

## Reliable Archival Storage with the RDX Removable Disk Cartridge

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More than ever before, Small and Medium Enterprises (SMEs) face growing data protection and retention requirements that can only be well served by storage solutions that combine high speed performance and long-term integrity in a single easy to use system. The common solution for SMEs requires they turn to disk or tape solutions and compromise either in performance, ease of use, or data integrity. However, as removable media continues to evolve, new solutions are emerging.

In this look into SME archival storage media, we discuss the requirements for a new generation of media that can overcome the limitations of the traditional choices. We then spotlight ProStor's RDX as one technology that packages together many best of breed characteristics of traditional media, demonstrates long-life under testing, and delivers a solution for easy to use, high performance, long-term archival storage.

### The Need for Archival Storage

Today, SME storage administrators are confronted with tremendous data growth coupled with seemingly ever-increasing demands for data retention. Every IT manager faces a litany of acronyms and abbreviations for agencies, regulations and requirements, any of which can may be critically important to their business – SEC, SOX, HIPAA, FISMA, NAIC, FDA, FRB, Basel II, PCI, and many others.

In the midst of the growing mountains of data, compliance and litigation requires the archiving and upkeep of aging data like never before. For the SME, such archiving simply demands performance, ease of use and long-term integrity in archival storage that is difficult to find. The activity of archiving creates wrinkles for many storage media choices that have in the past been clear winning solutions for cheap capacity and

long-term storage. For example, many archive applications continuously add and delete data from long-term storage media as new data is captured, and old data ages beyond a retention period. As data is repeatedly deleted and added over time, many media systems can develop large amounts of discontinuous storage or gaps in utilization that lead to poor performance, fragmentation, and decreased capacity. This then becomes a nightmare as administrators look into recovering unused space and fixing performance.

However, the simple truth is that even for routine backup, the mix of performance and ease of use in many media choices today could be better. The SME clearly needs a new type of media. This new media should provide characteristics like simple scalability, high sequential and random throughput for writing and recall, on-going capacity optimization in the midst of added and

deleted data, and easy implementation and management.

Existing media choices today all require compromises. On the one hand, the stalwart of long-term storage, tape, is complex when scaled to large capacities, slow for random retrieval of data, and difficult to manage. Complexity and difficulty in management often lead to poor practices that compromise data integrity.

On the other hand, mid-market disk systems are designed with simplicity of operation and high performance in mind. However, these systems suffer three critical drawbacks. First, they are not well suited for off-site protection and long term data archival. Second, these systems eventually reach scalability limits. Lastly, these disk-based systems are subject to failure during prolonged periods of continuous operation. Today, in order to compensate for the shortcomings of each type of media, the SME often compromises simplicity by combining both tape and disk in complex data protection systems that promise to deliver high performance and long-term data integrity. These systems may combine multiple tape libraries, tape multiplexing, disk caching, off-site replication, hierarchical storage management, and any other number of features to protect data, optimize the retrieval of key data, and reduce the demands upon slow performing long-term storage.

The SME clearly requires a better mix of performance and longevity requirements than common storage technologies provide. The sidebar in this document looks at the

## The Issues with Traditional Media

Especially for the SME, traditional backup and archive media choices present a number of challenges. Based on our research with end users, we have listed the most significant challenges that we hear:

### Tape Media

#### **Insufficient dynamic performance:**

Tape is simply the poorest performing media available today when it comes to dynamic, random interaction with data. Today, the SME requires fast interaction as user expectations for rapid data recovery increase, more data moves to near-line storage, and as compliance and litigation events require data retrieval occur more frequently.

#### **Insufficient capacity utilization:**

As dynamic addition and erasure of data occurs, capacity becomes grossly underutilized on tape. Interleaving data into freed tape segments is next to impossible, and few solutions can gracefully manage the complete re-write of tape volumes required to re-use capacity.

#### **Insufficient long-term retrieval:**

Tape media is unavoidably tied to the mechanisms in drives used to read and write it. The failure and obsolescence of the read/write mechanisms over time jeopardizes an organization's ability to retrieve data.

#### **High in maintenance:**

Tape systems require frequent cleaning and rotation of tape cartridges. These operations incur significant cost and require effort beyond the limits of many SMEs. Neglect of routine maintenance rapidly leads to data loss.

