October 2007

MANAGEMENT BRIEF

BUSINESS CASE FOR IBM SYSTEM STORAGE DS8000 TURBO SERIES

Reducing the Costs of Enterprise Disk Storage

International Technology Group

4546 El Camino Real, Suite 230
Los Altos, California 94022-1069
Telephone: (650) 949-8410
Facsimile: (650) 949-8415
Email: info-itg@pacbell.net

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EXECUTIVE SUMMARY

At the end of 2001, the average U.S. Fortune 1000 corporation contained around 20 terabytes (TB) of server disk storage. By yearend 2006, this had increased to more than 112 TB. On current trends, it will reach more than 828 TB by yearend 2011.

Managing growth has become the central challenge of enterprise storage strategy. As organizations seek to meet it, new approaches are being adopted. Storage resources are being managed as networked infrastructures of multimedia systems and software. New tools and practices are being applied to handle replication, protection and recovery of increasingly diverse types of data.

These shifts are paralleled by technological change. New generations of storage platforms deliver unprecedented levels of scalability and functionality. Virtualization, as well as tiered storage structures, automated provisioning, integrated storage management systems, and other new technology solutions are becoming widely adopted. Change has become the norm.

With one exception. In many organizations, financial practices have not evolved to deal with high-growth, technologically dynamic storage environments. Focus on purchase costs means that broader total cost of ownership (TCO) issues are neglected. Short-term planning cycles, and an emphasis on one-time deals, undermine the potential for more effective, longer-term cost management strategies.

As a result, customers often pay a great deal more for their storage resources than they need to. As capacities continue to increase, the bottom-line impact will expand. The effects of today's cost inefficiencies may, after even a few years of high double-digit or triple-digit growth, impose a serious drain on the financial resources of many organizations.

This report deals with these effects for high-end disk array systems. Specifically, it compares the cost implications, over a four-year period, of employing the systems of two vendors – EMC and IBM – with significantly different pricing policies.

Four-year costs of employing EMC Symmetrix DMX-4 and IBM System Storage DS8000 Turbo systems and software are compared for three large installations – a diversified financial services company, a global manufacturing company, and a government IT services agency – experiencing high levels of capacity growth. Installations are composites based on the experiences of multiple companies.

One conclusion emerges immediately. The majority of costs are incurred after systems are installed. For the three installations, ongoing costs (costs incurred after initial system installation) averaged 72.8 percent of overall four-year costs for DMX-4 systems, and 63.0 percent for DS8000 Turbo systems. Many organizations are clearly focusing on the wrong cost variables.

Significant differences between cost structures for DMX-4 and DS8000 Turbo systems also became apparent. This was particularly the case in two areas:

1. ***System costs***. These include hardware acquisition and maintenance costs, as well as license and support fees for EMC and IBM suites of point-in-time copy, real-time replication and multipathing software. Costs allow for hardware and software upgrades to handle growth.

   Four-year costs for use of DS8000 Turbo systems and software range from 32.7 percent to 40.1 percent less than those for DMX-4 equivalents in individual installations, and average 36.5 percent less overall. Costs were calculated using "street" prices; i.e., discounted vendor prices.

Lower DS8000 Turbo costs are due to lower hardware and software costs, particularly for upgrades, and to longer IBM warranty periods.

EMC offers two-year hardware and 90-day software warranties, while IBM offers one- to four-year hardware and software warranties. Four-year warranties were used as the basis of calculations for use of DS8000 Turbo systems. As a result, significant hardware maintenance and software support costs are incurred for DMX-4 systems, while there are no corresponding DS8000 Turbo costs.

(The term "software support," as employed in this report, refers to the same set of costs as "software maintenance." Vendor nomenclatures vary.)

