Quantum

WHITE PAPER

STORNEXT 4K REFERENCE ARCHITECTURES

Optimized Storage Solutions Based on Comprehensive Performance Testing

CONTENTS

ABSTRACT

Quantum recently announced purpose-built StorNext® reference architectures for 4K media workflows to maximize stream counts and optimize performance levels in accordance with users' specific needs. This white paper describes exhaustive testing based on over 500 combinations of disk formats, array configurations, client operating systems, and other variables—all conducted under rigorous, real-world conditions—which provided the basis for development of these reference architectures.

1.0: INTRODUCTION—STORAGE CHALLENGES FOR 4K VIDEO

Increasing demand for 4K/ultra-high-definition (UHD) TVs, computer displays, and cameras is driving the adoption of the 4K video specification for film and video production. To create more immersive, engaging experiences and to capture the highest quality pixels for every shot, content creators are capturing and generating programming with greater resolution, frame rates, dynamic range, color depth, and color gamut. They are shooting sporting events and action films in 4K and even 8K resolutions—at up to 120 frames per second (fps)—to present a tremendous level of detail, even in slow motion.

These changes are transforming the video viewing experience. But to deliver this richer, more captivating content, many content creators need faster, more expansive storage environments to capture, process, distribute, and archive this high-quality video.

How ready is your organization for 4K? Whether ramping up production to 4K today or preparing for the future, facilities are viewing their next storage purchase as critical. The comprehensive testing of our StorNext disk- and flash-based workflow storage systems was conducted with the single goal of empowering media facilities to make better-informed 4K storage infrastructure investments.

Balancing Capacity with Performance and Cost

Producing video at 4K resolutions and associated frame rates, dynamic ranges, and color depths requires significantly greater storage capacity than standard-definition (or even high-definition video). Compare the capacity required to store one hour of video at specific levels of 4K compressed and uncompressed video quality:

		Frame Rate (fps)	Data Rate (Mbps)	Capacity (1 hr)
High Definition 1920 x 1080	ProRes 422 HQ	30	30	112 GB/h
	10-bit RGB	24	200	717 GB/h
4K UHD 3840 x 2160	ProRes 422 HQ	30	111	380 GB/h
	10-bit RGB	24	807	2.8 TB/h
	ProRes 422 HQ	60	221	760 GB/h
	10-bit RGB 60 fps	60	1990	6.8 TB/h

WHAT IS STORNEXT?

Quantum StorNext has been the cornerstone of high-resolution digital video editing and finishing for nearly twenty years. StorNext is a parallel scale-out file system and storage policy manager. Most of today's shared storage systems are designed for standard computing and IT operations The StorNext file system features special system-level operations that can be tuned to the unique requirements of film and video workflows.

StorNext was the first widely adopted collaborative storage environment to deliver predictable, real-time performance for uncompressed film and video finishing. As resolutions and collaborative requirements have increased, so too have the performance and features of StorNext. Today, StorNext provides unblinking 4K performance and seamless, automated data movement and archiving from high-speed primary production disk to near-line NAS, object storage, cloud, and tape.

XCELLIS WORKFLOW STORAGE

Features and Benefits:

- Converged architecture—Xcellis combines compute, client access, and storage to create an efficient and powerful core for a workflow storage solution.
- Continuous scalability—Xcellis enables storage arrays to be seamlessly added to scale from the smallest configurations to the largest with no forklift upgrades.
- Multi-vendor access—Xcellis optimizes media workflow efficiency and media data access by giving all multi-vendor clients access to the same data.
- Massive scalability—Xcellis supports billions of files across up to 64 virtual file systems with capacity scaling to hundreds of petabytes. Scalability can be further extended using tape archival object storage or cloud.
- Flexible connectivity options—16 GB/s FC, 8 GB/s FC, 1 GbE (Gigabit Ethernet), 10 GbE, 40 GbE, and FDR InfiniBand.
- Powered by StorNext—Xcellis is designed to get the most out of StorNext, advanced data management for high-performance, multi-tier, shared storage.

Mastering in uncompressed 4K format consumes five to ten times as much capacity per hour as compressed 4K. Preparing a full-length feature film in 4K can easily generate hundreds of terabytes of data. To support multiple projects, depending on your workflow requirements, you would need a storage environment that could scale from a few hundred terabytes to multiple petabytes.

