SCI Briefing: A Technical Review of Hitachi Unified Storage

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Published: March, 2012
Technical Review of Hitachi Unified Storage

Introduction

Today’s data centers are in the unenviable position of dealing with an explosion of data growth. In fact, many data centers are struggling with 45-60 percent annual storage growth with small, if any, increases in physical and monetary resources. Continuous addition of storage solutions in silo-ed fashion has introduced administrative complexity surging to oftentimes create an operational morass. Adding even further strain is the unceasing demand by users for flawless, continuous IT performance.

Hitachi Data Systems (HDS) has recently released its Hitachi Unified Storage (HUS) series to mitigate these daunting problems. HDS’s new platform brings high-end storage capabilities into the midrange and targets small to medium sized data centers.

Data center concerns

Data growth

At many data centers growth is quickly outstripping their ability to effectively manage the expanding storage requirements. Exploding data growth using silo-ed file or block storage systems that segregate data into multiple domains just makes it more difficult and time consuming. Specifically,

- File data proliferates without limit, due primarily to the ever-increasing information intensity in today’s business activities. Intellectual work has emerged as the dominant work paradigm, from new product designs, to new factory plans, to the media and messaging needed to market/sell new products. Additionally, the mushrooming use of multimedia in everyday life, e.g., digital music, photos, and videos, is providing fresh fuel to this surge.
- Block data has also been expanding at a phenomenal pace primarily because of the needs of business to extract more actionable knowledge from every customer transaction. Analysis like this, demands vast warehouses of customer data that can be minutely dissected to derive a previously unknown insight to improve business performance.

Further compounding the data growth problem are the finite physical limits some data centers are experiencing in their ability to expand. Whether it’s power/cooling or actual floor space constraints, adding more capacity to some facilities has become impractical. Because of cost and time considerations, building new data centers oftentimes is also not a practical solution.

Administrative complexity

IT managers have been able to moderate storage acquisition costs due to the remarkable decrease in the $/GB price of today’s technological advances. However,
with these astonishing technology advances, the day-to-day operational complexity and expense of today's typical data center has proportionally increased. Data centers are struggling to manage this complexity with little or no budget increases to help offset rising administrative burdens.

**Demand for dependable performance**

More and more data center users are demanding impeccable, highly available performance. They insist on quicker application deployment and better, more dependable access to their data. Fierce competition has reinforced the maxim that when storage goes down, businesses cease operating and customers go elsewhere.

**Hitachi Unified Storage**

HDS has recently introduced the HUS series to address these and other concerns of today's small to mid-size data centers. The HUS platform is an amalgamation of its previously introduced and highly successful AMS mid-range block storage and its HNAS file sharing gateway solution. Advanced versions of the two are integrated into one hardware system, under a single management console.

**HUS hardware features**

**HUS systems**

The HUS comes in three versions, an entry level, mid-range and maximum configuration, or the HUS 110, HUS 130 and HUS 150, respectively. Each HUS comes with a block module and one or more file storage modules. Multiple file storage modules can be clustered together to service the file IO activity and each cluster node (file module) supports 4 Fibre channel ports to access block storage. Block module host port options vary depending on the HUS system selected.

Every HUS block and file storage module supports two controllers for redundancy and high availability. Also, each block storage controller includes a Flash cache backup device to hold data for recovery purposes in the event of a power failure. Specific configuration options for the three systems are shown in Table 1 below.
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<table>
<thead>
<tr>
<th>Block Module</th>
<th>Entry level HUS 110</th>
<th>Mid-range HUS 130</th>
<th>Maximum HUS 150</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAM Cache</td>
<td>8GB</td>
<td>16GB</td>
<td>32GB</td>
</tr>
<tr>
<td>Host Interfaces</td>
<td>8Gb/s FC, 1Gb/s or 10Gb/s iSCSI</td>
<td>8Gb/s FC or 10Gb/s iSCSI</td>
<td>8Gb/s FC or 10Gb/s iSCSI</td>
</tr>
<tr>
<td>Host Ports</td>
<td>8-FC, 4-iSCSI ports, or 8-FC and 4-iSCSI</td>
<td>8- or 16-FC, or 8-FC and 4-iSCSI</td>
<td>16-FC, 4- or 8-iSCSI, or 8-FC and 4-iSCSI</td>
</tr>
<tr>
<td>Internal drive slots</td>
<td>12 LFF or 24 SFF</td>
<td>12 LFF or 24 SFF</td>
<td>N/A</td>
</tr>
<tr>
<td>Drive counts</td>
<td>Up to 120 SSD, SAS and NL-SAS</td>
<td>Up to 264 SSD, SAS and NL-SAS</td>
<td>Up to 960 SSD, SAS and NL-SAS</td>
</tr>
</tbody>
</table>

