



Building Power Efficient Solutions With Cisco MDS 9000 Directors

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Introduction

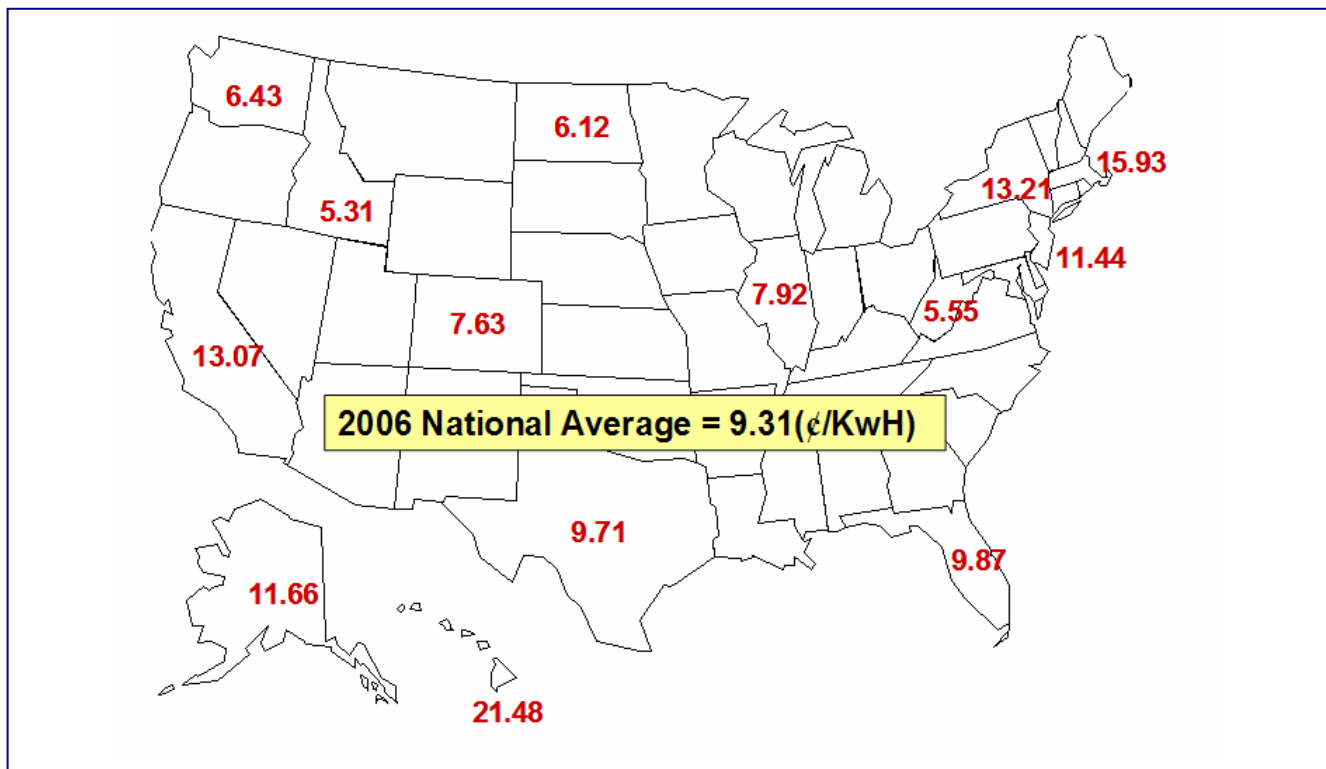
Power and cooling are surfacing as major concerns in companies of all sizes. Rising energy prices and drastic increases in the density and power requirements of server and storage solutions over the past few years have driven IT managers to consider strategies for reducing power consumption in the data center. Often, this begins with a myopic comparison of power ratings among competitive solutions at the component level. This manifests itself in the storage networking industry as a comparison of port level power requirements in storage networking equipment. In this report, we'll present an alternative and arguably better method of comparison - a solution-based approach for the analysis of overall power consumption. Real-world configurations will be presented with a focus on how Cisco MDS 9000 directors can be used to implement storage networking solutions that reduce overall power consumption in the data center.

The Power and Cooling Problem

Performance and availability historically have been the primary considerations when designing the IT infrastructure needed to support the business. Power and cooling are considered once every ten to fifteen years during the design of a data center facility. IT has the budget to buy the infrastructure and the facilities department pays the power bills. But, the rising cost of power and the ever increasing compute density of servers and storage are turning power and cooling into a boardroom concern.

According to the Department of Energy, the average cost of power in the United States has increased 25% since 2000 to 9.31 cents per kilowatt in 2006. As shown in Figure One, the cost of power varies significantly within the United States and is highest for regions along the densely populated East and West coasts.

Figure One: 2006 US Average Commercial Retail Price of Power



The high cost of energy is only one of the factors contributing to the overall rising costs of power and cooling in the data center. Technologies like blade servers and virtualization have radically changed the dynamics of predicting future power and cooling demands. The amount of power and cooling needed for each square foot of data center floor space is increasing dramatically as racks are filled with high compute-density equipment. While IT managers historically have been delighted to hear that processor speeds will double every 12-18 months in accordance with Moore's law, the new concerns are the power and heat problems that future advances will bring.

There are a number of approaches that can be used to address power and cooling problems in the data center. In this report, we examine an approach for reducing the cost of power and cooling solutions deployed in a storage network. Instead of comparing power requirements of storage switches at the port level, a comparison at the solution level is presented.

A Solutions Based Approach

The Cisco MDS 9000 is an upgradeable storage networking platform that supports a number of features which can be used to implement solutions to reduce overall power consumption in the data center:

1. Virtual SANs (VSANs)

VSANs provide isolated and segmented SAN fabric topologies on a common platform. VSANs consolidate multiple SAN fabrics on a single director while enforcing isolation and security between applications or business units. VSANs decrease power consumption by reducing the number of director frames deployed in the data center.

2. Inter-VSAN Routing (IVR)

IVR is used to interconnect multiple VSANs. One of the more popular uses of IVRs is providing access to shared resources, such as tape libraries, that may be distributed across multiple VSANs without having to join the multiple VSANs into a single fabric. VSANs and IVR are complimentary technologies that will consolidate multiple applications and business units onto a single director. This reduces the overall cost of power and cooling in the data center.

