

WHITE PAPER

OVERCOMING THE FIVE MYTHS OF SOLID-STATE STORAGE

INCREASE PERFORMANCE AND RELIABILITY WHILE LOWERING
THE TOTAL COST OF OWNERSHIP



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OVERVIEW

Today's solid-state storage technology is rapidly replacing hard drives and flash cards that are designed for consumer applications in many Enterprise System OEM applications. Solid-state storage offers many tangible benefits, such as:

- High performance
- Increased reliability
- Multi-year product lifecycles
- No product wear-out
- Methods to accurately forecast usable storage system life
- Security options beyond encryption

In many applications, solid-state storage costs less than traditional storage products when all aspects of storage ownership costs are analyzed.

Some common myths and misconceptions about solid-state storage exist. This white paper exposes the myths, and reveals the facts that Enterprise System OEMs must consider to make the optimal storage solution decision to best serve their valued customers.

When the myths are explained, and customer needs, product benefits, and true ownership costs analyzed, solid-state storage becomes a compelling replacement for hard drives and flash cards in many of today's embedded applications.

MARKET DRIVERS

Products from Enterprise System OEMs are touching and shaping the lives of consumers at an ever-increasing pace. If the storage system in an Enterprise System OEM's product fails, the user who has lost data, been the victim of a security breach, or had valuable software IP stolen, would blame the Enterprise System OEM — not the storage system supplier. This can result in lost business, the creation of ill-will, and a lack of consumer confidence in the Enterprise System OEM's product.



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Today's users want more from a storage system than just higher capacities; they demand storage technology that meets their performance, reliability, and security expectations in such diverse applications as:

- ATM machines
- Medical diagnostic equipment
- Video gaming consoles
- Specialty computing platforms
- Voting machines

Additional storage concerns arise from the pervasiveness of mobile computing and mobile communications that allows data to be accessed instantaneously and simultaneously from multiple locations, which exponentially increases application data and software IP security challenges.



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EXPLODING THE MYTHS

MYTH #1: SOLID-STATE STORAGE IS TOO EXPENSIVE

Reality

There are many applications where the capacity of traditional storage products far exceeds the user's requirements. Yet, hard drive manufacturers offer higher and higher capacity hard drives to maintain average selling prices, which forces users to buy 40GB or more of storage when their application requirements may be for as little as a few gigabytes. In fact, a recent study concluded that the vast majority of Enterprise System OEM applications require less than 4GB of storage, resulting in a closer cost parity between hard drives and solid-state storage. The cost per user-required gigabyte now favors solid-state storage over hard drives in many applications.

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MYTH #2: HARD DRIVES PERFORM WELL IN ENTERPRISE SYSTEM OEM APPLICATIONS

Reality

Field failure rates for hard drives in typical desktop PC and server applications range from 1% to 3% according to a February 15, 2005 report by RLG DigiNews. When hard drives are used in demanding or critical applications with extended duty cycles or in applications with vibration, temperature variation, or other environmental challenges, field failure rates are significantly higher. For example, it has been reported that voicemail equipment manufacturers, with their high duty cycle requirements, experience hard drive failure rates into the low double-digit percentage range. Solid-state storage offers far more durability and a significantly lower total cost of ownership in applications such as these.



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MYTH #3: COSTLY PRODUCT REQUALIFICATIONS ARE A FACT OF LIFE

Reality

Hard drives and flash cards that are targeted to consumer markets have short product lifecycles with little regard given to the multi-year lifecycles needed in the Enterprise System OEM market. This leads to forced product requalifications which are costly. Conversely, developers of advanced solid-state storage technology leverage product development strategies that enable them to continually introduce technology advancements without triggering product requalifications for their users. This strategy enables Enterprise System OEMs to offer true multi-year product lifecycles, alleviating the time and cost burden of allocating engineering resources to frequent product requalifications solely because of technology changes made by their storage supplier. Another benefit of eliminating requalifications is that Enterprise System OEMs that are required to have certifications or government agency approvals on their products, such as in the gaming and medical industries, would save these companies the hassle and expense of getting system certifications again just because the storage system manufacturer changed or discontinued a product.

