NEXSAN

# REDUCE BACKUP COSTS WITH HIGH-DENSITY ENERGY-SMART STORAGE

Ballooning data growth and ever-shrinking IT budgets have combined to push higher-density disk arrays to the forefront for almost any organization contemplating investment in new backup solutions. That's not surprising; after all, the promise of more backup capacity and performance in less data center real estate sounds irresistible to anyone seeking greater efficiency and cost-effectiveness from their existing IT infrastructure.

Which explains why so many storage vendors have rushed to produce high- density disk arrays—demand for such products is enormous, particularly among companies scrambling to back up rapidly-expanding quantities of unstructured and structured data. But focusing on a single storage criterion is simply not enough; indeed, a disk array can offer exceptional density but still fail to satisfy the space efficiency (see "The Power/Density Paradox," below), performance, power consumption and reliability requirements of its users



(Rev. 12/3/18)

## MYTH OF COMMODITY STORAGE ARRAYS

And therein lies the rub; it turns out that designing and building efficient, reliable storage arrays that can be packed far more tightly with disk drives is not nearly as straightforward as some vendors might have you believe. The notion that high- density backup arrays are mere commodities, essentially interchangeable except for their prices, is both inaccurate and potentially very costly to any organization that buys into it.

The mechanical and electrical design challenges (vibration, high temperatures, excessive power consumption, laborious disk replacement, etc.) that high-density backup arrays present are daunting, and they become significantly more difficult as storage density increases. Successfully addressing these challenges cannot easily be accomplished with off-the-shelf "white box" parts; it typically requires custom-engineered components specifically designed for high-density duty cycles.

Of course, this kind of engineering demands a substantial commitment of time and money on the part of a storage array vendor. Some vendors have chosen to forego this commitment, in an effort to reduce development and manufacturing costs. In so doing, such vendors diminish the importance of the mechanical and electrical design challenges noted above.

Unfortunately, the real-world consequences of this decision are shouldered by IT professionals: vibration-induced disk errors and delayed command completions, heat-induced disk drive and subsystem failures, excessive downtime to replace failed components, high energy costs, and—perhaps most unexpectedly—the inability to take full advantage of an organization's existing data center space due to "the power/density paradox."



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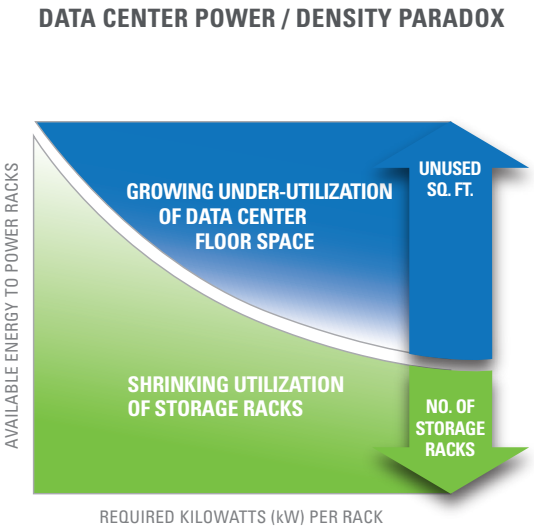


FIGURE 1
**AS ENERGY-HUNGRY, HIGH-DENSITY DISK ARRAYS ARE ADDED, POWER-CONSTRAINED DATA CENTERS EXPERIENCE SIGNIFICANT UNDERUTILIZATION OF FLOOR SPACE.**

## THE POWER DENSITY PARADOX

Given that greater storage efficiency is the fundamental goal of high- density backup arrays, it is especially ironic that high-density solutions can engender a problem known as the power/density paradox, which hinders end users from utilizing the very floor space that high-density architecture is intended to conserve.

Simply put, the total amount of power an equipment rack uses has grown with denser packaging; higher density translates into higher kWs per rack. And those higher power densities per rack are posing substantial difficulties for data centers that were built at a time when 2-3kW of power consumed per rack was common, and there existed more than enough power capacity to support them.

But in recent years the average power requirement per rack has doubled to 6-8kWs, and can reach as high as 15kWs for very dense packaging. Problems are compounded with inefficiencies in power distribution and the need for additional cooling. Buildings with infrastructures designed 10 years ago are now reaching their power capacity limits in terms of how many storage racks they can support... while data continues to increase at exponential rates.

Hence the paradox: By trying to solve a space problem, high-density solutions end up creating an entirely new problem...inadequate power. As most facilities don't have enough available power to expand, organizations are then left with few alternatives as they walk through a now-spacious data center that has run out of electrical capacity (see Figure 1 left).

