

ADAPT: Rapid-Rebuild Technology

Does more data mean less performance?

Since innovation is at the heart of Seagate's mission, we never stop fine-tuning the software that powers the Seagate® Nytro® X and Exos™ X systems. It means that we can provide our customers with the features they need to keep their data safe and accessible where and when they need it. That's why we developed ADAPT data protection technology. ADAPT—Autonomic Distributed Allocation Protection Technology—is Seagate's next-generation erasure encoding solution. It replaces traditional RAID types with a protection scheme that distributes the parity across a larger set of HDDs or SSDs. The upshots? Data protection is now available at a capacity higher than ever before—with rebuilds that are up to 95% faster than with traditional solutions. With ADAPT, system administrators will find scalability, flexibility, and infrastructure that is easier to maintain and expand. This white paper provides an overview of this software feature and highlights its key features and benefits.

How Capacity Affects Data Protection

Enterprises today rely more heavily than ever on data—from the data that drives their daily operations to the data that provides actionable information to create a competitive advantage in their industry. They also rely on evolving technology to keep that data safe and accessible, even during routine downtimes or in the event of unforeseen system failures.

According to Technik.net, the advent of RAID array solutions initially solved the data downtime problem:

“More and more organizations have created enterprise-wide networks to improve productivity and streamline information flow. While the distributed data stored on network servers provides substantial cost benefits, these savings can be quickly offset if information is frequently lost or becomes inaccessible. As today's applications create larger files, network storage needs have increased proportionally. In addition, accelerating CPU speeds have outstripped data transfer rates to storage media, creating bottlenecks in today's systems. By integrating multiple drives into a single array—which is viewed by the network operating system as a single disk drive—organizations can create cost-effective, mini computer-sized solutions of up to a terabyte or more of storage.”

However, RAID technology was optimized for use in environments with limited or finite storage capacity. Now companies are rapidly implementing storage solutions with very high capacity potential, and they are eager to leverage the same level of protection they've come to expect from RAID.

But with traditional RAID types, the overall system performance can slow down dramatically during rebuilds when storage capacity increases. This is because data is striped across multiple drives along with parity information. If a drive in a RAID set fails, the controllers use the parity information to help

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reconstruct the data from a failed drive on a spare drive. Unfortunately, the speed at which the system can be rebuilt is tied to the performance of a single HDD, in some instances amounting to over 50 hours. Today's high-capacity systems require new technology to replace data protection schemes that were developed based on much lower-capacity systems.

But what if that rebuild could be distributed to many drives in a RAID system and get the cumulative performance boost of multiple drives? This is a key benefit of the new ADAPT technology.

ADAPT is Seagate's unique contribution to the capacity-performance dilemma. It's an intelligent solution that simplifies the integration of high-capacity drives in RAID systems without compromising reliable data availability.

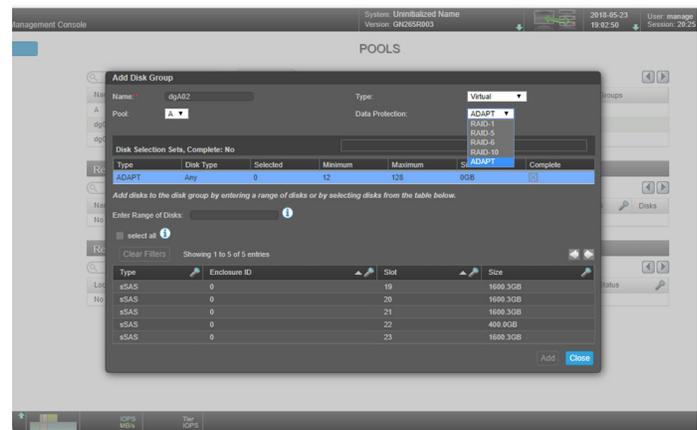


Figure 1 Adding a Disk Group in Web Management Interface. ADAPT is a data protection option along with RAID-1, 5, 6, and 10. The spare capacity value changes depending on the available space in the disk group. Spare capacity is determined by the system when disk groups are created, expanded, or rebalanced, and when disks are added to the group.