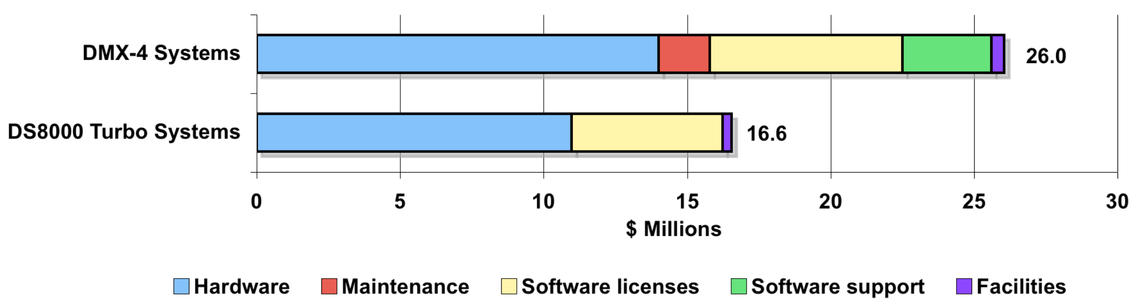
2. ***Facilities costs***. Four-year costs for data center occupancy and energy consumption for DS8000 Turbo systems range from 26.5 percent to 27.8 percent less than those for DMX-4 equivalents in individual installations, and average 27.1 percent less overall.

   Energy costs for DS8000 Turbo systems average 29.8 percent less than those for DMX-4 equivalents. Occupancy costs average 10.6 percent less than those for EMC equivalents. Facilities costs were calculated based on vendor specifications and industry norms.

   Combined system and facilities costs for use of DS8000 Turbo systems range from 32.6 percent to 39.8 percent less than those for DMX-4 equivalents in individual installations, and average 36.4 percent less overall. Figure 1 summarizes average results.

Figure 1

Four-year Combined Costs for EMC DMX-4 and IBM DS8000 Turbo Systems: Averages for All Installations



Details of installations, configurations and cost structures, along with sources of data and methodology employed for calculations may be found in the Detailed Data section of this report.

For all system and software offerings included in calculations, EMC and IBM discount extensively on a case-by-case basis, and may offer pricing arrangements to individual customers that differ from those employed for calculations presented in this report. Facilities costs may also differ between organizations.

The principle is nevertheless demonstrated. Organizations that base their financial planning on more granular cost measurements over longer periods, and purchase accordingly, may realize significantly greater cost savings than those that continue to employ traditional methods.

Many organizations have targeted innovation as core goals of their business and IT strategies. But innovation is not simply a technical matter. It is also about approaching challenges in new ways. The largest gains may come not from laboratory breakthroughs, but from simply examining and changing assumptions that have been held for too long.

COST PICTURE

Planning Practices

IT financial practices are often driven by budget cycles. This situation is not unique to IT. For a number of years, there has been a growing realization in the corporate world that budget-driven planning may undermine the realization of long-term financial goals by encouraging a short-term, tactical focus among decision-makers.

This recognition has led to growing use of more sophisticated financial planning tools and practices, as well as longer multi-year planning periods, rolling forecasts and budgets, and similar techniques in other business areas. Such approaches are clearly applicable to the IT world in general, and to its high-growth segments in particular. Not least of these are storage systems.

The high-end storage planning practices employed in many IT organizations originated in the 1990s, at a time when system capacities were a great deal smaller (the average initial install size for a high-end disk array did not exceed one terabyte until the 1999-2000 timeframe), high-end applications were less pervasive, cost structures were different, and expenditures were significantly less than today.

As a result, 1990s-style planning practices have become increasingly dysfunctional. This is particularly the case in two areas:

1. ***Product cycles***. Storage planning is often based on two- or three-year product cycles, on the assumption that growth will mean that systems soon reach their practical configuration limits.

   This approach may have been appropriate for earlier generations of technology. The greater scalability of latest-generation high-end systems means, however, that significantly larger configurations can be supported without experiencing performance bottlenecks.

   Latest-generation arrays are typically configured with from 20 TB to 50 TB of initial capacity for high-performance applications, and are realistically expandable to between 200 TB and 500 TB, depending on performance requirements, with current technologies. Three- to five-year product cycles may thus be appropriate.

   Moreover, the architectures of latest-generation systems are designed to allow high levels of expandability beyond current technology limits. Even longer planning cycles may thus be appropriate in evaluating vendor commitments.

2. ***Cost structures***. Conventional storage planning tends to treat storage systems as a capital investment; i.e., the focus is on purchase costs. In other segments of the IT world, for more than a decade, there has been an increasing emphasis on total cost of ownership (TCO) and other metrics that address a broader spectrum of costs over three- to five-year periods.

   TCO measurements typically deal not only with initial acquisition costs, but also with such items as upgrades, maintenance, support, personnel, facilities overheads such as power and cooling, and other operating costs. Industry experience has been that cost structures viewed in this manner may be significantly different from those of purchase-centric approaches.