So what can IT professionals do to mitigate this paradox? The answer is obvious: Deploy high-density disk arrays that have been purpose-built to provide superior power efficiency. Not only will this increase data center ROI by enabling more racks (and disk capacity) to be deployed in the available floor space, it also delivers a less- intuitive cost benefit thanks to the "cascade effect."



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## ENERGY EFFICIENCY AND THE CASCADE EFFECT

It may come as a surprise to learn that for every 1 watt reduction at the component level (processor, memory, hard disk and so forth), there is an additional 1.84-watt savings on the energy bill. This is known as the cascade effect, and is the result of inefficiencies—or loss of power—from power supplies, power distribution systems, UPS systems, cooling systems, building entrance switch gear, medium-voltage transformers, etc.

Because of the cascade effect, when the power load is reduced by 1 watt, a total of 2.84 watts are saved. The net effect is that every attempt to conserve energy at the component level ends up becoming a cost-reduction multiplier. For every watt saved by a subsystem, organizations achieve nearly 3 watts conserved at the meter. (see Figure 2 below).

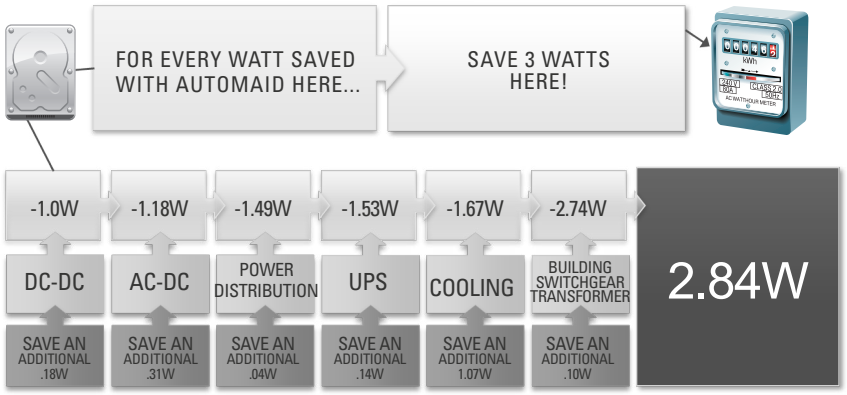


FIGURE 2
**THE CASCADE EFFECT AMPLIFIES THE BENEFITS OF SUBSYSTEM POWER SAVINGS.**

As can be seen, engineering greater energy efficiency into high-density disk arrays not only increases the rack density possible in a given amount of data center floor space (thus boosting data center ROI), it also delivers enormous operational savings in terms of reduced electrical utility costs thanks to the cascade effect. But there is yet another benefit of reduced power use...

[1] Source: Emerson Network Power



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FIGURE 3
**EFFECTS OF RV BECOME MORE SERIOUS IN ARRAYS**

## POWER MAKES HEAT, HEAT MAKES TROUBLE

Excessive power consumption does more than just constrain rack density in the data center and drive up operating costs, it also produces heat that is deadly to many computer components. It has always been understood that heat generated within a system can be a primary source of failures—temperature and reliability are inversely proportional. Some studies have found that 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 tempting to assume heat-related issues are rendered moot in an environmentally-controlled data center, destructively high temperatures can and do occur far too frequently within the subsystem itself. The growing popularity of high-density disk arrays has only worsened the problem.

In short, more densely-packed arrays consume more energy, which produces more heat. To combat these elevated temperatures requires more efficient heat management and better cooling. But this is made more challenging by the close-coupled layout of high-density arrays, which ensures there is less space between drives through which air can move. The presence of more copper tracking and connectors in the printed circuit boards required to connect the greater number of drives further impedes air flow.

Heat generation, heat transfer, overall air flow and fan management algorithms are all key considerations when designing an effective high-density disk array. Of course, addressing a problem at its source is a fundamental tenet of good engineering; for high density that entails reducing generation of heat in the first place by dynamically decreasing the energy consumption of the disk array as its workload drops.

This is a far more effective approach to heat control than using a phalanx of high-speed fans to combat excessive temperatures; as implied above, preventing heat is more efficient than dissipating it (fans consume power to get rid of heat that is generated by consuming power), and it minimizes the degree to which fans exacerbate another threat to high-density disk array reliability—vibration

## VIBRATION: NEMESIS OF HIGH-DENSITY STORAGE

Rotational vibration (RV) is generated by all disk drives, stemming from the two motors (spindle and actuator) within the units. Vibration can disrupt alignment between the head and tracks, forcing the drive to recalibrate itself before it attempts to read or write data; this significantly reduces net throughput performance. For lower-density SMB storage solutions, RV does not typically pose problems.

