WHITE PAPER

HITACHI
Inspire the Next

Storage Economics

Four Principles for Reducing Total Cost of Ownership

By Hitachi Data Systems Chief Economist, David R. Merrill

June 2011

Table of Contents

Executive Summary **3**

Storage Economics **4**

The Four Key Storage Economics Principles **5**

1. Price Does Not Equal Cost 6
2. Thirty-four Types of Money 6
3. Economically Superior Storage Architectures 8
4. Econometrics 11

Conclusion: Timeless Principles, Continuous Improvement **13**

Executive Summary

Difficult economic times require new perspectives and strategies for reducing the cost of storage infrastructure. The past several years of IT procurement have left many IT organizations with underutilized and oversubscribed storage capacity. Now, with a squeeze on capital and credit, many organizations are faced with edicts to do more with less and to make tough decisions on where to invest available funds. In particular, there are increased demands to do more with the existing, sunk infrastructure costs in the IT department. This paper outlines methods of quantifying storage infrastructure costs and identifying those that can be reduced. It presents techniques, developed on the basis of several years' findings, for reducing those costs.

Pressure on capital expenditures (CAPEX) and operational expenses (OPEX) will likely continue into 2012; technologists must look beyond lowering acquisition costs and search for additional savings. As pressures mount to reduce not only CAPEX spending, but, even more vitally, OPEX, IT organizations will need to make business cases to gain management support for both strategic and tactical investments.

Many storage engineers and architects limit their strategic planning to technology or operational perspectives. By adding basic cash flow analysis and measuring return on investment (ROI), return on assets (ROA) and total cost of ownership (TCO), managers can undertake initiatives based on more meaningful observations, thereby improving their overall strategy. When proposing cost reduction initiatives, IT must identify clear metrics and provide a full analysis of the payback and savings of these initiatives.

The good news is, there are proven strategic and tactical investments for storage infrastructure cost reduction. These range from technology components to organization and staffing changes, and even include methods of provisioning storage capacity to the end user. As new technologies become available, smart organizations will follow the principles of Storage Economics to evaluate them not just for their technical prowess but also for how well they can support business performance and particularly efforts to economize.

Hitachi Data Systems has provided a strategic framework for cost-reducing investments. Many medium-to-large IT centers have used this framework to achieve an economically superior way of deploying and growing their storage. These IT centers have achieved measurable cost savings: reduced waste, reduced labor time per terabyte of capacity, lower costs of growth, and reduction in power, cooling, floor space and maintenance fees for a unit of storage capacity. Some of these organizations' economically superior architectures have enabled them to defer capital spending by reclaiming or recovering stranded capacity that already existed in their data centers.

The lessons of these companies can be learned and repeated. One of the first steps is to define and measure current costs. We cannot improve what we cannot measure. This is the core of econometrics and key to providing continuous improvement of the storage estate.

Storage Economics

Hitachi Data Systems has been researching, learning and documenting findings and creating thought leadership in the area of Storage Economics since 2001. The principles developed have been tried and tested in good economic times as well as in recessionary periods. This approach takes a view at the intersection of storage technologies and financial principles.

Storage Economics attempts to align the operational and technical dimension of the storage infrastructure to a corresponding financial viewpoint. As the prices of disk continue to drop 15% to 30% per year, it is easy to develop the erroneous belief that a lower cost of acquisition will result in a lower cost of ownership. Storage Economics methods and practices provide measurable techniques that can expose the true costs of storage decisions and help IT leaders make plans to systematically reduce these costs over time.

New storage architectures are coming online at an increased rate of speed. Cloud computing, virtual machine (VM) sprawl, capacity-on-demand architectures and other architectures sometimes demand a review of existing storage infrastructures, prices, costs and operational methods. Remember that price does not equal cost. Applying these 4 principles when a new architecture is considered will help separate the price hype and the long-term operational costs associated with every new architecture.