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MYTH #4: STORAGE PRODUCT WEAR-OUT IS UNAVOIDABLE

Reality

It is crucial that a storage system *not* wear-out or fail during the required deployment cycle, as the costs associated with unscheduled downtime, field maintenance, product recalls, lost revenue, and customer goodwill for an Enterprise System OEM are significant. Solid-state storage technology features patented technologies such as robust wear-leveling and error correction code (ECC) algorithms, as well as early warning systems that forecast usable life to virtually eliminate the chances of storage system wear-out.

MYTH #5: STORAGE SECURITY OPTIONS ARE LIMITED FOR ENTERPRISE SYSTEM OEMS

Reality

In the past, system design challenges due to the small footprint and low-power requirements for storage systems used in many Enterprise System OEM applications prevented storage security options from extending beyond basic encryption technology. Today's leaders in solid-state storage technology offer an array of advanced user-selectable security options that prevent IP theft, protect application data, and manage data security via the host system — not the storage product.



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TOTAL COST OF OWNERSHIP

The total cost of storage ownership is far more complex than simply calculating the cost differential between various storage products. A lower individual unit cost per storage product is only relevant if all products being compared deliver the same benefits to the user. In Enterprise System OEM applications, reliability, data integrity, and storage system performance are paramount. Hard drives and flash cards originally designed for consumer applications do not have the same reliability and performance characteristics as solid-state storage products when deployed in the same application.

The following sections provide analysis reports of three Enterprise System OEM applications that explain the various factors that must be considered when calculating total cost of storage ownership.

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OEM CUSTOMER A

Market Segment: Industrial Equipment

Application: Flow Control Appliance

Storage Used: 40GB Hard Drive with an ASP of \$75.00

Storage Requirement: 2GB

OEM Customer A was experiencing hard drive failures that ranged from 5% to 15% of units deployed when users of their equipment increased their business or duty cycle requirements or exceeded certain system temperature and shock thresholds.



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	A	B	C
1	Units Per Year	5,000	
2	Hard Drive ASP	\$75.00	
3	Hard Drive Warranty (months)	36	
4	Failure Rate	5%	
5	Deployment Cycle (years)	5	
6	Field Maintenance Cost (per day)	\$1,000.00	
7	Percent of Failures Requiring Field Maintenance	10%	
8	RMA Cost (per transaction)	\$250.00	
9	Requalification Cycle (months)	12	
10	Requalification Time (months)	2	
11	Requalification Labor/OH Cost (per hour)	\$150.00	
12	Work Month (hours)	173.33	Equation: 2080/12
13	Average Selling Price of OEM Unit	\$5,000.00	
14	Percentage OEM Units Field Failures Resulting in Lost Business Revenues	10%	
15			
16	Over Deployment Cycle		
17	Total Units Purchased	25,000	Equation: B1*B5
18	Total Purchase Dollars	\$1,875,000.00	Equation: B2*B17
19	Total Failed Units	1,250	Equation: B4*B17
20	RMA Costs for Failed Units	\$312,500.00	Equation: B8*B19
21	Requalification cost	259,995.00	Equation: B5/(B9/12)*(B10*B11*B12)
22	Hard Drive Failure Rate Material Cost	\$187,500.00	Equation: (B5-B3/12)*B2*B4*B17
23	Field Maintenance Costs	\$125,000.00	Equation: B6*B7*B19
24	Lost Revenue Costs	\$625,000.00	Equation: B13*B14*B19
25			
26	Total Cost	\$3,384,995.00	Equation: B18+B20+B21+B22+B23+B24
27	Total Cost per Hard Drive	\$135.40	Equation: B26/B17

The Real Cost

After completing a detailed analysis, the Enterprise System OEM found that the actual cost of using a \$75.00 hard drive in this application was costing their firm \$135.40 per unit during the product deployment cycle. The \$60.40 or 81% price delta between what the OEM was paying for the hard drive and what it was actually costing their firm was calculated using the OEM’s most conservative historical field failure rate of 5%. After reviewing their analysis, the OEM quickly concluded that using a hard drive in their application was actually costing their firm millions of dollars annually, failing to establish goodwill with their user community and risking being perceived as a supplier of poorly designed products in addition to a variety of other concerns.