But the effects of RV become far more difficult in high-density disk arrays, where the vibration from nearby drives within the same enclosure can induce repeated recalibrations that can significantly degrade the effective throughput of the array (see figure 3).

There are several steps that can be taken to address this challenge. First, high-density backup arrays should employ enterprise-class disk drives with superior RV tolerance, which will help to ensure more precise positioning of the read/write head over a platter's data tracks.

Second, the drives should be installed using vibration-dampening bracketry, and mounted within the enclosure in such a way that the vibration of adjoining drives is out-of-sync with its neighbors, thus ensuring their respective vibrations tend to cancel each other out rather than reinforce them (similar in concept to noise- cancelling headphones).

Furthermore, cooling fans can be a significant source of vibration, particularly when they are run at high speed to help alleviate excessive system operating temperatures. The solution is to reduce disk drive power consumption, which decreases the heat generated by the drives and thus enables the fans to be run more slowly (which then produce less vibration and use less energy).

## HIGH-DENSITY DISK ARRAYS FOR BACKUP: ACCEPT NO COMPROMISE

As can be seen, the various challenges posed when designing a reliable and efficient high-density backup array are significant, but they can be resolved with innovative approaches and technologies that address energy consumption, heat management and vibration control. While many vendors are unwilling to make the costly commitments that such solutions demand, there are others that refuse to compromise...

## NEXSAN E-SERIES: HIGH-DENSITY BACKUP DONE RIGHT

Manufacturing high-density disk arrays for over a decade, Nexsan has acquired a wealth of experience that enables it to provide high-density backup solutions with an unrivaled combination of reliability, energy efficiency, capacity, performance and flexibility. The E-Series maximizes backup array storage density and power efficiency in a minimal footprint, consuming less than one-third the power and one-third the rack space of conventional backup arrays, thus dramatically reducing backup infrastructure costs.

Available in configurations that hold up to 60 disk drives (with the option to add expansion units), E-Series high-density arrays complement this enormous available capacity with the ability to mix and match capacity-optimized HDDs, performance-optimized HDDs and SSDs to accommodate primary or secondary storage applications. This flexibility is only possible because, unlike many other vendors' high-density arrays, the E-Series is purpose-built to deliver extraordinary reliability when operating under 24x7 enterprise-class workloads.

Overcoming the challenges presented by high-density disk arrays (for example, the power/density paradox discussed earlier) requires a thorough understanding of the technical issues involved...and the engineering expertise to design innovative solutions to those issues:

## SMARTER ENERGY SAVINGS

Nexsan AutoMAID® (Automatic Massive Array of Idle Disks) is a power-saving technology designed to manage energy consumption through a comprehensive policy-based approach. It enables E-Series high-density arrays to include the benefits of energy efficient technology, but without the performance limitations inherent to the "on-off" approach of first-generation MAID.

AutoMAID® also has the ability to spin down drives to lower energy consumption between data references. While earlier MAID technology was unable to quickly recall data when needed, AutoMAID® (when configured for Level 1 operation) delivers sub-second response times to the first I/O request, and remains at full power for every subsequent I/O request until enough idle time has elapsed to activate AutoMAID® energy savings once again.

### Level 0

- Disks at full power


**AutoMAID® Level 0**: Disks are fully powered and run at peak performance without restrictions.

### Level 1

- Heads parked / Unloaded
- Sub-second recovery time
- About 15% to 20% savings


**AutoMAID® Level 1:** Parks the heads and powers them down by policy or command. However, the actual drive continues to spin at full speed. If a request for an I/O is received, the heads simply wake up and load data with under 1-second response times and remain at full speed for every subsequent I/O request. The overall energy savings in level 1 is approximately 20 percent.

### Level 2

- Heads Unloaded, Slows to 4000 RPM
- 15 seconds recovery time
- About 35% to 45% savings


**AutoMAID® Level 2:** Parks the heads and slows the rotation speed of the disk from 7,200rpm to 4,000rpm. If a request for an I/O is received, the drive cycles up to full speed and loads the heads resulting in up to 15-second response times. The disk remains at full speed for every subsequent I/O request. The overall energy savings in level 2 is approximately 40 percent.

### Level 3

- Stops Spinning, (sleep mode; powered on)
- 30 to 45 second recovery time
- About 60% to 65% savings


**AutoMAID® Level 3:** Parks the heads and turns the drive motor off. If an I/O request is received, the drive spins up and loads the heads resulting in up to 30-second response times. The disk remains at full speed for every subsequent I/O request. The overall energy savings in level 3 is approximately 60 percent.

### Level 4

- Stops Drive Electronics
- 30 to 45 second recovery time
- About 70% savings


**AutoMAID® Level 4:** Parks the heads and stops the drive electronics. If an I/O is received, the electronics power on and the drive spins up and loads the heads resulting in up to 45-second response times. The disk remains at full speed for every subsequent I/O request. The overall energy savings in level 4 is approximately 85 percent.