Over the past few years, the cost of acquisition has gone from 50% to 60% of the TCO to less than 20% today. Relying on Moore's Law alone to provide lower price per gigabyte will not deliver lower costs of ownership. The other 80% of storage TCO (aside from acquisition) is what must come under scrutiny in tough economic periods. Strategic planners have to think in terms of the cost of disks approaching 0. The real costs of storage infrastructure are OPEX, and it is these recurring costs that managers need to identify and take action to reduce.

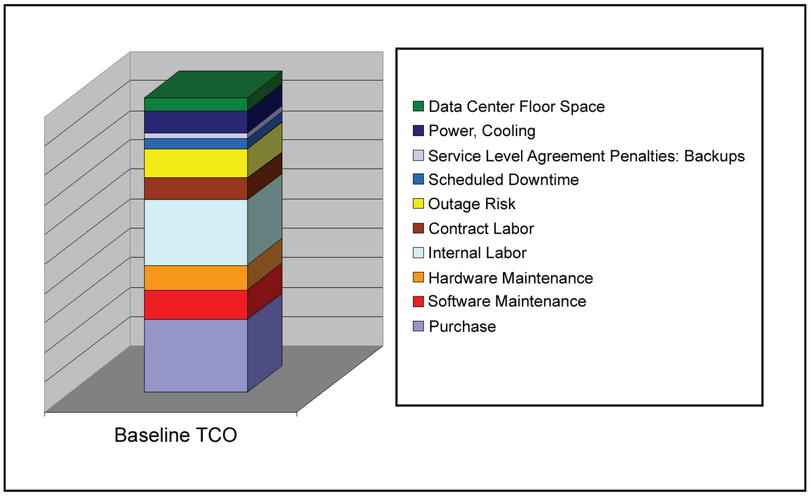
Cost-conscience architects and budget managers see the value in measuring IT infrastructure with a TCO baseline. A unit cost of ownership [cost per terabyte (TB) per year] is a simple method to depict all of the costs to own a terabyte of storage capacity. People are often confused when they notice the price of disk declining but their storage TCO does not change at the same rate and, in some cases, it increases. This happens because other parts of the TCO (labor, maintenance, power, floor space, migrations) are moving higher each year. When the focus is on procurement costs and not total costs, real business efficiencies are sacrificed.

TCO per terabyte per year (TCO/TB/year) can be represented in several ways. A stacked bar chart, such as the one shown in Figure 1, provides a comparative view of the various costs that make up storage TCO.

Not all storage economic actions are quantitative; some are qualitative in nature. For example, reducing the cost of risk of an outage can be part of an effective business case for change. When possible, converting technical and operational benefits into monetary terms will help make the business case for a storage strategy. In fact, every storage action or reaction can be stated in economic terms. Soft costs that are hard to measure still need to be identified and measured in a structured way to present the full impact of all risks, benefits and actions.

To make progress, an organization must map costs to proven methods and techniques that can actually reduce those costs. This paper outlines some 34 different types of costs that can be employed to create a TCO/TB baseline. With this in place, it is possible to map storage initiatives or investments to areas of measurable costs. This information can be used for storage design, to prioritize investments and initiatives, and to create a roadmap of activities based on their projected cost reduction potential and support of business needs. Alignment with business needs, prioritization of investments and cost-reduction plans have to be coordinated together. For example, power down disk, massive array of idle disks (MAID) and thinned volumes can reduce the total power consumption; but if the cost of power is not a significant element of your storage TCO, then this investment may not be fully justifiable.

Figure 1. Comparative View of Storage TCO



Hitachi Data Systems storage economic methodologies, models and tools encompass TCO, ROI, ROA and other financial and economic principles. For further information, see the Hitachi Data Systems blog (blogs.hds.com/david) and Web site, www.economizeyourstorage.com.