Improving Performance and Rebuild Times

ADAPT functions like RAID in that it is a data protection scheme, but its genius lies in dispersing the parity out to a number of drives. This structure enables the Seagate RAID controllers to take advantage of the combined performance of all those drives—versus being tied to a single drive. All drives in the ADAPT disk group must be the same type, and in the same tier, but can have different capacities. Consequently, ADAPT simplifies data center management, allows for easy growth, ensures that end-user applications have access to critical data, and dramatically reduces the time to successful fault tolerance (the ability to properly withstand an additional impact).

Thanks to ADAPT, the rebuild that took days now takes only minutes:

- When new data is added and the system recognizes that data is not distributed across disks evenly, it automatically moves the data to maintain balance.
- Reserving spare capacity for ADAPT disk groups is automatic since disk space dedicated to sparing is spread across all disks in the system.
- In the case of a disk failure, data is transferred to all disks in the disk group. This allows for quick rebuilds and minimal disruption to data input/output (I/O).
- The system automatically defaults to a target spare capacity that is equal to the sum of the two largest disks in the group. The target is now large enough to fully recover fault tolerance after loss of any two disks.
- ADAPT disk groups can also be expanded to either replenish current target spare capacity or to increase usable capacity.

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The table below shows the calculated numbers for performance impacts and rebuild times for a RAID 6 (8+2) disk group versus an ADAPT disk group of 24, 56, and 106 drives. The key takeaway: the greater the ADAPT disk group size, the more the data protection benefits accelerate. This reduces the amount of time until the disk group can survive a third drive failure—from over 55 hours to just 25 minutes in an ADAPT group with 106 drives! (See bottom row in chart. Note that these are modeled numbers and results may vary based on actual workload.)

Rebuild Time and Performance Under Failure

Metric	Traditional RAID 8+2	24 Drive ADAPT	56 Drive ADAPT	106 Drive ADAPT
Perf impact*, 1 drive down	-41%	-23%	-11%	-6%
Perf impact*, 2 drive down	-62%	-37%	-20%	-12%
Rebuild 1 drive	55.5 hours	24 hours	10 hours	5.3 hours
Fault Tolerance: 3rd drive failure	55.5 hours	9 hours	1.5 hours	25 minutes

Summary of Key Features and Benefits

Feature	Benefit
Parallel architecture	Reduces rebuild time by up to 95%, providing data protection, especially with large devices
Self-healing system	Automatically allocates spare capacity to recover common device failures
Mixed drive capacities	Maximizes usable capacity, reduces \$/TB
Universally compatible geometry	Simplified user configurations
Unique two-device fault tolerance	Increased data protection, even in the event more than one device fails
Expandable support pools, even while online	Excellent performance and capacity scaling from 12 to 128 devices
Sequential I/O performance	Supports multi-input HDD streaming applications

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Conclusion

RAID systems are engineered to protect against drive failure and now ADAPT offers an even higher level of protection against drive failure. Should one of the drives in the RAID system happen to fail, ADAPT greatly improves the time it takes to get that system back to a fully fault-tolerant state. Seagate understands you shouldn't have to sacrifice fast rebuild time and system performance, even in ultrahigh capacity systems. Our new systems offerings—Nytro X and Exos X—eliminate the capacity-performance conundrum by including ADAPT technology. Seagate Enterprise Data Systems develops end-to-end solutions—from enclosures to controllers, power/cooling modules, full management features, and data protection software. ADAPT is available by default in all Seagate systems, in addition to more traditional RAID data protection schemes.

As Seagate continues to bring higher density disk drives to market, our systems leverage larger and larger drives while maintaining the reliability and performance standards. Seagate Enterprise Data Systems develops end-to-end solutions—from enclosures to controllers, power/cooling modules, full management features, and data protection software. ADAPT is available by default in all Seagate systems, in addition to more traditional RAID data protection schemes.

For more information on Seagate Systems, visit [seagate.com/enterprise-storage/systems](https://www.seagate.com/enterprise-storage/systems).