### Level 5

- Turn off E60X expansion enclosure
- 30 to 46 second recovery time
- About 87% savings with SATA


**AutoMAID® Level 5:** Turns off the expansion enclosure. If an I/O is received, the enclosure powers on and the drives spin up resulting in up to 46-second response times. The disk remains at full speed for every subsequent I/O request. The overall energy savings in level 5 is approximately 87 percent.

## Massive Data Growth Projected

IDC predicts that the Global Datasphere will grow from an estimated 33 Zettabytes in 2018 to 175 Zettabytes by 2025.

*IDC, Data Age 2025: The Digitization of the World, November 2018.*

## AutoMAID® Dramatically Cuts Backup Energy Costs, TCO

| | Ordinary Disk Array | Nexsan™ E-Series | Difference (in Annual kWs) |
|---|---|---|---|
| Without AutoMAID (Annual kWs) | 770,179 | 479,297 | 37.8% |
| Using AutoMAID 1 & 2 (Annual kWs) | n/a | 132,777 | 82.7% |
| Annual Commercial Cost @ $0.11 /kW* (compares ordinary disk with Nexsan's AutoMAID® 1 & 2) | $84,720 | $14,605 | 82.7% |

*US Energy Information Administration, Electric Power Monthly, Table 5.6.A (June 2014)

### COMPREHENSIVE ANTI-VIBRATION TECHNOLOGY

To combat the performance and reliability degradation caused by excessive vibration in high-density arrays, Nexsan employs Anti-Vibration Technology which includes installing drives in sturdy drawers, mounting those drives in counter-rotating couplets to counteract vibration of the adjacent drive, isolating groups of drives and utilizing vibration-deadening hardware. Mounting the drives in this way also creates an unobstructed channel for airflow that helps to maximize cooling efficiency.

### ADVANCED COOLING FEATURES

Nexsan Cool Drive Technology™ uses Pulse Width Modulation (PWM) speed-controlled front-mounted fans that push air over the components with additional internal fans that pull air out the back via well-engineered, front to back air channels thus providing superior cooling for each drive. Mounting the drives in counter-rotating couplets also ensures that cooling airflow specifically targets the hottest parts of each drive (the electronics). Because the fans only need to spin at roughly half speed in normal operation, they produce less vibration, use less power, are quieter and last approximately ten times longer.

### EASIER SYSTEM MAINTENANCE

Nexsan Active Drawer Technology™ was an industry-first, making it simple for a single technician to maintain the high-density backup array. Servicing of drives or fans can be accomplished by just pulling out a drawer—while the system is being actively used, and so no downtime is required.

## SUPERIOR DISK DRIVE RELIABILITY

Nexsan's commitment to reliability includes stress-testing disk drives before they are installed in E-Series disk arrays, and testing again after installation to screen out sub-par drives. Coupled with the innovative design features of Nexsan E-Series high-density disk arrays (including AutoMAID®, Cool Drive Technology™ and Anti- Vibration Technology), this enables Nexsan to achieve one of the lowest drive failure rates in the industry—just 0.03 percent—while the industry average is approximately four percent.

## CONCLUSION

The allure of high-density backup solutions is undeniable; offering the ability to deploy far more storage capacity in less data center space, they hold out the promise of greater efficiency and lowered costs to organizations of every size. However, achieving those benefits requires a high-density disk array that has been specifically designed to address challenges with power consumption, heat, vibration and other issues that are inherent in such solutions. Nexsan E-Series high-density arrays comprehensively solve those challenges; by incorporating intelligent power management capabilities, they deliver greater reliability, lower operating costs and less drain on data center electrical capacity. Innovative cooling and anti-vibration technologies further enhance reliability, and ensure consistent performance. Simply put, the Nexsan E-Series makes the theoretical benefits of high-density arrays a practical, cost-effective reality.

## ABOUT NEXSAN

Nexsan® is a global enterprise storage leader, enabling customers to securely store, protect and manage critical business data. Established in 1999, Nexsan has built a strong reputation for delivering highly reliable and cost-effective storage while remaining agile to deliver purpose built storage. Its unique and patented technology addresses evolving, complex enterprise requirements with a comprehensive portfolio of unified storage, block storage, and secure archiving. Nexsan is transforming the storage industry by turning data into a business advantage with unmatched security and compliance standards. Ideal for a variety of use cases including Government, Healthcare, Education, Life Sciences, and Media & Entertainment. Nexsan is part of the StorCentric family of brands along with Drobo – and operates as a separate division to securely protect business information.



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