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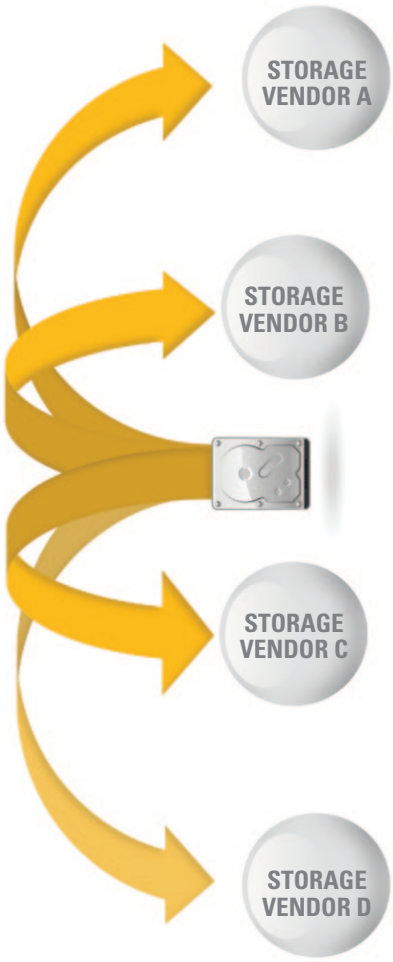
IF IT'S JUST A DISK
WHY THE RELIABILITY GAP BETWEEN STORAGE VENDORS?

If all storage array vendors buy disk drives from the same small set of disk manufacturers then why is there such a big reliability gap between storage vendors?

While excellent work has revealed the reality of failure rates and types, the focus has merely been on "what" happens when components fail. There is very little to describe "why" subsystems fail and "why" some vendors produce exceedingly reliable subsystems while others fall drastically short.

DISK DISTRIBUTION

If all storage vendors buy the same disk drives from the same small set of disk manufacturers…
Why is there such a big reliability gap between storage array vendors?



If all storage vendors buy disk drives from the same small set of disk manufacturers, it begs the questions, "Why is there such a big system reliability gap between storage array vendors?" "How can there be such a large difference in the annual fail rate (AFR) of disk drives when everyone is using the same disk?"

The reason for it is has to do with the fact that subsystem reliability is more about the storage array vendor than it is the disk vendor. Subsystem reliability must consider many more factors than just the disk drive itself; but the simple fact that the AFR rates of the same disk drives can be so different between storage vendors is a testament to the quality process undertaken by the most reliable subsystem manufacturers.

Vendors who are just after a buck are less attentive to product design, manufacturing processes and system testing than those vendors whose live and breathe the quality process. IT professionals need to count on systems to 'just run.' Some of these vendors use the same old designs and processes because they believe their reliability and quality is 'good enough.' Other vendors, however, have set a new standard in reliability and quality that exceeds enterprise class to deliver a lower storage management cost while giving IT professionals the best guarantee against disruption to business continuity.

Furthermore, while current RAID technologies do an adequate job of protecting your data in most environments, a disk drive or subsystem component failure does more than potentially impact business continuity, it affects thin management resources. These failures force an IT administrator to take what little time he or she has to service what should be almost maintenance-free.

Attention to reliability means attention to the details – the design, manufacturing and testing that goes into storage subsystems. Not all storage subsystems are created equal, and the same old brand names are no guarantee of high reliability for less money.

[1] Source: October 2008 CIO Magazine IT Budget & Staffing Survey

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"1/2 —the reliability of a component is cut in half for every 10 degree increase in temperature

CAUSES OF DISK SUBSYSTEM FAILURE

- Disk Failures—caused by imperfect media, damaged media, vibration, electronic failures and other mechanical issues
- Physical Interconnect Failures—caused by numerous electrical, electronic and mechanical situations. Physical interconnect failures make a disk appear to be missing
- Protocol Failures—caused by incompatibility or bugs between protocols in disk drivers and heads. Protocol failures result in I/O request failures and potential data loss
- Performance Failures—when a disk subsystem cannot service an I/O request within a specified amount of time

CAUSES OF DISK SUBSYSTEM FAILURES

Depending on the study, researchers put the range of disk drive failures anywhere between 20 and 55 percent of all failures in the typical subsystem. The physical interconnection between drives and controllers accounts for 27 percent to 68 percent of all failures. Consequently, the design, manufacturing and handling of the physical interconnect is crucial to overall subsystem reliability. Subsystems failures fall into four major categories:

Disk failures - caused by imperfect media, damaged media, vibration, electronic failures and other mechanical issues.

