THE POWER/DENSITY PARADOX

THE RESULT OF HIGH DENSITY WITHOUT POWER EFFICIENCY

High density storage can lead to a problem known as the power/density paradox which hinders end users from utilizing the very floor space that high density systems were intended to conserve.
Growing demand for storage capacity has motivated some storage vendors to cram as many disks as possible into a single product to manage capacity needs without expanding the storage footprint. As much as some vendors call the problem solved, it’s not that simple.

Without proper efficiencies and architecture, high density storage systems can create more problems than they solve and ultimately devastate your business. For some, that comes in the form of reliability issues with poorly constructed storage subsystems. For others, it comes in the form of the power/density paradox that hinders end users from utilizing the very floor space that high density systems were intended to conserve.

Let’s examine. The total amount of power an equipment rack uses has grown with dense packaging, i.e., higher density = higher kWs per rack. Higher power densities per rack are posing substantial difficulties for data centers that were built at a time when 2-3kW per rack were common and more than enough power existed to support them.

However, the average power per rack has doubled to 6-8kWs and 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 on what they can support as data continues to increase at exponential rates.

Organizations are also increasingly motivated to extend the useful life of everything from technology to facilities. This further fuels the demand to increase storage capacity without altering the storage footprint.
THE POWER DENSITY PARADOX ILLUSTRATED

With the costs associated with new data center construction, the allure of a high-density rack is attractive. However, without improvements to subsystem power efficiency, high-density storage leads to a problem known as the power/density paradox, as the following scenario illustrates.

Bearing this in mind, imagine a 4U storage subsystem with 60 drives. Without advanced power management to reduce the power consumption of a storage array, one could expect an average power draw of 1,750 watts with a peak load of 3,904 watts. A 4U subsystem would allow 10 subsystems in a rack which would produce a power draw of over 15.3kWs per rack.

That means only 30 racks could be put into a 10,000 square foot facility! By trying to solve a space problem, high density solutions end up creating an entirely new problem - power! As most facilities don't have enough available power to expand, organizations are left with few alternatives as they walk through a now spacious data center that is out of power. So what can IT professionals do to mitigate this paradox?

In a storage environment, each rack requires a certain amount of space for aisle room as well as for heat load which must be removed from the data center through air conditioning.

Ten years ago, a rack that may have drawn a total of 1kW would have about 65% of the available floor space dedicated to aisles, cooling, UPS, etc. That left 35% of the floor space available for racks.

Based on those numbers, a 10,000 square foot data center could have supported up to 500 racks on the data center floor. In a data center today, by increasing the power drawn to 10kWs, only 50 racks could be housed in the same space.

Many data centers end up trading space for power resulting in more empty space without more storage capacity, thus the paradox.

PROBLEM: The Power Density Paradox
THE MORE POWER HUNGRY DEVICES YOU PUT IN A RACK... THE FEWER RACKS YOU CAN PLACE IN A ROOM

1 Source: Emerson Network Power
THE POWER/DENSITY PARADOX COMPOUNDED: 
THE CASCADE EFFECT

It may come as a surprise to find out 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. What happens is that every attempt to save energy at the component level ends up becoming a cost reduction multiplier. For every watt saved by a subsystem, organizations get nearly 3 watts saved at the meter.

SOLVING THE POWER/DENSITY PARADOX: AUTOMAID™

If the power/density paradox is the problem and the cascade effect compounds the problem, what is the solution?

The only solution to the paradox is to decrease the total amount of energy used for a given storage density. That can be done by limiting the number of components within a subsystem or by making the subsystem itself more power efficient.

Nexsan uniquely takes advantage of the cascade effect to change the outcome of the power/density paradox through an exclusive solution known as AutoMAID™

AUTOMATIC MASSIVE ARRAY OF IDLE DISKS (AUTOMAID)

Automatic Massive Array of Idle Disks (AutoMAID) is a technology designed to manage power consumption through a policy system that saves significant amounts of power in the data center. By using Nexsan high density systems with AutoMAID, IT professionals can grow capacity without data center sprawl while reducing operating expenses.

AutoMAID doesn’t suffer the limitations of the first generation of MAID that took an “on-off” approach to power efficiency. AutoMAID delivers the benefits of power efficiency without the performance limitations inherit to the MAID 1.0 “on-off” approach.

AutoMAID also has the ability to spin down drives to lower energy consumption between data references. Whereas old MAID technology suffered from the inability to quickly recall data when needed, AutoMAID delivers sub second response times.

1 Source: Emerson Network Power
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. AutoMAID disks have four power management states:

- **AutoMAID 0** - the disks are fully powered and run at peak performance without restrictions.
- **AutoMAID 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 sub-second response times and remain at full speed for every subsequent I/O request. The overall energy savings in level 1 is approximately 20%.
- **AutoMAID 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%.
- **AutoMAID 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%.
- **AutoMAID 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 70%.
- **AutoMAID 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%.

