White Paper

Maximum Surveillance-Recording Stability with RECLine™ Firmware Optimization

Executive Summary

As the capacity and price gap between hard disk drives (HHD) and solid state drives (SSD) closes, SSDs will become more mainstream in the surveillance market. However, due to inherent issues of data deletion and writing in flash memory, certain background processes needs to be in place. These firmware operations will cause drops in sequential write performance. As video recording applications are almost only reliant on sequential write speeds, these drops will cause lower video quality and frame loss.

RECLine™ is a solid state drive SSD firmware optimization for surveillance applications that ensures a constant sequential write speed (minimal frame loss) when recording data. This is achieved through modifications to the garbage collection, wear leveling and TRIM functions of the SSD.

Introduction

Frame loss is the main issue to avoid when recording surveillance data. These drops in recording quality can render your otherwise pristine footage grainy and unusable. No matter what storage medium you are using, frame loss is a risk to your surveillance operation. Furthermore, high-quality recordings and simultaneous read/write operations are needed to run modern surveillance features, such as on-the-spot data analytics and facial recognition.

The surveillance industry has traditionally been employing HDDs as their main storage medium. This was mainly due to the advantages it held with regards to price, storage capacity, and longevity. However, SSDs are steadily closing the gap between the two, making it an increasingly attractive alternative to the HDDs. Due to the completely different structure of the SSD, it can easily run simultaneous read/write operations without interfering with data recording, making it the better choice for the most demanding surveillance operations.

While SSDs hold an advantage, frame loss can still occur due to the nature of how data is stored and deleted in flash devices. Certain firmware processes dealing with these inherent SSD attributes, such as garbage collection and wear leveling, can cause significant frame loss if not handled correctly. These firmware processes need to be optimized for sequential writing, which makes up the brunt of surveillance data.

This paper will dive deeper into the advantages of SSDs for the surveillance industry and give a detailed description of RECLine and its modification to firmware technology.

Background

HDD vs SSD

From early on, the SSD found fertile ground in the embedded industries as they are intrinsically more suited for space-constrained and rugged applications. It easily replaced legacy storage devices and also opened up for new applications. However, the surveillance market have been very late in adopting flash devices. This is mainly because HDDs can deliver high capacity at a reasonable cost and is a well-proven technology; so for simple surveillance setups, it is more than capable of providing reliable data storage.

However, many newer surveillance features such as on-the-spot data analytics and facial recognition require simultaneous read/ write operations. The mechanical structure of HHDs is poorly equipped to handle this, and in a continuous writing environment, this will inevitably lead to frame loss.

Having said this, it is not an either-or scenario. There are many ways you can set up a surveillance system that combines both of the storage mediums. For example, the HHD can play the role of archiving data at an external location while the flash device is used locally for data analytics and data compression.

Random and Sequential Write

There are two ways data can be written to storage devices. Random write means scattered data written to different parts of the storage device, while sequential writing is data that is continuously written, such as video recording. Most applications will handle a certain mix of these two writing methods, but surveillance will almost exclusively rely on sequential writing. Any surveillance system using SSDs should therefore use devices with firmware that is optimized for sequential writing. This way frame loss can be kept to a minimum.

Garbage Collection

Deleting files from SSDs is not a straightforward process. The storage space is divided into blocks, which is further divided into pages. Due to the inherent nature of NAND flash cells, data can be written into pages but can only be deleted in blocks. The issue is that blocks will often contain pages with both valid data and data to be deleted. To solve this, garbage collection kicks in when the SSD is not busy. The valid data is copied onto a new block and the first block containing the invalid data is deleted, leaving it open for new data to be written.

TRIM

TRIM is a command that works to make garbage collection more efficient. The file system is an abstraction of the actual physical layer of the SSD. In other words, if the user deletes a file, the SSD does not pick it up straight away, instead the SSD will only know that the file is invalid once the data has been overwritten. This can lead to the data being unnecessarily moved around from block to block, increasing write amplification (WAI). The higher the WA, the faster the NAND flash cells of the SSD will wear out, effectively decreasing device longevity.

