Technology Paper

Video Surveillance: The Migration to Disk-Based Storage

Introduction

Digital video surveillance systems continue to proliferate at an impressive pace. In a recent report, according to IMS Research, the estimated world-wide market for video surveillance equipment was US$8.2 billion in 2008, and is expected to grow at a compound annual growth rate (CAGR) of 10.1% to US$13.3 billion in 2013. Nearly one-third of the estimated revenue would be from hard drive-based surveillance DVRs and NVRs.[1] While post-9/11 security concerns have certainly played a significant role in this phenomenon, the ongoing need for more efficient and effective surveillance systems is also driving the movement to digital-based solutions.

To better understand the motivating factors behind this trend, it's useful to break down the operational capabilities of video surveillance systems into three fundamental categories:

- **Quantity**—volume of video streams a surveillance system can capture and store

- **Quality**—image quality of video data, expressed in terms of frames per second (fps) and frame resolution (for example, 720x480 pixels)

- **Accessibility**—how quickly stored video data can be retrieved and reviewed

1 Source: IMS Research, *The World Market for CCTV and Video Surveillance Equipment 2009 Edition,* August 2009

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The surging popularity of digital video surveillance solutions stems from their ability to deliver dramatic advances in all three of these critical areas. Boosting the quantity and quality of video data demands far greater storage capacity than is available from legacy tape-based systems. This leads digital surveillance systems to rely on purpose-built surveillance hard disk drives (HDD), which deliver prodigious capacities to eliminate a key bottleneck from these systems.

Similarly, tape-based systems are limited to sequential data access, severely constraining the speed and ease with which data can be retrieved. HDD-based surveillance storage again provides the solution, its random access capabilities vastly accelerating the retrieval and review of vital video information.

Simply put, HDDs are proving themselves a fundamental enabling technology of the digital surveillance revolution.

Reaching the End of Tape

Much like the home VCR market in the 1980s and 1990s, the video surveillance market has been dominated by analog-based video capture and recording of surveillance footage to traditional tape-based systems. And just as the home video market has quickly supplanted VHS tapes with the superior image quality and reliability of digital DVDs, so too is the video surveillance market eschewing tape-based solutions in favor of digital systems utilizing HDD storage.

The liabilities of tape-based storage are numerous and interrelated, demanding users strike a delicate compromise to achieve acceptable results.

Recording Time—This is a function of both tape speed and tape length. Decreasing the tape speed increases the maximum recording time per cartridge, but image quality can be significantly degraded. Increasing the tape length allows more recording time but requires thinner tape in order to fit in a standard cartridge; thinner tape is more fragile, increasing the chance of tape stretching or outright breakage.

Recording Quality—This is primarily a function of tape speed. Faster tape speed yields higher image quality, but cuts the maximum recording time per cartridge, thus requiring users to more frequently load/unload tapes throughout the day. Using thinner tape boosts maximum recording time but, as noted above, increases the chance of stretching and degraded image quality.
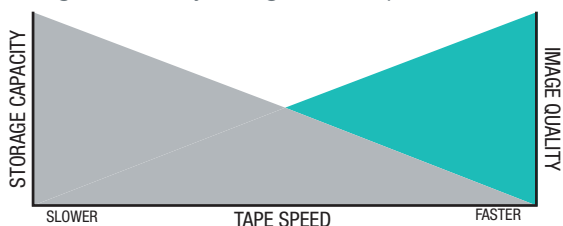
Multiplexing—Multiple video streams can be sent to a single recording device via the use of a multiplexer. However, tape-based storage entails compromise because a single cartridge can't simultaneously meet the needs of high-resolution streams (ideally recorded at higher tape speeds for maximum image quality) and low-resolution streams (preferably recorded at low tape speeds for maximum recording time).

