WHITE PAPER

CISCO SYSTEMS SAN CONSOLIDATION COST REDUCTIONS BASELINES AND RESULTS

Between January 2003 and January 2004, Cisco Systems® deployed 25 Cisco® MDS 9000 multilayer director switches in five production data centers (two in San Jose, California, two in Research Triangle Park, North Carolina, and one in Amsterdam, Netherlands), displacing the traditional storage networking infrastructure. The largest internal storage-area network (SAN) deployment in the company's history, the Cisco MDS 9000 rollout was the first significant installation of the (then) new Cisco storage networking switches.

Today, almost three years later, the Cisco enterprise SAN serves nearly 2 petabytes of raw networked storage and, with nearly 10,000 ports interconnected across North America, Europe, and the Middle East, is possibly the largest SAN in the world.

This white paper defines and examines the types of cost reductions and cost avoidances associated with the initial Cisco MDS 9000 SAN deployment and subsequent consolidation efforts. It provides an analytical reference to chronicle the financial impact of investment in both SAN technology and storage strategies to manage costs. Appendixes A through F give calculations and other supportive information for examples given in this paper.

EXPLOSIVE GROWTH

The primary business variable that accelerated the migration to consolidated data center SANs was the growth in data storage, with the average total growth rate for storage between fiscal years 2000 and 2002 reaching 57 percent—and some environments growing 100 percent or more each year. Direct-attached storage (DAS), long well-known for its inflexibility and inability to scale to meet enterprise needs, had crossed the 500-terabyte (TB) watermark at Cisco, and cumulative storage use was 20 percent.* Fixed Fibre Channel switches were seen as a temporary solution to meet the demand for increased port count. As more and more fixed Brocade and McData switches were deployed, however, it became clear that managing several SAN islands based on the fixed Fibre Channel architecture is only moderately more scalable than DAS. The immature software tools used to manage many disparate and discrete SAN islands created high rates of operational inefficiency, while the subsequent siloed SAN islands dedicated to multiple business industries did nothing to resolve the crisis of poor utilization. Between 1998 and 2002, roughly 75 SAN islands were deployed to support four business industries in the United States and Europe, but cumulative storage use remained below 30 percent.

The Cisco MDS 9000 SAN migration program, in conjunction with DAS-to-SAN consolidation efforts, resulted in significant cost savings in terms of both cost avoidances and cost reductions. The following sections outline the nature of these cost savings.

COST AVOIDANCE—RETURNS FROM CONSOLIDATION

Concurrent with the rollout of the Cisco MDS 9509 SAN switch platform, the company initiated a series of consolidation projects. In each of the three fiscal years between 2003 and 2005 (starting in January 2003), Cisco funded and staffed major storage consolidation projects in an effort to reduce costs and increase efficiencies. In the first phase of consolidation, 80 external (RAID) storage arrays (consisting of a mix of 9- and 18-GB disk drives) were consolidated down to eight 73- and 146-GB drive RAID arrays.

* Storage use is typically measured as the cumulative value of two metrics: allocation efficiency and utilization efficiency. Allocation efficiency measures how efficiently storage assets are allocated to the hosts; utilization efficiency measures how efficiently the applications on these hosts use the storage allocated to them.

For the purposes of this white paper, utilization rates are disclosed as a cumulative percentage, that is, the rate of allocation efficiency (in percent) multiplied by the rate of utilization efficiency (in percent).

Although the project required significant initial costs (US$7,868,835 in capital, including RAID arrays and Cisco MDS 9509 switches, and $430,550 in expenses, including Fibre Channel host bus adapters [HBAs] and hourly labor for cabling), the benefits, when measured with net present value (NPV) analysis, were positive:

- **Cost avoidance**—Maintenance reduction
  - Maintenance reduction on the original 80 frames was significant: US$4,352,331.42 per year for three years
- **Cost avoidance**—Data center crowding
  - Additionally, because of data center capacity concerns, an expansion to existing data centers was deferred: estimated US$27,000,000 over three years
- **Summary**—NPV
  - Using the total annual maintenance reduction of US$4,352,331.42 each year for three years as net benefits, but excluding all cost avoidances related to the deferment of data center expansion, and total cash outflows of $8,368,835.00 (excluding expenses for HBAs, but including an estimated $500,000.00 write-off of remaining net book value [NBV] for unused McData and Brocade gear), and a weighted average cost of capital (WACC) of 12 percent, the NPV for the first phase of Cisco MDS 9000 SAN consolidation totaled $2,084,730.70.
- **Summary**—Return on investment (ROI)
  - Using the same cash flow figures as previously (US$8,368,835.00 total investment and $13,056,994.26 total returns over three years), the NPV-discounted ROI for the first phase of Cisco MDS 9000 SAN consolidation was 19.94 percent.**