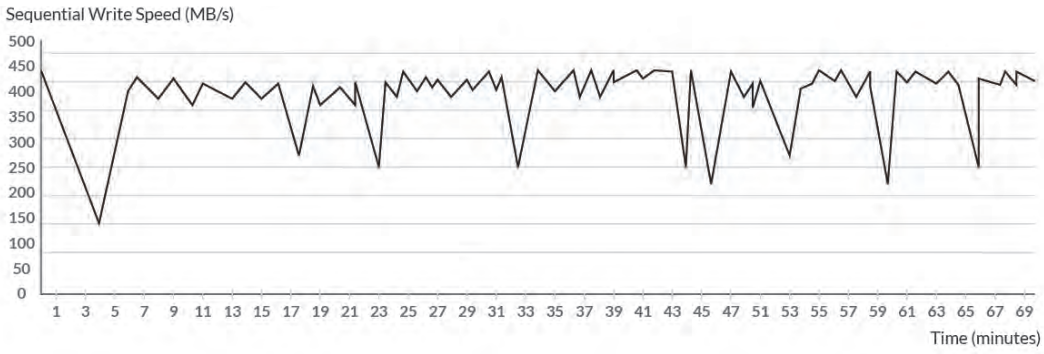
TRIM solves this by immediately marking the data as invalid regardless of if the original pages having being rewritten or not, allowing it to be deleted during the next garbage collection cycle.

Wear Leveling

With any computer, there are certain files that will mostly remain unchanged over longer durations, such as system files and certain applications. As NAND flash cells degrade with every program/erase (P/E) cycle, cells that hold the more permanent data see less use, leading to an uneven degrading of the cells and ultimately a shortened lifespan. Wear leveling ensures that this permanent data is regularly swapped between blocks to ensure that the SSD is used to its maximum potential.

Challenges

Surveillance operations are reliant on consistent, stable data recording. This is done by mitigating the factors that can lead to frame loss. Frame loss is usually caused by unstable environmental conditions and electromagnetic interference. For SSDs, the background operations of garbage collection, TRIM and wear leveling can also be an influencing factor. Graph 1 shows an SSD with standard firmware during a video recording test. Once the firmware operations start there are sudden and drastic drops in sequential write performance. This translates into grainy images and possible abrupt cuts in the recording data.



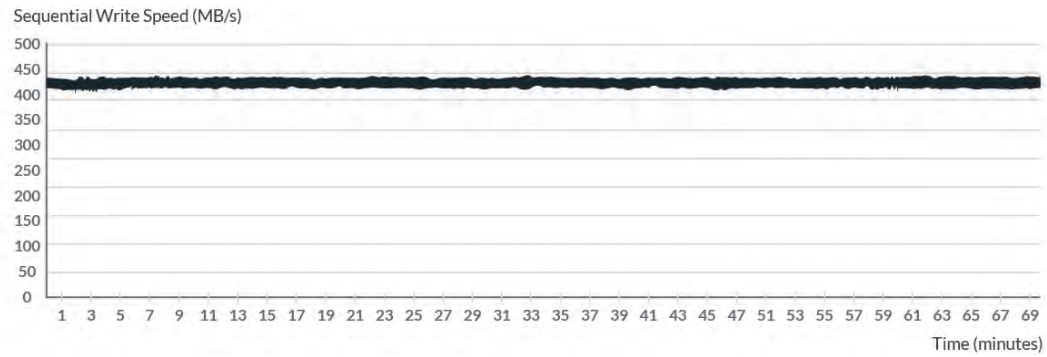
Graph 1: Recording test with standard SSD

Modern surveillance features often require that data is simultaneously read and written to a storage device. Because of their mechanical nature, HDDs are poorly equipped to handle this kind of operation, as the disk and read/write head can only move so fast. To fully implement features such as facial recognition and data analytics, faster and more stable storage devices are needed.

Solutions

Optimized Firmware

RECLine modifies garbage collection and wear leveling to be more in tune with the requirements of surveillance applications. Graph 2 shows a test run on a RECLine SSD where firmware has been optimized. Note that garbage collection is still being run with only a negligible impact on sequential write speed.



Graph 2: Recording test with RECLine SSD

The garbage collection process can cause write speed to slow down. With standard firmware, the frequency of garbage collection will inevitably cause frame loss when recording data. RECLine alters the timing and lowers the frequency of garbage collection, effectively dispersing the time of data transfer between blocks. Once the SSD runs out of capacity in the user area/ logical space (see Figure 1), it will start writing to the spare area (also called over-provisioning) as shown in Figure 2.