In many cases, hard disk drive (HDD) platforms will be the optimum way to accommodate rising data volumes, to support small workgroups working on uncompressed 4K content, and to control costs.

Flash can provide a tremendous amount of performance. Flash storage also provides excellent value in media workflows that require a high number of compressed streams—which can leverage the random I/O performance and lower latency of flash—and where high capacity is less important. Test results show that compressed workflows better leverage the performance characteristics of solid-state drives (SSDs) than do uncompressed workflows. Flash-based 4K environments benefit from a storage platform that automates data migration among the primary and near-line tiers, making it easy for users to archive completed content from SSDs to more affordable HDDs, cloud storage, or data tape.

2.0: QUANTUM XCELLIS PRODUCT LINE OVERVIEW

Media organizations that work with large amounts of 4K video data know full well the causes driving their pain—large files, more collaborators, shorter deadlines, and nearly constant upgrades. Far less obvious is a way to address this situation. Quantum Xcellis™ workflow storage is the ideal solution—flexible enough to be right-sized for any large data workflow, scalable enough to keep up with growing demands without degrading performance, and efficient enough to do all this and stay on budget. Xcellis scales simply by adding storage arrays, so every dollar invested pays off in more capacity and greater bandwidth.

By providing access using both IP-based network-attached storage (NAS) and storage area network (SAN), Xcellis eliminates the need to maintain multiple storage systems, the network traffic to move data between them, and the time and headcount to manage them. As a result, by using converged storage and access, organizations can scale their storage system much more efficiently.

Metadata and User Data Storage

StorNext manages access to data on disk through file system metadata. This high-performance "card catalog" of all content in storage and its associated names, permissions, sizes, access history, and archive status, is what makes StorNext so good in shared environments. The StorNext metadata model is part of the reason why StorNext provides such high performance and reliability.

Other shared storage systems—particularly those that rely on a distributed cluster topology—require a "file server" to provide content to the clients that request it. The server in the cluster is in the data path between the client and the storage. StorNext eliminates this infrastructure speed bump through the use of metadata servers that are entirely out of band. Once a client receives metadata pointing to the location of the desired content on disk, the remainder of the transaction is between the client and the storage with no compute interference. This makes StorNext particularly reliable and predictable when it comes to serving high-performance content like 4K video files.

3.0: TEST CONFIGURATION AND METHODOLOGY

The following section describes the Xcellis workflow storage configurations that were tested for the development of the StorNext 4K reference architectures.

4K Media Formats

The term "4K" is used to cover a wide variety of resolutions, frame rates, compression schemes, bit depths, and color characteristics. Understanding these differences and how they affect your storage infrastructure is crucial when you are trying to deploy a system that will service your present and future needs. In order to achieve a key goal of the testing, which was to guide customers to exactly the right configuration based on their requirements, each test configuration was benchmarked using six 4K formats. These included three compressed 4K formats ranging from 111 to 249 Mbps, and 3 uncompressed media formats ranging from 807 to 1990 Mbps.

4K Format	Resolution (W x H)	Frame Rate (fps)	Data Rate (Mbps)	Capacity Required (GB/h)
UHD ProRes 422 HQ	3840 x 2160	30	111	400
		60	221	796
UHD ProRes 4444 XQ	3840 x 2160	30	249	896
UHD (10-bit)	3840 x 2160	24	807	2905
		60	1990	7164
4K Full Ap (10-bit)	4096 x 3112	24	1224	4406

Xcellis Storage Array Configurations Overview

The testing involved 14 different Xcellis workflow storage configurations, including scale-up and scale-out configurations. Scale-up refers to expanding a redundant array of independent disks (RAID) controller-based array (also known as a Raided Bunch Of Disks or RBOD) with an expansion array (also known as Just a Bunch Of Disks or "JBOD") to increase capacity only. For example, a scale-up configuration of one Xcellis RBOD and one JBOD is referred to as an Xcellis "1+1" configuration.

Scale-out refers to adding an RBOD array to existing arrays which allows for a simultaneous upgrade in capacity and performance. A scale-out configuration of two Xcellis RBOD and JBOD combinations is referred to as an Xcellis "2+2" configuration.

The testing included scale-up configurations of Xcellis QXS™-412, QXS-424, QXS-648, and QXS-656 HDD-based array models, with the read performance of the QXS-6XX series controllers being approximately twice that of QXS-4XX series controllers. Scale-out configurations of QXS-424 and QXS-456 were also tested. The testing also included the Xcellis QXS-648 all-flash array.