   This is clearly the case for storage systems. Because of the rate of capacity growth, upgrade costs have increased consistently in most organizations. Despite longer vendor hardware warranties, maintenance costs have also expanded.

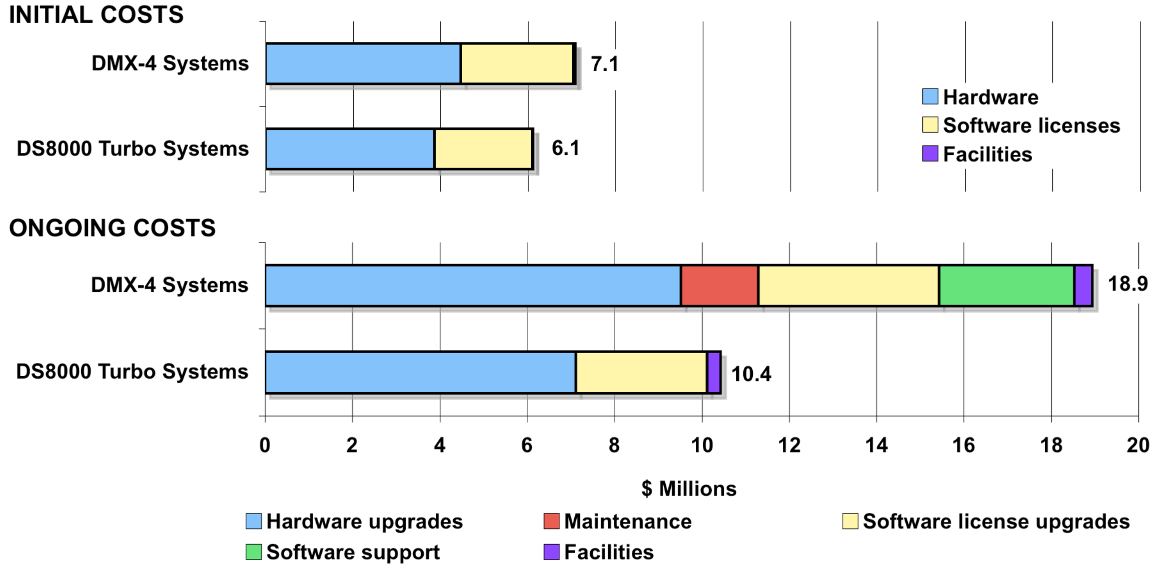
Software stacks have grown increasingly sophisticated and expensive, and advanced capabilities have been deployed on growing numbers of systems. Warranty periods, however, have often not changed for decades. Software support costs have continued to rise.

Larger system footprints, as well as rises in energy costs, have also meant that facilities overhead has become an increasingly significant issue for many organizations.

As a result, an increasing percentage of overall high-end disk systems expenditures are accounted for by ongoing costs. In the four-year comparisons presented in this report, for example, costs were distributed as shown in figure 2.

Figure 2

Initial and Ongoing Costs for EMC DMX-4 and IBM DS8000 Turbo Systems: Averages for All Installations



(Facilities components of initial costs shown here are for acquisition of support systems capacity for power and cooling. This subject is discussed later in this section.)

It is occasionally argued that the unpredictability of growth in storage demand makes multi-year cost measurement and planning periods unrealistic. This is questionable. Organizations often have sufficient experience to be able to project demand within specific ranges (e.g., 30 percent to 50 percent), and scenario-based planning is often feasible.

This argument tends, moreover, to miss a key point. One of the reasons why expenditure growth is unpredictable may be precisely because organizations do not conduct granular analyses of cost evolution over time. This makes it more difficult not only to project costs, but also to identify cost drivers and to use these as a means of means of containing future cost growth.

Where this is the case, cost inefficiences generated by 1990s-style planning practices may become self-perpetuating.

Deal Making

Most users, and all vendors, make deals for storage systems. If the process is handled properly, organizations may realize significant savings in ongoing as well as initial costs.

The first requirement is that all components of the storage system cost structure over a multi-year period should be addressed in competitive bidding. The duration of this period should be based on the organization's projections for capacity growth and functional capability, and on realistic lifecycles for current-generation systems.