The Four Key Storage Economics Principles

Where storage technology and economics meet, there exist 4 key tenets for strategic planning that can lead to continuous improvement and operational excellence: The 1st principle is, the cost of storage includes more than price. Hitachi Data Systems has identified 34 types of costs that compose TCO. Of these, not all are equal in relevance to an organization; for any organization, some are more strategically important to bear, reduce or eliminate than others. The 2nd principle, therefore, is that an organization must determine which are the relevant costs: costs on which to focus, to measure and to control. The 3rd principle is that there are economically superior storage architectures. Too frequently, organizations fail to recognize that business performance and the ability (or lack of it) to reduce costs over time are features of any technology. Some technologies have a well-documented edge over others in controlling and lowering TCO. Over time, new and better technologies will be introduced and the specific technologies that build an economically superior storage architecture will change, but the principle will remain constant. Organizations should evaluate new technologies for what they can contribute to business performance and, specifically, to cost-reducing performance as well as considering their technical functionality. The fourth and final principle of Storage Economics is that organizations should use money as 1 measurement for storage improvement. Once an organization has identified which costs are most strategic to control, it must develop an economic measuring system to quantify current costs and track progress in reducing them.

These principles transcend vendors, products and data types. Econometrics can be chosen based on the organization's priorities and strategies, applied to the entire storage infrastructure and brought to bear when evaluating future products and architectures.

Below, each of the 4 principles of Storage Economics is discussed in some detail.

1. Price Does Not Equal Cost

The total cost of acquisition (TCA) for storage is roughly only 20% of TCO. Just a few years ago, the price of the hardware and software was a much higher portion of TCO, but price erosion has changed that. The Hitachi Data Systems recommendation is to treat strategic plans with the concept that the price of disk is approaching 0. Far too often, procurement is determined by the lowest storage bid, without consideration of the fact that low-cost architectures often produce higher costs of ownership. Personnel responsible for (and measured on) acquiring lowest cost solutions do not have to answer for the total costs incurred in the IT department. If long-term, true OPEX and CAPEX reduction is really the goal, then a total cost model is essential.

Over time, the TCA will become less and less significant. Labor, maintenance, power and cooling currently drive a higher cost (some 3 to 4 times higher) than acquisition alone. Some analysts predict that the cost of asset retirements has already surpassed the TCA. Storage planners need to use TCO measurements (or econometrics) to better isolate and measure cost efficiencies in the storage infrastructure.

2. Thirty-four Types of Money

Since 2002, Hitachi Data Systems consultants have documented and characterized some 34 different types of costs that make up storage TCO. Some of these costs are hard or direct costs, others are soft or indirect. Some cost areas are OPEX while others are CAPEX. Each IT department needs to define what cost categories are relevant to creating their baseline cost picture and planning subsequent actions to reduce costs.

Quite often, reducing costs is an architecture design effort, not a product selection process. There are economically superior storage architectures, defined in part by how well they deal with various storage ownership cost categories. These categories include:

1. Hardware depreciation (lease) — yearly costs for hardware depreciation or monthly leases

2. Software purchase or depreciation — monthly or yearly costs for the purchase of the software. Some software can be capitalized with the original hardware acquisition.

3. Hardware maintenance — recurring maintenance or warranty costs for all storage hardware after the base warranty period

4. Software maintenance — recurring maintenance or warranty costs for all storage software

5. Storage management labor — management labor costs associated with the various tasks of storage management, such as provisioning, tuning, load balancing, troubleshooting and upgrades

6. Backup and disaster recovery labor — aside from storage management, additional labor related to backups and restores, as well as disaster recovery planning and testing

7. Migration, re-mastering — various costs associated with data migration at the storage system's end of life. In large environments, there is continuous labor effort associated with data migrations. Remastering costs are associated with data lifecycle costs while migration deals with the lifecycle costs of the storage system.

8. Data mobility — time and effort required to move data to different tiers or archive solutions. Different from remastering, data mobility follows the data lifecycle, not the system lifecycle.

9. Power consumption and cooling — kVA, BTU costs (converted to kW) of data center power. Power costs should include industrial grade conditioning and battery or diesel backup.

