



White Paper

Eliminating Unscheduled Downtime by Forecasting Useable Life

SiliconDrive SiSMART Technology

"There is a strong need in the market for technology that tracks drive usage and makes accurate predictions concerning lifespan."

Gartner Senior Analyst Joseph Unsworth



Executive Summary

No matter how dependable the storage device, sooner or later it wears out. Often, this occurs without warning after tens of thousands of write/erase cycles. Unexpected drive failures can cause a complete disruption of business, resulting in costly downtime and a loss of data and customers. Until now, there has been no definite way to predict when a storage device will fail.

WD has developed SiSMART (Self-Monitoring Analysis and Reporting Technology) to help embedded OEMs avoid this problem. By constantly tracking a drive's usage, SiSMART is able to report to the user the exact amount of useable life left on the drive. Drive usage information can be requested by the host at any time, and allows for an accurate prediction of the drive's life. This is especially important during the qualification process.

Users can take advantage of this information to set intervals for data collection, system maintenance, and drive replacement. This can save embedded OEMs upwards of hundreds of thousands of dollars a year in lost data, system downtime, and maintenance.

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Introduction

SiliconDrive solid state storage technology is specifically designed to meet the high-performance, high-reliability, and multi-year product lifecycle requirements of embedded OEMs in the netcom, military, industrial, interactive kiosk, and medical markets. WD's key focus is on decreasing the total cost of storage ownership over the entire system deployment by creating technologies to minimize unscheduled downtime, maximize security for the OEM's software IP, and to provide real-time feedback to enable the host system to manage its storage more effectively.

Applications requiring advanced levels of reliability and availability can employ WD's patent-pending SiSMART technology, which allows the host system to poll the SiliconDrive and receive real-time feedback as to the current usage. This technology allows the host to calculate projected remaining useable life and model the data transactions to ensure that the drive lasts throughout the scheduled deployment.

Background

SMART for Hard Drives

The Self-Monitoring Analysis and Reporting Technology (SMART) function was introduced in the ANSI standard group's release of the ATA-3 specification. The SMART technology is designed to act as an early warning system for pending problems with mechanical media such as hard disk drives (HDD). The integrated controller on the HDD works in conjunction with various sensors to monitor the HDD's performance and determines whether or not this performance is normal. The host system software can then poll the HDD using the SMART command and generate a flag to alert the user to a potential problem.

The theory behind this command is that HDD failures do not usually occur suddenly. Most failures result from issues that generally occur over time, such as the mechanics of the HDD spindle wearing out. The SMART feature was designed to monitor such issues, which limits data loss and unscheduled system downtime.

Solid State Drives

SiliconDrives do not have moving parts because they are solid state storage solutions, so many of the parameters monitored by the SMART function for HDDs are not applicable. Solid state drives are preferred in environmentally robust and high-duty cycle applications because they do not mechanically wear out, but there is still a concern about them wearing out when exceeding the endurance specification.

In much the same way a rechargeable battery loses its charge after several cycles, non-volatile solid state storage components can lose their ability to retain data after tens of thousands of write/erase cycles. This is usually specified by component vendors as endurance. When a block loses its ability to retain data or when data errors occur that cannot be corrected by the drive's ECC algorithm, the block is swapped with one from an available spare pool. When the spare blocks are exhausted and another error occurs, the solid state drive reaches critical failure and needs to be replaced.

Eliminating Unscheduled Downtime

There are two ways to eliminate unscheduled downtime:

- Develop technologies to prevent the failures and increase drive endurance.
- Provide monitoring technology to warn the host system of impending issues.

WD has engineered technologies that accomplish both of the following:

- PowerArmor eliminates drive corruption due to power disturbances (refer to the WD white paper entitled *Eliminating Drive Corruption from Power Disturbances* located at http://www.wdc.com/WDPProducts/SSD/whitepapers/en/SiliconDrive_PowerArmor.pdf).
- Solid state storage management algorithms such as advanced ECC and wear leveling over the entire SiliconDrive maximize the drive operating life and extend system-level endurance (refer to the WD white paper entitled *NAND Evolution and its Effects on Solid State Drive (SSD) Useable Life* located at http://www.wdc.com/WDPProducts/SSD/whitepapers/en/NAND_Evolution_0812.pdf).

Monitoring Data Transactions for Each Block

Most system designers require a better feedback methodology that yields meaningful data at any time during system operation. It is useful to understand when the application has reached points such as 10%, 20%, 50%, and so on, so that the host system can more accurately flag any issues in advance of when they are likely to occur (see [Figure 2](#)).

SiSMART goes well beyond only monitoring spares. To yield meaningful information at any point in time, SiSMART tracks and tabulates write/erase transactions for each block in the SiliconDrive. Based on this information and whenever requested by the host, SiSMART can calculate the percentage of drive life remaining. If the used percentage goes beyond a certain comfort zone, the drive can be replaced during the next scheduled maintenance period. Eliminating unscheduled maintenance calls can save embedded OEMs tens to hundreds of thousands of dollars per year.

