Storage Resource Management: A Practitioner's Approach

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Sun BluePrints™ OnLine – April 2002

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Part No. 816-4822-10
Revision 1.0, 03/27/02
Edition: April 2002

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The rapid growth of enterprise storage capacity for distributed computing systems must, necessarily, be mirrored by its rapid growth in its cost. If an enterprise storage organization has been growing its open-system distributed storage capacity at a rate of 100% per year, it must be assumed that the budget for this new capacity is likely growing at a similar rate.

If you compound this growth year over year, you can reasonably expect the cost of supporting this growth may, at sometime, become untenable. While megabytes may be *cheap*, terabytes and larger capacities are not. When it comes to managing storage, the key word is efficiency. It is not hard to buy and implement multiple terabytes of distributed storage (many organization have already done this), but it is hard and very costly to manage them.

An enterprise storage organization and the businesses that it serves must discipline themselves to maintain best storage practices to ensure maximum value and operational efficiencies from their distributed storage resources. For this reason, the implementation of storage resource management should be considered as an important part of any model for enterprise-level distributed storage. Whether these resources are locally attached or within complex switched matrices, the need for a unified and informed management practice has never been greater.

Organizations that have relied on the diligence of either central or syndicated storage management organizations using largely manual processes to do their job must now seriously consider the operational gains and subsequent return-on-investment they can obtain by implementing a storage resource management solution to assist them in maximizing their management practices.

In this document, storage resource management (SRM) systems and best practices are discussed, with a particular focus on the positive impact that SRM can have on controlling costs related to storage management by increasing operational efficiency within enterprise storage infrastructures.

Best Practice Principles for Storage

The operational and economic efficiency of any enterprise storage organization is a by-product of its storage best practices. Without the definition and adherence to these practices, no enterprise storage organization can hope to lower the risks associated with implementing and administering large distributed storage infrastructures. The definitions of storage best practices are not within the scope of this paper; however, the following principles do apply:

- Enterprise storage should be available and reliable.
- Enterprise storage should have acceptable performance.
- Enterprise storage should be scalable.
- Enterprise storage should fit into the backup strategy of the environment.
- Enterprise storage should have an acceptable total-cost-of-ownership (TCO).

These principles require practices that can be monitored to ensure conformity. An enterprise storage organization must gauge its success as an organization by monitoring all of the managed storage resources for conformity to these storage best practices and their defining principles.

SRM provides the management layer from which policy-based storage management becomes possible. Without this management layer, there is no way for you to gauge, nor expect compliance with, storage best practices. With its ability to monitor, inform, define, and enforce processes and practices that support the principles of storage best practices, SRM is itself a best practice for managing enterprise distributed storage infrastructures.

Storage Resource Management

M. Nicolett and C. Claps state that “The SRM infrastructure is a complementary set of products, standards, and procedures that provide reporting, analysis, and automated management of physical and logical storage availability, capacity, configuration and performance.”[1]

With a robust SRM system in place, you can view, trend, report on, and proactively manage both the logical and physical resources that comprise an enterprise storage stack. This functionality is imperative to maintain successful links between businesses and the technology groups that serve them. Different business functions exhibit a wide range of storage utilization behavior and may, therefore, demand

1. Gartner Research and Advisory Service Strategic Analysis Report, November 12, 1999, M. Nicolett, C. Claps.

multiple levels of service from the same enterprise storage organization. To manage only the physical attributes of this storage may be inadequate when the evaluation of multiple service-level agreements is needed.

Enterprise storage is not just disk, cables, and switches. Enterprise storage encompasses the applications and business processes that it serves. It must be managed with a discipline that reflects the behavioral characteristics of those applications and business processes. An SRM system, by definition, must manage physical resources, but it must also accommodate the view of storage that is business-function specific. Storage resource management must be capable of managing the physical, logical, and presentation (reporting) layers of enterprise storage stack performance, utilization, and configuration. The more robust the storage resource management system, the better the resulting data can be, and potentially, the higher the rewards from its implementation.

Storage resource management systems provide the following functions:

- Storage discovery trends for:
  - Operating platforms
  - Storage vendor type
  - File system type
  - Data access and modification times
  - File and directory sizes
- Unified views of heterogeneous storage resources across all major variants of distributed computing platforms
- Configurable views of storage resources by using multiple storage object classifications (logical storage groupings) for:
  - Applications
  - Development efforts
  - Data types
  - Servers
  - File systems
  - Database file systems
  - Directories, folders, and files
  - User account ownership
- Trending of behavioral characteristics in storage object classifications
- Predictive models for storage object classifications
- Event-driven storage automation
- Extensive reporting capabilities for all storage objects
- Open-system architecture and scalable design (extensibility)
- Ease of implementation and administration

Although all of these functions may not be available from any one commercially available system, an enterprise storage organization should focus on obtaining the SRM system that meets the greatest number of current and projected needs.

SRM systems can provide an enterprise storage organization with behavioral details of its storage systems. These details, when illuminated, provide a means to efficiently act on capacity planning, backup, data migration, and other storage management-related efforts that support storage best practices.

SRM Best Practices

Storage resource management best practices lead to the most efficient, reliable, and cost-effective operations of the enterprise storage stack.

In the best-case scenario, the development of SRM best practices flows as follows:

- Service-level agreement
- Storage best practices
- SRM best practices

However, this flow frequently develops differently when SRM is implemented into a mature, distributed enterprise storage infrastructure:

- SRM system implementation
- Storage discovery process
- Customer resource identification process
- Behavioral classification of customer physical resources
- Service-level agreement
- Storage best practices
- SRM best practices

In either scenario, SRM best practices reflect the storage best practices derived from business service-level agreements.

SRM Best Practices Definitions

Although many organizationally specific operating directives can impact best practices of any kind, storage included, it is still possible to define a basic set of SRM best practices.