10. Monitoring — SNMP, NOC and operations consoles for the storage, SAN and backup infrastructures

11. Data center floor space — cost per square meter of data center floor space. This often includes uninterruptible power supply (UPS) and raised floor costs.

12. Provisioning time — business impact for the time waiting from when the request is made until capacity is presented to the host

13. Cost of waste — 2 types: usable and not allocated, and allocated and not used

14. Cost of copies — database management systems (DBMS) and other applications often require copies to be made. In-tier or out-of-tier copies are possible. Test, development, quality assurance (QA), data mart, data loaders and similar applications all require multiple copies of structured and unstructured data.

15. Cost of duplicate data — besides multiple copies, there is often an overhead associated with several copies of the same data. This is very common in unstructured file systems.

16. Cost of growth — fundamentally, every storage architecture has a cost of growth. In high-growth environments with the wrong architecture, the cost of growth can be acute.

17. Cost of scheduled outage — microcode changes, capacity upgrades

18. Cost of unscheduled outage (machine related) — in both the storage system and the connections or data path

19. Cost of unscheduled outage (people and process related) — often due to capacity problems, operational control and physical thresholds

20. Cost of disaster risk, business resumption — business impact with slow or fast recovery after a catastrophic event (declared disaster)

21. Recovery time objective and recovery point objective (RTO and RPO) costs — business impact costs resulting from the time it takes to return to a recovery time (or point) after a system failure or backup recovery

22. Data loss — business and enterprise costs for lost, corrupted or unrecoverable data

23. Litigation, discovery risk — legal risk and e-discovery time costs associated with lawsuits. This also covers general data location and recovery effort time.

24. Reduction of hazardous waste — primarily an EU cost due to regulations such as RoHS. Noncompliant hardware may incur an additional tariff for disposal of the asset.

25. Cost of performance — impact to the business (good or bad) relative to total storage performance (IOPS, latency, MB/sec)

26. Backup infrastructure — fixed cost infrastructure for backup. This includes backup servers, media servers, tape libraries, drives, etc.

27. Backup media — local and remote media costs for backup; recurring and capacity related costs

28. Cost of risk with backup windows — business impact of shortened or limited backup windows

29. CIFS- or NFS-related infrastructure — filers, gateways and the necessary software to provide file servers and shared services in the enterprise

30. Local and remote data circuits — dark fibre used for SAN extensions, remote replication and the associated software

31. Storage area networking — dedicated Fibre Channel, iSCSI or NAS connection infrastructures. This includes routers, gateways, host bus adapter switches and directors.

32. Noncompliance risk (archive, data retention) — several legal and legislative requirements (HIPAA, Basel II, Sarbanes-Oxley, carbon emissions), noncompliance with which can incur fines, negative publicity and criminal prosecution

33. Security, encryption — costs associated with protecting, securing and encrypting data and the storage infrastructure

34. Cost of procurement — costs associated with time and effort required to acquire hardware and software. This includes required preparation, review, negotiation, selection and certification processes.

Not all of the above 34 types are necessarily equal in weight, importance or time relevance. In the experience of Hitachi Data Systems, IT planners tend to choose between 8 and 15 of these costs to create their organization's own TCO baseline. As in all cost analyses, some of the costs are hard (real budget is spent and can be measured) while some costs are soft (hard to quantify, such as the cost of a future potential event). Whatever costs, hard and soft, are chosen for measurement based on business needs, organizing and ordering them is essential for developing and implementing a plan that will reduce the total costs of storage. One cannot improve what one cannot measure.

