larger format disks to support larger mailboxes. Exchange 2010 also offers the Mailbox Resiliency feature which maintains redundant copies of message store databases using Database Availability Groups (DAGs). Hitachi's active-active architecture, in combination with HDP wide striping, reduces administrative overhead by eliminating the need to pre-provision based on future capacity or performance requirements.

Microsoft released the ESRP 3.0 test methodology and tools to address these changes. A significant change to the user profiles was made to adjust to the altered disk IO requirements. In Exchange 2007, user profiles fell into five classes ranked by the number of messages sent or received in a day on average; values ranged from light (25 messages per day) to extra heavy (200 messages per day). User profiles for Exchange 2010 are now simply identified by the number of messages per day (starting at 100, which was the Exchange 2007 "heavy" profile) and climb in increments of 50 to 500.

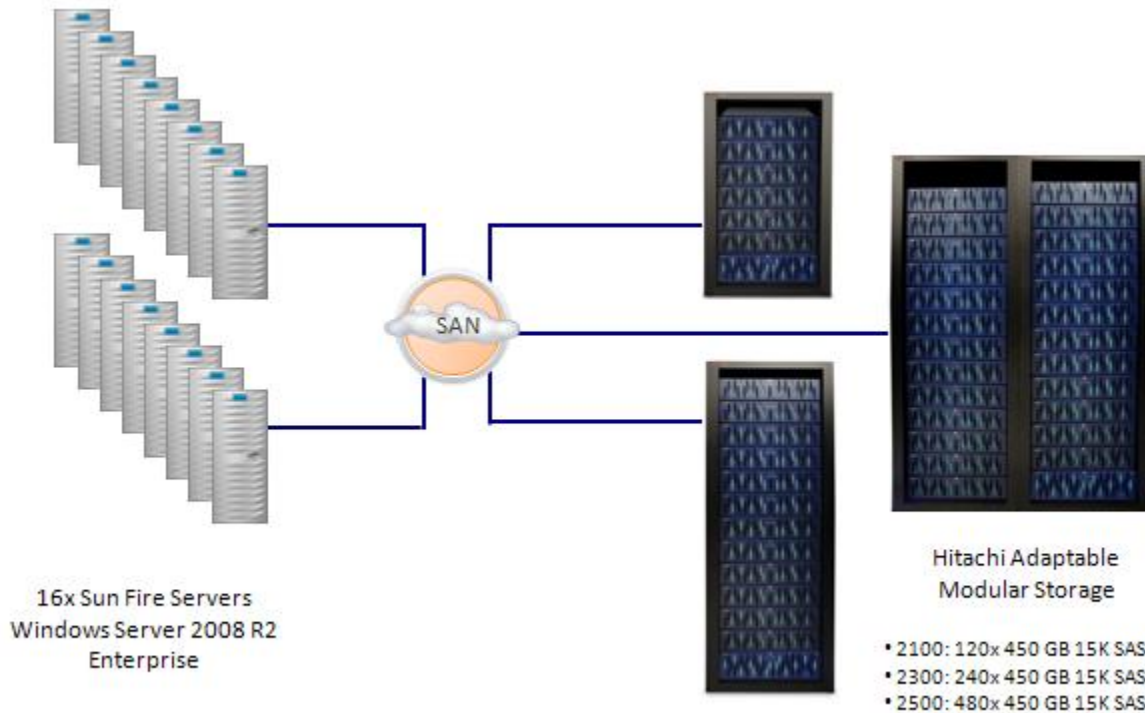
As will be seen in this analysis, the same storage configuration can support vastly different numbers of mailboxes depending on user profile and mailbox size. Exchange 2010's reduced IO requirements enable users to support more and larger mailboxes in a given system. Microsoft has asserted that larger mailboxes are better for users, IT administrators, and organizations as they utilize storage systems more efficiently while giving users better access to historical e-mail.

The goal of ESRP is to verify that a vendor's storage solution can reliably sustain an Exchange IO load in a specific configuration with predictable response times. Microsoft makes it quite clear that these tests should not be used for performance comparisons, but in practice, end-users routinely look to these detailed test results to gauge how well a given configuration will perform under specific conditions. This is not a bad use of these results, provided that all relevant factors are taken into consideration.

The ESRP Test Bed

As shown in Figure 6, Adaptable Modular Storage 2100, 2300, and 2500 systems were utilized for the testing—all configured with a full complement of 15K RPM 450 GB SAS drives. Sixteen Sun Fire 4270 servers were used to run LoadGen and Jetstress.