| File Module | | | |
| Nodes per Cluster | 1-2 File Modules | 1-2 File Modules | 1-4 File Modules |
| Cache per Module | 32GB | 32GB | 32GB |
| Ethernet Ports per Module | 4-10Gb/s, 6-1Gb/s, 5-10/100 Mb/s | 4-10Gb/s, 6-1Gb/s, 5-10/100 Mb/s | 4-10Gb/s, 6-1Gb/s, 5-10/100 Mb/s |
| File System Size | 256TB | 256TB | 256TB |
| File System Objects | 16 Million per Directory | 16 Million per Directory | 16 Million per Directory |
| Protocols | CIFS, NFS, FTP, HTTP | CIFS, NFS, FTP, HTTP | CIFS, NFS, FTP, HTTP |

Table 1 HUS configuration options

## HUS storage options

Physical storage options for all HUS systems include:

- For 2.5” or small form factor (SFF) disk drives, 300GB, 600GB or 900GB 10Krpm SAS drives at general availability and arriving in second half, 2012 will be a new, 300GB 15Krpm drive,
- For 3.5” or large form factor (LFF) disk drives, 2TB or 3TB 7200rpm nearline SAS (NL-SAS) drives,
- For SFF solid state drives, 200GB or 400GB SSDs.
Storage capacity can be expanded for any HUS system by adding 2U sized, LFF or SFF disk shelves that support up to 12- or 24-drives, respectively. For the HUS 130 and 150 systems, storage capacity options also include a 4U sized, LFF disk shelf that holds up to 48-3.5” disk drives. Consequently, with 3TB disk drives, the HUS 150 provides ~3PB of capacity and even the entry level, HUS 110 system supports up to 360TB of raw data storage.

**HUS block only options**

In addition to the unified storage described above, the HUS is also sold in block only configurations. Thus, if a data center really only needs block storage they can benefit from the latest Hitachi technology by just purchasing the HUS in its block only option.

**HUS performance**

The HUS markedly improves the IO performance of HDS’s previous generation storage. Specifically, for block storage.¹

- Sequential performance has improved by over 175%, maxing out at ~8.7 GB/second (sequential read, RAID 5, 256KB blocks),
- Random IO performance has also improved by over 30%, maxing out at over 72K IOPS (random read:write at 1:1, RAID 1+0, 8KB blocks).

For file storage performance, NFS and CIFS/SMB has also improved significantly. For example, recent HNAS 3090-G2 (roughly equivalent to HUS File Module) SPECsfs® 2008 results show significant NFS performance improvements from previous generation storage.²

Additional performance results using 15Krpm SAS drives and/or SSDs will be available later in the year.

**HUS functionality**

The newly introduced HUS also supports many advanced storage features in addition to its superior block and file storage services. These features were designed specifically to enhance data growth management, automate and simplify administration of this escalating storage capacity and promote optimum performance and system recovery.

¹ HUS 150 with 10Krpm 900GB SAS drives vs. previous generation storage using 10Krpm 600GB SAS drives.
Automatic storage tiering

One feature encompassing all the design improvements is the automated storage tiering or movement of data for peak performance supported by the HUS hardware configurations. HUS Dynamic Tiering is done on a page granularity (32 MB) basis and data is moved up or down the storage performance hierarchy according to access frequency. As such, infrequently accessed data can be stored on slower performing, nearline storage while more frequently accessed data is stored on better performing or SSD storage. When access requirements change, the data location is automatically shifted to provide optimal storage performance.