3. Intermixed Mainframe and Open Systems Traffic

Mainframe FICON traffic and Open Systems FCP traffic can be implemented on the same Cisco MDS 9000 director. VSAN and Role Based Access Control (RBAC) technologies can completely separate FICON traffic from FCP traffic so that Mainframe and Open Systems applications can be deployed on a common platform. Intermixing of Mainframe and Open Systems traffic on the same platform reduces the number of directors deployed in the data center. Fewer directors consume less power.

4. Fibre Channel over Internet Protocol (FCIP)

FCIP is built into the MDS 9000 Family platform. This capability historically has been implemented in routers outside of a director frame. Fibre Channel over IP (FCIP) allows data to be transported over Wide Area Networks (WAN) for disaster recovery purposes. Integrated FCIP support saves power, cooling and rack space compared to a traditional appliance-based approach.

5. Storage Services Module (SSM)

Fabric-hosted applications can easily be deployed on existing SAN infrastructures by inserting a Cisco MDS 9000 Family Storage Services Module (SSM) into open slots in one or more Cisco MDS 9000 Family directors. ESG lab has validated a number of SSM enabled applications including virtualization, data migration, remote replication and network-accelerated serverless backup¹. SSM solutions can be used to consolidate data services that previously ran on appliances and servers and reduce overall power consumption in the data center.

Following a tradition that has been extremely successful for Cisco in the Ethernet switching space, the MDS 9000 uses a platform-based architecture with a common operating system and user interface to provide investment protection and enable future growth. Services supported on the future-proof MDS 9000 platform can be used to architect solutions to mitigate overall power consumption in the data center.

¹ ESG Lab Validation reports are freely available at <http://www.enterprisestrategygroup.com>. The reports which highlight the capabilities of the Cisco MDS 9000 series SSM module are Cisco Serverless Backup, EMC Invista and EMC RecoverPoint.

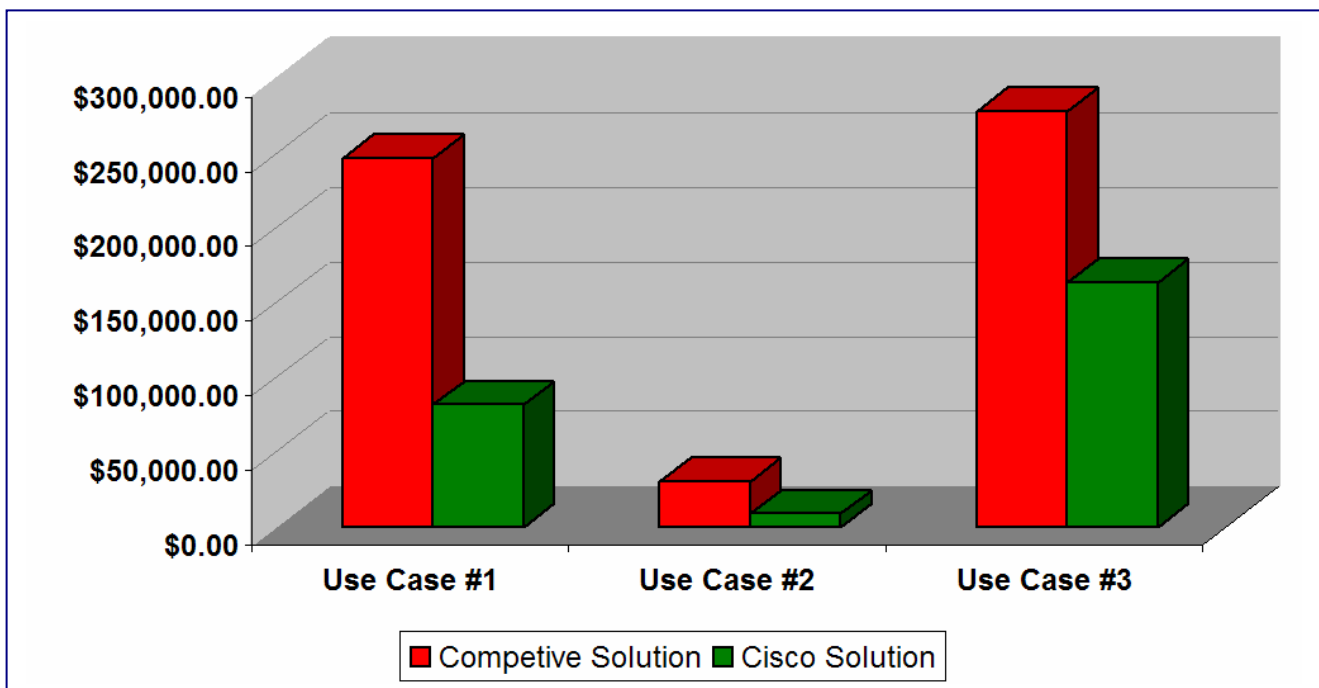
Use cases

The power and cooling requirements of Cisco MDS 9000 enabled solutions are compared to competitive solutions in this section. In each of the use cases, we assumed redundant SANs. We examined the configuration and power needed to implement each of the following solutions:

1. Isolated storage network traffic for three business units sharing a common backup infrastructure
2. Combined Mainframe and Open Systems storage network connectivity in the same data center
3. Extended storage for remote replication and tape vaulting between data centers

The total power and cooling needed to implement each of the solutions listed above was calculated for a three year period. The average cost of power in the United States in 2006 as reported by the Department of Energy (9.31 cents) was used to calculate the cost of deploying each solution. The savings that can be realized within the data center using the Cisco MDS 9000 use case solutions can be seen from the total cost of power required to deploy 10 of each of the solutions over three years in Figure Two.