Figure 6. The Hitachi ESRP Test Bed



The configuration details for each test run are summarized in Table 3, in the Appendix. Hitachi tested multiple scenarios with differing numbers of simulated mailboxes using both 1GB and 3GB mailbox configurations to highlight the flexibility and predictable scalability of the Adaptable Modular Storage 2000 family platform.

What the Numbers Mean

- Hitachi has published results for relatively small, medium, and large Microsoft Exchange 2010 configurations ranging from an Adaptable Modular Storage 2100 with 120 drives supporting 5,800 mailboxes on four servers up to an Adaptable Modular Storage 2500 with 480 drives supporting 100,800 mailboxes.
- Storage capacity utilization averaged 76% and the only test with utilization below 50% used 1 TB SATA drives with 1 GB mailboxes. Often, benchmark results are posted with a system at 25% capacity or less. This technique can artificially enhance results as the disk actuators avoid full seeks across the entire surface of the drive (this practice is sometimes referred to as “short-stroking”). In this case, the low utilization was the product of using large format SATA drives.
- Hitachi has published results for two of the Exchange 2010 user profiles defined by Microsoft: 100 and 150 messages per day.⁶
- Extremely consistent performance was realized for each test when looking at individual server results. This proves that the AMS 2000 family can scale both capacity and performance as needed.

⁶ Microsoft user profile definitions can be found in the appendix.

- Microsoft stresses that, to ensure a positive user experience, the Exchange database LUN requires read and write response times of less than 20 milliseconds so that Exchange can service users' client software quickly and efficiently. In this context, the 2000 family's performance is even more impressive. Consider a practical example: an Exchange environment where hundreds or even thousands of users all log in and check e-mail every morning at about the same time. The 2000 family's fast, consistent response times would provide the same responsiveness from their clients during peak load times as during relatively idle periods. The twenty-four hour reliability tests in ESRP confirmed that the 2000 family's SAS architecture was robust enough to provide consistent performance sustained over long periods with zero errors and 100% data integrity.

Figure 7. Hitachi Adaptable Modular Storage 2000 Family ESRP Results

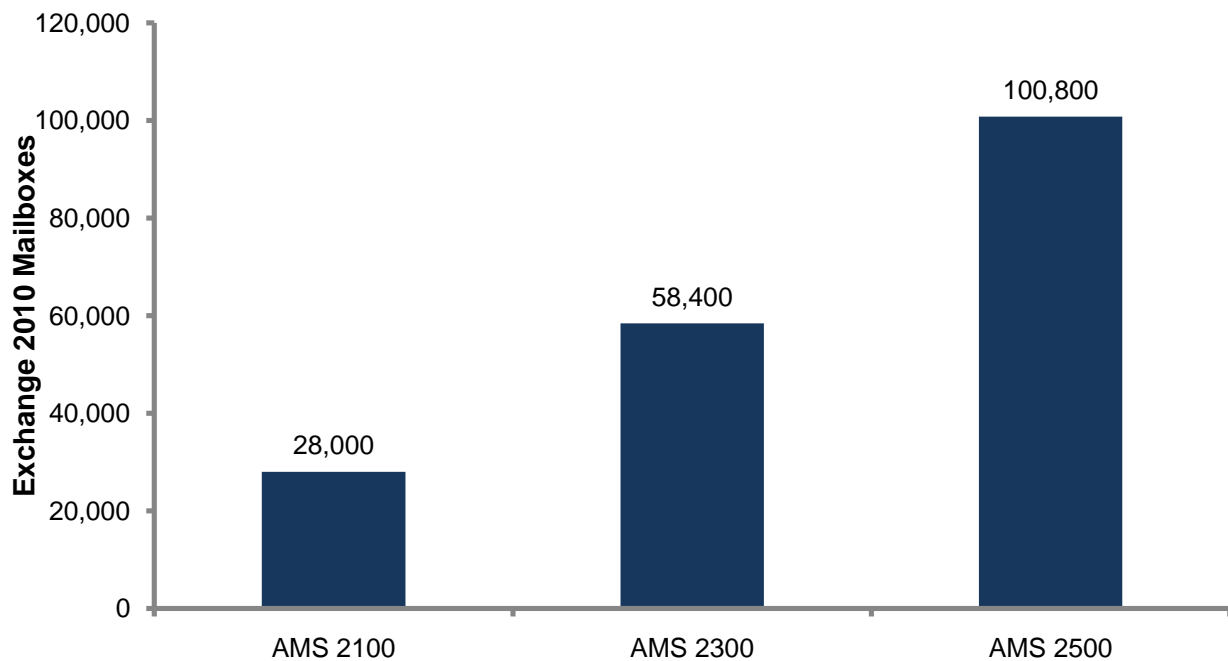


Figure 7 shows the Hitachi Adaptable Modular Storage 2000 family submitted ESRP 3.0 results with the highest number of mailboxes for each model. The columns in the chart represent the number of mailboxes supportable for the different user profiles and mailbox sizes tested by Hitachi. It's important to note a few things here:

- The Hitachi Adaptable Modular Storage 2000 family has demonstrated the performance and reliability required to support mission critical Microsoft Exchange deployments, scaling to 100,800 users in a single system.
- No environment is completely homogeneous and every Exchange implementation will have a mix of different user profiles in unique proportions, so the supportable number of mailboxes will never fall exactly into any one of these scenarios.
- ESRP is designed to assess storage performance and reliability only. Storage is only one factor to be considered when designing an Exchange solution; users need to consider server CPU and memory, network infrastructure and latency, recovery requirements, and resources consumed by other applications as well as the specific mix of mailbox sizes and usage patterns that will need to be supported. Microsoft provides extensive information on analyzing Exchange Server performance looking at all of these factors, which are outside of the scope of the ESRP-Storage program.⁷

⁷ <http://technet.microsoft.com/en-us/exchange/2010/default.aspx>

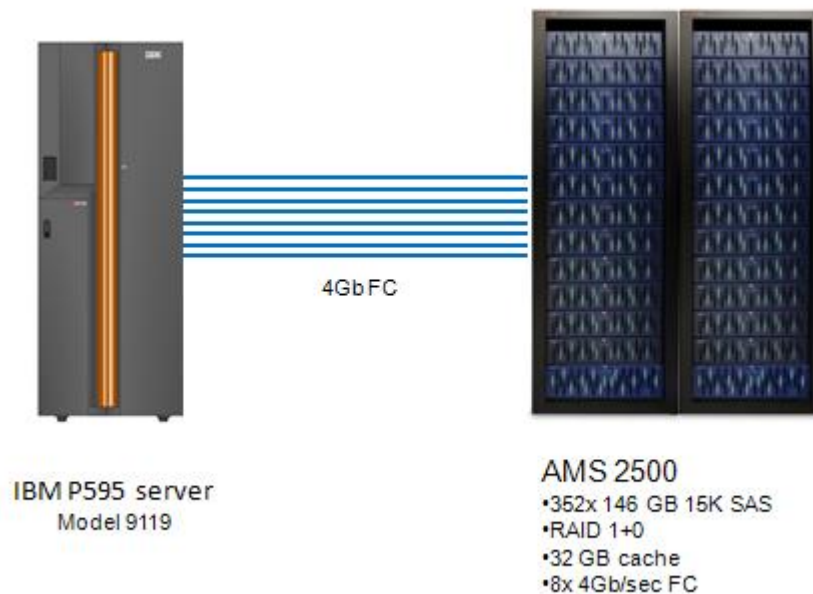
The SPC-1 Benchmark

ESG Lab also audited Hitachi's published results of the SPC-1 application-level industry standard benchmark suite maintained by the Storage Performance Council. SPC-1 testing generates a single workload designed to emulate the typical functions of transaction-oriented, real-world database applications. Transaction-oriented applications are generally characterized by largely random IO and generate both queries (reads) and updates (writes). Examples of these types of applications include OLTP, database operations, and mail server implementations. SPC results can be roughly mapped by users into easily understood metrics. For a credit card database system, for instance, it might be the number of credit card authorizations that can be executed per second.

The SPC-1 Test Bed

Like the ESRP program, the SPC requires full disclosure of very detailed configuration information. The test bed for the Adaptable Modular Storage 2500 SPC-1 test is summarized in Figure 8.