Subsequent phases of SAN consolidation onto the Cisco MDS 9000 platform, in fiscal years 2004 and 2005, produced similarly positive numbers (using the same calculations as noted in appendixes B and C): Consolidation phase II—NPV: $523,699.20; ROI: 32 percent; NPV-discounted ROI: 6 percent

Consolidation phase III—NPV: $708,133.32; ROI: 45 percent; NPV-discounted ROI: 16 percent

COST AVOIDANCE—RETURNS FROM UTILIZATION INCREASES

A secondary measure of net benefits from migrating from DAS to a consolidated data center SAN infrastructure is the overall increase in storage utilization. Increased utilization represents a significant cost-avoidance opportunity in that enabling the use of storage purchased but previously unused defers or cancels the need for incremental storage purchases within a certain timeframe.

- Cost avoidances related to utilization increases were calculated in the following manner using the following baseline measurements:
- Annual total cost of ownership (TCO) for storage of US$0.12 per MB (beginning in FY2002), decreasing to $0.075 per MB in FY2004
- Total combined DAS and SAN: 1.1 petabytes
- Estimated growth rates of 24 percent in FY2003 and 20 percent in FY2004 and FY2005
- Cumulative utilization of 20 percent (allocation efficiency multiplied by utilization efficiency)

Using these numbers as a benchmark, and measuring a cumulative utilization efficiency of 30 percent (a 10-percent increase overall averaged across all Oracle databases) after the first year of Cisco MDS 9000 migration, the total cost avoidance (after subtracting costs of investments in SAN hardware and software) over three years was US$15,607,500 (discounted for NPV, the total was $12,495,527.17).

- **Summary**—ROI
  - Using these figures, the ROI for cost avoidance on the same initial investment was 86 percent, and the NPV-discounted ROI was 49.31 percent.

**Traditional ROI was 35.91 percent.

ADDITIONAL COST REDUCTIONS—RETURNS FROM INCREASED OPERATIONAL EFFICIENCIES

Increases in operational efficiencies stemmed from two sources: the reduction in the number of managed storage and storage switching devices, and the use of centralized SAN fabric and device management software (in particular, Cisco Fabric Manager integrated into the Cisco MDS 9000 platform, and Cisco Fabric Manager Server).

Consolidation of data storage devices resulted in a significant decrease in not only maintenance expenses, but also the numbers of storage devices requiring human interaction and management.

Centralized SAN fabric management software (Cisco Fabric Manager and Fabric Manager Server) lets users manage multiple switch devices with a single "pane of glass," and in the example in this paper a single switch interconnected to the SAN running the Cisco Fabric Manager software package.

As the numbers of managed devices decreased and the management software was consolidated, the Cisco operational support team increased the number of managed terabytes per administrator from roughly 100 TB to more than 200 TB—an increase of more than 100 percent.[***]

In addition to greatly simplifying management, Cisco experienced a 6:1 reduction overall in the number of managed SAN devices during the first phase of the migration, indicating additional increases in operational efficiencies. This reduction in devices managed is attributed to the use of Virtual SANs, or VSANs. VSAN technology allows consolidation of multiple discrete, physical SANs onto one physical SAN managed logically, while providing the same reliability and availability to the same clients as when they were previously accessing disparate SAN islands. After the migration to a consolidated SAN with the Cisco MDS 9000 platform, each client was able to access a few VSANs as required, but these VSANs resided within the same physical SAN. VSAN technology provides increased use of SAN devices by reducing the number of discrete physical SANs required for the same level of redundancy and connectivity. In one specific environment, the Cisco Enterprise Resource Planning (ERP) development SAN, 14 SAN islands consisting of 28 physical devices were consolidated down to 5 VSANs on 4 Cisco MDS 9509 switches, a 7-to-1 reduction in managed devices.

It is important to note that no headcount reductions were incurred as a result of the migration to the Cisco MDS 9000 data center SAN platform.

SUMMARY

Cisco Systems experienced significant savings in terms of both cost reductions and cost avoidances with regard to storage consolidation between fiscal years 2003 and 2005. Enterprise customers pursuing a consolidated data center SAN strategy may experience similar net benefits with a combination of consolidation and migration projects built around a Cisco MDS 9000 platform-based architecture.

Table 1 summarizes the present value of total net benefits in each of the three years of the program.[****] Tangible benefits include reduction in maintenance costs, and intangible benefits include the deferral of storage purchases due to increased use. Tangible costs are all capitalized hardware costs, whereas intangible costs, such as those associated with learning curves, etc. are excluded.