Storage resource management systems must:

- Monitor all physical enterprise storage resources that are covered within the framework of existing service-level agreements.
- Represent these physical resources in logical application or business-function-specific constructs, as required by the storage customer.
- As required, represent physical storage resources within the following logical groupings:
  - Server
  - File system
  - Database
  - Directory
  - User
- Develop and enforce standard naming conventions for logical groupings.
- Provide or feed predictive capacity planning engines for these logical groupings.
- Develop customized monitoring configurations, based on service-level agreements.
- Monitor and trend logical and physical resources within a grouping to develop baseline behavioral trends.
- As defined by service-level agreements, automate processes related to managing the physical resources comprising logical storage constructs in a manner that maximizes value, performance, availability, and reliability of the customer's storage resources.
- Automate reporting on customer resources to ensure that customers are informed about their storage behavior.
- Provide customers with mechanisms to control consumption where possible and desirable within logical groupings, as defined by service-level agreements.

Application of these basic rules, when implementing an SRM strategy and extending them where necessary within the context of specific service-level agreements, makes the successful realization of the benefits of an SRM system possible.

SRM Scenarios

The following scenarios describe projects in which SRM systems improved the efficiency of the administration and planning of large, distributed computing storage infrastructures. These scenarios are not comprehensive outlines of storage-related efforts. They are descriptions of efforts in which SRM systems are used to increase the operational efficiency and management of distributed system storage resources. These systems have empowered the existing storage administration staffs to take on

greater responsibility without adding head count by reducing the effort of administration through the adherence to SRM best practices. These scenarios hopefully shed some light on how to use storage resource management systems and on the best practices for such systems to increase the efficiency and management of distributed systems storage infrastructures.

The scenarios are presented in two parts:

1. Strategic scenarios focused on planning for large infrastructure efforts
2. Tactically aligned scenarios that focus on consumption management

All of the scenarios are defined within the context of the following key SRM functions.

TABLE 1 Key SRM Functions

SRM Functions	Description
Storage discovery	Finds the detailed information about enterprise storage resources that can be used to better manage the enterprise storage stack.
Capacity planning	Projects capacity growth for one or more storage objects under SRM management.
Consumption management	Assists storage customers and administrators to mediate capacity consumption rates.
Data migration	Assists in the identification and planning stages of data migration efforts.
Charge back	Facilitates the development of accurate charge-back systems based on customer utilization habits.

Note – These key SRM functions are not mutually exclusive, but complementary. See “Appendix” on page 23 for an outline of the basic cost-avoidance calculations for the first scenario. Use this appendix to document return-on-investment (ROI) from the implementation of an SRM system.

SRM Strategic Scenarios

This section contains the scenarios that show the strategic value of SRM practices.

Scenario 1: Corporation W

Key SRM Functions: Storage Discovery – Capacity Planning

In this scenario, SRM helps to discover significant storage-related trends resulting in increased accuracy of the capacity planning decision-making process.

Corporation W is preparing to make strategic budgeting decisions for the upcoming year. One of these decisions is whether or not to continue expanding their enterprise storage capacity for distributed systems. Last year they expanded their UNIX™ and NT system enterprise storage capacity by 100%, and this year the businesses are planning a similar expansion. However, before agreeing to absorb the cost of yet another 100% expansion, senior management realizes that it needs better visibility within the current enterprise storage stack to calculate the actual data growth rate.

The question is simple: Based on actual data utilization growth metrics, can we see a real need to grow our current capacity by 100%? The enterprise storage operational staff must answer three basic questions:

- What is our current enterprise storage capacity?
- What is our current enterprise storage utilization?
- What is the growth rate of the enterprise storage stack?

No current reporting mechanism can offer this visibility. They have no way to trend capacity and utilization across all systems. They decide to implement an SRM system to provide them with the necessary data. An SRM product is selected and implemented on UNIX and NT servers within the firm. A management overview of the firm's storage is developed for senior management. The following data shows the findings from the SRM storage discovery phase.

TABLE 2 SRM Storage Discovery-Capacity Planning Table

Overall Capacity	Free Space	Used Space	Percent Utilized	Quarterly Growth Rates
12 Tbytes	5 Tbytes	7 Tbytes	58.33%	12%

A quick analysis of this data produces an annual growth chart, as follows.

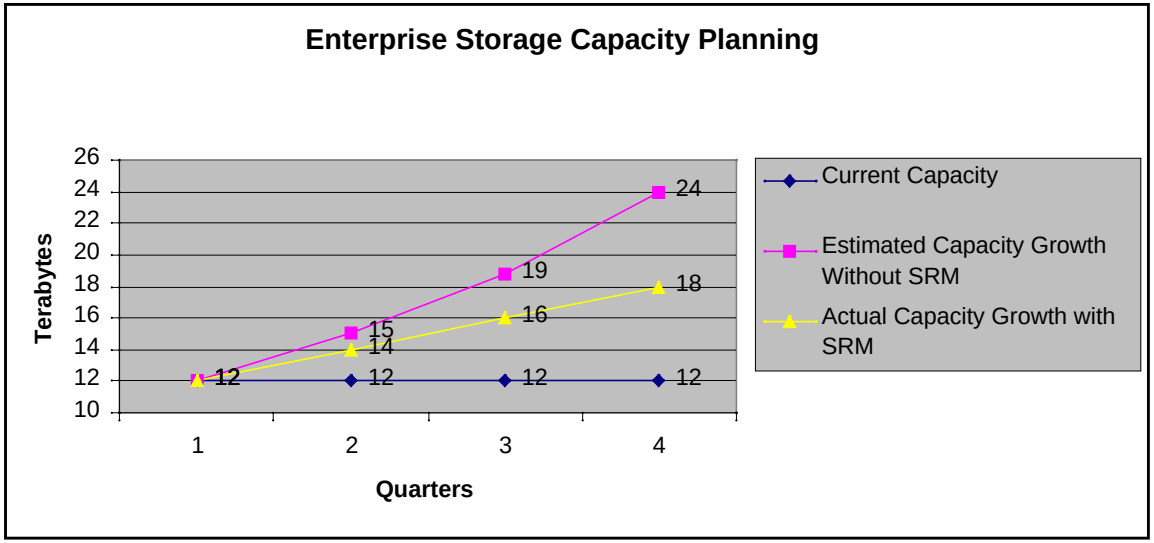

FIGURE 1 SRM Capacity Planning Chart

Based on the actual recorded growth rate of 12% per quarter (48% annual increase), the enterprise storage stack within the year requires only an additional 6 Tbytes of capacity to maintain existing utilization rates (58.33%). The pre-SRM estimated capacity requirement of an additional 12 Tbytes (100% expansion or 25% quarterly growth) would have meant the purchase of 6 Tbytes of unnecessary disk. Assuming a cost-per-megabyte of $0.30[1], 6 Tbytes of unnecessary disk, or 6,000,000 Mbytes, would cost the firm $1,800,000.00.

