The Performance Impact of Energy Efficiency

This white paper looks at how the performance of storage systems can be used to reduce energy costs. Buying storage systems on the basis of cost per capacity may create performance and energy issues. Test results show that LSI storage systems deliver better performance efficiency than the EMC, HP, and NetApps systems compared. Performance combined with energy efficiency should be considered when purchasing external storage systems.

Introduction

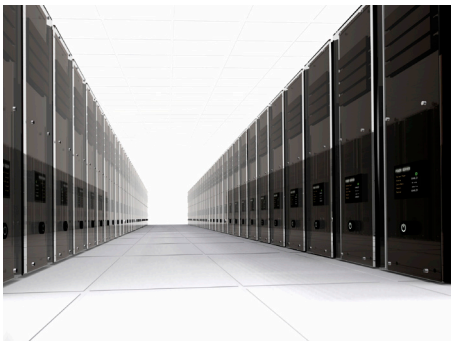
Data storage demands continue to increase. The value of information is ever increasing as are requirements to retain data for longer periods of time. Consequently, the amount of data being generated and stored annually continues to grow in environments of all sizes.

With this relentless growth comes the expense of powering and cooling the IT systems generating, utilizing and storing data. Environmental and energy topics have joined the list of business and technology related issues that executives and IT managers must now contend with. With soaring energy prices and even limited supply, IT managers must keep energy consumption in perspective without negatively impacting application performance.

Background

The top three power consumers in the data center are heating, ventilation and cooling (HVAC), servers and storage. Reducing the amount of power consumed in the data center is all about improving efficiency. HVAC power consumption can be reduced with more efficient cooling. Server power consumption can be reduced with more efficient servers as well as using servers more efficiently through virtualization and consolidation. For storage, it's also about efficiency.

The storage components that consume the most power, and as a by-product generate the most heat, are the disk drives themselves. As a result, improving the power consumption and cooling



Improving efficiency for HVAC, servers and storage is the key to reducing power consumed in the data center.

requirements of storage is straightforward — reduce the number of drives in the storage solution. And the best way to do this for primary storage is with efficient drive utilization.

There are several ways to reduce the number of drives in your storage system and improve utilization. The most obvious is through consolidation. Industry analysts typically quote the average capacity utilization for direct-attach storage at below 50 percent. Storage consolidation increases utilization to around 75 percent as administrators can draw from a unified storage pool and more effectively and dynamically allocate storage to servers and applications on an as-needed basis — reducing the amount of capacity overhead required and eliminating the unused storage that typically sits wasted in a distributed environment. Storage consolidation alone can result in a 25% reduction in power/cooling requirements due to more efficient drive utilization. The wide deployment of storage area networks, or SANS, has reaped this benefit.

While storage consolidation is one important aspect of efficient drive utilization, there are many others that can significantly impact the number of drives needed in a storage system and thus the power/cooling requirement of that system.

Storage Selection Criteria

As most primary storage systems utilize the same disk drives, it may seem hard to differentiate one system from another. The key is to realize that not all storage systems are created equal. Buying the same number of drives in one system vs. another may indeed create systems with equal power/cooling requirements, but what you get out of those systems can be significantly different.

Storage is typically purchased with one of two goals in mind — meeting capacity-oriented requirements or meeting performance-oriented requirements. For capacity-oriented secondary storage requirements, the IT manager's goal is clear — get the most capacity for the lowest price (while maintaining a base level of reliability). For performance-oriented primary storage requirements, IT managers will often face a dilemma. As they strive to lower their cost per terabyte, reduce the storage footprint, and minimize power/cooling requirements, they must be careful not to do so at the expense of application performance and service level agreements (SLAs).

Capacity-Oriented Storage

When purchasing storage for capacity-oriented secondary storage requirements, IT managers are looking for the lowest cost per terabyte. This is achieved with a combination of low-cost, high capacity drives and efficient capacity utilization.

Capacity-oriented applications are only interested in usable capacity, the capacity available to them to store and access data. Power and cooling requirements, however, are based on raw capacity as all the drives in the storage system must be kept spinning and be cooled. Capacity used for formatting, RAID protection, configuration metadata, and other overhead, must be subtracted from the raw capacity to determine the usable capacity.