For example, if a new system or upgrade will initially be configured with 50 TB of disk, and its practical capacity limit is 500 TB of disk, the realistic lifecycle with a 50 percent annual capacity growth rate will be five years. With 80 percent annual capacity growth, it will be three years.

Longer cycles may be appropriate if the vendor can guarantee further scalability through future new technology capabilities.

Vendors should be required to specify prices, and terms and conditions for initial as well as ongoing costs for the required period. Particular attention should be paid to four variables:

1. ***Configuration sizing***. The initial size of system configurations, and how efficiently they will be able to handle growth, will have a significant cost impact over time. Not only hardware acquisition and maintenance costs, but also license and support costs for software priced on a per-terabyte basis will be affected.

   For this reason, planning should take into account actual system performance and scalability levels. Although generalized performance data and benchmark results may provide reference points, organizations should undertake customized "stress tests" based on their own workloads, functional requirements and service-level objectives.

   Such tests should address not only short-term requirements, but also the configuration sizes and performance levels that must be supported in the foreseeable future.

2. ***System upgrades***. Vendor pricing may be different for initial configurations and for later upgrades to these. Of the two vendors compared in this report, for example, IBM pricing is generally consistent for initial installations and upgrades.

   EMC charges are often higher for upgrades. The company commonly, for example, charges a 40 percent premium for disk pack upgrades, and users have reported upgrade premiums for other DMX hardware and software offerings. In addition, prepaid maintenance coverage may not automatically extend to upgraded components.

   In an organization experiencing high levels of capacity growth requiring frequent upgrades, the bottom-line impact of such pricing practices over time will obviously be significant.

3. ***Warranty coverage***. Vendor warranties for high-end disk hardware and software vary widely. The industry's longest warranties are offered by IBM – four years for the company's DS8000 Turbo hardware, operating environment licenses (OEL), and Advanced Function software.

   In comparison, EMC offers a two-year warranty for DMX-4 hardware and Enginuity operating systems, and a 90-day warranty for its Enterprise Software products.

   The EMC and IBM software components included in comparisons presented in this report are Enterprise Software and Advanced Function offerings respectively.

4. ***Maintenance and software support costs***. These become more significant if costs are measured over longer periods.

   In the comparisons presented in this report, for example, software support averages 17.5 percent of ongoing costs for DMX-4 systems during the first two years. Because of warranty coverage, there are no hardware maintenance costs during this period.

   Over three years, however, DMX-4 software support and hardware maintenance costs average 23.9 percent of ongoing costs, and over four years this increases to 25.7 percent. Costs would continue to increase in subsequent years.

   It would also be necessary to allow for software support and maintenance costs for DS8000 Turbo systems if calculations extended to five or more years.

It may be appropriate to address other pricing variables. For example, configuration upgrade increments may vary between vendors, and this may also be the case for policies and prices for installation and upgrade services.

Differences in software ownership policies may also affect comparative costs. EMC, for example, regards licenses for its software as system- and customer-specific; i.e. license ownership may not be automatically transferred to another system or (if the system is sold) to a third party. A relicensing fee is required, which must be negotiated on a case-by-case basis. There is no equivalent IBM fee.

The pricing variables that are focused on, and the negotiating methods employed by individual organizations in dealing with vendors may vary. The overall objective, however, should be consistent: to obtain the best realistic prices over the longest possible period.

This can only be achieved if organizations begin the process with a clear understanding of storage system cost structures, and of the manner in which these will evolve over time. Obtaining the best short-term price might be appropriate for slower-growth segments of the IT world. But if storage capacity growth rates continue to increase – and there is every indication that they will – short-term savings may merely inflate the costs that will be incurred in the not-too-distant future.

Organizations may trust vendors. But they should verify the benefits that they obtain from that trust.

Energy Costs

As data center operating costs have continued to increase, greater attention is being paid to this area. A growing number of organizations are adopting "green" strategies in which energy cost trends are factored into IT planning decisions. The fact that these costs are expected to increase for the foreseeable future encourages such approaches.

At the most basic level, energy costs represent electricity consumed by IT equipment – in this case, by high-end disk systems. Although the amount of electricity used will be highest when systems are active, there will also be a background level of consumption when they are idle. In most installations, cost evaluations and projections should thus be on a 24x365 basis.