In this scenario, SRM best practices are used to assist senior management in understanding what storage costs are actually warranted based on efficient storage trends monitored within the enterprise storage stack. This view, which is strategic in scope, is one area where SRM systems can add significant value to enterprise storage organizations.

Scenario 2: Corporation X

Key SRM Functions: Storage Discovery – Capacity Planning – Data Migration

In this scenario, SRM discovers significant storage-related trends within logically configured storage objects. This information is then used for more efficient SAN planning.

1. See "Appendix" on page 23 for a cost-per-megabyte explanation.

A division within Corporation X is considering a SAN to replace its current stock of locally attached storage resources. The primary drivers for this move are:

- Utilization levels of locally maintained file systems are inefficient.
- Administrator-to-terabyte ratios are high due to the numerous and geographically dispersed local storage resources.
- Backup and recovery windows are becoming harder to maintain for the numerous and geographically dispersed local storage resources.

As part of their pre-SAN planning, Corporation X implements an SRM system to ascertain what data to target for SAN migration and how behavioral characteristics of this data might impact SAN configuration. They must answer three key questions before planning the SAN size and configuration.

TABLE 3 SRM SAN Planning Table

SRM-Related Question	SAN Planning Impact
What was the current size of the data to be migrated to the SAN (UNIX –NT servers)?	Initial capacity of the SAN and SAN zone planning
What is the annual growth rate of the data to be migrated (UNIX –NT servers)?	Initial SAN capacity requirements and projected SAN capacity requirements after one year
What are the characteristics of the data and the data activity levels (modification frequency on UNIX –NT servers)?	SAN backup planning and prioritization of data migration to the SAN

The answers to these questions determine the size, growth rate, and characteristics of the data that is deemed both critical and dynamic enough to be migrated to a new SAN.

Key personnel from the storage organization and divisional business units are brought together to construct the logical groupings of divisional storage resources by data function, as shown in the following table.

TABLE 4 Logical Groupings of Divisional Storage

Logical Groupings	Function
Application data	Production applications
User data	User community's personal and/or business needs
Database data	Database file repositories

To assist in understanding how different data types behave, these logical groupings are then monitored and trended by the SRM system.

These groups comprise:

- Server groups by OS type
- File system groups by OS type
- Directory or folder groups by OS type

Based on these groupings, they developed the following SAN capacity planning chart.

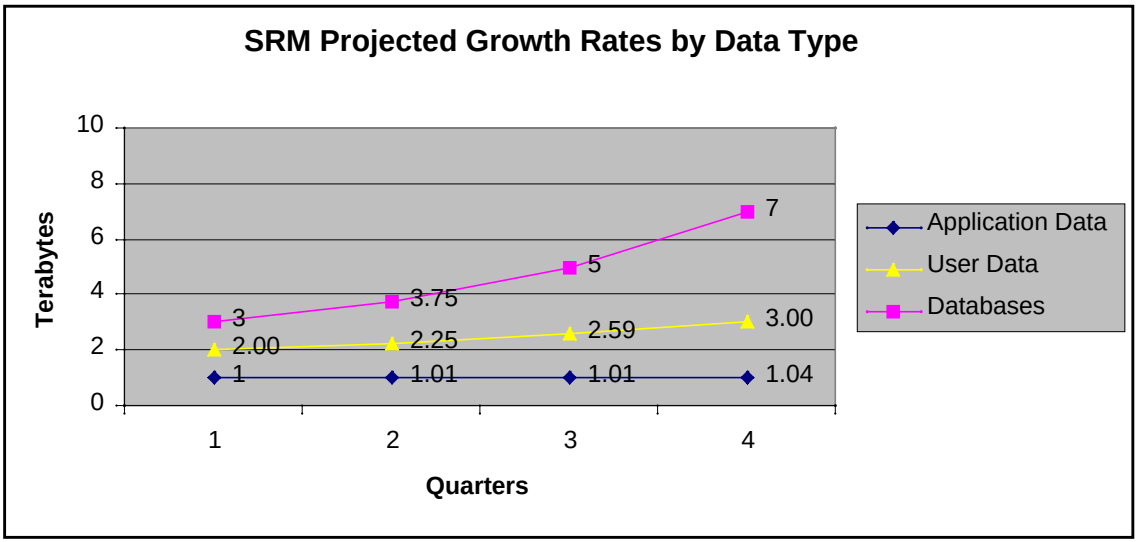

FIGURE 2 SRM SAN Capacity Planning Chart

Both the user and database data types are the most likely targets for migration to the SAN, based on their dynamic growth patterns, as follows:

- User data is projected to grow by 50% within the year.
- Database growth is projected to reach 133% within the year.
- Application data is projected to be tame at 2% within the year.

Having determined that the database and user data are the first data types to be migrated to the SAN, the storage organization and its business customers determined that the initial SAN capacity must be 7.5 Tbytes to accommodate the initial 5 Tbytes of user and database data plus one quarter's worth of projected growth for both data types. This leaves the SAN with a projected 20% capacity buffer by the end of the first quarter. This margin is deemed sufficient to buffer SAN utilization growth while future SAN capacity expansions are put in place. Yearly budgeting for SAN storage includes the cost of 12 Tbytes of SAN storage within the year. This number includes the projected year-end capacity requirements for user and database storage capacity (10 Tbytes) plus a 20% buffer.