Figure Two: Data Center Level Cost of Power Comparison



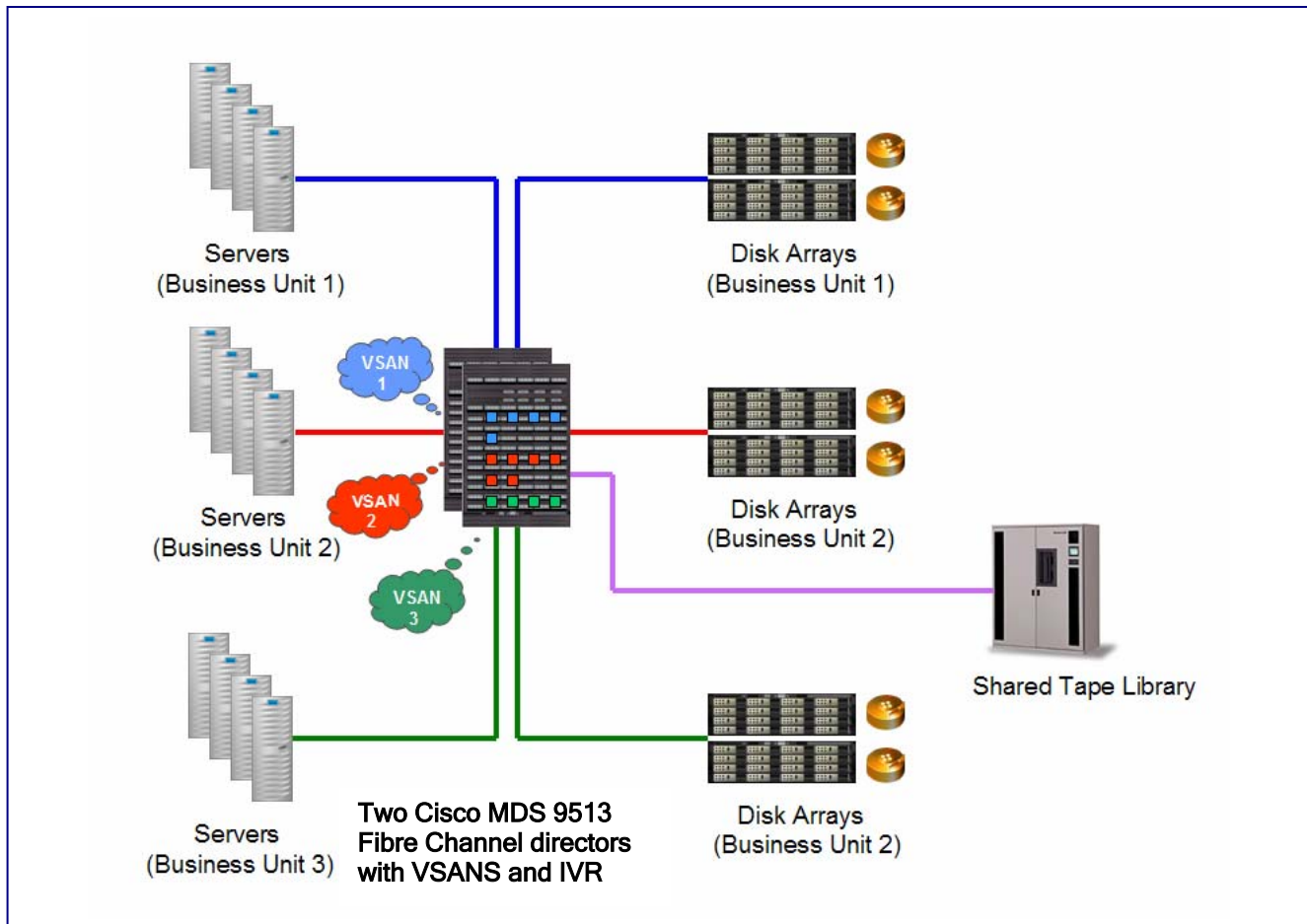
As shown, the cost of power for MDS 9000 enabled solutions (shown in green) is significantly lower than that of competitive solutions (in red). For example, in Use Case #1, the MDS 9000 is a third of the cost of a competitive solution. In each case, the cost of power for the MDS 9000 solution is lower than that of the competitive solution due to fewer total components deployed in the storage network.

The dollar amounts shown in Figure Two will vary depending on the number of Cisco solutions deployed. Some customers may have only one solution deployed, while others will have more than 10. Regardless of the number of solutions deployed, the relative difference in the cost of power required for the solution is the same. For example, consider Use Case #1. Figure Two shows the results for 10 solutions with a difference in power costs of \$165,433 (the savings for each Cisco solution is \$16,543). Regardless of the number of solutions deployed, the Cisco solution is one third of the cost of a competitive solution.

Use Case #1 - Consolidation and SAN Isolation

Isolated SANs are required for three business units within a mid-sized company. Each business unit needs 96 Fibre Channel ports for server and storage connectivity. A shared tape library is used for backup and recovery by all three business units. Fibre Channel routing is required between each of the isolated SANs to enable shared access to the tape library without having to create a single fabric shared by all three business units.