Larger block storage volumes and file systems

With the HDS HUS system, block storage volumes or LUNs can be configured to a maximum of 128TB. Consequently, block storage is much easier to manage as only one large LUN is necessary and configuring multiple, smaller LUNs is not required and in fact, unwarranted.

Alternatively, file systems can be up to 256TB in size. Single file systems this large are unusual in unified systems. Using this larger file system, however, mitigates the issue of having to move file directories as they outgrow their system limitations.

Dynamic provisioned storage

In addition to the larger block storage and file systems allowed by the HUS options, the unified storage system also supports dynamic or thin provisioning of both block and file data. There are multiple benefits of dynamic provisioning, all of which are significant in deferring future storage acquisition costs and alleviating some of the administrative management burden. Specifically, some of these advantages include:

- Using dynamic provisioning, capacity is only consumed when data is actually written to the system; without dynamic provisioning capacity is consumed upon configuration of a file system or LUN.
- Dynamic provisioning makes estimating LUN or file system sizes easier because by initially allocating a maximum size, to each application, future adjustments are not necessary and user disruption is not required. For example, a smaller file system could be initially configured for a maximum 256TB and then allowed to grow up to its limit without further disruption.
- With dynamic provisioning, data is automatically striped across all storage in a pool. System performance is thus improved because there are more disks and SSDs to service any IO request.
- When adding storage to a dynamic provisioned pool, data is striped across the new and old storage automatically, without operator intervention.

It should also be noted that block storage LUNS can be initially configured so that they too can grow to the maximum size available using dynamic provisioning. However, in contrast to file systems, LUNs can also be shrunk. As a result, if
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applications no longer need as much physical block storage its LUNs can be contracted, freeing up previously written blocks for other uses.

**Improved data copying and replication**

Other new, outstanding capabilities HDS has incorporated into its HUS systems encompass point-in-time or snapshot data copies and advanced replication technology. Specifically,

- HUS Block storage now supports up to 1024 read-only or read-writeable LUN snapshots. Using Hitachi Application Protector software, LUN snapshots can be taken directly from a Microsoft Management Console because HUS acts as a Windows VSS provider, and later this year will be able to be invoked directly from Oracle and SAP management consoles as well. Block snapshots use space efficient, copy-on-write technology to copy LUN data. In addition to snapshots, HUS also supports shadow-image LUN duplication to supply a physically distinct copy of block storage.

- HUS File storage now supports up to 1,024 read-only file snapshots or read-writeable file BlueArc JetClones. File snapshots can be created at the file, file directory or file system level and are primarily used for data protection. JetClones are done at file system level. JetClones are space efficient writable copies that can be used as a replacement for physical copies of file data. They are accessible just like the original source data but only consume space as data modifications occur. However, where necessary, JetClones can also be split off from the original data, providing a separate distinct file system copy.

As to replication advancements, all versions of the HDS HUS systems support replication of the full storage capacity of (up to ~3PB) to another HUS. This improvement has not impacted mirroring performance. In fact, replication performance impact has been greatly reduced. HDS has accomplished this feat by moving some replication status tables out of cache onto disk and thus allowing system DRAM cache to be solely dedicated to service ongoing IO activity.

The HUS systems also offer BlueArc JetMirror to replicate file data at the object level instead of the file directory level. Depending on customer needs, either file directory based or object-based replication may be the better solution. For example, with denser file systems having millions of small files, JetMirror can replicate such data to another HUS system up to 26 times faster than file directory replication since it keeps track of changes and only replicates data that was changed since the last replication request. However, object-based, JetMirror replication is done on whole file systems not file directories. As such, when a more granular level data mirroring is needed, a file directory based replication may be a better solution.
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Shared file and block storage using objects
All the HDS HUS systems allow file and block data to co-exist and share any underlying storage capacity available as a common storage pool. As such, file data can be intermingled with block storage just the same as with directories, all of which could then be potentially positioned right next to one another on the backend storage.

The added support for an object-based file system enables fast searches, intelligent in-frame file tiering, data migration, and fast replication over WAN. The object-based file system essentially maintains separate meta-data tables and provides added data management functionality unmatched by other vendors.