The capacities and growth rates by operating system allow the storage administration group to efficiently plan initial zone capacities within the new SAN. The SRM data shows the following data growth by OS type.

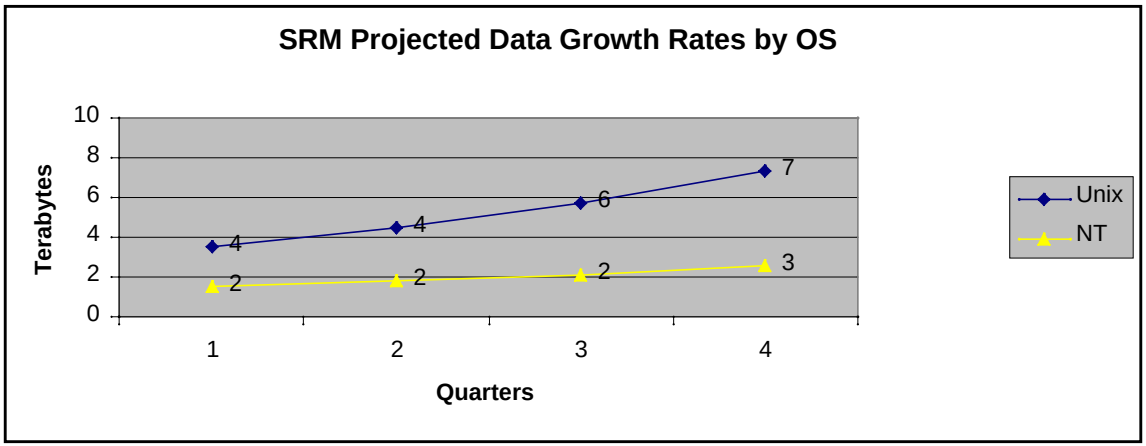

FIGURE 3 SRM Growth Rates by Operating System Type

From this data, storage organization was able to determine the following:

- Zone for the UNIX OS must support an initial capacity of 4 Tbytes, with a projected annual growth rate of 75%.
- Zone for the NT OS must support an initial capacity of 2 Tbytes, with a projected annual growth rate of 50%.

By applying growth rates by operating-system metrics to their planning stage, the storage administrators can more efficiently plan not only for overall SAN capacity, but also for efficient zone capacity configuration within the SAN.

SRM SAN Data Migration

The SRM metrics for the modification trends within data types are collected to help prioritize the migration of production data onto the SAN. This prioritization also helps ensure that production data that currently requires the most backup and restore efforts within the older, geographically dispersed infrastructure is the first to be moved to the new SAN. The plan is to identify the most dynamic data within each data type for first-phase migration. The capacity of data modified on a nightly basis also helps plan for the capacity of nightly backups within the new SAN. This backup-related data is considered very important because the ability to centralize critical backup and restore operations within the SAN is key to reducing costs while

increasing efficiency for enterprise storage within the firm. Therefore, proper sizing and efficient operation of the new SAN backup is central to the success of the migration plan.

The following charts show the modification metrics for user data and database data.