Direct energy consumption is, however, only part of the picture. "Multiplier" effects apply. For every kilowatt of electricity consumed by a storage system or server, it may be necessary to allow for from two to five kilowatts for computer room overhead, and for support systems such as those shown in figure 3.

Figure 3
Representative Data Center Support Systems

➢ Air conditioning units	➢ Operations monitoring & control systems
➢ Automatic transfer switches	➢ Power distribution systems
➢ Chillers/cooling systems	➢ Static transfer switches
➢ Control panels	➢ Structured cabling systems
➢ Electrical substations	➢ Uninterruptible power supplies

Allowance should also be made for the costs of backup generator capacity to guard against the effects of protracted utility outages. For all of these items, cost calculations should include acquisition, maintenance, occupancy, operations, and computer room and building-level overheads.

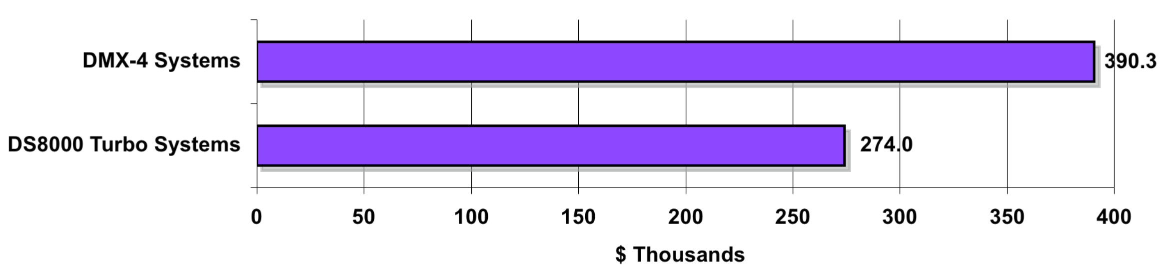
It may thus be appropriate to employ "loaded" cost per kilowatt (for support systems capacity) and per kilowatt-hour (for ongoing costs) assumptions to allow for these effects in planning. This approach was employed to calculate energy costs presented in this report.

Energy cost projections may also play a role in deciding which types of disk to employ. A 300 GB drive, for example, will typically consume as much electricity as a 146 GB disk, so overall energy costs per gigabyte of capacity will tend to be lower if higher-density media are employed.

Vendors have occasionally claimed significant improvements in energy efficiency for new systems by comparing arrays equipped with high-density drives to configurations employing older, lower-capacity devices. In practice, however, such differences tend to disappear if comparable drives are employed. Differences in system-level consumption become the key determinant of comparative energy costs.

For the comparisons presented in this report, for example, DMX-4 and DS8000 Turbo systems were both configured with 300 GB drives. Four-year energy costs for the latter, as figure 4 illustrates, averaged 29.8 percent less than for the former.

Figure 4
Four-year Energy Costs for EMC DMX-4 and IBM DS8000 Turbo Systems: Averages for All Installations



The basis of these calculations is described in the Detailed Data section of this report, which follows.

DETAILED DATA

Installation Profiles

The cost calculations presented in this report are based on profiles of high-end disk system installations in three large organizations:

1. ***Financial services company*** is a full-service retail bank that has diversified into commercial banking, brokerage, loan, mutual fund, financial advisory, and insurance businesses. For its most recent fiscal year, it reported revenues of over $20 billion, and yearend assets of over $400 billion.

   High-end disk arrays support a wide range of mainframe-, UNIX- and Windows server-based systems. These include proprietary core banking systems; a large-scale Siebel customer relationship management (CRM) system; online banking and financial services systems; data warehouses and data marts; company-wide finance, human resources and enterprise performance management (EPM) systems; and departmental and specialized systems.

   Disk systems, along with most of the company's server base, are located in two remote data centers. Data from critical mainframe-based and open systems is replicated between these for disaster recovery purposes.

   Over the four-year cost measurement period, high-end disk system capacity increases from approximately 538 TB to more than 1.9 petabytes (one petabyte equals 1,000 TB). Annual capacity growth rates range from 15 percent to more than 65 percent per year, depending on applications.

2. ***Manufacturing company*** is a global producer of consumer packaged goods with approximately $40 billion in revenues and 35,000 employees. It operates more than 40 manufacturing plants and 50 distribution centers.