Client and Networking Configuration

While StorNext-based Xcellis configurations provide support for Linux, macOS, and Windows clients, Quantum internal testing has discovered that Linux clients support the highest levels of media performance compared to other client types. Windows and macOS-based systems performed about 15% slower than Linux systems. This difference is attributed to number and type of I/O messages for each system, but this was not a goal of this round of testing. The remaining tests thus used Linux-based client configurations.

Each client workstation was connected to the Xcellis storage array configuration using a 16 GB/s FC SAN. A Fibre Channel SAN environment transmits files across its network directly in raw data blocks using deterministic connections. As a result, the bandwidth between each client workstation and the storage array is predictable. (The actual bandwidth in a shared file system like StorNext depends on the total activity of all clients accessing the system at the same time.)

I/O Testing

For the purpose of emulating as close to a real-world scenario as possible, an automated test application was used to generate content of the appropriate format and fill each storage array to 85% capacity. Storage systems that use the majority of space tend to search for data more than those that are nearly empty. Our tests were also performed on almost empty systems with no discernable difference in performance. The test material was sized to match high-quality RGB data and not the less demanding YUV data that is sometimes used for benchmarking. For uncompressed media, the automated application created frames to match published resolutions and data rates; for compressed media, individual files that mirrored published codec bitrates were used.

Tested Storage Arrays

The following arrays were used during testing to compare the performance of the variety of disk types, RAID controller performance, and number of disks per controller. Both QXS-4 series and QXS-6 series arrays were tested with the base models of the latter providing roughly double the I/O performance of the former.

Xcellis System	Controller Class	Drive Type & Speed	Drive Size	Drive Capacity	Number of drives	Raw Capacity Options (TB)
QXS-412	4000 Series	7200 RPM NL-SAS	3.5"	4 TB, 6 TB, or 8 TB	12	48, 72, or 96
QXS-424	4000 Series	10K RPM SAS	2.5"	1.2 TB or 1.8 TB	24	28.8 or 43.2
QXS-424 all-flash	4000 Series	SSD	2.5"	400 GB, 800 GB, or 1.6 TB	24	9.6, 19.2, or 38.4
QXS-456	4000 Series	7200 RPM NL-SAS	3.5"	4 TB, 6 TB, or 8 TB	56	224, 336, or 448
QXS-448 all-flash	4000 Series	SSD	2.5"	400 GB, 800 GB, or 1.6 TB	48	19.2, 38.4, or 76.8
QXS-648	6000 Series	10K RPM SAS	2.5"	1.2 TB or 1.8 TB	48	57.6 or 86.4
QXS-648 all-flash	6000 Series	SSD	2.5"	400 GB, 800 GB, or 1.6 TB	48	19.2, 38.4, or 76.8
QXS-656	6000 Series	7200 RPM NL-SAS	3.5"	4 TB, 6 TB, or 8 TB	56	224, 336, or 448

Best Practices Guide Validation

One of the major reasons behind the suitability of StorNext-based storage arrays for film and video workflows is the finite, system-level settings that are available such as stripe groups, LUN sizes, cache settings, and inode stripe width. Each of these settings can have a major impact on overall performance, depending on the underlying storage components and network connections. Prior to the testing, the team developed a "best practices" baseline to validate that each of these variables performed optimally for the configurations under test.

4.0: TEST RESULTS AND ANALYSIS

The exhaustive testing phase that covered these 14 configurations is arguably the industry's best view of how storage supports a 4K environment. The concurrent streams and aggregate throughput results provide media organizations with real-world guidelines for StorNext performance and scalability as well as benchmarks by which to evaluate other vendors' solutions.

Quantum QXS-412

Base and scale-up configurations of the QXS-412 were tested with 4 TB high capacity 3.5" large form factor (LFF) HDDs.

QXS Configuration	Drives	ProRes 422 HQ (30 fps)		ProRes 422 HQ (60 fps)		ProRes 4444 XQ (30 fps)		UHD (10-bit) (24 fps)		Full Ap (10-bit) (24 fps)		UHD (10-bit) (60 fps)		Raw Capacity
		Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	
QXS-412	12	6	.7 GB/s	3	6.0 GB/s	4	1.0 GB/s	1	.8 GB/s	0	N/A	0	N/A	48 TB
QXS-412 1+1	24	8	.9 GB/s	4	.9 GB/s	6	1.5 GB/s	2	1.6 GB/s	1	1.2 GB/s	2	4.0 GB/s	96 TB

Quantum QXS-424

Base, scale-up, and scale-out configurations of the QXS-424 were tested with 1.2 TB high-performance 2.5" small form factor (SFF) HDDs.