### Disk Media:

#### **Prone to long-term failure:**

Continuously spinning disk spindles reach their expected lifespan too quickly to be suitable for long-term data storage. As a result, most organizations reduce failure exposure by routine replacement and migrations.

issues with each of today's common backup and archival media choices.

### **New Requirements for Archival Media**

The market is populated with a number of media choices for long-term storage. None of these singularly meet the needs of SMEs, and consequently complicate both backup and archive. Clearly, the door is open for a new media solution with specific characteristics that can address the shortcomings of each of today's common media choices. These ideal characteristics include:

- Disk-like random and sustained performance
- Portability for offsite storage
- Avoidance of read/write mechanism obsolescence
- Green operation (low power requirements for dormant media)
- Easy scaling and expansion
- Ruggedness
- High duty cycles that allow repeated re-use without wear or deterioration
- Long stored life expectancy

Fortunately, the storage industry has witnessed a tremendous amount of innovation as vendors develop solutions better suited to long-term data storage. A shining example of this trend is ProStor's RDX removable disk cartridge. Next, we'll turn our attention to the ProStor solution and the capabilities of the RDX media platform.

### **Spotlight on ProStor RDX**

ProStor is the company behind the technology of RDX removable drive cartridges, currently sold by Tandberg Data, Exabyte, Imation, and several other system

#### **Long-term Scalability:**

Initially, disk systems easily scale in performance and capacity, but over longer periods of time, disk systems reach expansion limits that often require forklift upgrades.

#### **Lack of Portability:**

Designed for always present connectivity, disk systems have no easy way to support off-site protection. Moreover, replication from one site to another requires redundant equipment that may or may not ever be used and is too expensive for many SMEs.

#### **Online Disk is Expensive:**

Finally, maintaining traditional disk online for long-term archival storage requires routine upgrades to preserve integrity, scarce data center floor space, ongoing power consumption, and routine maintenance. These aspects all have direct hard costs associated with them.

#### **Optical Media:**

##### **Media quality and life expectancy vary widely, and are not easily identifiable**

The material composition of discs varies widely, and is not easily verified by the consumer. These different materials have significant impact on the life expectancy of the media.

##### **Mixed WORM and RW Media Introduces Increased Management Complexity**

Optical media itself often determines whether data can be re-written or written once only. As a result, managing the media for a system that requires both characteristics can be complex and error prone.

##### **Frequent media standard changes**

To date, there have been many deviations in optical media standards that confuse and delay evolutions in capacity. A short list of optical media choices today includes: MO, LaserDisc, MiniDisc, CD, DVD, DVD DL, FMD/DMD, HD DVD, Blue-ray, UDO, PDD, and more. Standardization issues have in fact retarded optical technology's ability to meet ever growing data storage needs. In order to use a ubiquitous media that better ensures future readability (e.g. DVD), storage solutions are constrained by capacities that are largely insufficient for today's enormous storage needs.

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OEM partners. With a number of high-profile partners for manufacturing and resell, ProStor RDX is widely available in the marketplace and has become a common and reliable choice for removable storage. ProStor specifically developed RDX technology to address the shortcomings of traditional tape and fixed disk long-term storage solutions.

Moreover, ProStor's RDX disk cartridge technology is built around an industry standard 2.5" form factor hard drive encased in a hardened package designed to tolerate a wide range of physical (dropping, crushing) and environmental (heat, humidity, contaminant) forces. This highly ruggedized removable media is accessed through an RDX dock. The RDX dock in turn is extremely simple, as it contains no read/write mechanisms and minimal componentry. The result is a storage system that is simple, has few parts that can fail or wear out, and delivers many more cycles of removal and insertion than other common removable media systems on the market. ProStor uses the comparison in Table 1 to differentiate the characteristics of RDX against a commonly available SME tape standard today.