   High-end disk arrays support SAP AG enterprise resource planning (ERP), supply chain management (SCM), business intelligence (BI) and other systems, along with a range of complementary applications. These are deployed primarily on UNIX servers.

   The company has recently undertaken a major consolidation initiative. Global ERP system and database instances have been put in place. Worldwide operations are now supported from two data centers located approximately 50 kilometers apart. Data from critical systems is replicated between these for disaster recovery purposes via high-speed local links.

   Over the four-year cost measurement period, high-end disk system capacity increases from around 379 TB to close to 1.2 petabytes. Annual capacity growth rates range from 12 percent to 45 percent.

3. ***Government IT services agency*** is a shared services organization supporting government IT operations in a European country. It provides IT infrastructure services for more than 2,000 applications for more than 300 user organizations.

   High-end disk arrays support a diverse range of applications deployed on mainframes, UNIX and Windows servers, and are housed in a primary data center and a satellite site employed for disaster recovery purposes. Data is replicated between these sites in real time.

   Over the four-year cost measurement period, high-end disk system capacity increases from around 230 TB to 624 TB. Annual capacity growth rates are in the 20 to 40 percent range.

Installation profiles were based on data on disk system hardware and software configurations, applications, capacity growth rates, host platforms (e.g., mainframes, UNIX, Windows or Linux servers, or combinations of these), and other topics supplied by 14 organizations in the same industries and approximate size ranges.

Using this data, composite profiles drawing upon input from multiple companies were constructed. A "best practices" approach was employed. For example, the experiences of one financial services company with high-end disk arrays supporting mainframe-based core banking systems were combined with those of a second with a large-scale CRM system, and others with data warehouses, data marts, and departmental systems.

In the case of the manufacturing company, the experiences of one company with business-critical SAP ERP systems were combined with those of others with SAP Business Information Warehouse (BW), SCM and other solutions. The government IT services profile was constructed similarly.

Installation profiles are summarized in figure 5. Terabyte values shown are for raw physical capacity.

Figure 5
Installation Profiles Summary

FINANCIAL SERVICES	MANUFACTURING	GOVERNMENT
Business Profile		
Diversified retail bank $400 billion assets 15 million customers 1,800+ branches 60,000 employees	Consumer packaged goods $40 billion+ revenues 40+ manufacturing plants 50+ distribution centers 35,000+ employees	Shared IT services 300+ customers 2,000+ applications 70,000+ users 1,500 employees
Initial Configuration		
Business-critical 2 x 76.8 TB, 2 x 33.6 TB ***Other systems*** 1 x 105.6 TB, 1 x 62.4 TB 3 x 38.4 TB, 1 x 33.6 TB Total: 537.6 TB	***Business-critical*** 2 x 38.4 TB, 2 x 28.8 TB ***Other systems*** 1 x 81.6 TB, 1 x 67.2 TB 1 x 48.0 TB, 1 x 28.8 TB 1 x 19.2 TB Total: 379.2 TB	***Business-critical*** 2 x 57.6 TB ***Other systems*** 1 x 43.2 TB, 1 x 72 TB Total: 230.4 TB
End of Period Configuration		
Business-critical 2 x 216 TB, 2 x 158.4 TB ***Other systems*** 1 x 264 TB, 1 x 254.4 TB 1 x 244.8 TB, 1 x 172.8 TB 1 x 148.8 TB, 1 x 100.8 TB Total: 1,934.4 TB	***Business-critical*** 2 x 148.8 TB, 2 x 81.6 TB ***Other systems*** 1 x 230.4 TB, 1 x 201.6 TB 1 x 115.2 TB, 1 x 91.2 TB 1 x 72 TB Total: 1,171.2 TB	***Business-critical*** 2 x 139.2 TB ***Other systems*** 1 x 259.2 TB, 1 x 86.4 TB Total: 624 TB

For each installation, configurations were developed for specific applications or groups of applications using latest-generation DMX-4 and DS8000 Turbo (including DS8100 Turbo and DS8300 Turbo) systems, and were upgraded to allow for annual capacity growth rates over a four-year period.

Configurations for both platforms employ RAID 5 technology, 300 GB drives, and 4 gigabits per second (Gbps) Fibre Channel front-end interfaces.