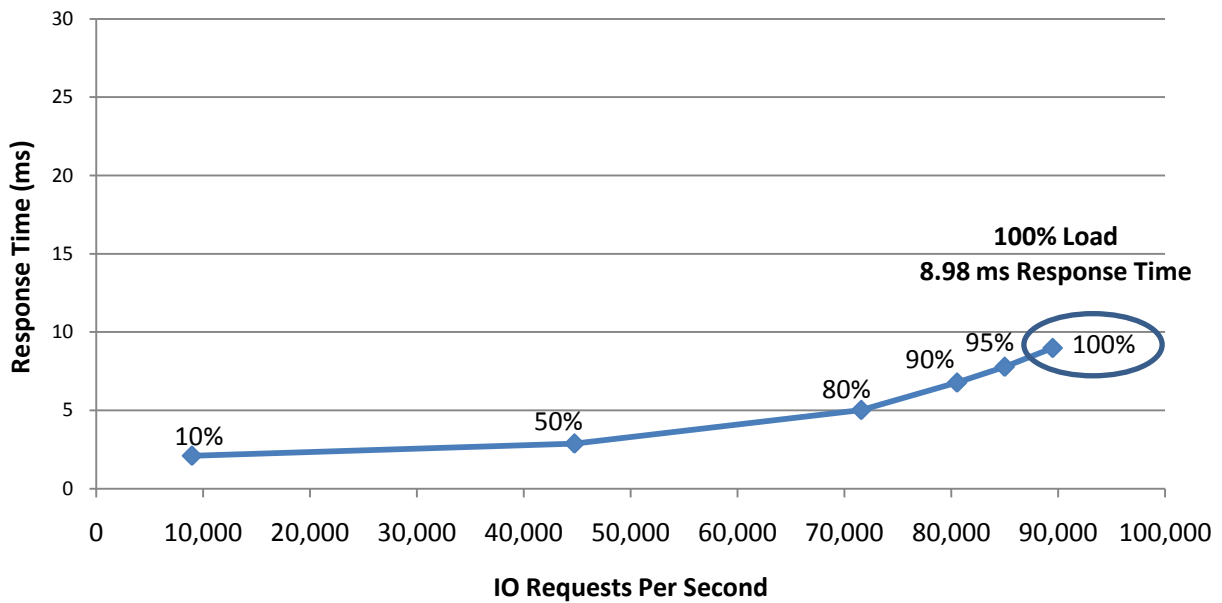
Figure 8. The Hitachi ESRP Test Bed



An additional element of SPC disclosure is the list pricing for the solution as tested. This allows for dollars per IOP comparisons of the cost-effectiveness of solutions.

SPC-1 Results

Hitachi has published an excellent result of 89,492 SPC-1 IO requests per second at 100% load with an average response time of only 8.98 milliseconds with the Adaptable Modular Storage 2500. Figure 9 shows a response time/throughput curve, which visually represents the performance of the system under test as load is increased. A long, flat curve indicates better performance, as this denotes that response time stays low as IOPS increase.

Figure 9. Adaptable Modular Storage 2500 SPC-1 Results


ESG Lab compared these results with submitted results for comparably configured, dual controller midrange storage systems. Table 1 summarizes our findings.

Table 1. SPC-1 Results Summary

System Under Test	SPC IOPS @ 100% Load	Response Time	Number of Drives	IOPS per drive	\$/SPC-1 IOPS
Adaptable Modular Storage 2500	89,492	8.98 ms	352	254	\$6.71
Adaptable Modular Storage 2300	42,503	6.33 ms	176	241	\$6.96
Adaptable Modular Storage 2100	31,499	8.15 ms	112	281	\$5.85
System 4	62,243	14.37 ms	256	243	\$11.70
System 5	60,515	20.80 ms	224	270	\$10.01
System 6	64,993	20.92 ms	288	226	\$8.79
System 7	24,997	24.12 ms	150	167	\$20.72

The Hitachi Adaptable Modular Storage 2000 family not only posted the best SPC-1 IOPS results for a dual-controller midrange storage system, it also delivered the fastest response time and best cost in dollars per SPC-1 IOPS by a wide margin. Response time is an extremely important component of SPC results; it is the delay an application will experience (and pass on to users) when a storage system is stressed to its limits. The generally accepted threshold for good performance in online transactional applications is 10 milliseconds, beyond which application delay begins to become apparent to users. The SPC will not certify any results higher than 30 milliseconds. The SPC-1 results published by Hitachi reinforce the results seen in ESRP testing and offer further proof of the 2000 family’s suitability for mission-critical, response time sensitive applications.

Why This Matters

ESG research indicates that performance is a key concern when deploying mission critical applications in a highly consolidated environment. With multiple application servers relying on a shared storage infrastructure, there is a worry that performance requirements can't be met affordably. As a matter of fact, 51% of ESG survey respondents reported that performance was their top concern, followed closely by capital and operational costs.⁸

Through careful examination of ESRP and SPC-1 results combined with hands-on testing, ESG Lab has verified that the Adaptable Modular Storage 2000 family can be deployed to cost-effectively provide easy-to-configure storage for Exchange environments of all sizes with excellent operational efficiency, offering affordable scalability, reliability, availability, and performance. As Exchange environments continue to grow in size and complexity and server virtualization becomes more widespread, SAN consolidation will become a requirement in more user environments in order to achieve these benefits and operational efficiencies.

