

A modern office interior with glass walls and a blue overlay. The background shows a bright, open-plan office space with large windows and a curved ceiling. A blue rectangular overlay covers the middle section of the image, containing the title and name. Below the overlay, a dark grey rectangular area contains the person's title. The Quantum logo is positioned in the bottom right corner, partially overlapping the dark grey area and the office floor.

ALL THINGS 4K

André Gignac

Pre-Sales Solutions Architect/Engineer/QXS Ambassador

Quantum

About your presenter



- 5 year Media Production Producer
 - Videographer, Writer, Director, Producer, Editor
- 10 year IT veteran
 - Apple System Administrator
 - Xsan Administrator
 - Quantum StorNext Administrator
- 5 year veteran of Media Solutions Design Architect/Engineer



The background features a dark, abstract composition with overlapping geometric shapes, including hexagons and circular patterns. A prominent blue banner is centered horizontally, containing the main title in white text. The overall aesthetic is technical and modern.

CHALLENGES AND LIMITATIONS TO 4K WORKFLOWS

Quantum

What Impacts 4K Performance

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➤ Data Rate

- Compressed or Uncompressed
- Resolution and Frame Rate



➤ Stream Count

- Number of cameras used in acquisition, composition layers, workstation requirements
- Mezzanine, proxy workflows, or RAW



➤ Host (Client) machine

➤ Drive type

Uncompressed - Defined

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8K UHD is on the way

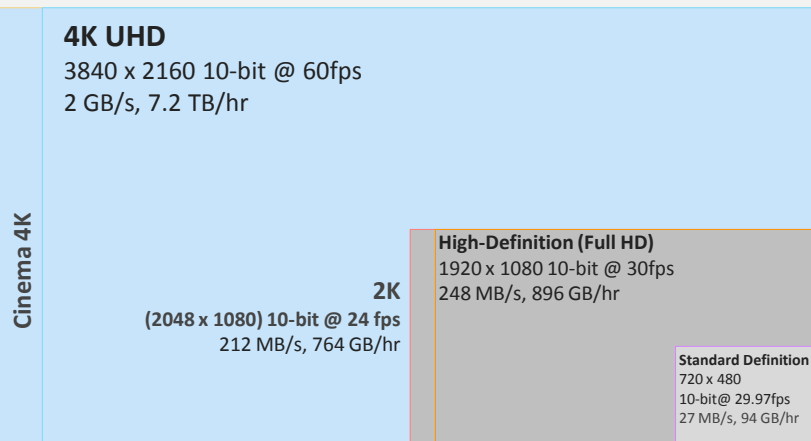
7680 x 4320 16-bit @ 60fps

12 GB/s, 12.9 TB/hr

The 4K Family

- Approx. 4X the horizontal resolution of HD
- 3840x2160, 4096x2160 most common
- 4096x3072, 4096x3112 variants
- All “4K”

4K DCI
(4096 x 2160) 10-bit @ 24fps
849 MB/s, 3.1 TB/hr



But All 4K Is Not Equal

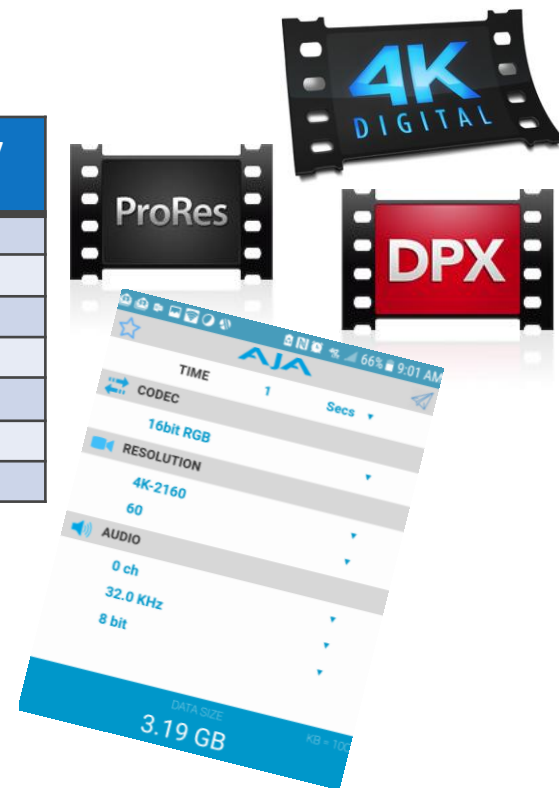


Tested formats and frame rates

4K Format	Resolution (W x H)	Frame Rate (fps)	Data Rates (MB/s)	Storage Capacity (GB/Hr)
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	2,905
		60	1990	7,164
4K Full App (10 bit)	4096 x 3112	24	1224	4,406
UHD (16 bit)	3840 x 2160	60	3190	11,484