QXS Configuration	Drives	ProRes 422 HQ (30 fps)		ProRes 422 HQ (60 fps)		ProRes 4444 XQ (30 fps)		UHD (10-bit) (24 fps)		Full Ap (10-bit) (24 fps)		UHD (10-bit) (60 fps)		Raw Capacity
		Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	
QXS-424	24	13	2.7 GB/s	5	1.1 GB/s	5	1.2 GB/s	2	1.6 GB/s	1	1.2 GB/s	1	2.0 GB/s	28.8 TB
QXS-424 1+1	48	17	1.9 GB/s	7	1.5 GB/s	8	2.0 GB/s	4	3.2 GB/s	2	2.4 GB/s	1	2.0 GB/s	57.6 TB
QXS-424 2+2	96	28	3.1 GB/s	13	2.9 GB/s	16	4.0 GB/s	7	5.6 GB/s	5	6.1 GB/s	2	4.0 GB/s	115.2 TB

Quantum QXS-648

Other tests were run on the base and scale-up configurations of QXS-648 with 1.8 TB high-performance 2.5" SFF HDDs.

QXS Configuration	Drives	ProRes 422 HQ (30 fps)		ProRes 422 HQ (60 fps)		ProRes 4444 XQ (30 fps)		UHD (10-bit) (24 fps)		Full Ap (10-bit) (24 fps)		UHD (10-bit) (60 fps)		Raw Capacity
		Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	
QXS-648	48	23	2.6 GB/s	13	2.9 GB/s	10	2.5 GB/s	5	4.0 GB/s	3	3.7 GB/s	2	2.0 GB/s	86.4 TB
QXS-648 1+1	96	60	6.7 GB/s	30	6.6 GB/s	12	3.0 GB/s	9	7.3 GB/s	6	7.3 GB/s	3	6.0 GB/s	172.8 TB

Quantum QXS-456 and QXS-656

Base, scale-up, and scale-out configurations of the QXS-456 and QXS-656 were tested with 4 TB and 8 TB LFF HDDs.

QXS Configuration	Drives	ProRes 422 HQ (30 fps)		ProRes 422 HQ (60 fps)		ProRes 4444 XQ (30 fps)		UHD (10-bit) (24 fps)		Full Ap (10-bit) (24 fps)		UHD (10-bit) (60 fps)		Raw Capacity
		Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	
QXS-456	56	14	1.6 GB/s	6	1.3 GB/s	5	1.2 GB/s	4	1.6 GB/s	2	2.4 GB/s	1	2.0 GB/s	224 TB
QXS-456x2	112	27	3.0 GB/s	13	2.9 GB/s	14	3.5 GB/s	8	6.4 GB/s	5	6.1 GB/s	3	6.0 GB/s	448 TB
QXS-656	56	19	2.1 GB/s	11	2.4 GB/s	10	2.5 GB/s	6	4.8 GB/s	4	4.9 GB/s	2	4.0 GB/s	448 TB
QXS-656 1+1	112	32	3.6 GB/s	10	2.2 GB/s	12	3.0 GB/s	7	5.6 GB/s	5	6.1 GB/s	2	4.0 GB/s	896 TB

Quantum QXS-424 and QXS-648 All-Flash Arrays

Base configurations of the QXS-424 and QXS-648 all-flash arrays were tested with 400 GB SSDs.

QXS Configuration	Drives	ProRes 422 HQ (30 fps)		ProRes 422 HQ (60 fps)		ProRes 4444 XQ (30 fps)		UHD (10-bit) (24 fps)		Full Ap (10-bit) (24 fps)		UHD (10-bit) (60 fps)		Raw Capacity
		Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	Streams	Bandwidth	
QXS-424 AFA	24	49	5.4 GB/s	24	2.9 GB/s	22	5.5 GB/s	6	4.8 GB/s	3	3.7 GB/s	2	4.0 GB/s	9.6 TB
QXS-648 AFA	48	66	7.3 GB/s	32	6.6 GB/s	30	7.5 GB/s	9	7.3 GB/s	6	7.3 GB/s	3	6.0 GB/s	19.2 TB

Test Analysis

A number of important conclusions can be drawn from the StorNext 4K workflow testing. These include inferences regarding appropriate drive types to be used based on the 4K media format and the workflow requirements. As with any benchmarking activity, these results should be taken with your priorities in mind. The trade-off triangle for disk performance in a given media workflow includes price, performance, and capacity. The sweet spot will be different for every use case and every organization.

