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Tape and Disk Costs – What It Really Costs to Power the Devices

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Management Summary

The introduction of lower cost drives, such as Serial ATA (SATA) drives, has many people convinced that disk is now as inexpensive as tape. Disk prices *are* dropping every year, as drives get larger in capacity, but tape vendors continue to increase the capacity of tape cartridges, allowing tape to maintain its lower cost. Acquisition costs are only part of the cost of owning storage. Other costs include the cost of floor space, software, maintenance, management, and electricity. Tape systems will always require less electricity than disk systems similar in capacity. Electrical costs have been rising yearly and energy consultants do not predicate any changes in this trend. Rising energy costs make it important, more than ever, when evaluating different storage systems, to consider the cost to power and cool equipment.

Energy costs become magnified because the amount of data that IT organizations must manage and store is growing by leaps and bounds. Many enterprises estimate that their data is growing at rates that exceed fifty to one hundred percent annually. Not only is the amount of data growing at an incredible rate, but also IT is now required to keep the data for longer and longer. Regulated companies are keeping emails for seven years or longer. Medical institutions are required to keep records for the life of the patient, or longer. Companies that are not subjected to regulations are being advised by their attorneys to keep corporate information, such as emails and instant messages, for many years.

Where should we store all this data? High-performance disk will always be the choice for online applications that require fast access. Applications with limited backup windows that require speedy recovery benefit from using lower cost, higher capacity SATA disk. These disk-based backups are commonly called disk-to-disk or D2D. Other applications can be backed up directly from primary disk to tape. Tape complements disk; previous versions of disk-resident backups, can be migrated to tape using a disk-to-disk-to-tape, or D2D2T strategy. Data, such as human resources records, emails, or last year's patient's records, for example, with low access frequency are candidates for low-cost, low-energy consumption tape systems.

Storing infrequently-accessed data on disk is equivalent to keeping your car running constantly in the driveway. The car is always ready to go if you need to drive anywhere and saves you several minutes of "warm up" time. Keeping a car constantly idling burns a lot of gasoline, an expensive proposition in today's world! Is it worth it to keep your car running because you *may* need to drive some place? Most people would consider this illogical – and wasteful. It is just as illogical (and expensive) to keep infrequently used data spinning on disk because you *may* need to access it later. To illustrate this point, let's compare the cost of two systems of similar capacity – one is an automated tape solution and one is composed of SATA disks.

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Comparing the Costs of Tape and Disk

Let's assume that an IT department needs to store about 125 TB of infrequently accessed data today. The company has projected a modest storage growth rate of 30% a year for the next five years. Tape and disk storage are never fully utilized at 100%. Here, we have chosen to use 85% utilization for tape and 70% utilization for disk. These utilizations can be achieved in many mainframe environments; however, open systems environments may not realize such efficiencies. By the end of the first year, the IT organization would need to purchase 232 TB of disk storage (at 70% utilization) or 191.2 TB of tape storage (at 85% utilization) to store the original 125 TB of data plus the additional 37.5 TB of new data. By the end of fifth year, IT would need a total of 663 TB of disk storage, or 545 TB of tape storage to accommodate the original data and the 30% additional new data every year. (See Exhibit 1, below.)

Exhibit 1 – Total Storage Requirements For The First Five Years

TBs	Year 1	Year 2	Year 3	Year 4	Year 5
Data Stored	163	211	275	357	464
Disk Storage Required	232	302	392	510	663
Tape Storage Required	191	248	323	420	545

Hardware Configurations

For the tape system in our analysis, we choose LTO-3 drives and cartridges installed in an automated tape library. We used list pricing for all hardware configurations.[1] (See Exhibit 2, at the top of the next column.)

For the disk system, we choose Serial ATA disk storage. To store 672 TBs of data, we require 15 controllers, each attached to seven expansion frames. **When comparing acquisition costs alone, the SATA disk system costs about 6.5 times the cost of the automated tape system.** (See Exhibit 3, below.)

Exhibit 2 – List pricing for automated tape systems

1 LTO Tape Library	$116,000
4 LTO 3 FC Tape Drives	$ 73,600
683 LTO 3 cartridges	$ 71,442
Total cost of tape system	$261,042

Source: A Leading Vendor

Exhibit 3 - List pricing for SATA Disk Systems

15 disk controllers	$398,205
105 expansion units	$1,244,850
9 racks	$43,650
Total disk cost	$1,686,705

Note: Each dual disk controller has 5.6 TB of internal storage. One controller with seven expansion units contains 44.8 TB of storage.
Source: Another Leading Vendor

Factoring in Environmental Costs

The LTO tape library occupies 10.4 square feet of computer room floor space, while the 9 racks housing the disk systems occupy 65.3 square feet. If the cost of raised computer room is charged at a modest rate of $20 per square foot per month, then the yearly cost for the disk systems is $15,672 a year, while the tape system costs only $2,496. **The SATA disk system occupies 6.2 times more floor space than that occupied by the tape system.**

The costs to power and cool the two systems differ by a wide margin. The cost of electricity varies widely by state, region, and country. For example, the Northeast and Western parts of the United States pay more for electricity than parts of the Midwest. Here, we choose to use the cost of $.145 per kilowatt-hour, which is the average cost of electricity to commercial customers in the New England area. The yearly electrical costs were calculated by the following steps.

[1] The current list price for Fibre Channel LTO-3 automation tape drives is $18,400. The list cost for one LTO-3 cartridge is $104.60. One LTO 3 cartridge can store up to 800 GB of capacity with 2:1 compression. This tape library with 683 LTO 3 cartridges has a capacity of 546 TBs.

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1. Adding the power requirements and the cooling requirements for each unit,
2. Multiplying that sum by the number of units,
3. Multiplying that product by 8760 (the number of hours in a year),
4. Multiplying that product by .145 (the cost per kWh).