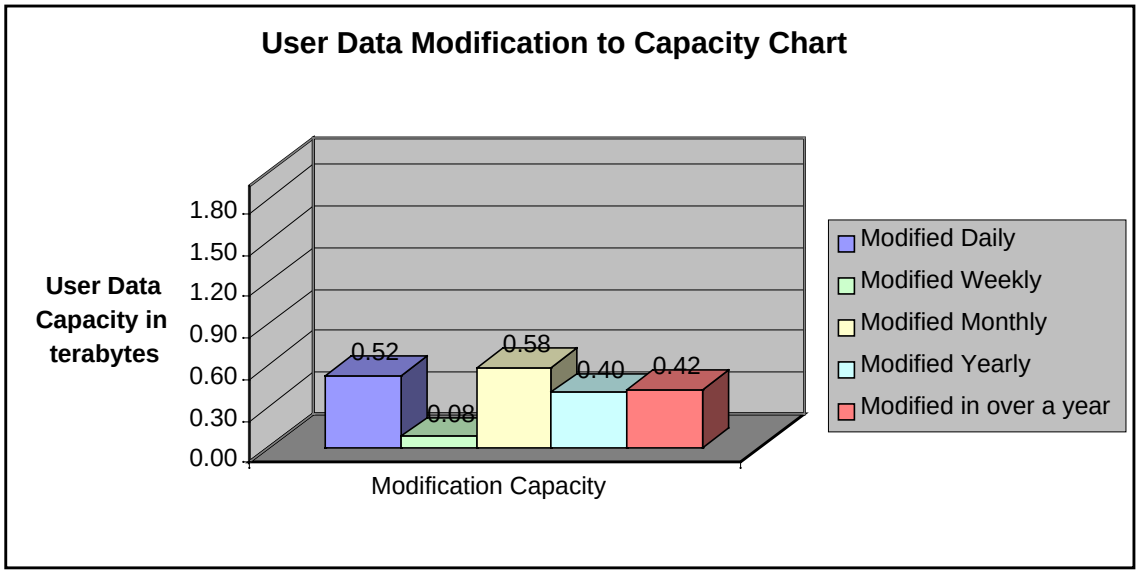

FIGURE 4 SRM Modification Metrics by Data Type

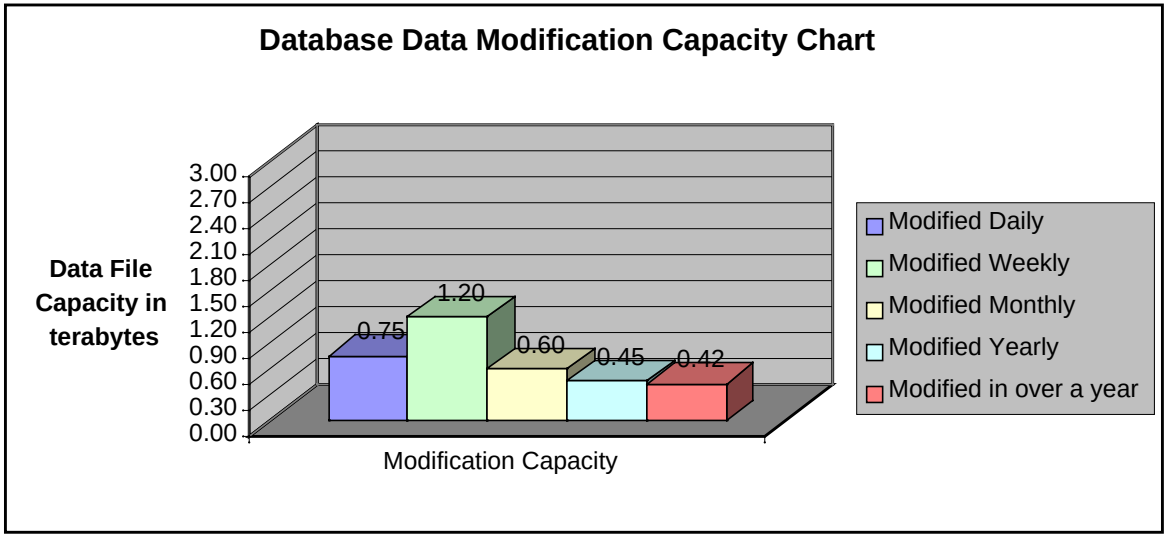

FIGURE 5 SRM Data Modification Capacity Charts

Using these modification capacity metrics, and the server, file system, and directory groupings within the SRM system, the storage administrators can map this modification capacity back to the individual directories, file systems, and, ultimately, servers on which this data is currently stored. They can now plan data migration on a server-by-server, file-system-by-file-system basis from the old infrastructure to the new SAN-based infrastructure, based on accurate data criticality and activity information.

The storage administration group can also plan for a SAN backup capacity of at least 5 Tbytes within the first month of operation, based on modification trends within the targeted migration data, as shown in the following modification trends chart.

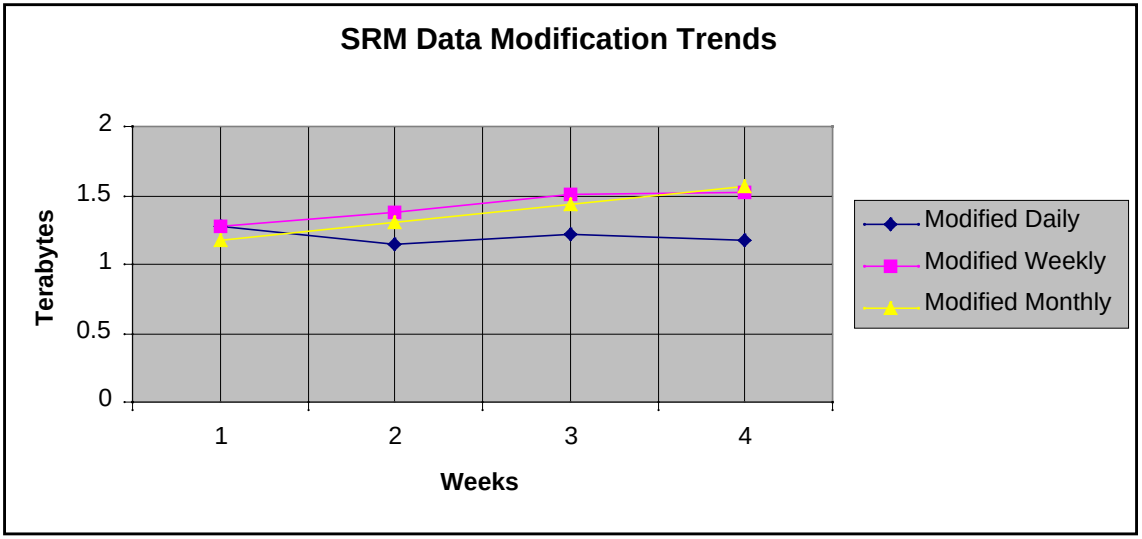

FIGURE 6 SRM Data Modification Trends

Target data that consistently shows modification stamps of over a month is scheduled for later migration to the SAN because its backup and restore activity does not pose a burden to the existing storage infrastructure. Data that shows modification stamps of over a year is deemed least important to migrate to the new SAN, and steps are taken to review less expensive storage architectures onto which this largely archival data can be moved.

In this scenario, SRM best practices were used to efficiently plan a new SAN. SRM metrics provide guidance for the initial size of both SAN storage capacity and backup capacity, as well as the most efficient path of data migration from the existing storage infrastructure.

SRM Tactically Aligned Scenarios

This section contains SRM best practices that add value through tactical efforts, such as consumption management.

Scenario 1: Corporation Y

Key SRM Components: Storage Discovery – Capacity Planning – Consumption Management

In this scenario, SRM helps to facilitate consumption management strategies.

Business unit managers within a division of Corporation Y are looking for a better understanding of how their storage is consumed. They want to develop storage best practices that can ultimately lead to a reduction in their storage-related costs, along with improved storage availability.

These unit managers ask the storage administration group to set up metrics within the SRM system to help them make better storage-related decisions. Working with the storage administration group, they create logical SRM groupings representing the individual business units within the division, as well as logical units representing two areas of user-related consumption: personal data and NT user profile directories. After these objects are placed under SRM management, the business unit managers provided a list of data points to the storage administrators to help them determine storage best practices within their areas.

