



Increasing Data System Reliability and Availability

A Study on the Effects of the Xyratex CERT
Hard Drive Integration Process

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Abstract

Recent published white papers demonstrate that desktop-class hard disk drives are generally failing to meet their reliability specifications. This white paper, however, describes the benefits to data system reliability and availability of the Xyratex Hard Drive Integration process in comparison to hard disk drive products that have not been subjected to Xyratex rigorous defect screening and Combined Environmental Reliability Testing (CERT) process. This paper will make specific reference to papers from Google and Carnegie Mellon University, and illustrates how the Xyratex Integration process enables desktop-derived, near line hard disk drives shipped to end user sites to consistently achieve the reliability specifications of drive manufacturers.

Introduction

This paper reports on the quantitative outcome of the Xyratex Hard Drive Integration process in terms of reducing the quantity of early failures or infant mortality of near line disk drive in end user installations. The effect of these failures reduces customer satisfaction and increases the total cost of ownership of storage systems. In an era when the dependency on data systems is growing rapidly, the compromise to data integrity can also have adverse effects on business operations, market reputation, and responsiveness. Recently, Google published a paper that sheds light on this critical problem. Their analysis is important because it:

1. is based on a far larger number of disk drives than is usually the case in such studies,
2. demonstrates that SMART drive parameters may not be effective alone at predicting individual drive failures, although possibly useful for predicting drive population failures, and
3. show that little correlation exists between temperatures drives are subjected to or their activity levels and drive failures.

These are significant conclusions. Contemporary to the publication of this document was a separate study presented by Carnegie Mellon University (CMU) in which they demonstrate that within the population subject to the study, fibre channel interface drives are no more reliable than serial ATA (SATA) drives, even though they are significantly more expensive.

Xyratex Expertise and Reaction

Xyratex has a long history of improving the reliability of storage devices and systems. Minimizing the risks of a drive failure is achieved in part through Xyratex's technical expertise in the development of storage systems and through a comprehensive test suite which sets Xyratex apart from its competitors. The Xyratex Hard Drive Integration process combines test facilities and methodology, is the foundation for why some of the largest brands within the storage industry trust Xyratex as their chosen OEM partner for disk arrays.

Publication of the Google and CMU papers has motivated Xyratex to further study its own drive fallout statistics arising from screening with the Xyratex Hard Drive Integration process. CERT is an integral part of this process, designed to stress storage subsystems to screen out marginal defects that will potentially cause early life failures. Part of the key to CERT is the fact that it's an integrated solution which can be used in a large-scale volume environment. Many of the test variables can be applied individually or concurrently, creating stresses that identify latent defects, and providing comprehensive test coverage.

Analysis

Both Google and CMU reviewed data spanning a five-year period and involving 100,000 disk drives. By contrast, the Xyratex test population reflects 5½ years of field data and more than 540,000 disk drives. Near line drives are defined as:

- enterprise-class reliability disk drives that operate at under-duty cycles usually less than 15 percent of power on hours (POH),
- designed for high volume production,
- derived from desktop drive designs,
- typically used for storing a large amount of data that does not need to be retrieved as quickly as data stored on enterprise-class drives,
- not as fast in retrieving data, but must be reliable and always online, and
- supporting access via the serial ATA (SATA) or parallel ATA (PATA) interface.

Xyratex agrees with Google that deployment experience is the critical measure of real reliability and our test results are exclusively reflective of the experience of disk drives installed in Xyratex systems. Moreover, Xyratex storage is deployed in a multitude of environments on a global basis and representing a wide diversity of applications. Xyratex deployment experience and understanding may well be different than Google's hence we may draw different conclusions.

