Optimizing archival services with hierarchical storage and HP storage solutions

Achieving optimal performance, availability, and economy with hierarchical storage

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Introduction

Enterprise data centers can require a substantial investment in hardware due to storage capacity requirements. Given price, performance, and availability goals along with the various storage technologies to choose from, an IT architect might compromise one or more goals in order to meet others—especially if relying on a single storage technology.

This paper discusses how taking a hierarchical storage approach using a mix of storage technologies can meet all the design goals of a data center providing archival services.

Why hierarchical storage?

Enterprise data centers providing archival services always require more storage space—unstructured data and databases can reach terabytes in size. Maintaining data on high performance storage arrays and configuring reliable backup and recovery can result in a budget-breaking expense. Since archived data becomes less relevant with fewer accesses over time, it doesn’t make economic sense to continue using expensive storage technology for data that is rarely, if ever, used.

Hierarchical storage offers a cost-effective solution for archival storage systems by using a tiered storage strategy (Figure 1). A tiered storage system keeps the most frequently accessed data on high-speed, higher cost storage devices and migrates aging and/or backup data to slower, lower-cost devices. A hierarchical storage management (HSM) system can monitor file activity and automatically migrate files to secondary or even tertiary archival storage media following a pre-defined period or access policy. If archived files are recalled, the HSM system migrates them back to the primary, high performance storage devices. HSM uses at least two tiers and can include more, depending on need.

Figure 1. This illustration shows data flow for a tiered storage system.
Hierarchical storage concept and strategies

The basic concept of a hierarchical storage system is analogous to the tiered operation of a PC. While running an application on a PC, the most frequently accessed data stays in a small amount of very fast cache memory. Less-used data is stored in relatively slower/cheaper system memory, and the file is saved (backed up) on the local hard drive. The user can then archive files by burning a DVD or saving to an external hard drive. In this example, HSM is provided by the operating system, the application, and the user. Enterprise hierarchical storage systems follow the basic tiering concept of the PC, but use various mass storage technologies managed automatically by an HSM application.

Effective hierarchical storage must meet the following requirements:

- Large and expandable storage capacity on different tiers
- Resource and migration management
- Quick access to frequently-used data
- Reliable access to backup and archival data

Addressing those requirements efficiently and economically requires storage resources and management software. A variety of storage technologies are available today—SSDs, HDDs, optical disk drives, and magnetic tapes, representing a range from high price/high performance to lower cost/high-capacity storage resource choices. A typical hierarchical storage system will classify data and manage it in storage tiers as outlined in Table 1.

Table 1. Listed below are storage tiers and characteristics of a typical hierarchical storage system.

<table>
<thead>
<tr>
<th>Tier</th>
<th>Function</th>
<th>Used for</th>
<th>Storage technology</th>
<th>Interconnect technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>Online storage</td>
<td>Frequently accessed data</td>
<td>SSDs, high performance SAS or FC HDDs</td>
<td>6Gb/s SAS, Fibre Channel, InfiniBand</td>
</tr>
<tr>
<td>Secondary</td>
<td>Online/nearline storage</td>
<td>Occasionally accessed and backup data</td>
<td>SATA HDDs</td>
<td>Fibre Channel, 10 Gb Ethernet</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Offline storage</td>
<td>Rarely accessed archival data</td>
<td>Optical drives, magnetic tape</td>
<td>Fibre Channel, 1 GB Ethernet</td>
</tr>
</tbody>
</table>

A hierarchical storage system assigns data to tiers based on age and access policies set by the administrator. Service-level objectives define the actual number of tiers and the types of technologies for each tier, but most systems use a common architecture. The primary tier holds the most frequently accessed data. High transaction performance is mandatory for the primary tier and best achieved with a disk array using high performance storage devices such as SSDs and SAS or FC HDDs.

The cost of high performance, primary tier hardware can be offset by migrating less frequently accessed and backup data to the secondary tier. The secondary tier can consist of less expensive HDDs integrated with the primary tier disks inside the same frame or configured as external storage. Secondary tier requirements include high reliability and quick recovery. Tertiary storage can consist of optical or magnetic devices and may use a robotic system for retrieving archival data on removable media. To eliminate the possibility of data loss, the backup tier of an HSM ecosystem should be in a location remote from the other tiers.