3.5" HDD Usage

High-capacity 3.5" HDD-based Xcellis workflow storage arrays such as QXS-412 and QXS-656 have a strong fit with media production environments having low uncompressed stream count and high-capacity requirements. For example, a scale-up version of the QXS-412 array has the same performance for full AP 24 fps and UHD 60 fps uncompressed 4K media streams as the scale-up version of the 2.5" HDD-based QXS-424 array, but in addition delivers 66% higher capacity.

QXS Configuration	Number of drives	ProRes 422 HQ (30 fps)	ProRes 4444 XQ (30 fps)	Full Ap (10-bit) (24 fps)	UHD (10-bit) (60 fps)	Raw Capacity
QXS-412 1+1	24	8	6	2	1	96 TB
QXS-424 1+1	48	17	8	2	1	57.6 TB

2.5" HDD Usage

The smaller 2.5" HDDs have a capacity of 1.2 TB, but have a higher rotational speed of 10,000 RPMs (versus 7200 RPM for 3.5" HDDs). As a result, Xcellis workflow storage arrays using 2.5" HDDs provide higher 4K stream counts with reduced rack space. For example, the 2.5" HDD-based QXS 424 1+1 delivers roughly twice the stream count for compressed streams compared to the 3.5" HDD-based QXS-412 1+1 array. Both arrays consume two rack units of space.

QXS Configuration	Number of drives	ProRes 422 HQ (30 fps)	ProRes 4444 XQ (30 fps)	Full Ap (10-bit) (24 fps)	UHD (10-bit) (60 fps)	Raw Capacity
QXS-412 1+1	24	8	6	2	1	96 TB
QXS-424 1+1	48	17	8	2	1	57.6 TB

2.5" SSD Usage

The Xcellis all-flash QXS-648 is ideal for environments having very high 4K compressed stream counts and low capacity requirements; for example, commercial or short-form 4K production that is effect-centric and where quality is the paramount requirement. Specifically, the QXS-648 all-flash array delivers twice the 4K compressed stream counts provided by QXS 424 2+2 systems, and more than four times the stream counts supported by QXS-412 1+3 arrays, albeit with a much lower capacity. Also, flash is significantly more expensive than spinning disks. On the low-cost, high-performance, high-capacity triangle, flash occupies the high-performance corner.

		Stream Count		Raw Capacity (TB)
Drive Form Factor	**Configuration**	**Compressed ProRes 422 HQ**	**Uncompressed UHD 24 fps (10-bit)**	
3.5" HDDs	QXS-412	6	1	48
	QXS-412 1+3	15	4	192
	QXS-456 RAID	14	4	224
2.5" HDDs	QXS-424 RAID	13	2	28.8
	QXS-424 RAID 2+2	28	7	115.2
2.5" SSDs	QXS-648 RAID All-SSD	66	9	19.2

Analysis Summary

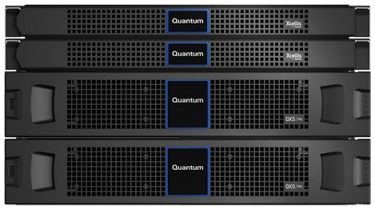
Considering the dramatically higher resolution of 4K media, it would be reasonable to assume that greater 4K stream data rates have the highest impact on storage arrays. However, the test results discussed above reveal that the higher number of compressed 4K stream counts impact storage array performance just as much as stream data rates.

In the case of HDDs, supporting concurrent compressed streams causes drive heads to race to read multiple streams, which increases latency and takes a toll on performance. Thus, while the cumulative bandwidth of individual compressed streams may be much less than the theoretical maximum performance of the array's controller, the latency of reading high numbers of streams can quickly overwhelm HDD-based arrays. As a result, arrays with faster, 10K RPM 2.5" HDDs are better suited for higher compressed stream counts than ones with slower 7200 RPM 3.5" HDDs. In comparison, the much higher data rates of uncompressed streams exhaust the throughput capacity of the storage controller much before drive latency becomes a factor.

