



White Paper

Best Practices for Maintaining Reliability of On-Board Equipment

Planning for equipment maintenance is an important process to ensure the best performance and optimal uptime. This white paper covers best practices to optimize performance of hard drives for mobile video surveillance systems.

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Introduction

Maintenance is an important life cycle component for virtually any product or system. We all know the consequences of neglecting a car's warning light or oil replacement schedule. Even in the most ideal situation it is crucial to plan for maintenance to ensure a continued reliability.

This holds true for mobile video surveillance systems. Similar to other important electronic devices, periodic maintenance is necessary for mobile video surveillance systems to ensure high performance, reliability, and longevity. Equipment used in mobile applications is susceptible to damage caused by vandalism, environmental conditions, impacts, power disruption, shock, vibration and temperature. The rigors of mobile applications on hard drives and related systems coupled with the reliance on recorded data in mobile video applications create an even greater need for preventive measures to ensure long-term reliability.

The Recorder Hard Drive Life Cycle

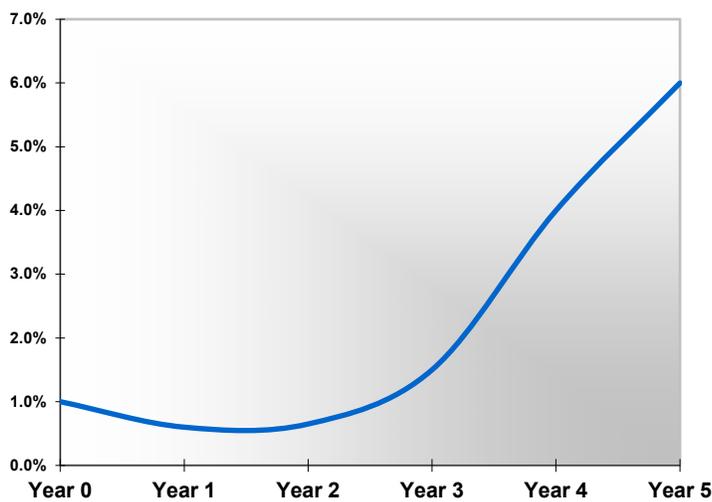
The most essential elements of a mobile video surveillance system are the digital video recorder (Recorder) and its associated hard drive. All aspects of the RoadRunner™ Recorder and associated systems are designed and manufactured specifically for mobile applications. While most hard drives are designed and manufactured for use in a stable, protected environment with periodic write-cycles, the RoadRunner system's hard drives are optimized specifically for both continuous recording and the rigors of a mobile environment.

The industry standard life expectancy of a hard disk drive is from three to five years.¹ This standard is primarily based on hard drive performance within a stable protected environment. Hard drives used in both stable and unstable environments may live a useful life beyond five years; however, failure rates increase dramatically past the five year threshold.

Large-scale studies on hard drive life cycles are scarce² so most current life cycle data is based on the published life cycles by drive manufacturers. To specify the reliability of their products most hard drive manufacturers use two related metrics: the *annualized failure rate (AFR)*, which is a percentage of disk drives in a population that fail in a test scaled to a per year estimation; and the mean time to failure (MTTF)³ or mean time between failure (MTBF). The relationship between AFR and MTBF/MTTF is: $AFR=1-exp(-8760/MTBF)$. "This equation assumes that drives are powered on for the full 8760 hours of a year, and gives the estimated fraction of an original sample of drives that will suffer from disk failures, or equivalently, 1-AFR is the fraction of drives that will show no failures over a year. It is based on an exponential failure distribution."⁴

It's important to note; however, that disk failures measured using single-value metrics such as MTTF and AFR cannot capture the fact that real life failure rates are not constant.⁵ Most assume that hard drive failure rates follow what is known as “the bathtub model,” where early failure – “high infant mortality” – is followed by a few years of low failure rate, and then begin to wear out and fail. The graph ends up looking like a bathtub; hence, “the bathtub model.” In actuality, based on large scale studies, real world failure rates begin low and steadily increase over the years with no “sweet spot” of low failure.⁶

Annualized Failure Rate (AFR), Hard Disk Drives



The potential for hard drive failure increases over time. Therefore, we recommend replacement after 3 years of use to maintain the highest reliability.

Assessing Risk and Risk Tolerance

It is important to determine the level of risk exposure that will be tolerated when weighing options during a product's useful life. When preventive measures are taken, the longevity of a product is improved and enhanced. Risk methodologies may include mandatory replacement at established intervals (a proactive approach) or stocking of replacements (a reactive approach). This creates an initial investment of hard costs but significantly reduces risk in field failures or available inventory respectively.

Organizations are encouraged to adopt uniform practices that will align with their assessed tolerance for risk and established budgets. Based on technical data, objective evidence and routine analysis, Apollo Video has established recommended "Best Practices" for organizations to consider when managing required performance and risk tolerance.

Best Practices

Preemptive Replacement of Hard Drives

As discussed previously - despite the harshness of the mobile environment, our recommendation for maintaining high standards of system reliability is to replace hard disk drives every 3 years. This aligns with industry standards, most of which are based on hard drive use in non-mobile environments. While many hard drives can, and will, continue recording for 5 years or longer, the risk of missing critical data if operated past the recommended time period is great, especially considering the low replacement costs in comparison with the risk of failure.

Apollo Video offers a hard drive replacement program that is an easy, cost effective, and environmentally-friendly method for preemptive (or remedial) replacement of hard drives while reusing the hard drive enclosure. The process is simple - send the drive (in its protective enclosure) to the repair department and they will return the enclosure with a new hard drive installed. Apollo Video customer support technicians can help arrange a program that will keep your fleet operational by scheduling batch replacements.