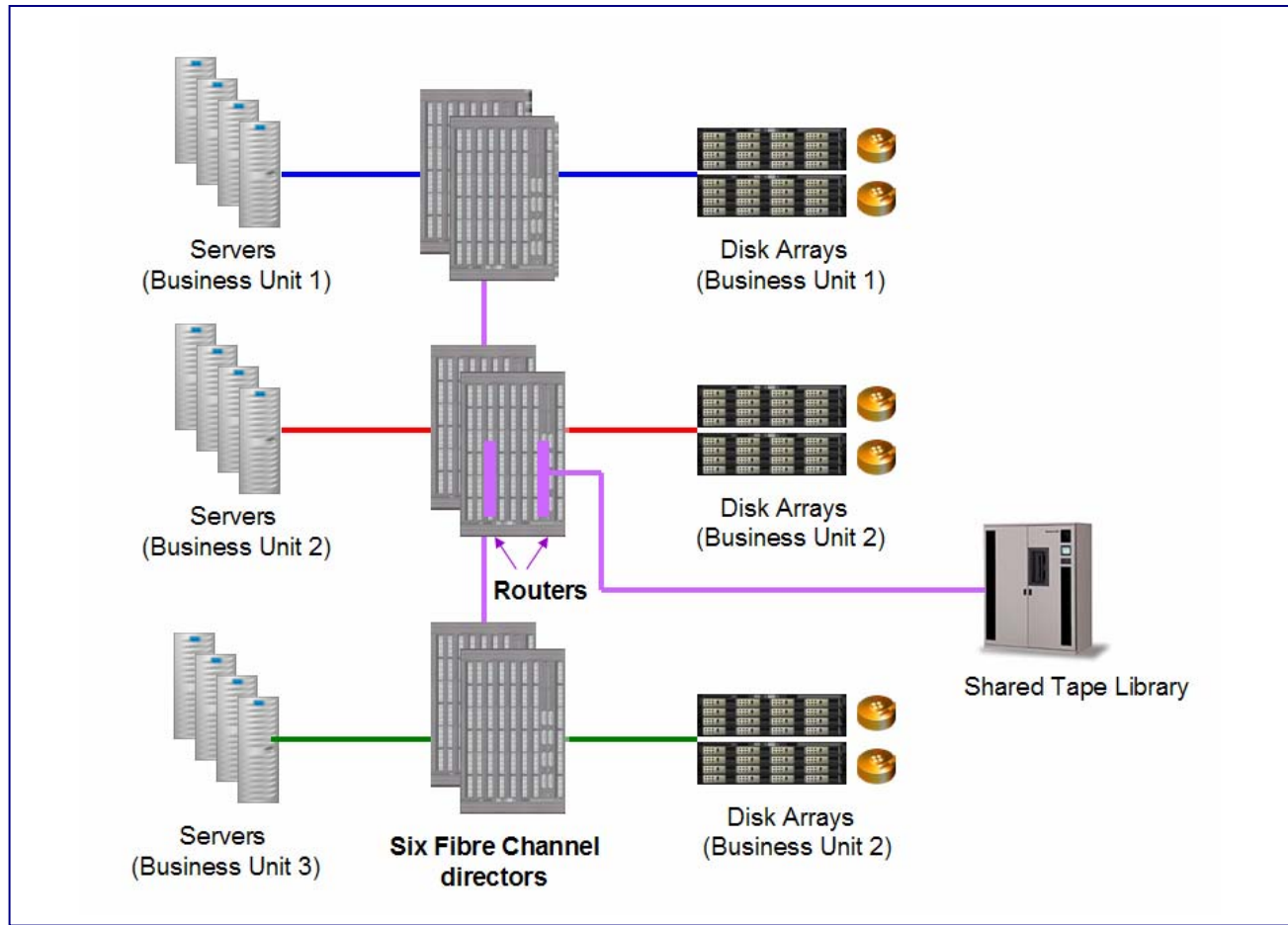
Figure Three: The Cisco MDS Solution for Use Case #1



As shown in Figure Three, each of the business units is connected to an isolated pool of servers and storage using a VSAN configured on the MDS 9513. For example, the servers belonging to Business Unit 1 are connected to Disk Arrays belonging to Business Unit 1 using Fibre Channel connections shown in blue. As shown in the blue cloud, five ports on the MDS 9513 are configured as the VSAN for Business Unit 1. The Inter VSAN Routing (IVR) connection shown in purple is used to provide shared tape library access for all three business units.

VSANs are used to provide total isolation of the storage network traffic between each business unit. Servers and storage can be added, moved, or changed within each VSAN without changing the physical structure of the SAN. IVRs are used for the transfer of backup and recovery data between servers in each business unit and the shared tape library without having to merge the VSANs into a single logical fabric. A functionally equivalent competitive solution is shown in Figure Four.

Figure Four: A Competitive Solution for Use Case #1



Note that three physically isolated SAN fabrics have to be built using six directors, compared to the two-director Cisco MDS configuration shown in Figure Three. Also note that routers, which could be implemented using external devices, are required. In the competitive solution shown in Figure Four, the routers are installed in the director chassis².

A summary of the configuration and power requirements for the Cisco and competitive solutions is presented in Table One. Power calculations were performed using publicly available documentation. An average cost of power in the United States of 9.31 cents per kilowatt hour and 60% of the cost of power for cooling were used to calculate the total cost of power for the solution over a three-year period of ownership. The Cisco solution saves power using two directors instead of six, requiring 67% less power than the competition.

Table One: Configuration and Power Usage Summary for Use Case #1

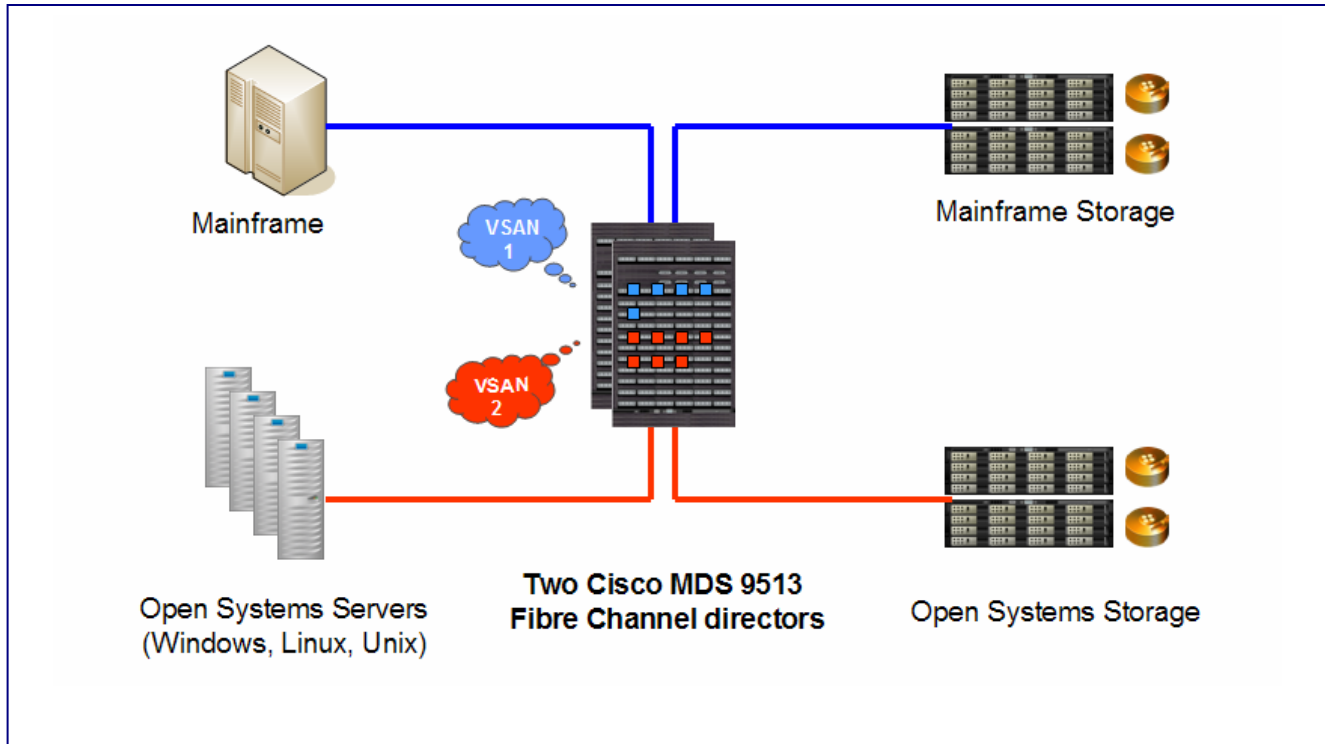
	Cisco Solution	Competitive Solution
Total Power Required	2094 Watts	6320 Watts
Power costs over 3 years	\$5,123	\$15,463
Power for cooling over 3 years	\$3,074	\$8,197
TOTAL 3 year cost of power	\$8,197	\$24,741
Savings	\$16,543 (67%)	