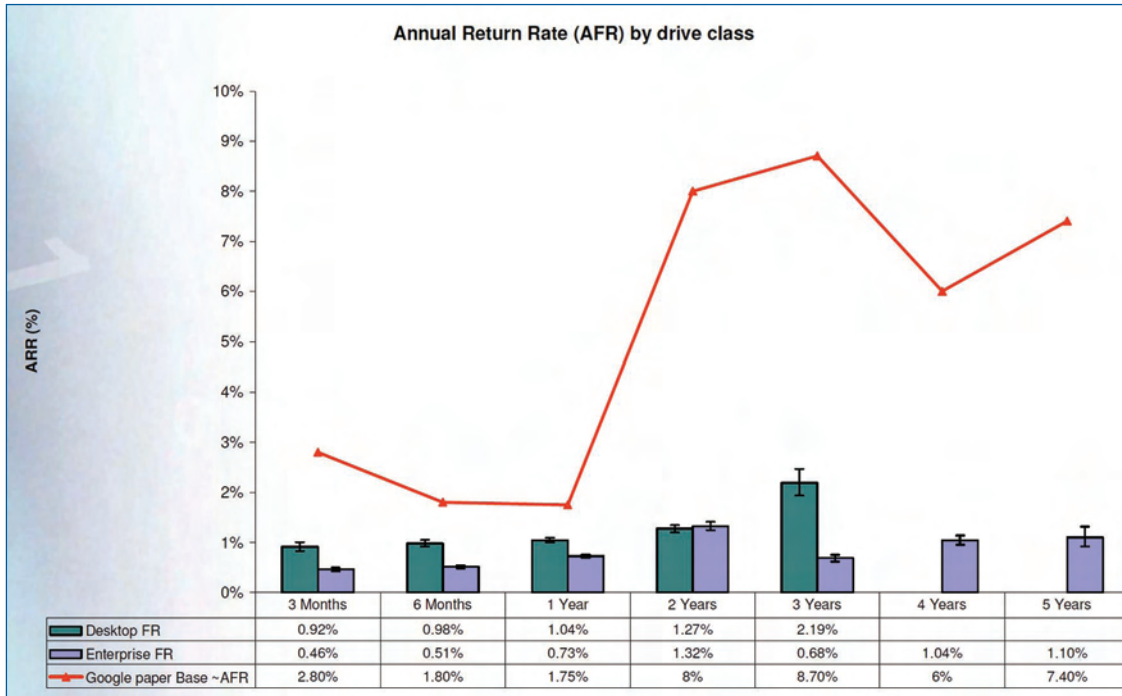
Data Capture

Xyratex utilizes a comprehensive database, enabling the tracking of products and their components by serial number. This database records all shipment information together with data on failures that occur; including date and failure type information. Drives with known and fixed batch issues have been excluded from our analysis.

Failure Criteria

Drives returned to Xyratex are tested by the disk drive manufacturers' proprietary test platform. Utilizing this equipment ensures the drives are functionally tested against specification, leaving minimal opportunity for the hard disk drive vendor to dispute failure classification.

Results



Significance of the these Results

The base annualized failure rate (AFR) from the Google paper (SATA & PATA drives), is significantly higher than the Xyratex failure rate. Desktop drives subjected to the Xyratex Hard Drive Integration process routinely achieve the specified manufacturers' AFR while operating in Xyratex storage systems. It should be noted the specified AFR of some desktop or 'near line' drives has been decreasing over recent years to closer align with the specified reliability of Enterprise drives. The Xyratex integration process is consistently an asset in ensuring drives meet their specified AFR.

Xyratex Enterprise AFR is significantly lower than the Xyratex Desktop AFR (with the exception of year 2, where the AFR is similar). Predominantly the actual AFR is in line with the vendor specified AFR. The increase in the Year 2 AFR is dominated by returns from government agencies where the drive is rendered unusable prior to failure analysis. Enterprise drives have a marginally increasing AFR with age, however the AFR is not significantly higher than manufacturers' specification. With the exception of Year 2, which could be effected by the influence of the government agency drive returns, Xyratex data is consistent on this point. The Desktop AFR also increases



gradually with age around the specified AFR, with the exception of the drives integrated in Year 3. These were the first desktop drives used within Xyratex products; the specified AFR for these drives was 1.46%. As the Desktop population ages, Xyratex expects this figure to reduce due to improvements in the Desktop drives production.