<table>
<thead>
<tr>
<th>Ordinary Disk Array</th>
<th>Nexsan™ E-Series</th>
<th>Difference (in Annual kWs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without AutoMAID (Annual kWs)</td>
<td>770,179</td>
<td>479,297</td>
</tr>
<tr>
<td>Using AutoMAID 1 &amp; 2 (Annual kWs)</td>
<td>n/a</td>
<td>132,777</td>
</tr>
<tr>
<td>Annual Commercial Cost @ $0.10/kW* (compares ordinary disk with Nexsan’s AutoMAID 1 &amp; 2)</td>
<td>$77,018</td>
<td>$13,298</td>
</tr>
</tbody>
</table>

*US Energy Information Information Administration (July 2013)
With an estimated 40% of all data center power consumption going to storage, saving up to 60% on energy costs with AutoMAID has significant benefits. With AutoMAID, the key consideration and benefit is the ability to use high density storage with power efficient technology without impacting storage performance. The result is capacity growth without facility expansion while delivering overall cost reduction on a platform that doesn’t compromise storage performance. It is the ultimate in storage efficiency — power, space and cost.

**AUTOMAID IN ACTION**  
**California Institute of Technology (Caltech) & NASA’s JPL**

Caltech hosts around 2.5PB of astronomy imaging data for the Jet Propulsion Laboratory for NASA, of which about 99% is on Nexsan E-Series SAN storage according to Eugene Hacopians, a senior systems engineer at Caltech.

To cut energy costs on some 3,000 spinning disks, Hacopians noted, “...Caltech uses AutoMAID level one and two to maximize the performance versus savings tradeoffs.”

Caltech uses their E-Series on AutoMAID level one and has set the policy to retract heads and power them down after five minutes of no activity. By doing so, Caltech saves 20% on their energy costs. Caltech also has a policy that after 2 hours of non-activity, AutoMAID level 2 is activated. With AutoMAID-2, in addition to the heads being retracted, the drive slows the rotation speed of the platters from 7,200 RPMs to 4,000 RPMs. This contributes to a 40% savings in energy. Combining the inherently energy-efficient E-Series systems with the savings of AutoMAID provides impressive energy consumption and cost savings.
AN IRRONIC SUCCESS STORY

As much as Nexsan has helped organizations world-wide to cut costs and mitigate the power/density paradox, never did Nexsan foresee the irony that they might become the subject of their own success story.

Each year, Nexsan holds a partner conference for North American partners in Las Vegas where some 6.6 Gigawatts of power is available from eight power-generating facilities in the region — including the mighty Hoover Dam.

In 2009, Nexsan planned an experience room to demonstrate several storage systems resulting in 367TBs of capacity along with 14 servers.

The conference hotel delivered news that the 8.7kWs necessary to power all of the equipment was available, but the 29,000 BTUs of cooling necessary to remove the heat was not. The result was a power/density paradox and a storage conference without storage systems!

Based on the amount of power used at full load, the hotel required a dramatic reduction in the equipment used. Rather than accept the reduction in equipment, Nexsan leveraged its own power reduction technology. By using AutoMAID level 3, total power consumption was reduced from 8.7kWs to 3.8kWs which ultimately reduced cooling from 29K BTUs to 13K BTUs.

With a 56% reduction in power and a 56% reduction in cooling, the conference hotel had no problem handling the power and cooling requirements.

**SOLUTION: AutoMAID and the Cascade Effect**

For every Watt saved with AutoMAID here... Save 3 Watts here!

-1.0W DC-DC
-1.18W AC-DC
-1.49W Power Distribution
-1.53W UPS
-1.67W Cooling
-2.74W Building Switchgear Transformer

2.84W

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CONCLUSION
Whereas most might view high density storage as a way to free up facility space, there is a power/density paradox that must be addressed. Whereas other high density storage systems create a power/density paradox, AutoMAID is the clear solution to that risk.

By combining energy savings with high density, IT professionals get what they need most — more capacity while reducing floor space and costs. And with AutoMAID, those cost savings can finally be achieved without reduction in storage performance making AutoMAID the best solution to the power/density paradox and your storage needs.

In a new world of data expansion and economic contraction, storage efficiency is king. Nexsan’s highly efficient storage systems lead the industry in power efficiency, space efficiency, and cost efficiency.

ABOUT IMATION
Imation is a global data storage and information security company. Imation’s Nexsan portfolio features solid-state optimized unified hybrid storage systems, secure automated archive solutions and high-density enterprise storage arrays. Nexsan solutions are ideal for mission-critical IT applications such as virtualization, cloud, databases, and collaboration; and energy efficient, high-density storage for backup and archiving. There are more than 11,000 customers of Nexsan solutions worldwide with more than 33,000 systems deployed since 1999. Nexsan systems are delivered through a worldwide network of cloud service providers, value-added resellers and solutions integrators. For more information, visit www.nexsan.com.