For the purposes of these comparisons, it is assumed that performance of DMX-4 and DS8000 Turbo systems for the same applications is comparable, and that configurations are of the same size in terms of overall raw capacity. Actual user experience may vary.

For DMX-4 calculations, business-critical system configurations were equipped with EMC Symmetrix Remote Data Facility (SRDF) real-time replication software, and all systems were equipped with the company's TimeFinder point-in-time copy and PowerPath multipathing tools.

For DS8000 Turbo calculations, systems were equipped with IBM Global Metro Mirror or Global Mirror, FlashCopy, and Subsystem Device Driver (SDD) software providing functionality equivalent to SRDF, TimeFinder, and PowerPath respectively. SDD is a no-charge product.

All configurations reflect current technology, used in an efficient manner to achieve relatively high levels of consolidation, performance and service quality. They may not correspond to configurations or deployment approaches in any individual organization. Users should adopt configuration sizing and deployment approaches appropriate for their own requirements.

Cost Calculations

Costs were calculated as follows:

- ***System costs*** include hardware acquisition and maintenance, as well as software licenses and support. All costs were calculated using discounted street prices.

  Warranty periods of two years for DMX-4 hardware and operating systems, and four years for DS8000 Turbo hardware, OEL and software were allowed for in calculations. For DMX-4 software, 90-day warranty coverage is allowed for software other than operating systems.

- ***Facilities costs*** include data center occupancy; acquisition and maintenance costs for support systems including uninterruptible power supplies (UPS), power distribution systems (PDS), cooling equipment, and back-up generator capacity; and energy consumption by disk systems as well as support systems.

  Data center occupancy costs were calculated based on footprints for EMC DMX-4 and IBM DS8000 Turbo systems, including service clearances. Allowance was also made for surrounding aisles and other inactive areas. Costs were calculated using a conservative assumption for cost per square foot per year for existing data center facilities – i.e., there is no allowance for new facility construction costs.

  Support systems costs were calculated based on discounted purchase and maintenance prices for models from leading vendors supplying large corporate data centers.

  Configurations were prorated; e.g., if disk systems required 40 percent of the capacity of a 30-ton data center cooling unit, costs were calculated based on 40 percent of acquisition and maintenance costs for this unit over a four-year period. Allowance was also made for occupancy costs for support systems.

  Electricity costs were determined using vendor specifications for disk systems as well as support systems. Calculations were based on specific utilization levels and hours of operation for individual disk systems or groups of disk systems, which vary between installations. A conservative assumption for average cost per kilowatt-hour was employed. This remained constant over the four-year measurement period.

  All facilities calculations are for U.S. costs.

Cost Breakdowns

Detailed breakdowns of four-year costs for all profile installations are presented in figure 6.

Figure 6
Detailed Cost Breakdowns

Installation	EMC DMX-4 SYSTEMS		IBM DS8000 TURBO SYSTEMS	
	Initial Costs	Total Costs	Initial Costs	Total Costs
Financial Services				
Hardware	6,291.6	21,200.0	5,464.1	17,086.0
Maintenance	0	3,127.2	0	0
Software licenses	3,816.6	10,479.1	3,102.4	7,622.5
Software support	0	4,807.9	0	0
Facilities	55.1	662.6	39.0	486.7
TOTAL ($000)	**10,163.3**	**40,276.8**	**8,605.5**	**25,195.2**
Manufacturing				
Hardware	4,764.6	13,893.1	3,851.3	10,513.9
Maintenance	0	1,135.0	0	0
Software licenses	2,317.6	5,909.2	2,280.8	5,354.5
Software support	0	2,639.1	0	0
Facilities	39.3	463.0	26.3	334.4
TOTAL ($000)	**7,121.5**	**24,039.4**	**6,158.4**	**16,202.8**
Government				
Hardware	2,356.7	6,905.2	2,258.9	5,325.5
Maintenance	0	1,045.9	0	0
Software licenses	1,586.8	3,735.4	1,340.6	2,782.0
Software support	0	1,841.6	0	0
Facilities	21.8	239.2	14.8	174.4
TOTAL ($000)	**3,965.3**	**13,767.3**	**3,614.3**	**8,281.9**

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ITG

4546 El Camino Real, Suite 230
Los Altos, California 94022-1069
Telephone: (650) 949-8410
Facsimile: (650) 949-8415
Email: info-itg@pacbell.net