5.0: STORNEXT 4K REFERENCE ARCHITECTURES

The testing described in the earlier sections determined stream counts and performance levels for specific StorNext-powered Xcellis workflow storage systems, when flash is the most cost-effective solution for high-performance, higher-resolution workflows, and when a spinning disk configuration provides better performance for less cost. The test results led to the creation of four 4K reference architectures with specific stream counts that can scale up as needed to provide additional capacity and performance.

StorNext Base 4K

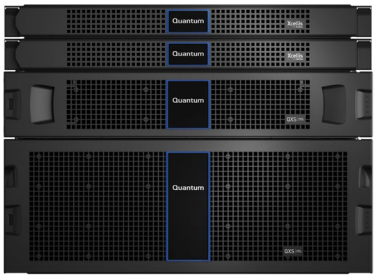


Ideal for small workgroups working in compressed formats, StorNext Base 4K is based on the Xcellis QXS-412 array that supports up to 15 streams of compressed and two streams of full-aperture 10-bit uncompressed 4K[1]. The StorNext Base 4K entry-level configuration uses 4 TB 3.5" HDDs, while 6 TB HDD upgrade options are available. The base unit supports converged metadata, while upgrade options for support of a dedicated metadata controller (required for archiving support) are available.

Stream Count by Format and Number of Arrays

Array Count and Drives	ProRes 422 HQ 30 FPS	ProRes 4444 XQ 30 FPS	Full AP 10-bit 24 FPS	UHD 10-bit 60 FPS	Raw Capacity (TB)
1 x 12	6	4	N/A	N/A	48
2 x 12	8	6	2	1	96
4 x 12	15	6	2	1	192

StorNext High-Capacity 4K



For groups that need additional capacity for primary storage, StorNext High-Capacity 4K based on the Xcellis QXS-456 array scales to support up to 24 streams of compressed and up to 6 streams of full-aperture 10-bit uncompressed 4K. The StorNext Base 4K entry-level configuration uses 4 TB 3.5" HDDs, while 6 TB HDD upgrade options are available. The base unit supports converged metadata, while upgrade options for support of dedicated metadata controller (required for archiving support) are available.

Stream Count by Format and Number of Arrays

Array Count and Drives	ProRes 422 HQ 30 FPS	ProRes 4444 XQ 30 FPS	Full AP 10-bit 24 FPS	UHD 10-bit 60 FPS	Raw Capacity (TB)
1 x 56	14	6	2	1	224
2 x 56	24	17	6	2	448

[1]All performance data assumes READ operations for RGB data on 85% full arrays using 4 TB drives.

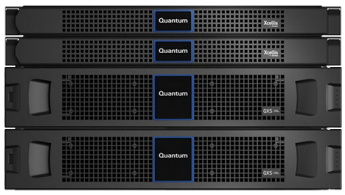
StorNext Performance Disk 4K

StorNext Performance Disk 4K is the ideal starting point when higher stream counts and capacity with extreme scalability are required. It is based on the Xcellis QXS-424 and scales to support up to 28 streams of compressed and up to 5 streams of full-aperture 10-bit uncompressed 4K. The StorNext Performance Disk 4K entry-level configuration uses 1.2 TB 2.5" HDDs, and 1.8 TB HDD upgrade options are available. The entry-level unit includes a dedicated metadata controller for automated archiving support.

Stream Count by Format and Number of Arrays

Array Count and Drives	ProRes 422 HQ 30 FPS	ProRes 4444 XQ 60 FPS	Full AP 10-bit 60 FPS	UHD 10-bit 60 FPS	Raw Capacity (TB)
2 x 24	17	8	2	1	57.6
4 x 24	28	16	5	2	115.2