Hard Drive Health Monitoring

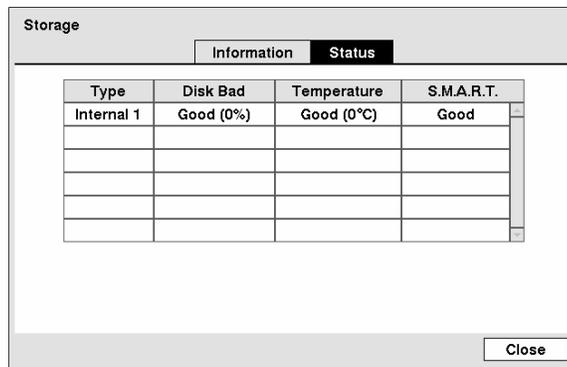
The RoadRunner system's hard drive contains features that allow the user to determine the age and can help in predicting failures. The serial number on the hard drive is used to establish the manufacture date of the drive as well as traceability for that unit's life. This allows users to establish the drive's age from the initial installation point and determine the appropriate time for replacement within the timeframe we recommend to maintain the highest level of data integrity.

Once installed and operational, the health of a hard drive should be monitored periodically. This can be accomplished using several methods. Physically viewing video will allow a user to ensure the drive is functioning as expected.

Advanced tools are designed to provide information with more efficiency. The RoadRunner system features self-diagnostics, automatic notification and S.M.A.R.T. (Self-Monitoring, Analysis, and Reporting Technology) protocol. Additional information about obtaining this data from the Recorder can be found in the Recorder Operating Manual. The screen shot image that follows displays information that a user can view to investigate the health of the hard disk drive. This information can be easily viewed remotely from a central location at regular intervals.

When used with other tools, S.M.A.R.T. can be a reliable method for detecting hard drive failure. Using S.M.A.R.T. a large-scale study found that drives with detected scan errors are ten times more likely to fail than the group with no errors.

Apollo Video's Vehicle Information Management - ViM Software™ also provides methods to remotely monitor and easily check system health. When equipped with the Recorder Health Module, users can view connection status, system logs and configure the software to provide email notification of system events. Health reports provide Recorder, camera and hard drive information.



Type	Disk Bad	Temperature	S.M.A.R.T.
Internal 1	Good (0%)	Good (0°C)	Good

The RoadRunner Recorder system provides pertinent information about the health of the hard disk so it can be replaced before a failure occurs.

Preventative Maintenance Services

To help ensure reliable and skilled system monitoring and servicing, Apollo Video offers several types of service options. Service options range from a single fleet-wide system check to ongoing periodic maintenance. A customer support technician can help in choosing the system that best meets the needs of your organization.

Conclusion

Hard drives are a serviceable part that should be routinely replaced. As cited, we recommend replacing hard disk drives after 3 years of use, given there are no other indicators that indicate a failure. All systems should be monitored to maintain reliability and optimal uptime. The frequency and depth of monitoring will correspond to your risk tolerance and resources. Indications of potential failure can be detected using a variety of monitoring tools and data. We suggest using several tools to monitor performance. S.M.A.R.T technology is a built-in tool that provides hard drive health data quickly and efficiently. Additionally, ViM Software provides quick and easy tools to check hard drive and other system health indicators as well as increasing access to video and fleet information.

With these tools and the service plans offered, system monitoring and maintenance can be easily implemented in a cost effective manner that ensures long-term reliability and protection of crucial video data.

Resources

¹ How Long Do Computer Hard Drives Last? Computer Repair, June 18, 2013.

<http://iqcomputerservices.com/blog/hard-drive-failure>.

² Pinheiro, Eduardo, Wolf-Dietrich Weber and Luiz Andre Barroso. Google Inc. Failure Trends in a Large Disk Drive Population. February 2007.

³ Schroeder, Bianca and Garth A. Gibson. Disk failures in the real world: What does an MTTF of 1,000,000 hours mean to you? Carnegie Mellon University, Computer Science Department.

⁴ Annualized failure rate (AFR). Wikipedia.

⁵ Schroeder, Bianca and Garth A. Gibson. Disk failures in the real world: What does an MTTF of 1,000,000 hours mean to you? Carnegie Mellon University, Computer Science Department.

⁶ Hensen, Valerie. KHB: Real-world disk failure rates: surprises, surprises, and more surprises. Linux.net. June 12, 2007. <http://lwn.net/Articles/237924/>.

About Apollo Video Technology

Apollo Video Technology provides innovative transportation information, management, safety, and security solutions. The RoadRunner™ mobile video and audio recording system provides exceptional quality with management software optimized for wireless downloading and live video streaming. Since its release in 2004, Apollo Video has supplied the RoadRunner system to over 400 agencies worldwide, representing more than 35,000 total implementations.

Renowned for reliability, durability and ease of use, Apollo Video solutions improve accessibility of data and deliver streamlined, fleet-wide management of video surveillance and on-board equipment to reduce liability, mitigate risk and improve efficiency, while reducing maintenance and operating costs. Apollo Video is unique in the industry, providing software interoperability and compatibility across multiple generations of hardware.

Apollo Video has been ranked the No. 1 supplier of transit bus mobile video surveillance equipment in the Americas since 2010 — an achievement that further supports the Company's commitment to offer its customers superior, compatible solutions throughout the lifetime of their fleet.

In 2017, the Company partnered with Luminator Technology Group. Recognized globally for delivering state-of-the-art passenger information systems and vital transportation solutions, the collaboration with LTG enhances integration, product and technology offerings to better serve existing and future customers.