Physical interconnect failures - caused by numerous electrical, electronic and mechanical situations. Physical interconnect failures make a disk appear to be missing.

Protocol failures - caused by incompatibility or bugs between protocols in disk drivers and heads. Protocol failures result in I/O request failures and potential data loss.

Performance failures - when a disk subsystem cannot service an I/O request within a specified amount of time (with no other failure listed above) Performance failures typically indicate a partial failure of unstable connectivity or one or more disks that are heavily loaded with disk-level recovery such as sector re-mapping.

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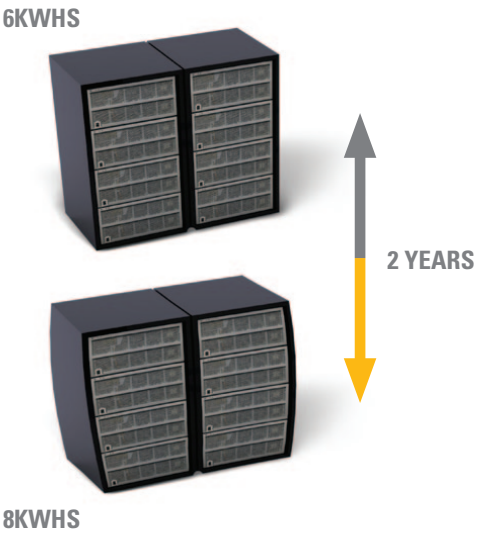

POWER DENSITY INCREASE

In the last two years, power density per average rack has risen from 6kWhs to 8kWhs. Power consumption in a rack is going up because vendors are packing more capacity and components into a given amount of space. The more densely packed rack now needs more energy, which produces more heat, which requires efficient heat management and more cooling.

RECENT DISK FAILURE STUDIES

In one notable study[1], researchers from Carnegie Mellon University (CMU) found that failures have both short-term and long-term correlation meaning that components can die young or old. The shared common belief is that most components, including disk, will experience a higher initial rate of failure (infant mortality) then settle down for a few years into a low failure rate before they begin to wear out and fail.

The study showed otherwise: failure rates began low and steadily increased over time! Further, the CMU study found there was no correlation between class of drives and failure rate. In fact, the most reliable disk set was composed of enterprise SATA drives only, which are erroneously regarded to be less reliable than SAS or Fibre Channel.

In another study, Google looked at a technology built into disk drives known as SMART (Self-Monitoring Analysis and Reporting Technology). Google observed that any SMART errors correlated strongly with disk failures. In one example, they found that if SMART reports scan errors that occur when the disk checks data in the background by reading the entire disk, a failure is likely within eight months with about 30 percent of the drives failing completely.

[1] Conducted by Carnegie Mellon University and presented at the 5th USENIX Conference on File and Storage Technologies in San Jose, CA

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MYTH 1

RAID and Disk Density Reliability:

A couple of myths have been propagated as of late to spread FUD (fear, uncertainty and doubt) regarding the reliability of SATA disk drives and the suitability of RAID technologies regardless of subsystem design and quality processes.

While the attempt may be trying to seed doubt for poorly designed equipment using consumer-grade technologies, Nexsan maintains that for enterprise-grade storage systems (the only kind which should be considered for data center applications), reliability continues to steadily increase despite the increasing size of disk drives.

The first argument put forward by critics is that the data sheet Hard Error Rate (HER) for disk drives doesn't appear to be halving for every doubling of disk density. Therefore, by this logic, drive failures (or lost data) must be increasing on a per-drive basis. HERs are related to the number of errors per bit read, not per bit stored. This is an important distinction because it means that for a RAID system returning 100GB of read data, the error rate will be lower for 1TB drives than for a system based on 250GB drives.