3. Economically Superior Storage Architectures

There are economically superior storage architecture options that can be put into place, either incrementally over time or as part of a complete data center technology refresh. These architectures may not be the cheapest to buy, but they are cheaper to own. Some are best suited for high-growth environments, others reduce compliance or legal support costs, and even others are best if power and space are the major concern. Currently, some of the key ingredients for economically superior architectures are:

- Virtualization of volumes, file systems, storage systems
- Dynamically tiered storage
- Intermix storage (disk types) within the same storage system (solid state disk or SSD, SAS, SATA)
- Thin provisioning
- Power down disk, MAID
- Multiprotocol SAN storage
- De-duplication, data compression
- Integrated archive
- Capacity on demand
- Management, policy-based storage provisioning

A structured design and cost planning approach provides a management and technical framework for these key ingredients to be manipulated and prioritized in such a way as to prescribe an economically superior architecture that will be unique for each organization. Since price does not equal cost, a holistic approach is required to identify, measure and prioritize architecture elements. The approach must align storage with business needs to produce short- or long-term cost savings to the enterprise. Because each organization's best infrastructure is unique, organizations embarking on a structured approach generally combine technical elements with professional services engagements to obtain the desired reductions in TCO.

New IT architectures like cloud, unified computing platforms and virtual architectures can re-establish business and operational goals for the organization. Price and cost are usually mixed in with these requirements, but we have to be cautious about chasing low price storage architectures (like DAS or local disk) at the future expense when these systems need to scale. Storage economic models can help determine the location of the inflection point (at capacity or time). It is important to know when these "scale-out-sprawl architectures" hit the point of diminishing returns, and therefore become more expensive to own. These diminished returns manifest in several ways:

- Redundant non-shared resources (network, cache memory, operating system instances)
- Overprovisioning for spare or reserve capacities
- Stranded processors, terabytes of capacity
- Power and floor space necessary for all the redundant capacity
- Management burdens to administer and optimize

Over time, new technologies continue to emerge that can contribute in building economically superior storage architectures. At present, however, the experience of Hitachi Data Systems points to a critical 3 technologies that organizations can be implemented in concert to create their individual best storage architecture: Storage virtualization is a key element that has been proven over the years to make an impact on storage TCO. Virtualization is more than a technical building block; it can serve as a foundation that enables other key capabilities, such as dynamic tiered storage and dynamic (thin) provisioning. Together, these 3 key elements — storage virtualization, tiered storage with automated, policy driven movement between tiers, and thin provisioning — can deliver a TCO reduction of 20% to 35% over older storage architectures. Hitachi Data Systems customer case studies and testimonials demonstrate improvements of this magnitude.

Each of the "big 3" elements of an economically superior storage architecture has technical and economic benefits on its own, but when unified in the core of a new storage architecture, the overall impact is greater than the sum of its parts. This compound effect of storage virtualization, dynamic tiered storage and dynamic provisioning can be measured in terms of:

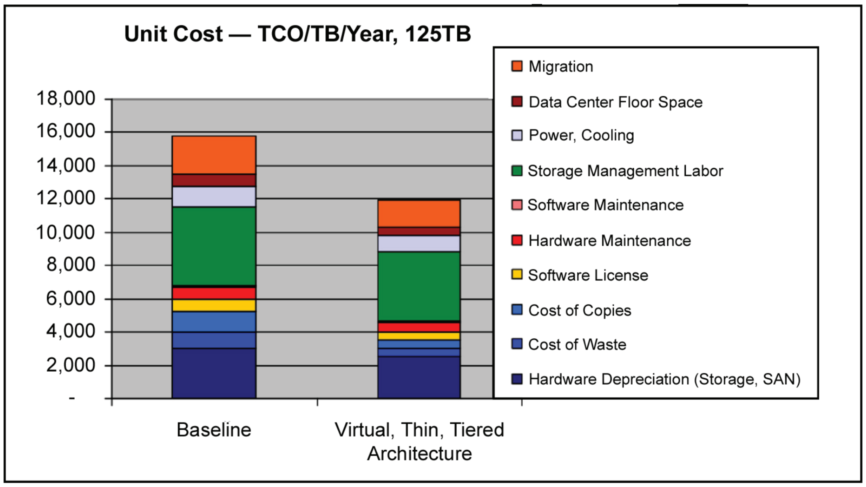
- **Significant storage reclamation** — both 1 time reclamation and a significantly lower cost of growth over time
- **Return on assets (ROA)** — assets are better utilized and can be utilized even beyond the depreciation life
- **Smaller storage estate** — delivers the same quality of service
- **Device migration** — nondisruptive heterogeneous storage migration
- **Backup and recovery** — virtual tape library and de-duplication reduces backup and recovery times. Multitier storage reduces the cost of copies. A pooled and centrally controlled virtual pool can share backup services, replication, snap copy management, etc.
- **License costs per terabyte** — reduced as storage capacity grows
- **Scheduled downtime** — nondisruptive maintenance, migration, upgrades, provisioning
- **Change management** — common management of heterogeneous assets, nondisruptive configuration changes and less labor time required for provisioning
- **Environmental** — reduced floor space, power, cooling as measured per terabyte (kVA/TB or kW/TB)