StorNext All-Flash 4K

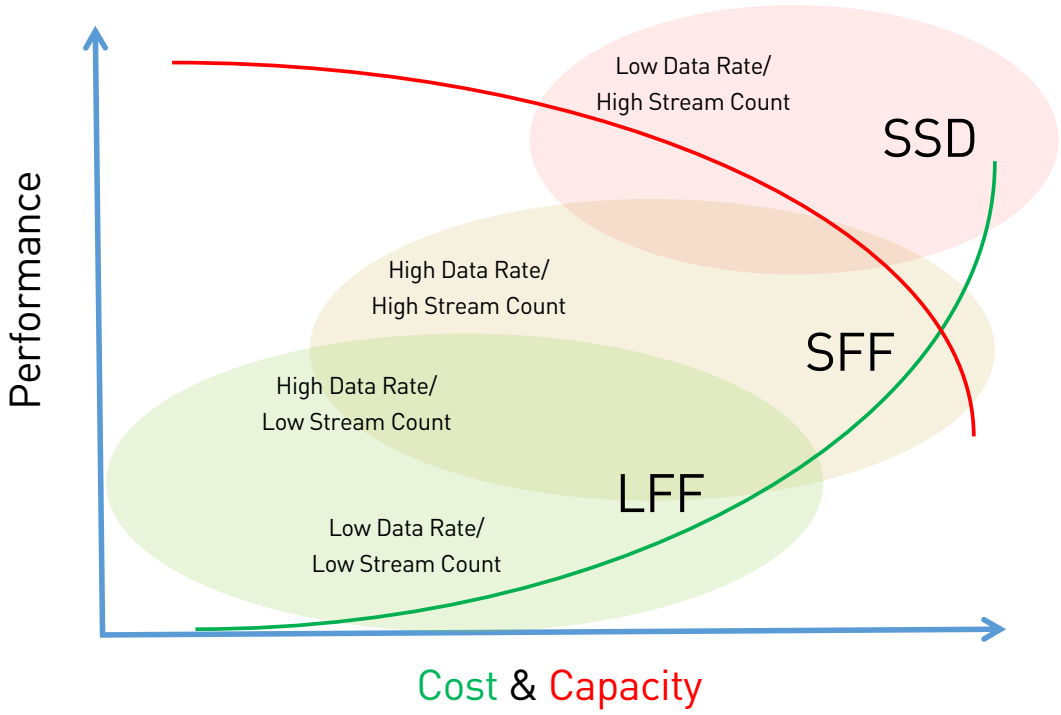


StorNext all-flash 4K supports maximum compressed stream counts and uncompressed support for high value content production. It is based on Xcellis QXS-648 all-flash array and scales to support up to 66 streams of compressed and up to 6 streams of full-aperture 10-bit uncompressed 4K. The StorNext all-flash 4K entry-level configuration uses 400 GB SSDs, and 800 GB and 1.6 TB SSD upgrade options are available. The entry-level unit includes a dedicated metadata controller for automated archiving support.

Stream Count by Format and Number of Arrays

Array Count and Drives	ProRes 422 HQ 30 FPS	ProRes 4444 XQ 30 FPS	Full AP 10-bit 24 FPS	UHD 10-bit 60 FPS	Raw Capacity (TB)
1 x 24	49	22	3	2	9.6
1 x 48	66	30	6	3	19.2

Figure 1: Best fit by 4K media type (Red–Low Capacity, Yellow–Mid Capacity, and Green–High Capacity)



In summary, stream count was found to be as important a factor for media choice as stream data rates and capacity requirements for StorNext 4K reference architectures.

- 3.5" HDDs are best for a low number of compressed 4K stream counts requiring high capacity.
- 2.5" HDDs are best for a higher number of compressed 4K stream counts with mid-capacity requirements.
- SSDs are ideal for very high compressed 4K stream counts that require low capacity.

6.0: CONCLUSIONS

In-depth testing of 14 different Xcellis workflow storage configurations using the 4K media formats described in this white paper formed the basis of StorNext 4K reference architectures. This testing provided the following key conclusions regarding stream counts and performance levels, when and where flash is the most cost-effective solution for high performance, higher-resolution workflows, and when a spinning disk configuration can provide better performance for less cost.

- Stream count was found to be as important a factor for media choice as stream data rates and capacity requirements for StorNext 4K Reference Architectures.
- 3.5" HDDs are best for a low number of compressed 4K stream counts requiring high capacity.
- 2.5" HDDs are best for a higher number of compressed 4K stream counts with mid-capacity requirements.
- SSDs are ideal for very high compressed 4K stream counts that require low capacity.

ABOUT QUANTUM

Quantum is a leading expert in scale-out tiered storage, archive and data protection. The company's StorNext® platform powers modern high-performance workflows, enabling seamless, real-time collaboration and keeping content readily accessible for future use and re-monetization. More than 100,000 customers have trusted Quantum to address their most demanding content workflow needs, including top studios, major broadcasters and cutting-edge content creators. With Quantum, customers have the end-to-end storage platform they need to manage assets from ingest through finishing and into delivery and long-term preservation. See how at **www.quantum.com/customerstories-mediaent**.

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