4K Format Guide

- 4K is horizontal resolution of approx. 4,000 pixels
- There are several resolutions that qualify as 4K
- UHD or “Quad HD” is 4x HD resolution (TV)
- Full App 4K is Super 35mm resolution (Film)



How Operating Systems Differ

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- › Linux is the optimal performer

- More efficient HBA drivers



- › Windows drivers have more CPU overhead, less efficient

- Windows is 15% less efficient than Linux



- › 40-60% less efficient in multi-client environments than either

- macOS is overly aggressive with I/O requests



4K Challenges in Post



- › Flat-bidding
- › Unknown shooting ratios
- › Last-minute client demands

4K

- › UHDp60, HFR, HDR, WCG accelerating quality, consumption and delivery
- › Film / tape to RAW on disk
- › More cameras = more streams
- › VFX and grading = more bandwidth, nodes & disk



- Varying size and data rates challenge standard file systems
 - Reading, writing, tracking, sharing and protecting
- NAS-based HD will struggle with 4K workflows
 - Latency from packetization is real
- RAID 5 Performance/Protection Tradeoffs
 - Large TB drives in RAID 5 leave valuable media exposed during rebuilds



The Right Drive for the Job

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Matching Drive Type to Stream Count Requirements

▶ LFF HDDs

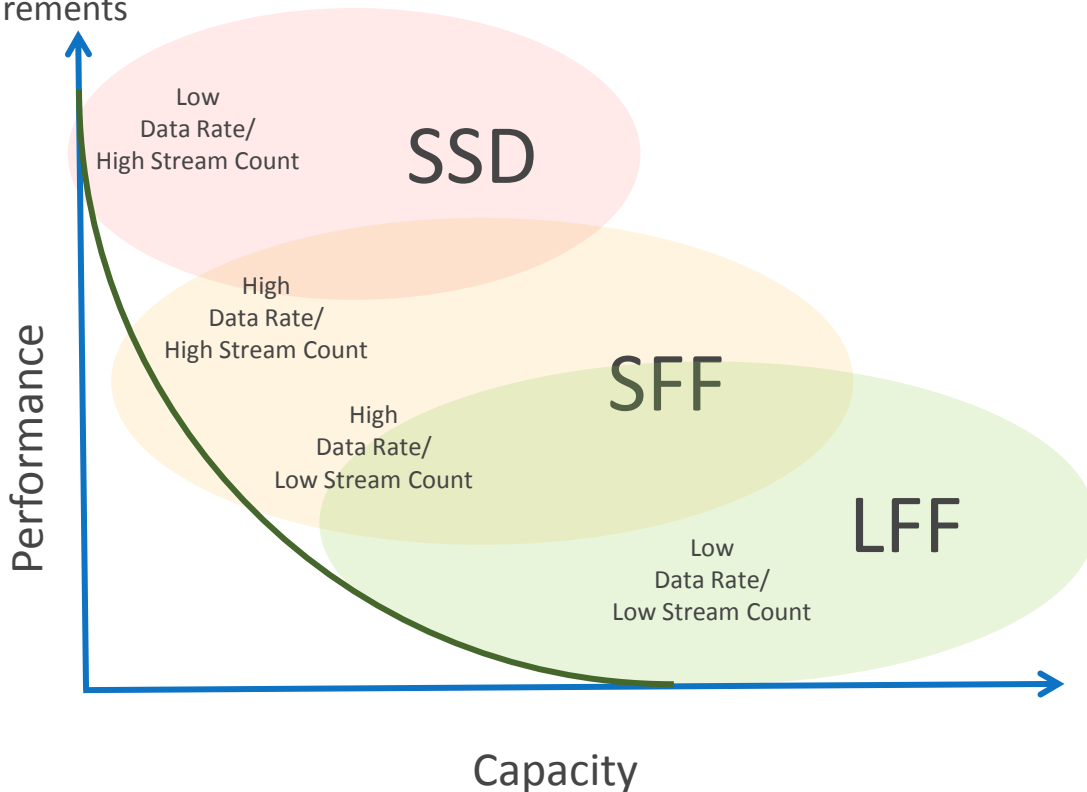
- High-capacity
- Low performance (7.2K RPM)
- Affordable