Also, for a system of a particular capacity, say 10TB, the system built with 250GB drives will need 42 to 44 disks while the system built with 1TB drives requires just 11 disks. Because the claimed MTBF on the disks remains the same, users can expect the system built out of 1TB drives to have a failure rate that is ¼ of the system built out of 250GB drives.

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RECENT DISK FAILURE STUDIES

It has always been understood that heat generated within a system can be a dangerous source of failures. Temperature and reliability are inversely proportional. Some studies have shown the reliability of a component is cut in half for every 10 degree increase in temperature. It is no different for a storage subsystem. Whenever a drive gets too hot, long term reliability is seriously compromised. While it is easy to feel safe in an environmentally controlled data center, "hot" temperatures can and do happen far too often within the subsystem itself. In fact, the new focus on density has increased the "hot" temperature risk.

In the last two years, power density per average rack has risen from 6kWhs to 8kWhs. Power consumption in a rack is going up because vendors are packing more capacity and components into a given rack to save on floor space as data grows.

However, packing more technology into a smaller footprint has repercussions. The more densely packed rack now needs more energy, which produces more heat, which requires efficient heat management and more cooling. Heat generation, heat transfer, overall flow and management are key considerations to an effective design.

WHAT VERSES WHY

It is interesting to note that in these and other studies, while excellent work has revealed the reality of failure rates and types, the focus was merely on "what" happens when components fail.

There is very little to describe "why" subsystems fail and how storage vendors can avoid it. Increased subsystem availability can be achieved only when designs incorporate solutions for the "why." The lack of these solutions results in a constant battle of maintenance and outages that increase the cost of managing storage, not to mention, the exposed risk to your business continuity.

IT administrators and managers should investigate the investment their storage provider has made in a process feedback loop that analyzes reliability data collected from manufacturing, testing and customers, and ties that directly to process engineering. Check to see if those results are collected and how the analysis is implemented into their process/design objectives.

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MYTH 1 (CONT.)

RAID and Disk Density Reliability:

The area of concern for systems is the possibility of getting an unrecoverable read error on a block while rebuilding RAID set. However, the claimed error rate for manufacturers has been decreasing faster than capacity has increased over the last few years. For example,

- 120GB drive: 1 bit in 10e13 bits read;
- 250GB drive: 1 bit in 10e14 bits read;
- 1TB drive: 1 bit in 10e15 bits read;

Validating this point is actual field experience. Everyone who is in the storage industry, or who has been a customer for a number of years, knows that today's enterprise grade terabyte-sized SATA disks are far more reliable as compared to SATA disks from 7 years ago despite being around ten times larger in capacity. The data sheet HER numbers have had little resemblance to the actual field failure rates. There's no substitute for real-world experience and the resulting cumulative advancements in drive, controller and enclosure technology.

Nexsan has tens of thousands of RAID systems in the field, most of which are running RAID 5, and many of which are running RAID 6. Nexsan technical records show that data loss due to drive failure in recent years is an exceedingly rare event for RAID 5 arrays and essentially non-existent for RAID 6 arrays.

NEXSAN - EXCEEDING ENTERPRISE CLASS

Field-proven with over 21,000 systems in over 60 countries, Nexsan has set the bar for reliability standards among disk storage subsystems. Most vendors report their field replaceable unit (FRU) annual failure rate (AFR) at less than 1 percent. However, independent reliability studies have shown that customers observe AFRs as high as 4 percent with other vendors1. The Nexsan third-generation, high-density design has a customer-reported AFR of much less than 1 percent.

How did Nexsan exceed the reliability and availability of enterprise storage subsystems? The journey to Nexsan's level of reliability began when all disk drive reliability levels were not as good as they are today.

Nexsan closely monitored all aspects of subsystem reliability from the beginning and learned that great subsystem reliability required a systemic approach to analysis and resolution across all the technology-based operations of the company.