The business-requested SRM user-data-related metrics are:

- Number of users
- Capacity of all user data areas
- Capacity of all user profile areas
- Average consumption by user for personal and profile areas
- Growth rates on all personal user data areas
- Growth rates on all user profile areas
- Growth rates on individual user data directories
- Growth rates on individual user profile directories
- Growth spikes in user personal data areas
- Growth spikes in user profile directories
- Lists of user directories over a designated size
- Lists of user profile directories over a designated size

Using these data points, two different reports are created for the business managers:

- The strategic report details the total capacity for user data and profile directories, the average consumption for both these areas, and the growth rates for these two areas across all server resources.
- The tactical report lists largest current consumers of space, user data, or profile directories that have grown greater than a designated threshold between daily SRM scans.

Using these two report types, the business managers, in conjunction with their storage administrators, hope to better determine a path to storage best practices for their areas.

TABLE 5 SRM Consumption Management Business Unit Report

Unit Number	Users	Data Capacity	Profile Capacity	Average Data Capacity	Average Profile Capacity
Unit 1	117	53,259	10,652	455	91
Unit 2	154	40,437	8,087	263	53
Unit 3	134	28,056	5,611	209	42
Unit 4	86	10,661	2,132	124	25
Unit 5	23	3,301	660	144	29
Unit 6	12	3,352	670	279	56
Unit 7	192	44,999	9,000	234	47
Unit 8	193	17,804	3,561	92	18
Unit 9	183	52,845	10,569	289	58
Unit 10	43	12,019	2,404	280	56
Totals	1,137	266,733	53,347	235	47

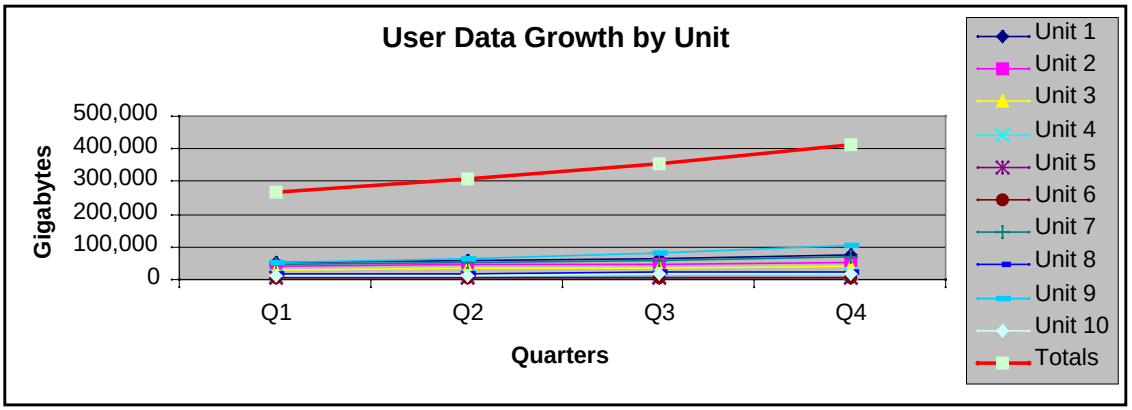

FIGURE 7 SRM Consumption Management Charts

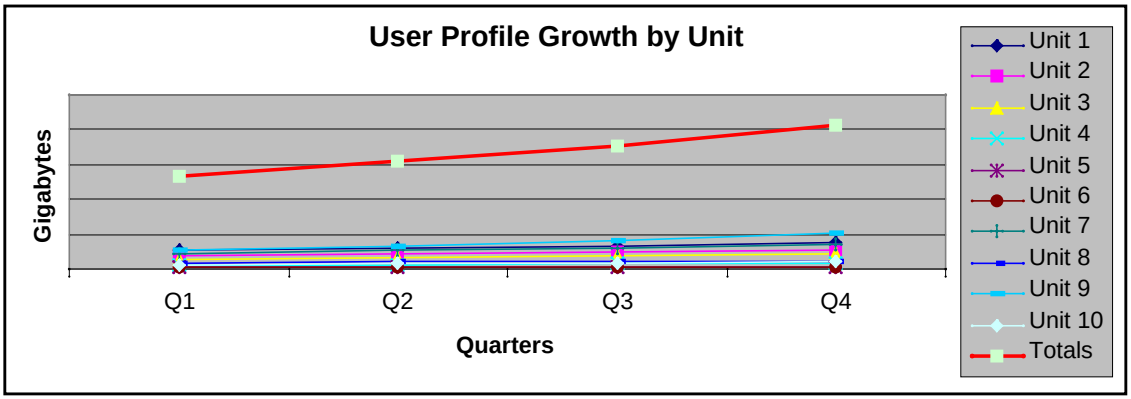

FIGURE 8 SRM User Profile Growth

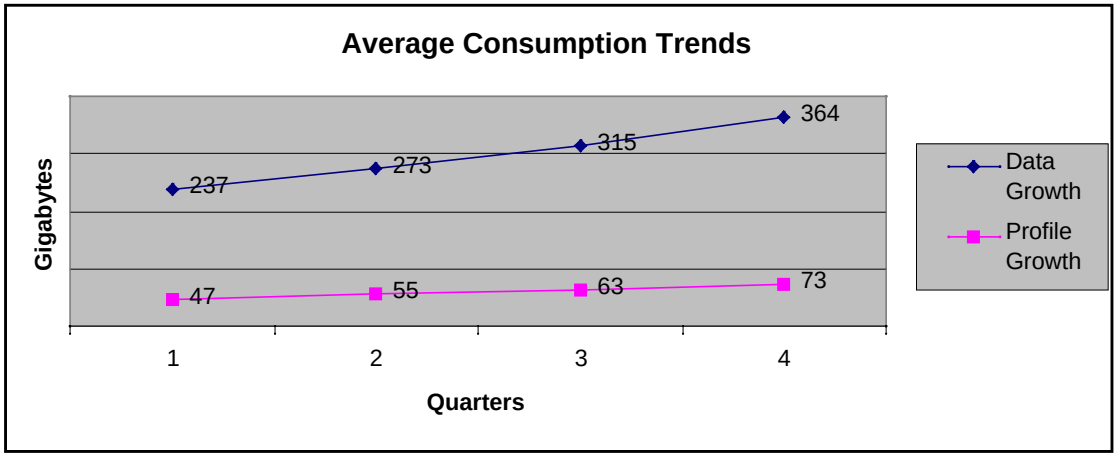

FIGURE 9 SRM Average Consumption Trends

An analysis of the SRM consumption management data shows that average user data and profile storage consumption will increase by 54% and 55%, respectively, within the next year if no action is taken to manage consumption.