▶ SFF HDDs

- Low capacity
- High performance (10K RPM)
- Higher priced

▶ SFF Solid State Drives (SSDs)

- Lowest capacity
- Highest performance
- Highest price

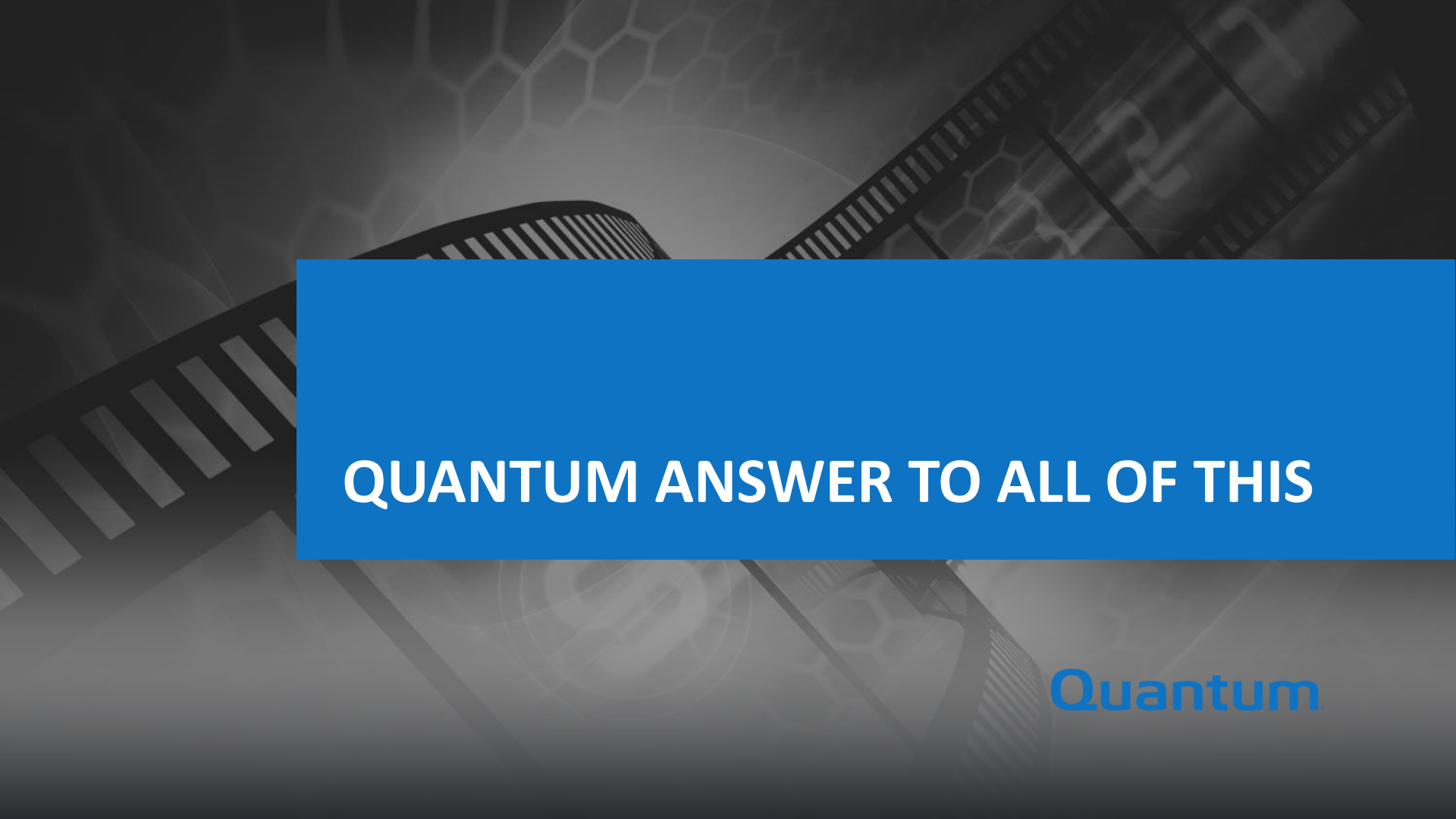


Host Interconnects Summary

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- Fibre Channel is still really good for AFA shared host connectivity
 - Dual 32Gb will get 8GB/s to a single host
 - Brocade claims 80% - 90% of AFA is on FC
 - 32Gb FC runs on a single piece of duplex fiber with LC-LC connectors
 - Lowest latency option
- iSCSI is ok
 - Packetized network will have higher latency than Fibre Channel
 - 40Gb Ethernet sounds fast but it is really 4x 10Gb (four cables or a special copper cable)
 - 25Gb Ethernet will help because it uses standard fiber with LC-LC connectors
- NAS
 - File based presentation will add overhead with the same networking as iSCSI
 - NetApp is positioning NAS with flash for archive as a future option with very low endurance flash
- NVMe
 - This is the future
 - NVMe Over Fabrics is how NVMe will get to the host (not commercially available yet)
 - EMC had DSSD using a direct PCIe network, it will not likely be a widespread option



The background is a dark, monochromatic composition of various geometric and architectural elements. It includes a honeycomb pattern in the upper left, a series of parallel lines forming a grid-like structure on the right, and a curved, ribbed shape on the left. A large, solid blue rectangular banner is positioned horizontally across the middle of the image, containing the text 'QUANTUM ANSWER TO ALL OF THIS' in white, bold, sans-serif capital letters.

QUANTUM ANSWER TO ALL OF THIS

Quantum

- StorNext 6!
- Specific benefits to 4K
 - QoS
 - Stripe Group management “Live”
 - Tunable parameters
 - ASR, ISW, Stripe breadth, # of stripe groups
- Xcellis more than just metadata servers
 - Converged Architecture