The end result is that ProStor has engineered a removable storage media with an ideal mix of both tape and disk drive characteristics. Hard drive internals give the RDX high random and sustained performance. A ruggedized, removable shell then turns that disk into an appropriate media for off-site vaulting. Furthermore, that removability allows easy capacity scaling similar to tape by adding to the pool of rotated cartridges. Not

	<b>RDX 300GB</b>	<b>DAT160</b>	<b>DLT-V4</b>
<b>Capacity</b> (native)	300	80	160
<b>Forward Compatibility</b>	Yes	No	No
<b>Data Rate</b> (native, MB/s)	45	7	10
<b>Access Time</b> (seconds, average)	~20ms, including rotational latency	~50 seconds	~70 seconds
<b>Drive AFR</b>	~1%	~10%	~10%
<b>Media Life</b> (# of uses typical)	5,000+	~50	~50
<b>Cleaning Frequency</b>	Never	Weekly	Weekly
<b>Drive/Dock Street Price</b>	\$189	\$900	\$1,000
<b>Media Street Price</b>	\$350	\$40	\$50

Table 1: Comparison of RDX, DAT160 and DTL-V4 cost and performance characteristics

to be overlooked, removability also minimizes power consumption compared to always-on near-line disk systems – in addition to rapidly spinning down during inactivity, RDX cartridges used for archive and long-term storage can simply be undocked, and stored on a shelf while powered-off.

**Longevity Testing In Depth**

One specific area of importance for archival media is length of life. ProStor specifically

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designed the RDX system to deliver long-term storage that would outlast the retention requirements of most users' data. To ensure survivability and long life, ProStor engineered together several components:

- Special purpose 2.5” hard drives that secure drive heads by ramp loading them at the end of activity. This removes a source of accidental media and head collisions that frequently damage traditional drives.
- Inactive state spin down that avoids wear and tear on drive components.
- A casing and enclosure designed for high insertion rates.
- A ruggedized shell that can withstand a 3½ foot drop to concrete and prolonged exposure to heat, dust, ESD, and other environmental contaminants.

Engineering is one thing, and real life demonstration is another. Consequently, to validate these product specifications, ProStor participated in an accelerated life expectancy test by a third-party laboratory facility to gauge how the RDX cartridge would survive in real world use.

ProStor’s accelerated life span testing subjected a number of hard drive test units (standard 3.5” SATA drives and RDX cartridges) to controlled and variable heat and humidity conditions by test groups while exercising the devices in expected real-world usage patterns. These tests were aligned with the ISO and ANSI standards for accelerated life expectancy testing of Magnetic-Optical disc media (ISO 18926 and ANSI / PIMA IT9.26-1997 and ECMA 379), with minor, non-material exceptions taken due to the differences in media (there are no

standardized life expectancy tests for hard drives).

Every media life expectancy test is based on limited variables and statistical averages, and can only provide rough estimates of the expected service life of media under specific storage and handling conditions. In our opinion, ProStor’s testing of RDX by Magneto-Optical (MO) media standards was the right foundation for establishing archival life expectations against other media choices. Since MO media is largely protected from abrasion and contaminant exposure, tests are designed to gauge the effects of heat and humidity. These are the same factors that are likely to impact the life expectancy of ruggedized RDX cartridges. Further, MO is broadly recognized as the longest life expectancy in archival media, and sets the high-water mark for RDX cartridge comparisons.

Media Type	Anticipated Life Expectancy	Source
MO disc	57 years	NIST testing
Digital tape media (various)	20-30 years	Various tests and manufacturer specifications
CD/DVD	20 – 30 years (dependent upon quality)	NIST, NARA, and Library of Congress testing

Table 2: Common projected life expectancies from standardized accelerated life expectancy testing

Moreover, ProStor’s testing actually holds RDX cartridges to a higher standard than MO discs. Specifically, a more rigorous

standard was applied to the testing of the RDX cartridges in three different areas. First, RDX cartridges contain all of the system's mechanical parts, and the testing subjected the entire RDX cartridge system to stress. In contrast, MO media tests only subject the MO media to stress. Archived data integrity in a MO system will be subject to mechanical components that may fail much more readily, and the media itself may be subject to a larger number of variable forces that an RDX cartridge specifically protects against. An RDX cartridge will likely sustain a broader range of environmental and physical forces longer than MO, and consequently survive better.

Second, the RDX cartridges were held to a higher standard for tolerable defects than MO media, discarding any drive that encountered an unrecoverable error, even if all other data remained intact. The MO testing standard monitors for a specific level of bit errors in the media after exposure, and this bit error rate may or may not yield accessible data depending on the drive mechanism and/or structure of the data.