The algorithm that HSM uses for determining when data migration from tier to tier occurs will vary with each application. For example, an application that processes sales information will typically have the current month’s sales reports accessed daily, last month’s reports accessed weekly, and last year’s reports hardly accessed at all. For this type of service, the administrator can set the data migration policy to occur primarily based on the age of the data. The allocation of storage space for each tier will also vary depending on the application. In the case of sales reports mentioned previously, the amount of primary and secondary tier storage space may remain fairly stable from month to month, while the archival storage space would increase every year.
Depending on the particular disk array systems involved, tiering can occur at multi-array or intra-array levels. Multi-array tiering assigns a tier to each array or array group, and tier division is mostly associated with equipment frames. Intra-array tiering assigns tiers within an array. For example, a single disk array with heterogeneous storage devices may have SSDs and HDDs arranged as separate tiers within a frame. Intra-array data migrations for such a system are controlled by firmware native to the array or by software running on a separate server. An externally connected storage array might then operate as a third tier. Data migration control for infrastructures that combine intra-array and multi-array tiering may thus be layered between the software controlling intra-array transfers and the HSM application governing all arrays.

**Applying hierarchical storage with HP storage solutions**

HP storage solutions offer the flexibility to create multi-array and intra-array tiering strategies and the expandability to satisfy exponential growth of data. You can assemble a complete hierarchical storage system with HP storage solutions that work harmoniously together.

**Primary tier solutions**

Primary tier solutions must meet the high performance and availability requirements of critical, frequently-accessed data. The HP storage solutions discussed in this section readily meet primary tier requirements yet also have multi-tier capabilities.

**The HP 3PAR storage system**

The HP 3PAR Storage System (Figure 2) has the robust functionality of primary (tier 1) storage and the cost structure of secondary (tier 2) storage. The HP 3PAR system combines autonomic tiering/provisioning/management with server virtualization and an active mesh controller to meet your performance and service goals with 50% to 75% fewer disks and up to 90% less administration time.

The autonomic operation of the system is provided through the HP 3PAR controllers and built-in software that allows the system to run with minimal intervention on the part of the administrator.

Autonomic tiering is provided by the HP 3PAR Optimization Suite of software. Two types of policy-driven, non-disruptive autonomic storage tiering are implemented; dynamic and adaptive. Dynamic optimization analyzes how volumes use physical disks and makes intelligent adjustments to align application requirements to QoS levels and ensure optimal volume performance and capacity utilization. Adaptive optimization uses a fine-grained data movement engine that redistributes data at the sub-LUN level to independent regions within a volume. This provides highly reliable tiered storage that delivers the right QoS at the right time to meet service level requirements.

Autonomic provisioning is provided by software allowing you to create host, volume, and domain groups intelligently. Rapid Provisioning software eliminates the need for array planning by providing application-tailored provisioning through fine-grained virtualization of lower-level components. Thin provisioning software optimizes drive utilization and avoids over-allocation of space by eliminating the need for dedicating storage capacity up-front on a per-application basis.

The active-mesh controller combines the benefits of both monolithic and modular architectures while eliminating price premiums and scaling complexities. With the active-active controller design of some systems, each LUN or volume is active only on a single controller. The active-mesh design of the HP 3PAR system allows each LUN to be active on every controller of the system for load-balanced performance and cost-effective scalability. Multiple controller nodes are joined through a full-mesh interconnect to form a cache-coherent cluster that meets cloud-computing requirements for efficiency, multi-tenancy, and autonomic management.
Fine-grained virtualization (Figure 3) divides each physical disk into granular building blocks ("chunklets") that you can independently assign and dynamically reassign to logical disks of different QoS levels. This level of virtualization means each disk drive can participate at a number of service levels for the most efficient use of physical assets. Writes are striped widely across all system resources (controllers, cache, disks, and disk chassis loops) for both high performance and a high capacity utilization rate.

As a single array, the HP 3PAR system establishes three tiers—tiers 0 and 1 using SSDs and high performance HDDs respectively for primary (online) storage, and tier 2 using enterprise SATA drives for secondary (nearline) storage.

Figure 3. The illustration below shows the fine-grained storage virtualization of the HP 3PAR system.

The HP 3PAR Management Console simplifies administration through a unified, point-and-click interface. 3PAR System Reporter software provides performance and capacity management that allows you to troubleshoot, plan, monitor, and collect information for Service Level Agreement (SLA) and chargeback capabilities. 3PAR Host Explorer software automates discovery and collection of detailed host configuration data to speed provisioning and simplify maintenance.

Virtualization and automation features are built into the HP 3PAR system to work with leading virtual server software products such as VM vSphere™, VMware View, Microsoft Windows Server 2008 Hyper-V®, Citrix XenServer™, Red Hat Enterprise Virtualization (RHEV), and Oracle VM. This capability allows you to purchase 50% fewer physical servers, cut storage capacity by 50% or more, and spend 90% less time managing your virtual data center.