 - SAN, NAS, IB, Block over IP
 - DLC still stands out above and beyond most if not all Ethernet transport – Line Rate
- Performance shared file system across Linux, Windows and macOS
 - Who does that, and at these performance numbers?

StorNext 6



➤ Storage

— QXS

- QXS-3, QXS-4, QXS-6 Series Controllers
- LFF 7.2K HDD, SFF 10k HDD, SFF SSD
- Fiber Channel, 12Gb SAS, iSCSI
- One button configuration (OBC)

➤ Archive in 4K

— Archive is critical

- Use tools like Komprise and DataFrameworks for Analysis

— Use Storage Manager with confidence

— Expand StorNext to use Lattus, Tape, & Cloud as extensions of the filesystem

- Test!!
 - Storage direct connected, RAID only
 - Storage with StorNext
- Give real world guidance on what our solutions will support
 - 4K reference architectures
 - Updated sizing tools
 - Guaranteed performance
 - Built-in automated tuning

A grayscale photograph of chess pieces on a board, with a blue rectangular overlay on the right side containing the title text.

TESTING OVERVIEW

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Setup

Switch

- Brocade 32Gb Fiber Switch
- 1Gb Ethernet Metadata Network

Storage Configuration

- Rack elevation

Workstations

- Linux z840 32Gb 2-port FC
- Linux z840 32Gb 2-port FC
- Linux IBM 16Gb 4-port FC
- Windows Server 2-port 8Gb FC
- MAC Pro OSX 10.12 – Thunderlink 16Gb FC
- MAC Pro OSX 10.12 – Thunderlink 16Gb FC
- MAX Pro OSX 10.11 – Thunderlink 2-port 8Gb FC

Dell 10Gb Force10
Brocade G620 64 ports

QXS-424 (2.5"
1.2 TB)
2xRBOD
2xEBOD

QXS-412 (3.5"
4TB) RBOD+EBOD

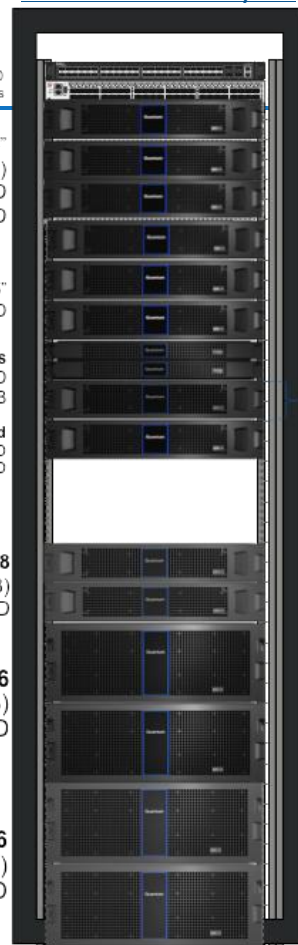
Xcellis
Dedicated MD
- 12x900GB

QXS-424 Hybrid
12x400GB SSD
12x1.2TB HDD

QXS-648
(2.5" 1.8TB)
RBOD + EBOD

QXS-656
(3.5" 8TB)
RBOD+EBOD

QXS-456
(3.5" 4TB)
2xRBOD



What was used to produce streams of 4K

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Unconstrained RAW performance baseline