The disk system costs over 25 times more money to power and cool than a similar capacity tape system. (See Exhibit 4, below.)

Exhibit 4 - Yearly Electrical Costs for Automated Tape Library

	Power Requirements per unit	Cooling Requirements per unit	Total Yearly Electrical Costs
1 LTO Library	1.6 kWh	1.6 kWh	$4,065
4 LTO 3[1] drives	.017 kWh	.017 kWh	$173
Total Yearly Costs			$4,238

Note: LTO 3 drives consume 29 watts of power when writing data and 13 watts when idle. For this example, we assumed that the drives were writing 25% of the time.

A yearly electrical bill of $109,745 for the disk system may not seem excessive for a system that costs almost $1.7 million dollars. However, after five years, the electrical cost of $548,725 is over 32% of the initial acquisition costs. On the other hand, the five-year electrical bill of $21,190 for the tape systems is only 8% of the acquisition cost.

This assumes that electrical costs will remain the same over the next five years. However, most energy consultants fear that electrical costs will continue to rise, which will add substantial to the cost of storing data on disk.

New England commercial customers are all too familiar with the rise in energy costs. In January 2005, the average cost of electricity was $.113 per kilowatt-hour. In January 2006, that cost rose to $.145, a whooping 28% increase. (See Exhibit 5, at the top of this column.)

Exhibit 5 -Yearly Electrical Costs for SATA Disk System

	Power Requirements per unit	Cooling Requirements per unit	Total Yearly Electrical Costs
15 disk controllers	.33 kWh	.39 kWh	$13,718
105 expansion frames	.33 kWh	.39 kWh	$96,027
Total Yearly Costs			$109,745

We would like to believe that electrical costs would not rise at 28% per year. Let's take a more conservative approach and assume that a New England commercial company sees an increase of 10% per year.

If electrical costs increase by 10% a year, the electrical bill to power and cool the tape systems for five years will be $25,873, or about 10% of the original acquisition price. In five years, the electrical bill for the disk system will be $670,000 – or 40% of its original cost. If electrical costs increase by 20% a year, then the cost to power and cool the disk drives for five years is almost half the original acquisition cost. (See Exhibit 6, below.) **Simply put, the cost to power and cool equipment cannot be ignored. It must be part of the evaluation process when considering the purchase of any new storage devices.**

Some Caveats

In three pages, we've given you a basic framework to compare the costs of tape and disk. Your reality may require a more thorough analysis. Please see the "Some Caveats" in the box on the top of the following page for items that you may want to add to your analysis.

Exhibit 6 - Yearly Electrical Costs With A 10% Increase In Electricity Each Year

	Year 1	Year 2	Year 3	Year 4	Year 5
Tape Systems	$4,238	$4,662	$5,128	$5,640	$6,205
Disk Systems	$109,745	$120,720	$132,792	$146,071	$160,678

Source: Clipper analysis

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Some Caveats

These cost calculations are an exercise to highlight the effects of environmental costs on long-term storage solutions. A more complete study might also include the following.

- **The cost to replace disk and tape after several years.** Many enterprise customers replace disk systems every two to three years and replace tape systems about every five years.
- **The cost to phase in equipment purchases as needed.** Not all of the equipment in the initial configuration would be required in the first year.
- **The cost of maintenance after the warranty expires.** Warranty periods differ by vendor and by system. Maintenance prices also vary depending on the vendor and the type of coverage required.
- **The costs associated with protecting disk-resident data by RAID schemes.** Mirroring, or RAID-1 protection would double the cost of the disk systems. Other RAID schemes, such as RAID-5 can require additional disk storage without requiring double the amount of disk. Many RAID-5 implementations require at least 20% more disk capacity.
- **The cost for spare disk drives.** The disk systems were configured without any disk spares. Most disk vendors recommend one spare disk for each expansion frame. This will increase the cost of the disk systems.
- **The software and personnel costs to manage the storage devices.**
- **The cost to backup or replicate the data stored on these systems for disaster recovery.**

Conclusions

Key Findings

1. SATA disk system has nearly 26 times higher energy costs than tape system.
2. SATA disk system acquisition costs about 6.5 times the cost of automated tape system.
3. Assuming electrical rates remain same, the cost to acquire, power and cool disk systems for five years is almost 8 times the cost to acquire, power, and cool automated tape systems.
4. The cost to power and cool equipment must be part of the TCO.

Evaluating the Cost of Storage

When evaluating different storage solutions, some enterprises may focus on the initial acquisition costs, but fail to think about other costs, such as maintenance and energy costs, that can add to the cost of storage over several years. Storage hardware costs have been decreasing each year. Some vendors offer extended warranties which decreases maintenance costs. Some enterprises have equipment maintained by third party maintainers (TPM) to reduce maintenance costs. However, most have few choices when it comes to electricity. They may not have the option to go to another energy provider. The only way they can control energy costs is to choose storage wisely. Disk storage is designed to support high-performance, online applications. It can also be well suited as an initial backup target for select applications.

However, tape is well suited to store data that must be retained for long periods of time (and it is environmentally and energy-cost friendly). And, due to its removable and portable attributes, tape is ideal for implementing best practice data protection strategies. Storing infrequently-accessed data on disk is similar to keeping your car idling in the driveway - it wastes energy and it costs money. Any storage evaluation must include the energy costs to run the equipment. In our example, the disk systems initially cost 6.5 times the cost of the automated tape system. Adding five years of energy costs widen that gap; now, the disk systems are almost eight times more expensive!

For some enterprises, a blend of tape and disk in a D2D2T storage complex may provide the tools needed to optimize backup/restore performance, data protection, and costs. **Take control of energy costs and choose storage wisely.**

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