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OEM CUSTOMER B

Market Segment: Telecom

Application: Edge Router

Storage Used: 256MB Flash Card with an ASP of \$20.00

Application Requirement: 256MB Storage System

OEM Customer B is a global telecom company that was experiencing high failure rates because it used flash cards in an Enterprise System OEM application. The OEM's end-product had a five-year deployment cycle and due to flash card wear-out, flash card failures from power anomalies, and forced storage system requalifications, the OEM was facing skyrocketing field replacement and warranty costs. Furthermore, customer goodwill was at its lowest level in years because of the high failure rate and unexpected downtime of the OEM's equipment.



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	A	B	C
1	Units Per Year	5,000	
2	Flash Card ASP	\$20.00	
3	Flash Card Warranty (months)	12	
4	Failure Rate	5%	
5	Deployment Cycle (years)	5	
6	Field Maintenance Cost (per day)	\$1,000.00	
7	Percent of Failures Requiring Field Maintenance	10%	
8	RMA Cost (per transaction)	\$250.00	
9	Requalification Cycle (months)	12	
10	Requalification Time (months)	2	
11	Requalification Labor/OH Cost (per hour)	\$150.00	
12	Work Month (hours)	173.33	Equation: 2080/12
13	Average Selling Price of OEM Unit	\$5,000.00	
14	Percentage OEM Units Field Failures Resulting in Lost Business Revenues	10%	
15			
16	Over Deployment Cycle		
17	Total Units Purchased	25,000	Equation: B1*B5
18	Total Purchase Dollars	\$500,000.00	Equation: B2*B17
19	Total Failed Units	1,250	Equation: B4*B17
20	RMA Costs for Failed Units	\$312,500.00	Equation: B8*B19
21	Requalification cost	\$259,995.00	Equation: B5/(B9/12)*B10*B11*B12
22	Flash Card Failure Rate Material Cost	\$100,000.00	Equation: (B5-B3/12)*B2*B4*B17
23	Field Maintenance Costs	\$125,000.00	Equation: B6*B7*B19
24	Lost Revenue Costs	\$625,000.00	Equation: B13*B14*B19
25			
26	Total Cost	\$1,922,495.00	Equation: B18+B20+B21+B22+B23+B24
27	Total Cost per Flash Card	\$76.90	Equation: B26/B17

The Real Cost

A detailed analysis by the Enterprise System OEM revealed that their \$20.00 flash card solution was actually costing their firm \$76.90 during the product deployment cycle. This total cost of ownership variance of \$56.90 or 285% adversely impacted the OEM's profit and customer satisfaction ratings. After reviewing their analysis, the OEM quickly concluded that using a flash card in their application was actually costing their firm millions of dollars annually, failing to establish goodwill with their user community and risking being perceived as a supplier of poorly designed products, in addition to a variety of other concerns.

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OEM CUSTOMER C

Market Segment: Medical Equipment

Application: Chemical Analysis Equipment

Storage Used: 80GB Enterprise-Class Hard Drive with an ASP of \$200.00

OEM Customer C is an international medical equipment manufacturer that supplies complex chemical analysis diagnostic equipment. The OEMs storage requirements were challenging because they need to comply with strict HIPAA and FDA requirements. The OEM was using an Enterprise-class hard drive, and even with paying the significant price premium for this class of hard drive versus a typical hard drive, they were still experiencing a 1% field failure rate of their equipment due to storage failures. The OEM was further adversely impacted by frequent hard drive requalifications because of the relatively short product lifecycle of these products in comparison to the OEM’s end-product, which were subject to an extensive and expensive FDA qualification process.