² The power calculations are the same for the competitive solution shown in Figure Four regardless of where the routing is implemented.

Use Case #2 - Shared Mainframe and Open Systems Connectivity

An enterprise-class data center wants to add 24 ports of Mainframe connectivity to an existing Open Systems storage network. Mainframe connectivity using the FICON protocol must be isolated from Open Systems traffic using the FCP protocol.

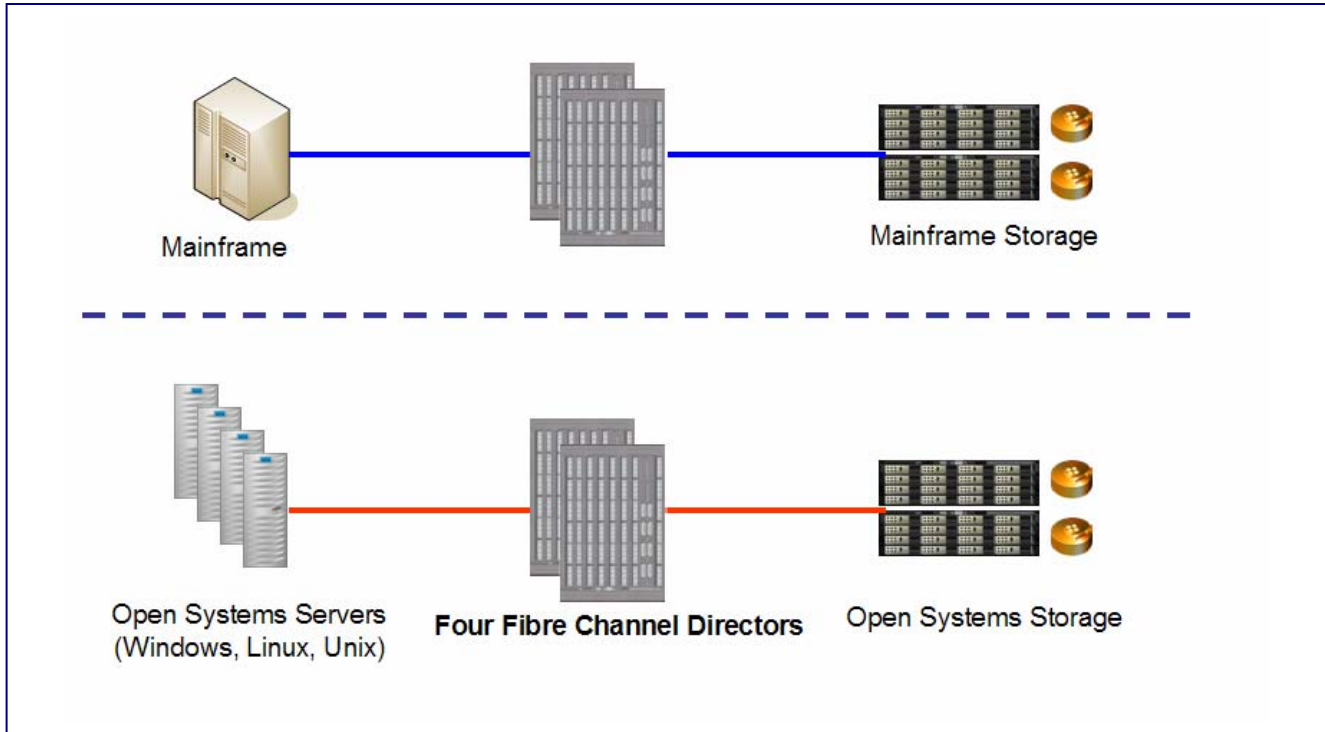
Figure Five: The Cisco MDS Solution for Use Case #2



As shown in Figure Five, a pair of Cisco MDS 9513 directors is used to create a highly available storage network for Mainframe and Open Systems connectivity. A storage network for Mainframe traffic is implemented using FC ports configured as an isolated FICON VSAN (as shown in blue). Open Systems servers and storage traffic are implemented on the same pair of directors using FC ports configured as an isolated FCP VSAN (red).

ESG has spoken with a number of end-users who have a long standing practice of implementing separate Mainframe and Open Systems storage networks. This is due to the challenge of mixing FICON and FCP traffic on the same director using traditional storage networking technology. With traditional solutions, the data center administrator must create and maintain separate zone sets for Mainframe and Open Systems traffic. Cisco MDS directors support VSANs which are easy to configure and provide more resilient isolation. Cisco has advised ESG that a number of customers are mixing Mainframe and Open Systems traffic on the same director using VSAN technology. ESG spoke with one such customer who moved recently to a mixed configuration to implement Mainframe and Open Systems disaster recovery using a common infrastructure.