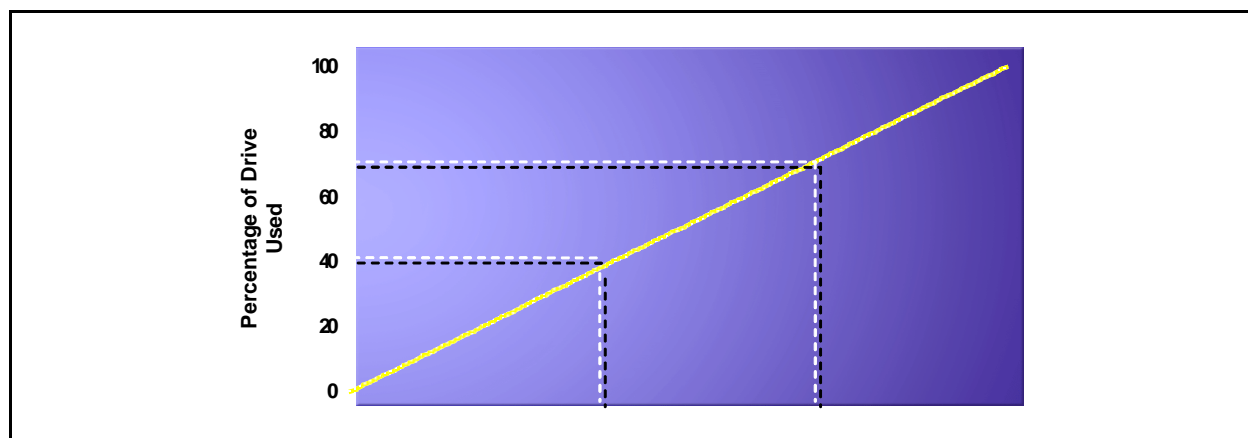


Figure 2: Percentage of SiliconDrive Used Over Time

Modeling System Usage

Another benefit of the feedback provided by SiSMART is the ability to perform storage usage modeling. It is very difficult for system designers to fully understand all data transactions between the host and the drive — especially if operating and file systems are used. SiSMART eliminates this uncertainty.

Example

An OEM that manufactures enterprise edge routers uses SiSMART to model the data storage requirements of its system. The router is constantly logging data and write/erase endurance is a significant issue.

To properly size the SiliconDrive, the company had to review the data collection requirements. First, the company needed to determine which parameters to monitor and how often to log those parameters. Next, the company had to determine how long they wanted to deploy this product in the field — in this case, five years.

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The company had used flash cards in the past. The flash cards had no feedback mechanism and the company felt it would need to double the size of the card to give them the required comfort level for meeting the five-year deployment target. With SiSMART technology, the company deployed the capacity originally defined, resulting in an immediate cost savings.

The company tested the SiliconDrive in the field for six months, and then brought the system back to their test lab and ran the SiSMART utility to determine drive usage. It turned out that the drive was less than 5% utilized, so the company not only felt comfortable with its current application, it found a new data reporting requirement and collected even more data — potentially giving them a competitive advantage in their market. The company could upgrade their system and still feel confident in meeting the five-year target.

SiSMART Utility

The following table shows how the SiSMART function stores and tabulates the parameters for retrieval by the SiSMART utility.

| Parameter | Description | Values |
|-----------|---|--|
| SiSTAT | Returns the write/erase statistics of each block. | Integers |
| SiWEAR | Yields the percentage of wear over the entire SiliconDrive. | Decimal value representing a percentage. 1.02 = 1.02% of the drive used. |
| SiSPARE | Yields the number of spare sectors used and number of spares remaining. | Integers |

The SiSMART utility can run on Microsoft Windows XP, Linux, or DOS-host systems. This executable utility can also be integrated into applications directly. Software libraries and source code will be available under NDA to those customers wanting to tailor this function to their unique requirements.

Conclusion

Traditional solid state drives and flash cards did not incorporate any type of feedback mechanism and consequently were allowed to operate until they exceeded the endurance specification and failed.

The ability to monitor write/erase endurance is analogous to monitoring fuel in an automobile. Having no monitoring solution is like driving the car without a fuel gauge. The system operates until it “runs out of gas.” Monitoring spares only is like having a light that comes on just before running out of gas. There may or may not be enough time “to get to a gas station” before the system fails. SiSMART monitoring technology is like having a complete fuel gauge. Preventative maintenance (“filling up”) in advance of a failure ensures the system operates properly and does not experience any unscheduled downtime.

For more information, visit WD’s website at <http://www.wdc.com>.

Related Documents

Refer to the *SiSMART* User’s Guide.

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1 Megabyte (MB) equals 1 Million Bytes; 1 Gigabyte (GB) equals 1 Billion Bytes. Accessible capacity may vary depending on the operating environment.

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