When it comes to how efficiently storage systems utilize raw capacity, there are dramatic differences from one vendor to the next. Buying 10 TB of raw capacity from one vendor will not get you the same usable capacity as 10 TB of raw capacity from another. Systems that support the highest usable capacity as a percentage of raw capacity will be able to meet capacity requirements with fewer drives, thus lowering power and cooling requirements.

The LSI superior storage controller technology enables IT organizations to meet their performance SLAs with fewer disk drives, reducing their energy consumption and energy-related costs.

Performance-Oriented Storage

While performance-oriented storage is also impacted by raw vs. usable capacity; another dimension comes into play — performance per drive. Just as we want to get the most usable capacity per drive for capacity-oriented requirements, in order to lower power and cooling cost for performance-oriented applications we need to get the most performance out of each drive operations.

Primary external storage systems performance is characterized by one of two metrics — I/O per second (IOPS) or throughput. IOPS is the key metric for transactional applications, such as OLTP, databases or email, with a small-block, random access application profile. Throughput performance is measured in Megabytes per second (MB/s); and is important for bandwidth-oriented applications, such as video streaming, surveillance and other rich media applications. Customers that can meet their IOPS or throughput performance needs with the fewest number of drives will benefit from the lowest power/cooling requirements.

As disk drive capacities have increased, users have enjoyed dramatic decreases in cost per terabyte. This has been great for throughput-oriented applications that can typically meet performance requirements with a relatively few number of drives. These capacity-intensive applications benefit from the large-capacity drives in more ways than one as they are able to store more data, for less cost, and still meet performance needs.

Transactional applications, however, face a dilemma. The temptation to reduce the number of drives by using higher capacity drives is significant as this produces the lowest cost per TB. And while these drives may lead to a more economical storage configuration with lower energy requirements, it's a false sense of improvement with regard to performance as these solutions will probably not deliver adequate application performance to meet SLAs for primary, IOPS-sensitive applications.

IT organizations have been conditioned to assume that an increase in effective storage performance equates to higher energy costs due to additional disk drives being required. Likewise, the presence of more disk drives does not guarantee increased performance on a storage system. For optimum performance of primary external storage systems, a robust storage controller is needed that can fully utilize the capabilities of all attached disk drives in an energy efficient manner.

It's clear that the LSI storage system offers a significant IOPS/Watt advantage over the competition when configured similarly for transaction processing.

Performance Efficiency

LSI conducted research in an effort to determine how storage systems balance performance and energy consumption. What we learned was that some storage systems consume more energy to achieve a given level of performance than LSI primary storage systems in a similar configuration.

Finding specific and applicable performance information about primary external storage systems can be difficult. "Spec" numbers from data sheets state maximum values for several performance metrics, but do not reflect the "real world" performance users receive from their applications. At the other extreme are solutions that are promoted with an aggregate of individual disk drive manufacture (raw) performance values leaving the consumer to assume what is the actual real effective performance. This problem has been widely known, and for the past seven years the Storage Performance Council (SPC), an industry consortium, has created benchmarks to address this need.

LSI is a founding member and a strong supporter of industry standard benchmarks for the following reasons:

- They provide a standardized, vendor neutral, test environment
- They require full disclosure of the metrics produced, configuration tested, and the costs involved through a Full Disclosure Report (FDR)
- They include a rigorous peer review process to ensure compliance with the specs

The intention is that anyone could take the information from the Full Disclosure Report (www.storageperformance.org) and rerun the tests and produce the same results. Unfortunately some vendors refuse to participate in SPC benchmarking. In those cases we have relied on vendor supplied public performance information.

Since all major storage vendors do not have SPC results posted with their current systems, another test was needed. While using proprietary benchmarks conducted by a single storage vendor is never ideal, a white paper published by a major storage vendor was found that made performance comparisons possible.

Figure 1 shows the performance efficiency and power effectiveness in terms of IOPS per watt, that is, how many IOPS can be performed per watt of power consumed for each of the storage systems in a similar configuration.