Third, the ISO and ANSI standards for testing MO media specifies a 95% confidence level, while ProStor's third party test lab used a 99% confidence level. As a result, standardized testing of MO media will portray a longer comparative life expectancy, even though there is much greater risk that the media may be unusable (approximately 500% greater at the limits of life span projections).

From testing, ProStor identified a 30 year or greater life expectancy for an RDX cartridge

stored in moderately controlled environmental conditions (78°F with 95% non-condensing humidity). This number greatly increases under stringently controlled environmental conditions to 100 years or more (68°F, 30% Relative Humidity). At controlled temperatures, storage managers should take solace in the fact that RDX cartridges, in terms of pure longevity, should exceed or match the longevity of other media choices. Notably, for users expecting long-life from standard SATA drives, ProStor's tested non-RDX 3.5" SATA drives demonstrated they may have a comparative life expectancy of only a few years.

### **Long-life RDX as Archival Storage**

In comparison to today's media choices, RDX demonstrates an ideal mix of longevity, high performance, scalability, removability, and ruggedness. We'll look next at how this combination of characteristics meets the requirements that we have identified for a new type of archival storage media.

#### **RDX: High performance**

As we've discussed previously, dynamic access to tape based archives is excruciatingly slow. Furthermore, even basic backup performance with tape suffers when backup clients are unable to sustain consistent throughput rates to avoid tape stops and starts. RDX disk cartridges deliver best in class random access performance that is ideally suited for the dynamic nature of near-line archival storage and retrieval. Moreover, RDX cartridges demonstrate high sustained throughputs, comparing favorably with the best of tape technologies on the

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market. The file system and hard drive underpinnings of the RDX system maintain optimized performance and capacity, filling gaps created by deleted data and managing fragmentation that deteriorates the performance of many archive media choices.

Finally, as hard drive materials continue to evolve (e.g. perpendicular magnetic recording) technology will push platter densities beyond 125GB, and enable 2.5” drive capacities to exceed even today’s large capacities. Transfer rates will subsequently increase as densities increase, but these new drives will be fully compatible with current RDX technology. The latest generation 2.5” drives with the highest platter densities have already increased transfer rates to 60MB/s.

**RDX: Removable and scalable**

While exceeding the performance characteristics of tape, RDX matches tape in terms of removability and expansion capabilities. In short SMEs can manage quickly accessible, near-line archival storage and protected backup storage with a single system that can meet the needs of both. That system allows them to easily meet off-site storage requirements and easily expand capacity through the cost effective addition of RDX cartridges. Furthermore, as data importance and access patterns change over time, data is easily archived and protected completely offline without complex data migrations or use of multiple types of media.

**RDX: Cost Effective**

While it is seldom recognized at time of implementation, the primary cost component of tape storage systems has always been the media. Over time, the cost of replacing worn

tape far exceeds the costs of acquiring the tape system itself. RDX duty cycles, which are 1000 times greater than common tape media, mean that RDX cartridges will never need to be replaced with typical usage. This makes RDX many times cheaper than tape. As an example, Table 3 calculates the comparative costs between DLT-V4 tape, DAT160 tape, and RDX cartridge solutions that rotate 1 Terabyte of media on a daily basis, 6 days a week, for 5 years, and utilize cleaning tapes weekly.

	<b>RDX</b>	<b>DAT160</b>	<b>DLT-V4</b>
Capacity	300GB	80GB	160GB
Cost of Drive	\$189	\$900	\$1,000
Cost of Media	\$350	\$40	\$50
Number of Media in Rotation	4	13	7
Number of Media Uses Each	5,000+	50	50
Cleaning Tape Cost	N/A	\$40	\$80
Cleaning Tape Uses Ea.	N/A	20	20
Number of Media Cycles for 5 years (each media)	1560	1560	1560
Amount of Daily Backup	1TB	1TB	1TB
Time to Perform Daily Backup (hours)	6.2	39.7	27.8
Cost of Media for 5 yrs	\$1,400	\$16,224	\$10,920
Cleaning Tape Cost at 5 years	\$0	\$520	\$1,040
<b>Total Cost</b>	<b>\$1,589</b>	<b>\$17,644</b>	<b>\$12,960</b>

Table 3: Total 5 year Cost for an RDX and tape storage systems using 10 cartridges/tapes daily.