In response to this consumption analysis, quotas are designated for the data and profile directories for each individual user. These quotas are derived from the SRM average utilization metrics compiled in the SRM consumption management reports. Quotas for the data areas are set to 400 Mbytes, and profile quotas are set to 50 Mbytes. This action gives business managers and storage administrators a year to incorporate the data area quotas into their daily management routines and to establish a hard storage practice that eliminates storage consumption related to the growth of user profile directories.

To support these consumption management efforts, quotas enforced by the SRM system are configured to alert users and their storage administrators when quotas are exceeded, and the tactical SRM reports are published for review by the business unit managers. In this way, considerable storage consumption related to user profile capacity can be avoided, while user data area growth is placed under a much more efficient management model, which clearly delineates user-data-area offenders.

Through the implementation of SRM best practices related to the consumption of logical user data objects (user data and profile directories), storage administrators and business users efficiently implemented storage best practices that beneficially impact costs, administration, and availability of their distributed storage resources.

Scenario 2: Corporation Z

Key SRM Components: Storage Discovery – Capacity Planning – Data Migration – Consumption Management – Charge Back

In this scenario, SRM helps to facilitate consumption management, leading to the development of a storage-utilization-based charge-back system.

Within Corporation Z, storage administrators want to target a specific data class, which they think might be responsible for significant storage consumption. They configure the SRM system to discover and trend consumption related to archive messaging folders within business units. They identify this class of data because archive messaging folders are suspected to:

- Exist on a large number of servers
- Contain large files
- Undergo frequent modifications
- Require frequent backup and restore overheard

They hope that by correctly classifying behavior within this data classification, they can properly plan for archive messaging folder consumption going forward.

TABLE 6 SRM Storage Discovery and Capacity Planning Table

Item	Value
Number of servers housing archives files	200
Total capacity	2.25 Tbytes
Utilization	25% (of existing utilization)
Quarterly growth	15%
Projected annual growth	1.6 Tbytes
Total number of folders	20,000

TABLE 6 SRM Storage Discovery and Capacity Planning Table *(Continued)*

Item	Value
Folders under 100 Mbytes	40%
Folders between 100-400 Mbytes	49%
Folders between 400 Mbytes and 1 Gbytes	9%
Folders over 1 Gbytes	2%
Number of folders over 500 Mbytes	1,600 (8%)
Space consumed by folders over 500 Mbytes	45% (1 Tbytes)
Average messaging folder size	160 Mbytes

SRM Data Migration

SRM data indicates that the archive messaging folders are growing quickly over very distributed resources. This finding substantiates the concerns of the storage administration staff. Archive messaging folders are large, active, and dispersed. These archives require a very high degree of maintenance with a large and growing impact on backup and restore operations, as well as general file-system-based storage outages. Only 11% of the archive messaging folders are consuming 45% of all consumption related to archive messaging folders. This indicates that a fairly small community of users is consuming an inappropriately large amount of storage.

The storage administrators decide upon the following actions:

- Centralize archive messaging folder capacity.
- Place strict quotas on folder size.
- Implement a tiered charge-back system to assist storage customers in understanding the costs associated with their storage practices.

In preparation for the mail folder move to centralized repositories, SRM is used to determine the following:

- Exact location of each archive messaging folder file
- Number of archive messaging folders within each divisional business unit to be migrated
- Capacity of all archive messaging folders within each divisional business unit to be migrated

The following table shows the SRM data migration numbers.

TABLE 7 SRM Data Migration Table

Business Unit	Number of Servers	Percentage of Mail Folder Capacity	Number of Files
1	15	25%	4,000
2	25	15%	3,500
3	50	37%	7,500
4	10	23%	5,000

With this data in hand, and with minimal service disruption, the storage administrators now plan an orderly migration of archive messaging folders by business unit on a server-by-server basis to the new centralized archive messaging folder storage.

Storage administrators configure the new SAN-based storage to allow the SRM system to monitor consumption on newly centralized directory structures devoted to archive messaging folders. These structures represent their respective business unit customers and can be tracked as logical units within the SRM system. Administrators then trend these logical units and monitor them for use in a charge-back system.

SRM Consumption Management

The next step for the storage administrators is to properly determine archive messaging folder quotas for use in conjunction with charge back system. They consult the SRM data to better understand folder distribution count (FIGURE 10) and size metrics (FIGURE 11).