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	A	B	C
1	Units Per Year	5,000	
2	Hard Drive ASP	\$200.00	
3	Hard Drive Warranty (months)	36	
4	Failure Rate	1%	
5	Deployment Cycle (years)	5	
6	Field Maintenance Cost (per day)	\$1,500.00	
7	Percent of Failures Requiring Field Maintenance	50%	
8	Consulting Engineer (per day)	\$1,500.00	
9	Consulting Days	20	
10	RMA Cost (per transaction)	\$250.00	
11	Requalification Cycle (months)	12	
12	Requalification Time (months)	2	
13	Requalification Labor/OH Cost (per hour)	\$150.00	
14	Work Month (hours)	173.33	Equation: 2080/12
15	Average Selling Price of OEM Unit	\$500,000.00	
16	Percentage OEM Units Field Failures Resulting in Lost Business Revenues	10%	
17			
18	Over Deployment Cycle		
19	Total Units Purchased	25,000	Equation: B1*B5
20	Total Purchase Dollars	\$5,000,000.00	Equation: B2*B19
21	Total Failed Units	250	Equation: B4*B19
22	RMA Costs for Failed Units	\$62,500.00	Equation: B10*B21
23	Requalification cost	\$259,993.31	Equation: B5/(B11/12)*B12*B13*B14
24	Hard Drive Failure Rate Material Cost	\$100,000.00	Equation: (B5-B3/12)*B2*B4*B19
25	Field Maintenance Costs	\$187,500.00	Equation: B6*B7*B21
26	Consulting Engineer	\$30,000.00	Equation: B8*B9
27	Lost Revenue Costs	\$12,500,000.00	Equation: B15*B16*B21
28			
29	Total Cost	\$18,139,993.31	Equation: B20+B22+B23+B24+B25+B26+B27
30	Total Cost per Hard Drive	\$725.60	Equation: B29/B19

The Real Cost

A detailed analysis by the Enterprise System OEM revealed that their actual storage requirement for their operating system, application data, and user data was only 6GB, yet they were purchasing an 80GB hard drive because this was the lowest capacity product their hard drive vendor offered. After concluding their data needs analysis and factoring in the cost of field failures, repair costs, requalification costs, and

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other ancillary costs, the OEM concluded that they were actually paying \$725.60 for their storage product, not \$200.00. This \$525.60 or 263% total cost of storage ownership increase, combined with other considerations such as the failure to establish goodwill with its user community and risking being perceived as a supplier of poorly designed products, made the OEM realize that they needed to use a different type of storage solution.

THE SOLUTION

Each of the three previously-discussed Enterprise System OEMs concluded that hard drives and flash cards were not the proper storage solution to meet the exacting requirements of their Enterprise System OEM applications. All three OEMs realized that solid-state storage, although initially appearing as more expensive on a cost per gigabyte or product invoice price, is less expensive to use than their current storage products when all the factors of the total cost of storage ownership were considered.



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CHOOSING A SOLID-STATE STORAGE SUPPLIER

When choosing a supplier, be aware that not all solid-state storage is engineered equally.

SiliconSystems' SiliconDrive™ is advanced solid-state storage technology engineered to overcome the problems associated with hard drives and flash cards when deployed in Enterprise System OEM applications.

The following sections describe the SiliconSystems difference, and clearly demonstrate how its industry-leading SiliconDrive and SiliconDrive Secure™ product families deliver the highest storage system performance and reliability in the industry while simultaneously providing the lowest total cost of storage ownership.

ELIMINATE DRIVE CORRUPTION

Industry experts estimate that nearly 75% of all storage system field failures are due directly to power related issues, such as power spikes, brownouts, surges, blackouts, and other power disturbances that can cause data loss and/or data corruption.

SiliconDrive and SiliconDrive Secure both integrate SiliconSystems' patented PowerArmor™ technology that is

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engineered to virtually eliminate the damage power disturbances can create. PowerArmor's patented voltage detection circuitry alerts the host system of any power fluctuations and prevents the transmission of system commands until power levels are normalized.

Additionally, when power is lost, storage systems can be corrupted and data ruined, resulting in downtime as the storage system is reformatted, operating systems reinstalled, or the OEM's end-products returned to the factory to be repaired. These issues directly impact overall end-product reliability, dependability, customer goodwill, and total cost of ownership. SiliconDrive and SiliconDrive Secure with patented PowerArmor technology offer design engineers a way to virtually eliminate these costly problems.



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ELIMINATE UNSCHEDULED DOWNTIME

Unexpected storage system failures can cause a complete disruption of business, resulting in costly downtime, loss of data, and potentially result in lost revenue and customers. Until now, there has been no definitive way to predict when a storage system will fail.