### **RDX: Data Preservation for the future**

Digital preservation best practices dictate that media must be regularly migrated to avoid risk of loss by both media failure and access mechanism obsolescence. Yet from our discussions with end-users, these risks are seldom recognized. Moreover, there is seldom investment in any type of effort to preserve archived media through regular migration.

RDX effectively avoids these risks by delivering removable backup and archival storage built around long-life, highly protected cartridges that encapsulate the access mechanism as well as the media. By packaging the media and access mechanism together, organizations looking to retrieve data in the far distant future only require the availability of SATA - a common, standardized system interface today. Looking back through time, such interfaces have had much longer presence in the marketplace than media read/write mechanisms. As one example, ST506/MFM controller adapters supporting circa 1980 technology can still be found on the market today. ProStor RDX clearly makes sense as storage for data that is expected to be retained for a long time.

### **RDX: Ubiquitous Hard Drive Underpinnings Equals Versatility**

RDX media is distinctly positioned as a platform that can be easily enhanced with advanced security and storage optimization capabilities. Core features within popular operating systems (Windows, OS X, Linux) can already encrypt and/or de-dupe storage on disk media, and more enhanced capabilities are readily available in a large

number of third party products. Furthermore, ProStor has recently introduced their InfiniVault archiving and compliance appliance. InfiniVault is a complete data archiving solution built around removable RDX cartridges. InfiniVault systems will enhance RDX core capabilities to include automated advanced encryption, key management, hardware enforced WORM and archived data retention policy management. These features will extend the RDX solution into a comprehensive, single point solution for sophisticated compliance and retention management. In contrast to traditional media systems, RDX's versatility as a drive-based media system allows this functionality to be easily integrated into the system without introducing complex point solutions into the data protection process.

### **Taneja Group Opinion**

ProStor RDX demonstrates the versatility of a new, emerging class of backup and archival storage. After years of struggling with the mismatch between the performance characteristics of different types of media and user requirements, growing disk capacities are allowing vendors to be innovative in their application of the technology to the problem. Innovative solutions run the gamut from Content Aware Storage (CAS) to Massive Arrays of Independent Disks (MAID) to ProStor's RDX cartridges.

ProStor's RDX technology is without a doubt one of the simplest and easiest to use forms of disk-based archival technology. As a result, RDX delivers flexible, performant,

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affordable archive storage for users ranging from the home office to small and mid-sized enterprises. ProStor provides real versatility by ratcheting up the performance of media, while still allowing businesses to remove and shuttle storage anywhere, anytime. At the same time, ProStor simply removes on-going management overhead associated with managing the traditional performance and capacity mismatch of backup and archive storage.

Of course, a lingering question has remained about the true long-term integrity of disk-based systems. However ProStor's third party testing demonstrates that ProStor's RDX cartridge can without a doubt be a comparably robust platform for long-term archival storage, and meet the needs of most users even under non-optimal conditions.

Furthermore, RDX is the right technology at the right time for the SME. Archiving is a must have for most businesses today. For organizations that need to retain data for compliance, regulation, or litigation purposes, easy, high-speed access to long-term storage is important. Retrieving data for legal reasons has always been arduous when it involves restoring and digging through numerous slow, hard to access backup tapes. Furthermore, revisions to the Federal Rules for Civil Procedure in 2006

make it likely that general pools of media, even those split across dual purposes such as backup and archive, may expose a business to fully searching all data stored on that medium. When that pool is tape, the cost of search and retrieval can be enormous. RDX's high performance access rates can facilitate fast search and retrieval at significantly lower cost.

RDX removable disk matches the best in class capabilities of near and long-term storage mediums, while providing a turnkey, flexible solution. In short, RDX combines long-life with performance and cost that is ideal for mid-market. We look forward to future developments that will no doubt grow RDX cartridges into increasingly sophisticated solutions like ProStor's InfiniVault, supporting increased scalability, coupled with security, and data retention management. Without a doubt, the simple but hardened underpinnings of RDX make it the ideal platform for the development of such sophisticated data management applications. Today, ProStor RDX is useful anywhere that fast, removable storage is needed. Traditional vendors of tape, optical, and even disk-based near-line storage media should take notice. RDX is coming and it can easily obsolete other traditional tape, optical, and disk-based approaches.

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