Figure Six: A Competitive Solution for Use Case #2



A summary of the configuration and power requirements required to add 24 ports of highly available Mainframe FICON connectivity to an existing Open Systems storage network is presented in Table Two. Note that 70% less power is required for the Cisco solution, which uses only two directors compared to four in the competitive solution.

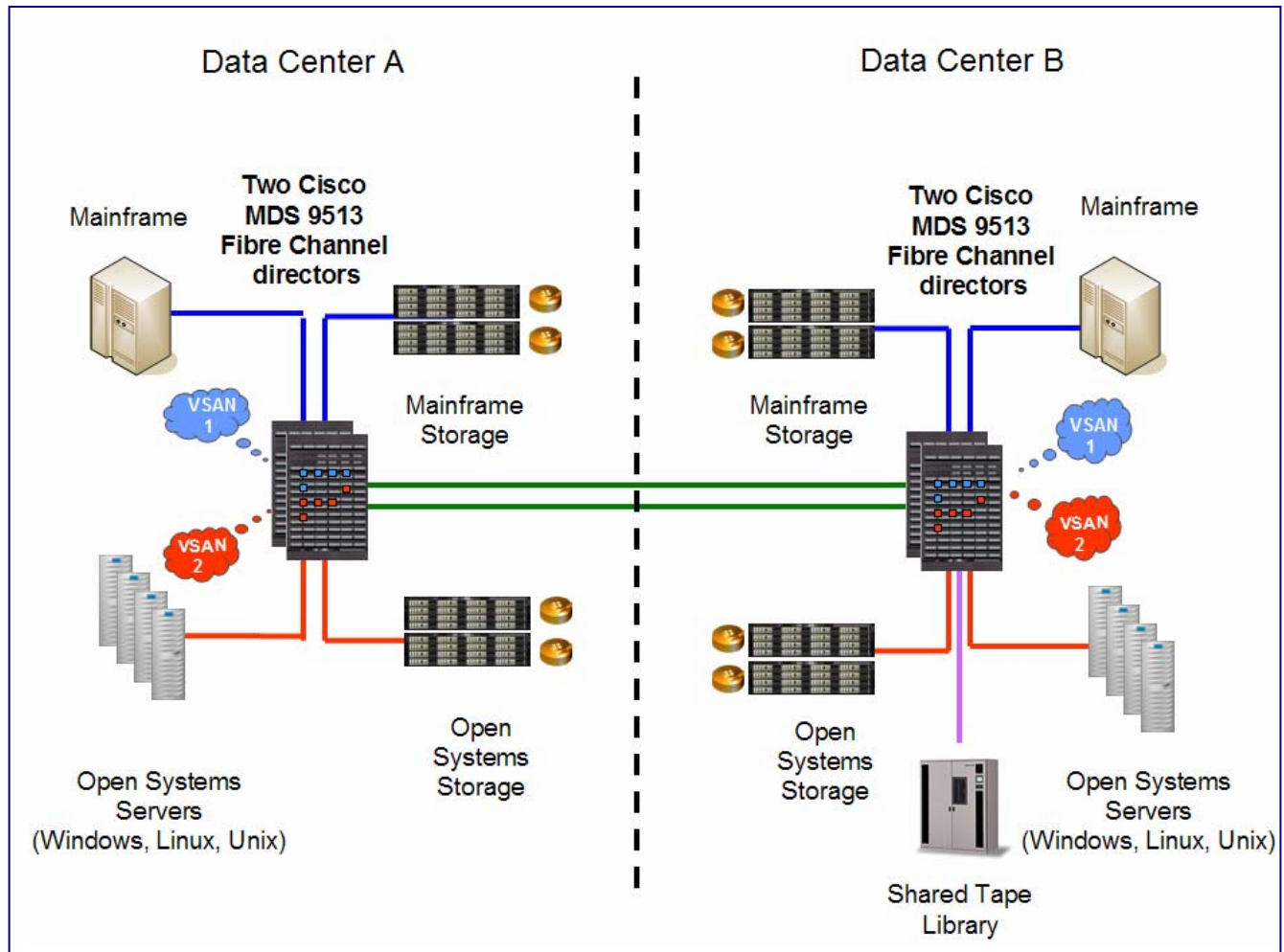
Table Two: Configuration and Power Usage Summary for Use Case #2

	Cisco Solution	Competitive Solution
Total Power Required	230 Watts	780 Watts
Power costs over 3 years	\$563	\$1,908
Power for cooling over 3 years	\$338	\$1,145
TOTAL 3 year cost of power	\$901	\$3,053
Savings	\$2,152 (70%)	