HP 3PAR Utility Storage software provides thin provisioning to eliminate the tradeoff between capacity efficiency and performance often found in database environments. HP 3PAR Recovery Manager software offers cost-effective Oracle- and SQL-aware snapshot technologies for efficient and reliable restores.
The HP XP P9500 Disk Array

The HP XP P9500 Disk Array is an enterprise-class storage system that uses virtualization technology to maximize resource utilization to maintain high availability of primary tier data. Configured with high performance drives, the P9500 array provides a hierarchical storage system with online/top-tier performance for primary storage.

Figure 4. This illustration shows the HP XP P9500 Disk Array.

The P9500 array can be deployed as a singular primary tier, but also comes with management tools including Smart Tiers and Tiered Storage Manager (TSM) software that allows intra-array tiering. Both tools provide intra-array migration functionality, allowing a mix of SDDs and HDDs to be designated as different tiers. Smart Tiers software transparently performs intra-LUN data migrations between tiers inside the array. The software monitors data access performance and frequency in thin-provisioning pools at the page level and provides policy-based migration to a different tier automatically or manually. The storage administrator can configure up to three tiers per policy.

TSM software provides intra-array HSM functions by migrating data without disrupting online applications. The storage administrator can set migration policies by associating quality of service (QoS) requirements (such as cost, performance, and data protection level) to the storage technologies available inside the system. This software works with both internal disk drives and external storage systems such as the HP Modular Smart Array (MSA) P2000, the HP Enterprise Virtual Array (EVA) P6000, or the HP 3PAR system.
The HP IBRIX X9000 series of storage systems

Unstructured data can exhibit exponential growth that impacts performance and places huge storage costs on a data center. HP IBRIX X9000 storage systems (Figure 5) offer performance, management, and scalability that extend well beyond traditional NAS systems. With built-in tiering and data migration capabilities, HP IBRIX X9000 systems can provide intra-array tiering within a single frame.

The HP X9320 system allows you to start small, and scale capacity and performance as needed. The HP X9730 system offers substantial start-up capacity, and multiple X9000 systems can be combined for multi-array tiering (Figure 6). Simplified, modular scalability allows the HP X9000 system to grow on demand—up to 16 petabytes within a single global namespace.

The HP IBRIX X9000 system is available with CommVault® Simpana®, a unified HSM application that enables rich, policy-driven data placement. CommVault Simpana balances cost and performance by uniting both disk and tape elements and dynamically placing data sets on the most suitable storage tier. CommVault Simpana software integrates with key business applications such as Microsoft Exchange and Lotus Domino Messaging Services, collaboration services such as Microsoft SharePoint, and other enterprise-wide file shares across heterogeneous operating system platforms. With this solution, storage appears as a single virtual resource pool of disk and nearline D2D/VLS/tape tiers that can be dynamically altered to balance cost and performance.

Figure 5. The HP IBRIX HP X9000 series includes the X9320 and the X9730 systems.

Figure 6. Multi-tier archiving with the X9000 system delivers seamless and transparent access to information regardless of storage tier or medium.
The secondary tier solution—HP StoreOnce D2D system and HP Data Protector

A business’s ability to recover from a major disruptive incident is defined by its Recovery Time Objective (RTO) and Recovery Point Objective (RPO). RTO is the time (in hours) required to recover a data system following a disaster or, put another way, the amount of time a business can afford to have the data center down. RPO is the maximum amount of downtime a business will tolerate (from a data standpoint) in the event of a data center disaster. RTO and RPO values can be influenced by the speed and efficiency of the backup and restore process.

Data centers often use magnetic tape or network-attached storage (NAS) for backing up data. Tape libraries meet reliability goals, but usually do not meet RTO/RPO goals. Network attached storage (NAS) can meet recovery goals but requires large amounts of capacity and file protection schemes.

Hierarchical systems hold backup data in secondary tier storage. The HP StoreOnce D2D system (Figure 7) is a disk-to-disk backup appliance that can provide high performance secondary tier (nearline) storage and uses deduplication for efficient storage and responsive data recovery. The StoreOnce D2D system can be configured as a virtual tape library (VTL) or as a NAS subsystem.

Configured as a VTL target, the StoreOnce system emulates physical tape and library devices so that it integrates seamlessly with widely-used backup applications. The StoreOnce D2D system can act as a staging post for disk-to-tape migrations because backup data is stored in tape format.

Configured as a NAS target, the StoreOnce system appears to the operating system and application as a network file system (NFS) or Common Internet File System (CIFS) disk share. The NAS configuration offers file share backup functionality ideal for SQL Server native backup.