Accessibility—Tape-based surveillance storage can only *sequentially* access a desired piece of video data. That is, a search that begins at point A on a tape and ends at point B (where the desired video footage resides) must traverse *all of the data in between those two points.* This greatly slows down access, particularly when the start/stop points are at opposite ends of the tape.
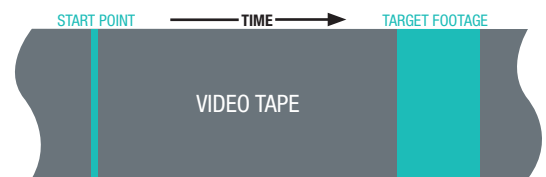
Furthermore, once found, the desired footage can suffer degraded image quality from repeated reviewing. Because the tape is in actual physical contact with the tape head, frequently playing and rewinding the tape can gradually wear away the magnetic coating that stores the video data. Image degradation can also occur during storage due to print-through, wherein magnetism from adjacent tape layers bleeds through to imprint ghost images.
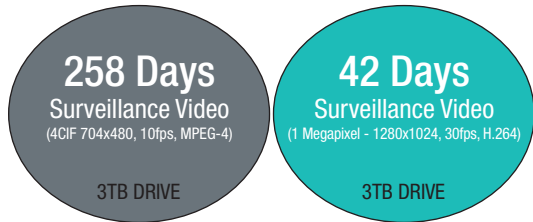
The HDD Advantage

With the above points in mind, it should come as no surprise that digital video surveillance systems utilizing hard disk drives are rapidly replacing tape-based systems. Bringing unprecedented power to vital security applications, these disk-based solutions enable a comprehensive range of benefits and capabilities.

Huge Recording Capacity—Offering up to 3TB capacity per disk drive, surveillance storage systems equipped with HDDs ensure unprecedented freedom to deploy a multitude of cameras for broad, comprehensive video surveillance coverage. Dozens, even hundreds, of video streams can be accommodated simultaneously, all without the need to periodically remove/insert tape media.

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Furthermore, this wealth of capacity pays important dividends in the ability to archive video for extended periods. Archive periods can be economically extended from thirty or sixty days to months (even years), providing additional security protection as well as ensuring compliance with rigorous regulatory and legal requirements.

258 Days
Surveillance Video
(4CIF 704x480, 10fps, MPEG-4)

3TB DRIVE

42 Days
Surveillance Video
(1 Megapixel - 1280x1024, 30fps, H.264)

3TB DRIVE

Superior Image Quality—Eliminating analog limitations (poor signal-to-noise ratio, saturation, tape stretch, etc.) that undermine recording quality, HDD storage ensures consistently superior image quality. And having banished tape's trade-off between recording speed/quality and recording time/capacity, it also enables multiplexed streams to be individually configured for optimum results.

Even more importantly, the enormous capacity of disk-based storage enables users to specify more aggressive capture rates and resolution (for example, 30fps and 740x480 pixels) to maximize image quality. Such settings can rapidly consume vast quantities of storage space, which an HDD-based system can readily supply.

As a result, image quality need never be compromised because of limited storage capacity, a key consideration with today's intelligent video applications (see below).

Rapid Accessibility—Disk-based surveillance storage offers *random* access to any video data on the disk drive. This means that the read/write head can go *directly* to the desired video footage, bypassing all of the data that lies between the search's starting point and its destination.

START POINT ← INSTANTANEOUS → TARGET FOOTAGE

DISK DRIVE

This ensures vastly faster access to video footage than tape-based storage; furthermore, with no tapes to swap in and out, the surveillance system's disk drives (and the video images they contain) are always immediately available.

And because the disk drive's read/write head does not physically contact the platter, video footage can be reviewed again and again without image degradation.

Advent of Intelligent Video

The value proposition of digital surveillance systems equipped with hard disk drives becomes even more compelling when intelligent video applications are added to the picture. Taking full advantage of the high-resolution, capacity-intensive video streams that HDD storage effortlessly handles, intelligent video applications will profoundly increase both the capabilities and cost-effectiveness of video surveillance systems.