Use Case #3 - Storage Extension

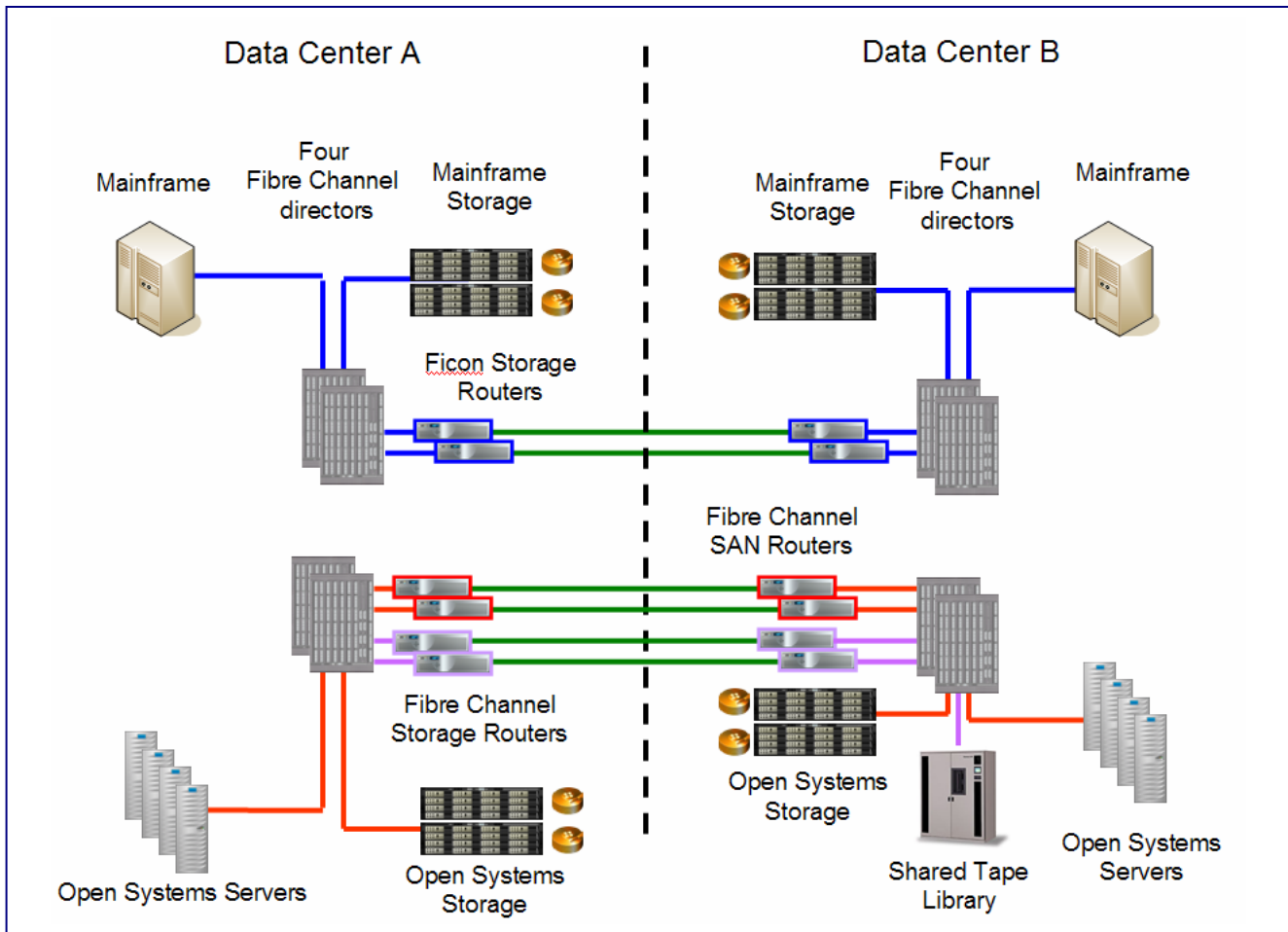
An enterprise-class data center with Mainframe and Open Systems storage networks wants to extend connectivity to a remote data center for business continuance and tape vaulting. Mainframe connectivity using the FICON protocol must be isolated from Open Systems traffic using the FCP protocol. A tape library in one data center will be used for backup and recovery by Open Systems hosts in both data centers.

Figure Seven: The Cisco MDS Solution for Use Case #3



A pair of Cisco MDS 9513 directors is used in each data center to create a highly available storage network for Mainframe and Open Systems connectivity. A storage network for Mainframe traffic is implemented using FC ports configured as an isolated FICON VSAN (as shown in blue). Open Systems servers and storage traffic is similarly implemented on the same pair of directors using an isolated FCP VSAN (red). The storage networks are extended to the remote data center using integrated Cisco IP Storage Services Modules (green). The IP modules installed in the MDS 9513 directors at each location are used to provide the connectivity, routing, write acceleration and tape acceleration services required for Mainframe and Open Systems data replication and tape vaulting.

Figure Eight: A Competitive Solution for Use Case #3



A competitive solution is shown in Figure Eight. Note that eight directors are required in the competitor's configuration, compared to only four in the Cisco configuration. An extra pair of directors in each data center is required to provide physically isolated SAN fabrics for Mainframe and Open Systems data traffic. Separate appliances are required for storage routing - two pairs of FICON storage routers for the Mainframe SAN (as shown in blue); two pairs of SAN routers for the Open Systems SAN (red); and two pairs of routers supporting fast write tape acceleration for tape vaulting (purple). A summary of the configuration and power requirements for the Cisco and competitive solution is presented in Table Three.

Table Three: Configuration and Power Usage Summary for Use Case #3

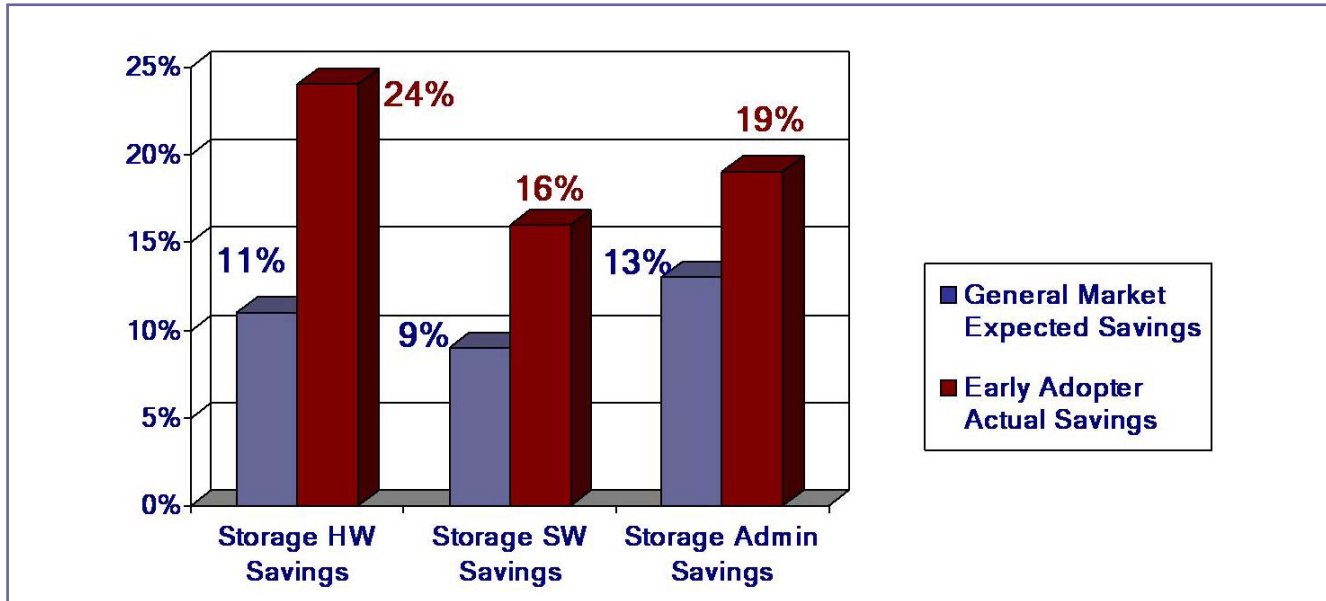
	Cisco Solution	Competitive Solution
Total Power Required	4188 Watts	7120 Watts
Power costs over 3 years	\$10,247	\$17,420
Power for cooling over 3 years	\$6,148	\$10,452
TOTAL 3 year cost of power	\$16,395	\$27,872
Savings	\$11,477 (41%)	