Single name space
Each HUS File Module can hold up to 125 file systems and to ease administration, the HUS also provides an option to cluster multiple file systems into a single, large namespace up to the full configuration of storage. With single name space, storage administrators can use one mount point to access all file systems across all HUS File Modules within an HUS cluster. Single mount points can significantly reduce administration burden as compared to systems that require separate mount points per file system. In addition, from a user’s perspective, it’s easier to locate and use file data under the same directory structure.

Enhanced file server consolidation
HUS’s Enterprise Virtual Server (EVS) makes consolidating a number of separate, smaller NAS systems into one HUS system much easier for administrators. In fact, data centers consolidating smaller NAS boxes into a single, larger system and wanting to retain the same IP addresses as the original file system mount points can now do so with EVS. This new capability can also streamline the consolidation of IP addressed, hard coded configurations of isolated NAS boxes. These isolated boxes are now easily incorporated into the consolidated HUS file system without the major disruption of yesteryear.

Dynamic virtual controllers
Another administrator friendly feature the HDS HUS system supports is the Dynamic Virtual Controller (DVC). This feature load balances block IO activity across controllers, i.e. LUNs are no longer locked to a specific block module controller and thus, its IO can move to a less busy controller. DVC also eliminates the need to assign a particular controller to service block LUN activity for file systems. Again, DVC automatically load balances block IO underlying the file systems data without the need for operator monitoring or intervention.

Increased VMware integration
As a unified storage system, the HUS supports virtual machine data as block LUNs or NFS files depending on customer preference. In addition, HUS has vCenter plugins, VASA and VAAI integration to ease the use of HUS in VMware environments. HUS
storage use also simplifies almost all virtual desktop deployments by supporting over 1,024 file JetClones or LUN snapshots of a single VM gold boot .vmdk disk.

**Hitachi Command Suite’s single management framework**

HDS now supports both HUS block and file storage with its Hitachi Command Suite (HCS) management software minimizing training and easing system operations. In fact, HCS has been enhanced to support the full portfolio of HDS storage products and as a result, making management of all of a data center’s HDS storage from a single HCS console a reality.

**Object data tiering and searching**

HDS has other hardware and software products which, when coupled with the HUS system, result in a truly symbiotic alliance. For example, when the automatic storage tiering of the HUS storage is combined with HDS’s Hitachi Content Platform (HCP), external out-of-frame file tiering can be supported. That is, HCP can migrate file data to/from the HUS File Module, and when archived, the HUS will automatically maintain an indirect pointer (aka “stub”) to the data.

Also, file data within the HCP can have custom meta-data added that can be used to provide content management services superior to those available within the HUS system alone. These HCP content management capabilities include archiving, regulatory compliance, enabling e-Discovery, dedupe, disposing expired data and keeping data intact and unchanged. While support for a separate object-store device is not unique, the fact that the HCP can use the same storage pool as the HUS makes it a more cost-effective and easier to deploy solution.

Another HDS product providing an advantageous complement to the HUS storage system is Hitachi Data Discovery Suite (HDDS). Use of this HUS-HDDS combination can provide e-Discovery-like search capabilities for file data. Additionally, HDDS can be used to index all file based data in a data center and thus, provide a single platform to support any litigation, information retrieval or other information repurposing effort. Moreover, with the HDD-MS for Microsoft SharePoint product, files can be migrated from the SharePoint server to either an HUS or HCP to help offset SQL Server fixed volume limitations. Small “stub” files are left behind on the SharePoint server so that clients are unaware of any physical data movement.

**Summary**

With the advent of HDS’s HUS advanced storage product, much progress has been made in mitigating the data growth, performance and administrative management concerns of today’s data centers. The hardware configurations are varied enough to fit the needs of small to mid-sized data centers.
Even more impressive, the features of the HDS unified storage system including storage tiering, dynamic provisioning, improved data copying and replicating and using an object store format, easily place the HUS product at the leading edge in storage for these clients. In fact, integrating file and block storage on top of object data support has transformed data storage beyond today's segregated systems, providing enhanced capabilities, better performance, and easier management. When HUS is coupled with HCP and/or HDDS, the enhanced HDS storage complex can fulfill all of a data center's content management needs within a single management framework with the same storage infrastructure servicing file, block and object storage needs.