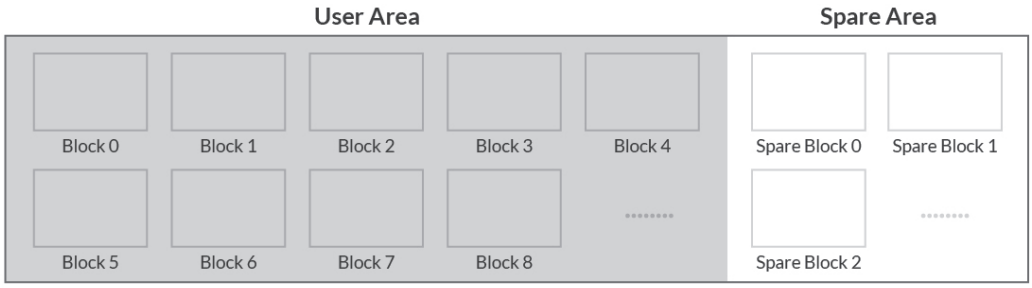


Figure 1: The user area of the SSD is fully written

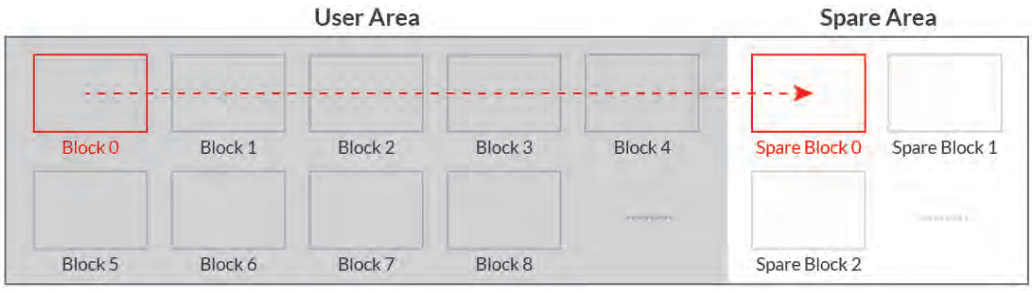


Figure 2: The SSD starts writing to Spare Block 0

As the firmware is optimized for surveillance recording, the SSD will treat all sequential data as overwritable. This means that the small amount of random data on Block 0 will slowly be consolidated by the dispersed garbage collection routine. When Spare Block 0 is fully written to, data will already have been deleted from Block 0 and the valid random data is consolidated (see Figure 3). As the consolidating of the small amounts of valid data is handled in small and dispersed operations, the overall frame loss caused by garbage collection is negligible.

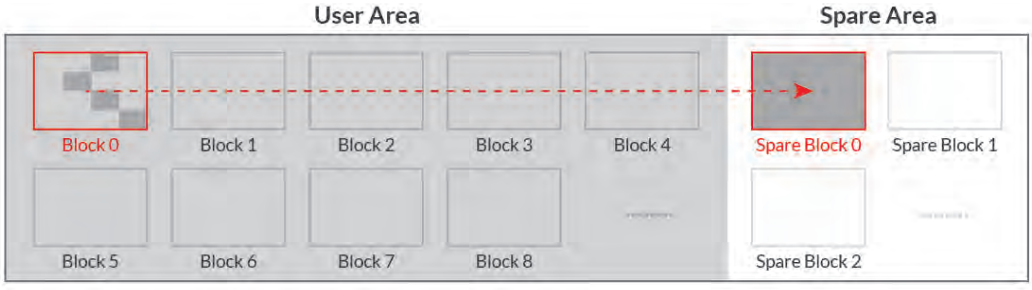


Figure 3: Dispersed garbage collection for full drive

The main purpose of wear leveling is to make sure data writing happens evenly among all blocks. However, as surveillance recording is mainly sequential writing, this issue largely solves itself as data is continuously written to and deleted from most blocks. Wear leveling frequency can therefore safely be reduced to ensure a more stable writing performance.

The TRIM command itself does not cause frame loss, and enabling it for RECLine further enhances the efficiency of garbage collection.

Simultaneous Read/Write

As opposed to the moving parts of the HDD, the solid state drives, as the name implies, has no moving parts. Accessing the data requested by the system is a simple matter of locating the correct flash section. As such, the SSD are the best alternative for surveillance applications that require simultaneous read and write operations.

Conclusion

SSDs are the storage medium of the future. But for surveillance, there are certain obstacles that need to be addressed. RECLine offers an optimized solution to the inherent issues of flash drives by tweaking garbage collection and wear leveling to minimize frame loss. This way, the operator can be certain that their storage solution will not impact recording quality and that the system is ready for any modern surveillance feature.

The Innodisk Solution

InnoREC™ series				
				
2.5" SATA SSD 3MV2-P	SATA Slim 3MV2-P	CFast 3MV2-P	M.2(S80) 3MV2-P	mSATA 3MV2-P

Innodisk Corporation

5F., NO. 237, Sec. 1, Datong Rd., Xizhi Dist., New Tapei City, 221, Taiwan
Tel : +886-2-7703-3000
Fax : +886-2-7703-3555
E-Mail : sales@innodisk.com