The Bigger Truth

IT is increasingly being asked to do more with less. Storage profiling and benchmarking frameworks like ESRP and SPC-1 help IT design storage solutions that will perform predictably and cost effectively in support of mission-critical application deployments like Exchange 2010 in consolidated environments with high availability. Consolidating the Exchange environment onto a homogeneous storage infrastructure allows users to fully realize the benefits and operational efficiencies that a platform like the Adaptable Modular Storage 2000 family has to offer.

ESG Lab found that the Hitachi Adaptable Modular Storage 2000 family provided impressive operational efficiency in support of Microsoft Exchange 2010. Enterprise class SAS drives, as offered in the Adaptable Modular Storage 2000 family, provided the same reliability and performance as enterprise Fibre Channel drives—proven by ESRP reliability testing. The SAS backplane in the Adaptable Modular Storage 2300 system tested by ESG Lab intermixed SAS and SATA drives in the same drive enclosures for cost-effective scalability.

The Adaptable Modular Storage 2000 family also demonstrated enterprise class functionality automatically and transparently. Every ESRP 3.0 result was obtained using Hitachi Dynamic Provisioning (HDP) with wide striping to leverage large logical pools of storage for simple to manage, smoothly scalable performance. Active-active controllers with automatic load balancing allowed for greatly simplified host SAN and LUN provisioning, simplifying management and reducing operational costs.

The Hitachi Adaptable Modular Storage 2000 family performed exceptionally well in both ESRP 3.0 Microsoft Exchange simulation and SPC-1 OLTP testing, demonstrating predictably scalable performance and excellent cost benefit. The Adaptable Modular Storage 2000 family's combination of enterprise class features with easy-to-manage usability and reduced operational costs is powerful and worthy of serious consideration by any IT organization in search of a cost-effective solution for hosting mission critical applications like Microsoft Exchange 2010.

⁸ Source: ESG Research Report, [The Impact of Server Virtualization on Storage](#), December 2007.

Appendix

Table 2. Test Environment and Configuration

Storage			
Hitachi Adaptable Modular Storage 2300 – 105x 146 GB SAS drives 60x 1 TB SATA drives 8x 4 GB FC connections		Firmware 0852/A-M	
2x Brocade 5000 32 port 4 Gb FC switches		Firmware 5.2.1	
VMware ESXi v. 3.5 Servers – 1x Dell PowerEdge R905 4x Quad core Opteron CPU 64 GB RAM 2x QLogic 2462 4 Gb/sec FC HBA		Guest Operating System: Windows Server 2008 R2 Enterprise (6.1.7600.0)	
Iometer			
Version		2006.07.27	
Access Specification	IO Size	Random/Sequential Distribution	Read/Write Distribution
Exchange 2010 EDB	32 KB	90% Random	80% Read
Exchange LOG	5 KB	100% Sequential	100% Write
Test	Number of Servers	Physical Drives	RAID Protection
ESRP	1	20	RAID 1+0, 5x 2+2 groups
Iometer	1	20	RAID 1+0, 5x 2+2 groups
Microsoft Exchange User Profiles			
50 KB messages Sent/Received Daily	Exchange 2007 Equivalent	Estimated IOPS per user	Estimated IOPS per user used for mailbox calculation (+20%)
100	Heavy	.10	.12
150	Very Heavy	.15	.18
200	Extra heavy	.20	.24

Table 3. ESRP Exchange Configurations and Results

Adaptable Modular Storage Model	Disks	Daatabase Storage Capacity Utilization	User Profile (Msgs per Day)	Mailbox Size	Number of Simulated Servers	Mailboxes	Average DB Read Latency
2100	120 450 GB SAS	80.8%	150	3 GB	8	5,800	6.3
2100	120 450 GB SAS	80.7%	150	3 GB	8	9,440	11.5
2100	120 450 GB SAS	79.8%	100	1 GB	8	17,200	6.1
2100	99 450 GB SAS	79.7%	100	1 GB	8	28,000	13.1
2300	240 1 TB SATA	26%	100	1 GB	16	20,000	16.7
2300	240 450 GB SAS	79.8%	100	1 GB	16	34,400	7.5
2300	240 450 GB SAS	79.5%	100	1 GB	16	58,400	16.1
2500	480 450 GB SAS	79.9%	150	3 GB	32	40,800	14.8
2500	480 450 GB SAS	79.8%	100	1 GB	32	68,800	9.3
2500	480 450 GB SAS	67.2%	100	1 GB	32	100,800	16.0



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