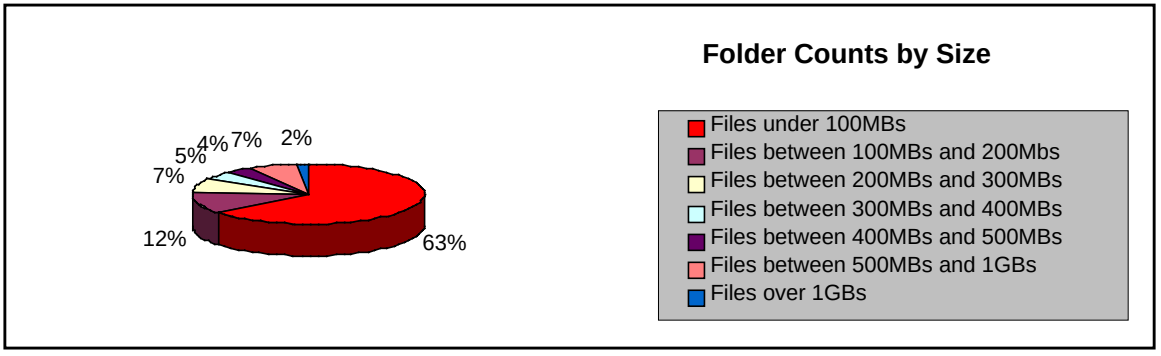

FIGURE 10 SRM Folder Counts by Size

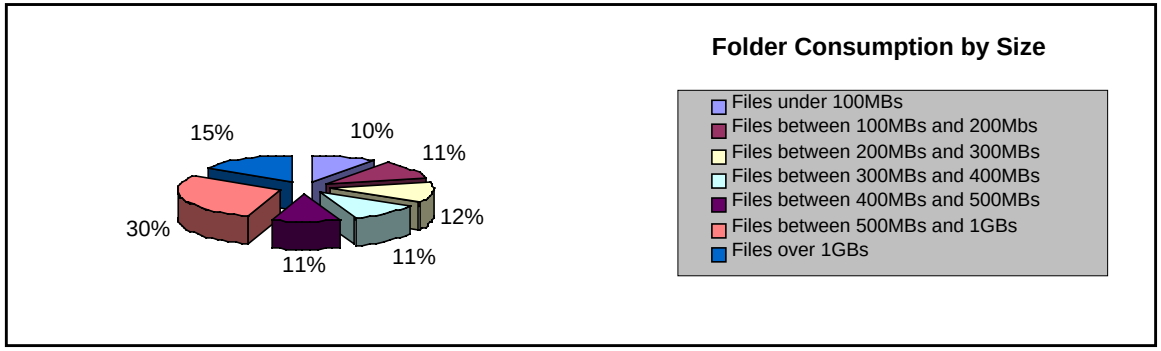

FIGURE 11 SRM Folder Consumption Management by Size

With this information in hand, the storage administrators determine that 92% of all archive messaging folders is under 300 Mbytes in size with an average size of 160 Mbytes. However, these same folders are responsible for only 33% of the capacity currently consumed by all archive messaging folders. By targeting only 8% of their current archive messaging folder population to conform to a new 300 Mbytes quota policy, they can realize significant storage consumption reductions across 67% of the space currently associated with archive messaging folder consumption. With the SRM system in place, identifying this 8% population is easy and reliable, down to the individual users responsible for the consumption.

SRM Charge Back

Armed with the consumption management data, the storage administrators work closely with their business customers to develop a charge-back system that supports a new agreement tailored to enterprise storage service levels. This agreement can ultimately help their customers control storage consumption and associated costs. The charge-back system is fed by the SRM data. Using the SRM system data, the charge-back system for archive messaging folders tracks for the following items:

- Consumption for the entire division
- Consumption by business unit
- Consumption by user
- Consumption within quota by business unit
- Consumption over quota by business unit
- Percentage of business unit users over quota
- Percentage of business unit users within quota
- Individual users within business units within quota

- Individual users within business units over quota
- Daily, quarterly, and annual growth rates by business unit

This charge-back system, developed through the implementation of SRM best practices, provides a means of identifying behavioral characteristics of a logical storage object (archive messaging folders) active within the physical storage resources of a distributed storage infrastructure. This data enables storage administrators and business users define storage best practices impacting the availability, cost, and administration of archive messaging folders. Without an SRM system in place to monitor, configure, trend, and automate the management of the files, a charge-back system would have been virtually impossible to develop or support. However, with SRM in place, charge back is possible, even practical.

Summary

SRM can lead to many benefits. It is not a spot implementation to fix a given storage problem. Rather it is a storage best practice through which policy-based storage management is made possible. SRM "*is a complementary set of products, standards and procedures.*" Like all storage best practices, it must be maintained rigorously to ensure that storage organizations obtain the knowledge persistence and management visibility they require to operate efficiently.

Many SRM best practices are logical and easy to implement and can quickly benefit the enterprise storage organization and its customers. The scenarios presented in this paper are but a few roughly drawn examples based on real-life experiences with SRM systems. Many other scenarios are possible. In particular, SRM practices used within the database server space to monitor and trend database growth rates, replication consumption, and backup and restore performance quickly come to mind.

The principles of storage management best practices, as defined in this paper, require storage practices that lead to the most available, reliable, scalable, performance-tuned, and cost-efficient distributed storage infrastructures. Without the proper management layer in place to ensure that these principles are supported, gauging the relative success of any storage best practice is virtually impossible. When managing the risks related to the cost and operational efficiency of an enterprise storage stack, no storage best practice is more valuable than SRM. With its ability to define and enforce storage best practices, SRM makes the total cost of ownership of large distributed storage infrastructures more palatable by increasing the operational efficiencies of the distributed storage administration staff throughout the spectrum of its responsibilities.

Appendix

This appendix briefly outlines how SRM can influence cost avoidance in storage-related purchases. It is very simplified and uses Scenario 1 (Corporation W) as a working model. For the calculations in this scenario, disk storage, and resource-hour costs to support a storage infrastructure are estimated as follows:

- Disk storage is a fully burdened cost, including: the maintenance, backup, physical plant resources, and supporting hardware. The cost in this scenario is $0.30 per Mbyte.
- Fully loaded cost of a system-storage administrator is $100 per hour.

Furthermore, we assume that costs related to the purchase and implementation of an SRM system are factored into the cost-avoidance calculations for this scenario.

In this scenario, plans for storage capacity are based on high-level estimates of historical capacity expansions for enterprise storage at 100% annually. Based on the SRM data from the storage discovery and capacity planning phases, the goals for the next year are significantly changed from a 100% increase in capacity to a more accurate 48% increase. This adjustment reduces expansion by 42%.

TABLE 8 SRM Cost Avoidance Table

Item	Estimated Costs Without SRM	Estimated Costs With SRM
Disk	12 Tbytes *0.03 = $3,600,000.00	6 Tbytes *0.30 = $1,800,000.00
SRM	No associated costs	SRM system = $500,000.00
SRM implementation	No associated costs	Resource hours = $10,000.00
Total project costs	$3,600,000.00	$2,310,000.00
Costs avoided through SRM	$1,290,000.00	