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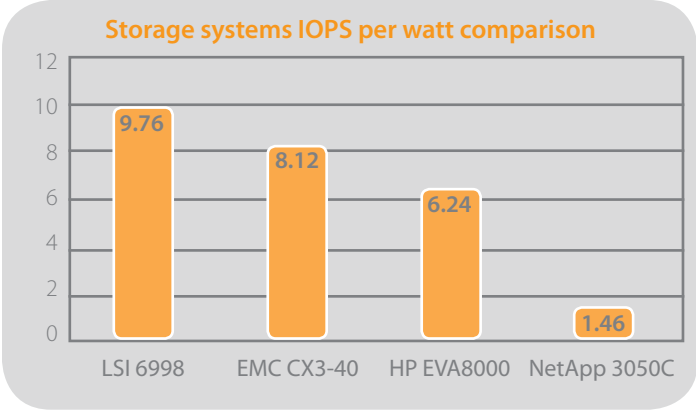

Figure 1.

Figure 2 shows the performance comparison of the different storage systems from a bandwidth or throughput (MB/s) perspective for example to perform data backup.

LSI's superior storage controller technology enables IT organizations to meet their performance SLAs with fewer disk drives, reducing their energy consumption and energy-related costs.

The result? As seen in Figure 1 and Figure 2, LSI's storage systems enable more effective performance per watt with the same number, or even fewer disk drives than its competitors. In the example shown in Figure 1, the LSI 6998-based storage system configured with 224 disk drives achieves the best IOP/watt with fewer disk drives compared to an EMC CX3-40 and HP EVA8000 each with 240 disk drives or the NetApp 3050c with 262 drives, all using 146GB 15K Fibre Channel disk drives.

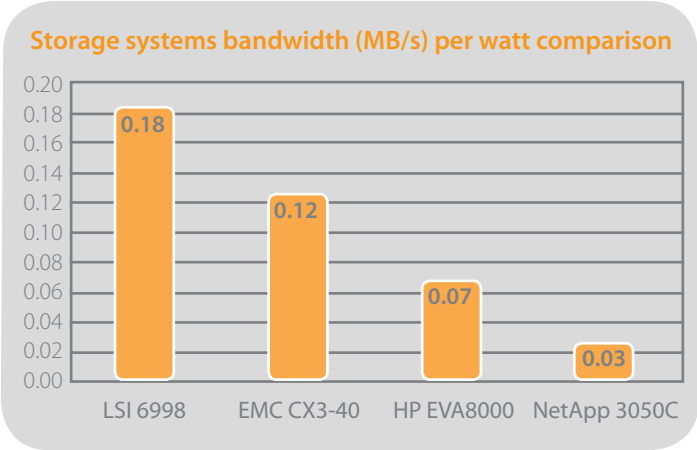

Figure 2.

LSI has introduced a means for measuring effective storage usage including performance and energy efficiency with a metric, which we've called "IOPS/watt". IOPS/watt is an indicator of useful work along with storage system performance efficiency and energy effectiveness of primary external storage. By looking at and comparing energy consumption to deliver a given level of performance instead of looking at storage capacity and power consumed, IT customers can realize benefits of improved performance and reduced energy costs without sacrificing availability.

Conclusion

Many local and regional electrical utilities have rebate and incentive programs associated with reducing your energy footprint and consumption for homes and business including leveraging more efficient and effective IT equipment. The energy efficiency of enhanced storage performance effectiveness of primary external storage systems can reduce your environmental costs by providing adequate performance to meet SLAs with fewer disk drives. Adding performance effectiveness combined with energy efficiency as a buying criterion can reduce both capital and operational expenditures costs.

There is one sure-fire way to reduce the heat and energy consumption of storage systems, reduce the number of disk drives. This approach, however, can not come at the expense of performance. LSI builds some of the industry's most performance effective and energy efficient disk controllers. This means that LSI storage systems get the most out of each individual drive and deliver the highest performance with energy efficiency.

The Green Grid

LSI is a general member of the Green Grid, a non-profit consortium dedicated to advancing energy efficiency in data centers and business computing ecosystems.

the green grid℠ member

The organization is chartered to develop meaningful, platform-neutral standards, measurement methods, processes and new technologies to improve energy efficient performance of global data centers.

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