*** The managed TB per storage manager metric is not an exact measure of operational efficiency because a few hosts with many terabytes attached can skew the numbers significantly; however, the TB per administration metric offers a quick way to estimate workload and output. In examples specific to Cisco, the premigration metric was calculated using ten full-time equivalents (FTEs) spending an estimated 50 percent of their time supporting 500 TB of raw storage. The post-migration numbers reflect the current team roster with 9 FTEs supporting 2 petabytes of raw storage—or 222.22 TB per administrator.

**** Present value in each year is the value of the benefit divided by (1 + Rate)t. NPV is merely the sum of present value for all benefits. Refer to appendix A for an explanation of NPV.

Table 1. Summary of Investments and Benefits

	Year 0	Year 1	Year 2	Year 3	Total (Current US$)
Tangible Benefits (Present Value)	–	$3,886,010.20	$3,469,651.96	$3,097,903.54	$10,453,565.70
Intangible Benefits (Present Value)	–	$4,645,089.29	$4,147,401.15	$3,703,036.74	$12,495,527.17
Less					
Tangible Costs	$(8,368,835.00)	–	–	–	$(8,368,835.00)
Intangible Costs		–	–	–	
Overall benefit		$8,531,099.49	$7,617,053.11	$6,800,940.28	$14,580,257.87

The NPV for the entire project was US$14,580,257.87, and the internal rate of return (IRR) was 74.22 percent.***** The payback period for the investment was roughly one year.

APPENDIX A—CALCULATING NET PRESENT VALUE

Net present value (NPV) for the examples in this document was calculated using the following formula:

$$\text{NPV} = \sum_{t=0}^{T} \frac{CF_t}{(1+Rate)^t} = CF_0 + \frac{CF_1}{(1+Rate)^1} + \frac{CF_2}{(1+Rate)^2} + \frac{CF_3}{(1+Rate)^3} \cdots \frac{CFt}{(1+Rate)^t}$$

where:

CF_0 is cash flow out at the beginning of year 0—This is the total capital expenditure related to the project and is always a negative number.

T is total number of time periods.

CF_1 is cash flow in at the end of year 1—This is the total savings and cost avoidance from the project for the first year.

CF_2 is cash flow in at the end of year 2—This is the total savings and cost avoidance from the project for the second year.

CF_3 is cash flow in at the end of year 3—This is the total savings and cost avoidance from the project for the third year.

CF_t is cash flow in at the end of period t—This is the total savings and cost avoidance from the project for period t. For IT investments, typically period t is the third and final year of the project, coinciding with the depreciation of the assets from the initial investment and project start at year 0.

Rate is the rate used to measure returns from a project. In this case, it is the Cisco weighted average cost of capital (WACC), which is typically valued at 12 percent.

APPENDIX B—CALCULATING RETURN ON INVESTMENT

Return on investment (ROI) in the examples in this white paper was calculated as follows:

ROI = (Sum of all returns)—(Sum of all investments))/(Sum of all investments)

***** The NPV function in Microsoft Excel assumes that all cash flows are received at the same point throughout the year. Using the NPV function in Excel (versus the calculation shown in Appendix A) shows a slightly lower NPV for the project: $13,018,087.38.

APPENDIX C—CALCULATING INTERNAL RATE OF RETURN

Internal rate of return (IRR) is the rate at which net present value (NPV) is equal to zero. IRR is often used in conjunction with NPV to measure the value of projects that are internal and not dependant on market rates or revenue generation. To calculate IRR, you can use an iterative (or trial-and-error) method to find the rate, use the "Solver" add-in for Microsoft Excel after setting NPV to zero, or use the IRR function in Excel.

Typically, if the IRR is greater than the cost of capital (or any other commonly agreed-upon internal hurdle rate for projects), then the project is deemed successful.

APPENDIX D—CALCULATING PAYBACK PERIOD

Payback period analysis determines the number of time periods (typically in months, quarters, or years) required to reach the break-even point of an investment. For example, if the total investment is US$1000 and the cash inflows are $500 every year for three years, the payback period is two years.

APPENDIX E—ACTUAL REDUCTION IN STORAGE TOTAL COST OF OWNERSHIP

The overall reduction in Cisco's total cost of ownership (TCO) for storage (depreciated over a 30-month schedule) is recorded as follows:

- TCO per MB annual FY02—$0.12
- TCO per MB annual FY03—$0.10
- TCO per MB annual FY04—$0.075
- TCO per MB annual FY05—$0.032

APPENDIX F—FIBRE CHANNEL PORT COUNT

Fibre Channel Port Counts	Dec-02	Dec-03	Jan-04	Feb-04	Jul-04	Jul-05
McData Ports	1984	1280	64	0	0	0
Brocade Ports	1072	592	64	0	0	0
Cisco MDS Ports	0	2560	4304	4432	5500	9780

FOR MORE INFORMATION

References

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