HP StoreOnce D2D systems include built-in data deduplication, a compression technique that splits files into chunks of data for economizing space and improving network efficiency. A chunk common to two or more files is stored once with links to any file that uses it. When a file is accessed, it is reassembled from the common and unique chunks. HP StoreOnce D2D uses the variable-size chunking technique. Compared to fixed-size chunking, variable-size chunking is a more granular scheme that results in higher deduplication ratios for the most efficient use of storage space. The type of data stored determines the degree of deduplication. With compressible data that is mostly the same, deduplication can reduce the data (and therefore the disk space required) by 20x. Data reduction will be less if the data is largely unique or non-compressible.

Besides preserving storage capacity, deduplication optimizes network bandwidth. Since replication and archival transfers move deduplicated data, only a fraction (down to 1/20th) of the original size of uncompressed data is moved. Reducing the volume of data movement quickens recovery time (RTO) and allows more frequent backups for reduced RPO.

The HP StoreOnce D2D system becomes a powerful data protection and backup infrastructure with HP Data Protector. HP Data Protector is a software solution that uses intelligent, meaning-based data management to protect data across physical and virtual environments. All management can be centralized with the Data Protector GUI allowing all backup and restore operations for physical and virtual systems to be monitored and configured from a single location. Tasks can be easily delegated to other administrators to access Data Protector from locally installed consoles. Data Protector utilizes both the NAS and VTL interfaces of the StoreOnce appliances for use as backup devices to primary tier arrays such as the P9500. HP Data Protector version 6.21 (and later) allows for federated deduplication that leverages the HP StoreOnce deduplication engine. This solution allows deduplication to occur only once and at any of three locations—the application source, the backup server, or the target device, meaning that remote office/branch office (ROBO) locations can be a part of a centralized data protection and backup/recovery system.
The tertiary tier solution—the HP Enterprise System Library G3 Tape Library

Data in a hierarchical storage system eventually becomes a candidate for migration to archival storage. The constants in archival data are that it grows continuously, needs long-term protection, yet should remain readily available. The HP Enterprise System Library (ESL) G3 Tape Library (Figure 8) can provide the tertiary tier (offline) solution that satisfies those requirements for a hierarchical storage system.

Figure 8. The HP ESL G3 Tape Library.

The HP ESL G3 Tape Library is compatible with the leading operating systems and backup applications and as such integrates easily within a hierarchical storage system. Data is protected though AES 256-bit hardware-based data encryption and HP’s Enterprise Secure Key Manager (ESKM). The system can also use Write-Once Read Many (WORM) media and meets SEC and HIPPA integrity guidelines for data integrity verification beyond seven years. Access to the system can be further enhanced with the Security Manager option that allows only authorized hardware to access tape drives and critical data.

The HP ESL G3 Tape Library meets high reliability and availability requirements with a 3 million MSBF (mean swaps between failure) rating and the use of redundant power supplies and host connectivity failover mechanisms.
HSM with Quantum StorNext

Quantum StorNext software works with HP storage products to provide a high performance data migration and archiving system. StorNext includes an integrated data movement engine that transparently migrates files between tiers of storage to reduce data retention costs while providing data protection. StorNext also reduces the need for storage provisioning, enhancing storage layout for performance and expansion and allowing the workflow to handle larger models. Data deduplication, replication, and a streamlined management console have been incorporated into the latest release of StorNext. For the latest information on StorNext refer to the link in the ‘For more information’ section of this document.

Conclusion

Using hierarchical storage that employs a mix of storage technologies allows you to build a cost-efficient multi-tiered storage system that meets your performance goals and recovery/archival requirements. Incorporating automatic migration and archiving of data files removes user intervention from the storage policy procedure and enhances data integrity for large-scale environments.

For more information

Visit the URLs listed below if you need additional information.

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<thead>
<tr>
<th>Resource description</th>
<th>Web address</th>
</tr>
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<tbody>
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<td>HP P9500 XP disk array family</td>
<td><a href="http://www.hp.com/go/p9500">http://www.hp.com/go/p9500</a></td>
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<tr>
<td>HP StoreOnce D2D</td>
<td><a href="http://www.hp.com/go/storeonce">http://www.hp.com/go/storeonce</a></td>
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<tr>
<td>HP Data Protector</td>
<td><a href="http://www.hp.com/go/dataprotector">http://www.hp.com/go/dataprotector</a></td>
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<tr>
<td>HP ESL G3 Tape Library</td>
<td><a href="http://www.hp.com/go/tape">http://www.hp.com/go/tape</a></td>
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<tr>
<td>HP IBRIX X9000 system information</td>
<td><a href="http://www.hp.com/go/x9000">http://www.hp.com/go/x9000</a></td>
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