At its core, intelligent video reviews the exceptional detail found in high-resolution video streams and analyzes it to recognize visual patterns. Perhaps the best-known use of this technology is facial recognition; intelligent software analyzes the faces of persons in stored surveillance footage, comparing their features to the faces of known suspects/criminals on file. When a match is identified, the application automatically notifies security personnel for follow-up investigation.

Of course, these applications review stored surveillance footage (review being too calculation-intensive for real-time processing) for other visual patterns as well. For example, the application can be configured to identify unusual behavior (for example, a person running in an area where such activity is unusual), flag suspicious persons and alert security staff. Or it can compare reference video images of a locked door to surveillance footage to check for signs of a break-in.

The remarkable synergy between intelligent video applications and digital video surveillance systems makes the benefits of disk-based surveillance storage even more compelling. That said, all disk-based storage is not the same. Surveillance has unique requirements that demand drives specifically engineered to meet those needs. Such drives offer compelling advantages over conventional drives.

Seagate® SV35 Series™ Drives: Purpose-Built for Surveillance

The Seagate SV35 Series hard disk drive is the first drive specifically engineered and optimized for digital video recording in security and surveillance applications. As one would expect, SV35 Series drives deliver prodigious capacity (up to 3TB) to store massive amounts of digital video: 258 continuous days per camera (704x480, 10fps), 42 continuous days per camera (1280x1024, 30fps) recording 24 hours a day, 7 days a week.

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But SV35 Series drives drives do more than just deliver outstanding capacity; they also address the disk drive durability challenges inherent in always-on surveillance environments. Given the potentially critical nature of the security data involved, the application-specific features employed in the SV35 Series drive to enhance reliability take on even greater significance.

As can be seen below, the SV35 Series family of surveillance disk drives includes custom features not found in conventional desktop drives to intelligently deal with heat management and power consumption:

- **Advanced power management features**—SV35 Series drives require lower startup and operational current, enabling the design of low-cost power supplies. The drives also include the capability to power down when not in use, saving both power and enabling more efficient system cooling.

- **Intelligent workload monitoring**—SV35 Series drives utilize monitoring algorithms to sense specific workload profiles that can stress key systems and then take corrective action.

- **Designed for 24x7 operations**—SV35 Series drives can withstand the intense duty cycles common in digital video recording for security and surveillance.

The enhanced functionality of SV35 Series drives doesn't end there. The drives are also optimized for write performance in both seek- and write-caching firmware. This is key for video surveillance storage workloads, where writing data can represent up to 95% of the hard drive's operation. Favorable performance and drive longevity are highly dependent upon this enhanced write functionality. Additionally, SV35 Series drives support the ATA-7 command set, enabling their read/write profiles to be tuned to video- or data-specific, as appropriate.

Conclusion

Widespread adoption of digital surveillance systems is being driven both by heightened security concerns and the desire for more powerful, cost-effective surveillance systems. Hard disk drive storage is the linchpin of digital security solutions, delivering an unprecedented combination of capacity, speed and durability to enable a compelling new class of intelligent video applications.

Seagate is leading the surveillance storage revolution with the SV35 Series family of disk drives, the industry's leading line of drives specifically built for the unique requirements of digital video surveillance systems.

www.seagate.com

Summary: Desktop Drive vs. Seagate SV35 Series Drive		
	Seagate® SV35 Series™ surveillance drive	**Conventional desktop drive**
Custom Drive Features	Excellent; extensive power management features reduce heat, power use; surveillance-optimized for high write workloads	None; not designed to handle heat in rigorous power-on and workload environment; not optimized for workloads of surveillance configurations
Projected Reliability	Excellent; workload monitoring protects drive under heavy use	Unknown; not designed for use in always-on surveillance environment
Overall Value	Excellent; dedicated drive design comparable in price to traditional desktop drives	Poor; workload, heat issues negate lower initial purchase price