Through tightly controlled and executed standards, Nexsan designs, manufactures, and tests against exacting standards to reduce failure rates. Others make such claims, but the reliability of a Nexsan storage system speaks for itself.

EXCELLENCE IN DESIGN

Excellence in design is a key focus at Nexsan. For example, drives slide into an accurately engineered slot specified to ensure a snug but not tight fit. In the Nexsan high density product, the drives are positioned with back-to-back counter-rotating couplets. Why? Doing so reduces the additive effect of vibration which has a significant impact on system reliability over time.

Moreover, Nexsan's mid-plane interconnect design maximizes high density cooling with unrestricted, non-blocking airflow. The design is unique and just another reason why a Nexsan disk subsystem is more reliable than competitive systems.

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<1% —Nexsan's third-generation, high-density design has a customer-reported AFR of less than 1 percent.

EXCELLENCE IN HANDLING

Another Nexsan best-of-class practice eliminates subsystem stress during shipment that can cause undetected damage to the mid-plane and disk drives.

When the most vigilant care isn't taken in shipping and handling, g-load stress is amplified and more readily transferred directly to the mid-plane, drives and connectors. As a result, those systems may power on and "check-out", but an "under the radar" latent failure may be lurking. The lesson? It is far better to exercise strict packing and handling policies to avoid the potential failure caused through shipping damage.

For example, Nexsan ships all drives outside of the chassis in special containers that are specifically designed to survive the rigors of shipping. Further, Nexsan has designed a drive installation methodology that is simple, error free and fast to install while offering greater reliability.

EXCELLENCE IN HEAT REDUCTION

Once the subsystem is installed and running on site, heat and cooling are key considerations in overall subsystem reliability. To ensure users receive the best reliability possible, Nexsan works with outside partners to conduct airflow and temperature studies for its chassis cooling design.

Nexsan starts from a drive spacing concept that considers the minimum-allowable space required to ensure sufficient airflow and cooling under extreme or failure conditions. Contrast this against the typical competitor's design that adds a few extra drives into a chassis with no apparent concern for long-term reliability.

The design of a chassis on paper is one thing. Exhaustively testing a chassis design in environmental chambers, while paying particular attention to worse case situations, is another. No Nexsan design goes to production without exhaustive environmental testing and a passing score for airflow and temperature.

MYTH 2

RAID and Disk Density Reliability:

A second myth to spread FUD states that the doubling of drive densities every 18 months has led to an explosion in the length of time a RAID rebuild takes which increases the chance of double drive failure during the rebuild window. And, due to HER, RAID rebuilds will usually have one or more uncorrectable bad spots.

This is counter to actual technological advances. First, the sequential performance of disk drives is increasing, and though it doesn't quite keep pace with drive capacity growth, the gap is not unreasonable.

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MYTH 2 (CONT)

RAID and Disk Density Reliability:

Secondly, RAID controllers are going away from shared networks and going to more modern switched fabrics like SAS. This, in connection with the hardware-level support for rebuild calculations, means that the rebuild performance of RAID controllers from generation to generation is keeping pace nicely with drive capacity increases.

Drive error rates of all kinds, including media defects, as well as outright failure, are decreasing faster than capacity is growing; and, in real-world experience, the likelihood of a uncorrectable bad sector on a rebuild of RAID-5 continues to decrease while the odds of such a failure on RAID-6 are so close to zero that Nexsan has never seen it happen in a real-world site.

These myths seem to be coming from companies with little or no experience with SATA or are misrepresenting/misunderstanding data in order to promote complex, costly and unnecessary technology which was designed to fix a non-existent problem.

Historically, a few other companies tried to propagate similar myths back when drives were 5 to 10 times less reliable than today, which might have even made some sense, but the market rejected it just like they are going to reject the current round of myths.

Unfortunately, the propagation of these myths are not helped by storage array vendors whose subsystem design and quality processes do not meet the rigors of enterprise class needs.