The measurable economic impact on TCO with thin provisioned, tiered and virtualized storage architectures can be dramatic. Hitachi Data Systems consultants have formally and informally measured TCO and ROA with clients who have implemented these key technologies, and have found that the resulting TCO improvement averages approximately 25% within the first year after implementation.

- Customers report that they are running on about half the total storage infrastructure (cabinets, drives, software) compared to their previous architecture.
- The cost of waste and the cost of migrations tend to be the top 2 impact areas.
- Older assets tend to gain an extended useful period, especially when they are used in a lower tier of capability.
- Labor and general storage management efficiencies can be measured in terms of improved provisioning time, workload balancing, troubleshooting time and chargeback effort.

Advanced storage architectures can represent a real cost savings compared to traditional or tiered-island architectures. Figure 2 provides an example, illustrating that the most significant drops in TCO with the new architecture come from reductions in the cost of waste, migration, copies and labor.

Figure 2. Cost Reductions of Advanced Storage Architectures



Advanced storage architectures also impact costs in adjacent infrastructure areas. Deploying the right storage architecture (technically, operationally and economically) can also reduce the costs of non-storage infrastructure.

- Virtual machines — hypervisors
- Unified compute, POD or stack architectures
- Virtual desktop (VDI)
- Backup and data protection schemes

4. Econometrics

The old saying that you can't improve what you can't measure certainly applies to Storage Economics. Organizations should develop a new series of management dashboards to "follow the money" that is spent over the lifetime of their assets. Econometrics can be applied to a single storage system, a particular tier of storage, the backup-and-restore process or disaster protection costs. Higher-level abstractions can be created to show top-level costs as well. The TCO/TB/year metric is a simple enough model to create and update, and it provides the means to make critical comparisons over time.

Another key metric used by some is TCDO, or the total cost of data ownership. The difference of TCO and TCDO is that all the storage costs are not divided by the total usable capacity, but by the total amount of data. This approach exposes several problematic cost areas, including:

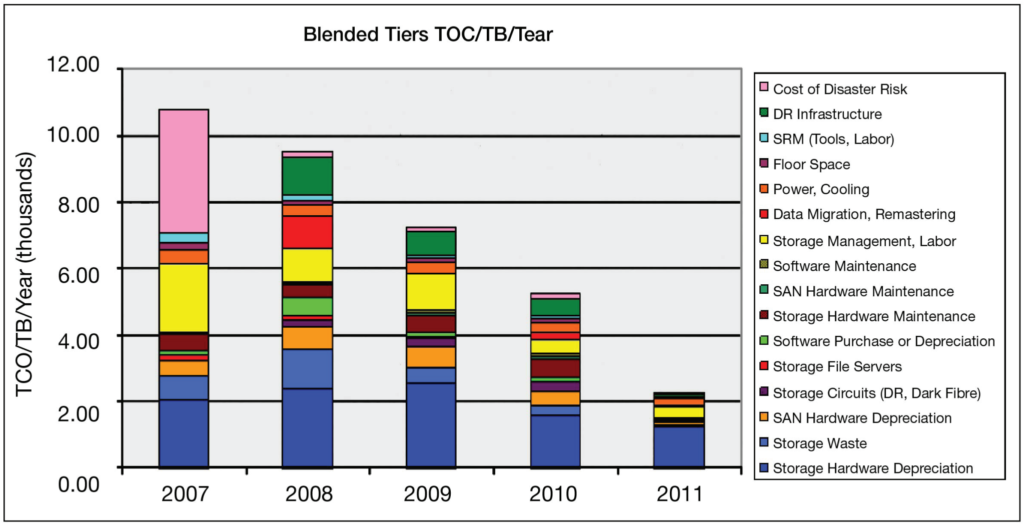
- Cost of waste — both usable and unallocated, and allocated but not used space
- RAID overhead costs
- Cost of copies