Conclusions

Google and CMU are motivated to investigate real levels of disk drive reliability because each is affected by the apparent gap between published disk drive specifications and the reality of deployed storage outcomes. At present, the data suggests an annual failure rate of nearly 6% for disk drive products used in corporate data systems. This is far above the 0.88% to 2.0% vendor statistics claim.

Comparing the results within this paper to the results presented by the Google and CMU papers, buyers of disk drives experience higher levels of disk drive failure if they haven't utilized a comprehensive integration process. This is especially so in the infant mortality or early system life— approximately the first ninety days of services. In short, Xyratex patented integrated system test yields the highest mean time between failures (MTBFs) with fewer failures.

Complementing the test and qualification process is a genuine strength in designing storage systems. Xyratex designs are high reliability and high efficiency choices for storage and server OEMs. More than 20 years of disk drive and storage subsystem development enables Xyratex to eliminate or mitigate rotational vibration and other mechanical effects which may induce failure or reduce drive performance. Well-designed airflow and thermal management schemes ensure efficient cooling. Power systems operate to minimize wasted energy. Xyratex storage offers a market-leading position on cooling efficiency with the lowest power consumption/density on market.

Xyratex storage supports multi-drive failure resiliency, delivering the assurance of data storage uptime and availability. Guaranteeing continuous access to critical data is imperative for many organizations, regardless of size. IT departments increasingly require that storage systems be available year round, 24 hours per day, seven days a week. Connecting storage through a Network (SAN) also increases vulnerability to network problems, but Xyratex multi-pathing mitigates risk by automatically utilizing more than one path to a system.

Xyratex storage enclosures have proven to be very cost effective in operation with minimal downtime or disruption. Xyratex designs feature hot swap components, backwards compatibility, and flexible configuration options. No forklift upgrades are required with Xyratex. Customers merely have to qualify new generations of disk drives rather than the drives and enclosures. Xyratex delivers total cost-efficiency via its emphasis on ultra density: 4U 48 drive mass storage RAID system delivering 72 TB of affordable near-line storage in a 4U rack mount. Xyratex systems' high performance features are well-appreciated by our customers: Xyratex was first to market with 4Gb/s FC host connectivity, SAS point-to-point drive architectures, dual active high availability and single controller configurations.

Xyratex – Dependable by Design

Xyratex has worked for many years to improve the quality, reliability and effectiveness of storage devices and systems. This paper describes the benefits to data system reliability and availability of the Xyratex Hard Drive Integration process in comparison to hard disk drive products that have not been subjected to this rigorous defect screening and CERT. Storage not subjected to the CERT process will demonstrate lower rates of data system reliability and availability. CERT, in combination with our advanced methods for qualifying disk drives and a superior enclosure design, are the basis for long term reliability. More information about the disk drive qualification process is available via the Xyratex website.

References

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http://209.85.163.132/papers/disk_failures.pdf

About Xyratex

Xyratex designs and builds storage solutions that are used by the world's leading OEMs and solutions integrators to provide high-capacity, high-performance data storage for NAS, Fibre Channel SAN and IP storage. Our innovative solutions are the underlying platforms for a variety of storage applications including server-attached storage, networked data storage and disk-to-disk backup. Our customers come from a variety of markets such as broadcasting, digital media, medical imaging, and topography. Xyratex RAID solutions reduce OEM development costs, feature enterprise-class RAID functionality including RAID-6 and snapshot, sport high availability, dual controller configuration support, and they are highly reliable. Over 22,000 Xyratex RAID systems have shipped since 1998 and Xyratex fault tolerant data protection for the storage market leverages best in class power, packaging, and energy efficiency.

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