EXCELLENCE IN PROCESS ENGINEERING

Process engineering is a constant task. Nexsan has incorporated this principle and continuously improves products to ensure that cooling requirements, among other priorities, are well-specified. It is the innumerable little things that count like:

- very high-spec, high-life ball bearing fans
- continuous improvements to the efficiency of power supplies to produce less heat

Not to be ignored is the SATABeast's push-pull cooling design that includes a separately sealed cooling zone for the controllers.

EXCELLENCE IN TESTING AND MANUFACTURING

Back in the days when Nexsan was getting started, ATA drives were prone to high failure rates. To reduce the rate of failure and ensure enterprise-class reliability, Nexsan created a rigorous set of stress tests to isolate weak and marginal drives. Those that could not survive accelerated stress tests were then, and still are, returned to the manufacturer as unacceptable.

As a testament to the Nexsan quality process, the largest manufacturers of disk drives use Nexsan disk enclosures to stress their own high-end drives as part of their test regimen. Beyond that, Nexsan also uses additional tests, proprietary and unique, that are the ultimate coup de grâce in disk drive testing.

Protocol failures are avoided by ensuring adherence to a tightly controlled revision process. Nexsan checks each drive and will not accept firmware levels unless they have been qualified, period.

From a manufacturing point of view, the more frequently an individual drive is handled, the greater the probability of failure. Therefore, Nexsan ensures that a drive is never handled more than three times. It may sound like a little thing, but it is the accumulation of all the little things that embodies Nexsan's best-in-class quality control measures.

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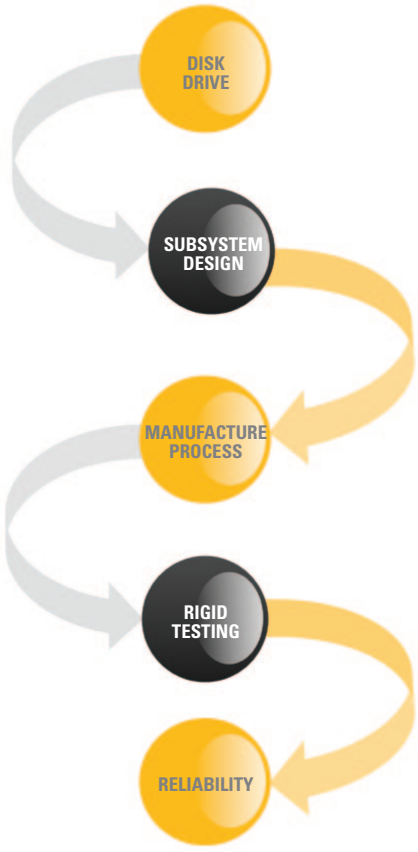

QUALITY PROCESS

Disk Drive
+ Subsystem Design
+ Manufacturing Process
+ Rigid Testing
= Reliability

CONCLUSION

Innovative design, quality manufacturing, rigid testing are all targets of any good storage vendor. Whereas some vendors may point to a single capability they excel in, Nexsan engineering stands apart as a leader in all three.

By combining that excellence with a powerful process feedback loop that encompasses 10+ years and over 20,000 systems in the field, Nexsan has delivered a drive AFR of much less than 1 percent.

With ground breaking efforts in design, manufacturing and testing, Nexsan constantly scrutinizes every step of the quality process for optimal delivery of the highest level of reliability.

With Nexsan, users are always going to get the quality they need with the energy, space and cost efficiencies necessary to compete in a new economic and storage environment that demands reliable and highly efficient storage.

ABOUT NEXSAN

Nexsan® is a leading provider of innovative data storage systems with over 10,000 customers worldwide. Nexsan's pioneering hybrid storage systems combine solid-state technologies, spinning disk storage and advanced software to deliver radical new levels of performance and capacity at lower cost. The company's advanced technologies enable organizations to optimize traditional, virtual and cloud computing environments for increased productivity and business agility. With more than 28,000 systems deployed since 1999, the company delivers its data storage systems through a worldwide network of solution providers, VARs and system integrators. Nexsan is based in Thousand Oaks, Calif. For more information, visit **www.nexsan.com.**

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