SiliconSystems' patent-pending SiSMART™ (Self-Monitoring Analysis and Reporting Technology) technology acts as an early warning system to self-monitor usage and accurately forecast the usable life of SiliconSystems' SiliconDrive and SiliconDrive Secure products when deployed in an actual application. SiSMART technology allows Enterprise System OEMs to build intelligence into their host system that enables users to set maintenance and data collection thresholds to ensure storage system life and reliability. The intelligence and power of SiSMART technology can result in the savings of hundreds of thousands of dollars a year in lost data, system downtime, and maintenance costs for Enterprise System OEMs.

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PREVENT WEAR-OUT

It is a common misconception that storage system endurance, the number of write/erase cycles that can be performed before a solid-state storage system wears out, is only a function of storage media — but it is a much more complex analysis than this. In fact, there are three components that must be considered when calculating solid-state storage system endurance:

- Storage media
- ECC
- Wear-leveling algorithm



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SiliconDrive and SiliconDrive Secure technology optimizes all three of these elements. SiliconSystems employs the most advanced and highest quality storage media available designed to achieve maximum endurance and performance to meet the critical requirements of the Enterprise System OEM market. SiliconDrive and SiliconDrive Secure integrate an industry-leading ECC algorithm that provides exponentially better correction than standard ECC algorithms originally designed for storage media used in consumer applications. By combining advanced storage media and superior ECC with a proprietary wear-leveling algorithm that evenly distributes wear over the entire SiliconDrive, SiliconSystems achieves endurance rates that are more than 200 times better than products designed for the consumer electronics market.

STOP FORCED REQUALIFICATIONS

SiliconSystems' SiliconDrive and SiliconDrive Secure architecture enables continuous technology advancements while supporting both current and previous product generations. Enterprise System OEMs are no longer required to requalify storage systems based on the timing of technology advancements made by the storage supplier. Rather, product requalification is driven by and timed to technology advancements — not product obsolescence. This results in a tremendous cost savings for Enterprise System OEMs.

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PROTECT APPLICATION DATA AND SOFTWARE IP FROM THEFT

The data security industry has primarily focused its efforts on providing data security for portable storage devices used in the consumer electronics industry. The basic premise for consumer data security has been that users need the security algorithm to travel with the storage device, like a USB flash card, since the data may be used on multiple systems such as:

- Office computer
- Home computer
- Internet kiosk



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Enterprise System OEMs operate under a different premise. Data must be rendered unreadable if the storage system is removed from the Enterprise System OEM's host system for which it was intended. Highly visible security breaches, such as a storage system with sensitive military documents being found for sale in a bazaar in Bagram, Afghanistan, have become more prevalent as embedded storage products store an ever increasing amount of sensitive data.

SiliconDrive Secure is a comprehensive suite of user-selectable security options that ties security to the host system, rendering the data unreadable if the storage system is removed from the original host system. SiliconDrive Secure prevents application data and software IP theft, protects data from falling into the wrong hands, stops data corruption, and prevents accidental or malicious overwrites.

CONCLUSION

The final barrier for Enterprise System OEMs to deploy high-performance, high-reliability, multi-year life cycle storage solutions is the price dilemma. In many Enterprise System OEM applications, the storage system is the weakest link in the overall system design because of the mechanical nature of hard drives and basic endurance issues associated with flash cards — neither of which were designed for Enterprise System OEM applications.

Many designers assume that purchasing a low-cost storage solution will, by itself, lower their total cost of storage ownership. Industry experts and market analysts now realize that this is a false assumption and that a wide array of factors

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must be considered to accurately compute the total cost of storage ownership.

SiliconSystems provides advanced solid-state storage technology specifically designed to meet the exacting requirements of the Enterprise System OEM market and deliver the lowest total cost of storage ownership. SiliconSystems has changed the economics of storage ownership by integrating patented and patent-pending technology to eliminate field failures, eliminate unscheduled downtime, prevent storage system wear-out, and protect application data and software IP. The result is a substantial decrease in the total cost of storage ownership.



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