Network-based Storage Services

A Storage Services Module (SSM) deployed in a Cisco MDS 9000 series director can be used to implement intelligent network-based storage services including storage virtualization, online data migration, network-accelerated serverless backup and remote replication. ESG Lab has tested each of these capabilities working in concert with software from leading storage and backup software vendors³.

ESG surveyed 210 IT decision-makers responsible for evaluating and purchasing storage networking technologies to see who is considering intelligent network-based storage services and why⁴. The results, shown in Figure Nine, indicate the expected and actual savings achieved by 21 early adopters of intelligent network-based storage services.

Figure Nine: Early Adopter Savings



ESG spoke with an early adopter of network-based online migration who confirmed that storage hardware savings could be realized by implementing a tiered storage strategy using intelligent network-based online data migrations. Storage hardware savings were achieved using online data migrations between storage arrays, which increased storage utilization across all of the arrays. The customer indicated that he was able to avoid a planned purchase of a new tier-one storage array as a result. The savings reported were in excess of the 24% storage hardware savings reported by early adopters as shown above in Figure Nine.

Similar to the benefits that can be achieved with server virtualization, one of the primary benefits of storage virtualization is increased utilization. Better utilization not only reduces the cost of hardware, but it also reduces the cost of power. For example, consider a data center with four tier-one storage arrays. An increase in storage utilization could be used to reduce the number of storage arrays from four to three. This not only reduces the cost of storage hardware by 25%, but also reduces the cost of storage system power by 25%.

ESG recommends that customers consider the adoption of network-based storage services to reduce costs and power consumption in the data center. ESG also recommends that customers consider the total power requirements of a storage virtualization solution. Cisco supports adding storage virtualization with an upgradeable module in the MDS 9000 Series director compared to competitive solutions which require the addition of separate appliances or routers in the storage network. Competitive solutions may also require the use of more directors or ports. Each of these considerations adds to the power requirements of the total solution.

³ ESG Lab Validation reports are freely available at <http://www.enterprisestrategygroup.com>. The reports which highlight the capabilities of the Cisco MDS 9000 series SSM module are Cisco Serverless Backup, EMC Invista and EMC RecoverPoint.

⁴ ESG Research Report: *The Future of Network-Based Storage Intelligence*, September 2004.

Conclusion

Data center power and cooling issues are at the top of the minds of many corporate execs and data center facilities managers. IT managers have reported that they have run out of power with only half of the space in the data center occupied. Others have reported that they cannot deploy new applications because power demands cannot be met. Some CFOs are realizing that the data center is consuming more power than a small town. In many companies, the CFO has realized that containing the costs of power and cooling is a strategic initiative that can reduce operating costs and positively impact bottom line growth.

The case studies presented in this report clearly indicate that selecting the appropriate technology to implement a data center level storage networking solution requires more than just reading specs - especially when it comes to making decisions about power and cooling. For example, a pair of MDS 9000 Series directors used to implement a solution for three isolated business units sharing a tape library for backup and recovery revealed that:

- The Cisco MDS 9000 solution consumes 66% less power than a competitive solution
- Power savings over three years of \$16,543 can be realized for each pair of MDS directors
- A large site with 30 business units using 10 pairs of Cisco directors can save \$165,430 over three years

While ESG believes that the approach used to examine the total power requirements of the storage networking solutions presented in this report is valid, we recommend that IT and facilities managers work together with their suppliers to perform their own analysis based on their specific requirements. A number of factors can influence the results, including the FC ports to be deployed in the network and the extra equipment required for a total solution. Regardless, ESG is confident that consolidating as many services as possible onto the fewest number of platforms can be used to reduce power consumption in the data center effectively.

ESG also recommends that IT and facilities managers keep things in perspective when architecting power efficient solutions for the data center. Networking and storage equipment are worthy of consideration and conservation, but the biggest consumers of power in the data center today are cooling equipment and servers. Improvements in power distribution, cooling and data center air flow can yield significant savings. Server virtualization can be used to drive up utilization, which yields more work performed for each dollar spent on power. Storage virtualization and a solution based approach to storage networking consolidation can yield similar benefits.

Cisco has a track record of working with customers to deliver best of breed technologies and solve critical customer problems. Driven by customer demand, Cisco is investing in green initiatives including power conservation. Through partnerships with infrastructure vendors and investments in efficient power and cooling designs, Cisco is dedicated to helping customers mitigate power and cooling usage in the data center.

Cisco currently offers power efficient solutions and is dedicated to the delivery of power-optimized data center solutions in the future. An example of this can be seen in the recently announced MDS 9124 fabric switch. The MDS 9124 is built around a 24 port ASIC that delivers flexibility and scalable entry-level storage networking connectivity with very low power requirements. As Cisco has done repeatedly in the past for the IP networking market, ESG suspects that ASIC investments will be used to reduce power consumption throughout the MDS product line.

The use cases presented in this report demonstrate that a Cisco MDS-based solution can require substantially less power than a competitive solution. The methodology used indicates that what really matters is the power requirement of the solution - not the power used by an individual switch port. Using the leverage of power efficient network-based intelligent storage services and consolidation, the Cisco MDS 9000 is a scalable platform that provides an evolutionary step towards the delivery of future solutions.