As an example, the TCO for 1TB of storage might be measured to be US$12,000/TB/year. If the amount of data stored in that 1TB is only 200GB, then the TCDO would be US$60,000/TB/year.

Econometrics can also provide a modeling framework for mapping storage ownership costs (or budget) to the activities that will produce the resulting savings. These activities then can be put into short- or long-term roadmaps that will derive the correct dependencies and priorities. For instance, IT planners can link infrastructure investments they are considering to their projected TCO or TCDO reduction.

IT planners need to steer away from total budget, which is mostly driven by storage growth appetite, and measure unit cost improvements that are projected or realized over time. Comparative graphs, such as the one shown in Figure 3, can show the impact of strategic and tactical investments in storage TCO over a number of years. This method can give management confidence in cost reduction initiatives, because the actual savings impacts can be seen and compared to prior years.

Figure 3. Impact of Strategic and Tactical Investments in Storage TCO



Generally speaking, any storage architecture investment under consideration should be mapped to cost categories that it can substantially change, so that technology investments can be evaluated for their business performance, not just their technical performance.

Finally, the organization's collection of investment ideas and plans needs to be correlated and put into a storage roadmap or architecture roadmap. This roadmap is typically found within the storage architecture framework, and it provides a multiyear plan of events and investments that will produce continuous improvement to the business. With a roadmap of options identified, ROI calculation techniques can be an effective cost justification method to help prioritize and provide business case development for the various (sometimes competing) options.

In sum, the organization is best served, and cost savings most likely to be maximized, when IT's technical and operational investment ideas are aligned to business benefits and/or cost improvements. Econometrics needs to be a systemic element in IT's strategies, business alignment tactics and budgetary processes.

Conclusion: Timeless Principles, Continuous Improvement

Price does not equal cost; cost includes much more than purchase price. When seeking to control storage costs, an organization needs to determine which types of costs are most relevant to control and measure them. Reducing costs is often not simply a matter of selecting products, but of designing a storage architecture that is more supportive of the organization's cost-reduction goals.

Some storage architectures are known to help reduce costs; such architectures are termed "economically superior." At present, the "big 3" elements of an economically superior storage architecture are storage virtualization, dynamic tiered storage and thin provisioning. When these elements are unified in the core of a new storage architecture, the overall impact is greater than the sum of its parts.

Organizations should use econometrics to "follow the money" spent on storage assets over their lifetimes, and map IT investments to business benefits and cost improvements.

These are the 4 key principles of storage economics. The technologies that create superior storage architectures will certainly change over time, but the principles are themselves timeless. Following them will lead to continuous improvement, and should be a part of any organization's operational best practices.

To effectively manage total cost of ownership of storage over time, organizations need to internalize the 4 principles of Storage Economics and apply them in evaluating new technologies. The organizations most successful at controlling costs of storage will be those that use the common business language of money to guide their planning and purchasing.

Hitachi Data Systems Corporation

Corporate Headquarters
750 Central Expressway
Santa Clara, California 95050-2627 USA
www.HDS.com

Regional Contact Information
Americas: +1 408 970 1000 or info@hds.com
Europe, Middle East and Africa: +44 (0) 1753 618000 or info.emea@hds.com
Asia Pacific: +852 3189 7900 or hds.marketing.apac@hds.com