- Push all clients to the maximum performance to show maximum performance of controller
 - This is how we first discovered the flooding of IO on the controller from OSX
 - Read ahead cache settings not optimal

Applications - streams baseline

- Davinci Resolve
 - Linux
 - macOS

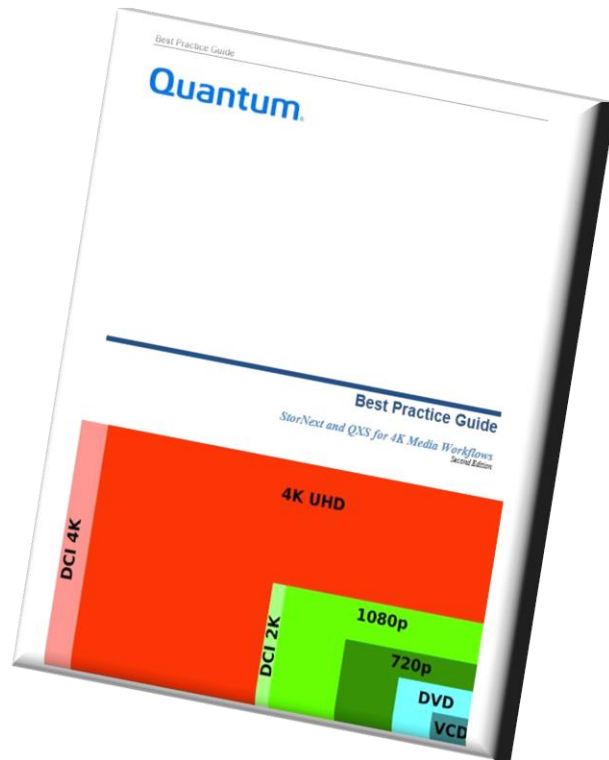
Utilities – count those streams

- vidio
 - Sample streams (first line is compressed simulation of Prorez 4444 XQ)
 - `vidio -c -d -f 8690074 -n 10000 -N 10000 -F 30 -v -w dir1 dir 2 dir 3 ....`
 - `vidio -c -d -f fa4k -n 5000 -F 24 -v -w dir1 dir2 dir 3 ....`
- frametest
 - Sample streams
 - `frametest -w 8486 -n 10000 -s -f 30 -t 1 dir1`
 - `Frametest -w 4k -t 4 -n 5000 -f 24 dir1`

Best Practices Guide: Second Edition



- Recommendations on:
 - All flash array configurations
 - QXS-4
 - QXS-6
- Spindle speed comparisons
- Operating system performance attributes
- Appendix for media formats and bitrates



Compressed Stream Count by Product

		Compressed											
		Apple ProRes 422 HQ 30 fps				Apple ProRes 422 HQ 60 fps				Apple ProRes 4444 XQ 30 fps			
		0% Fill		85% Fill		0% Fill		85% Fill		0% Fill		85% Fill	
		Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read
QXS-6	QXS-648 RAID	40	32	36	23	20	16	18	13	17	15	17	13
	QXS-648 RAID + Expansion	40	64	48	60	20	38	23	30	20	26	14	27
	QXS-656 RAID	39	31	39	19	19	16	19	11	18	14	18	10
	QXS-656 RAID + Expansion	46	48	47	32	23	15	22	10	21	12	21	12
QXS-4	QXS-456 RAID	31	19	26	14	18	10	13	6	16	9	12	5
	QXS-456 RAID x2	48	28	42	27	30	16	29	13	29	17	22	14
	QXS-424 RAID	19	12	17	13	9	6	9	5	8	8	7	5
	QXS-424 RAID + Expansion	33	20	29	17	17	10	15	7	15	9	13	8
	QXS-424 RAID x2 + Expansion x2	59	35	49	28	35	22	28	13	31	22	23	16
	QXS-412	13	8	11	6	6	4	6	3	6	4	7	4
	QXS-412 + Expansion	25	11	19	8	13	7	10	4	12	6	8	6

► Uncompressed Stream Count by Product

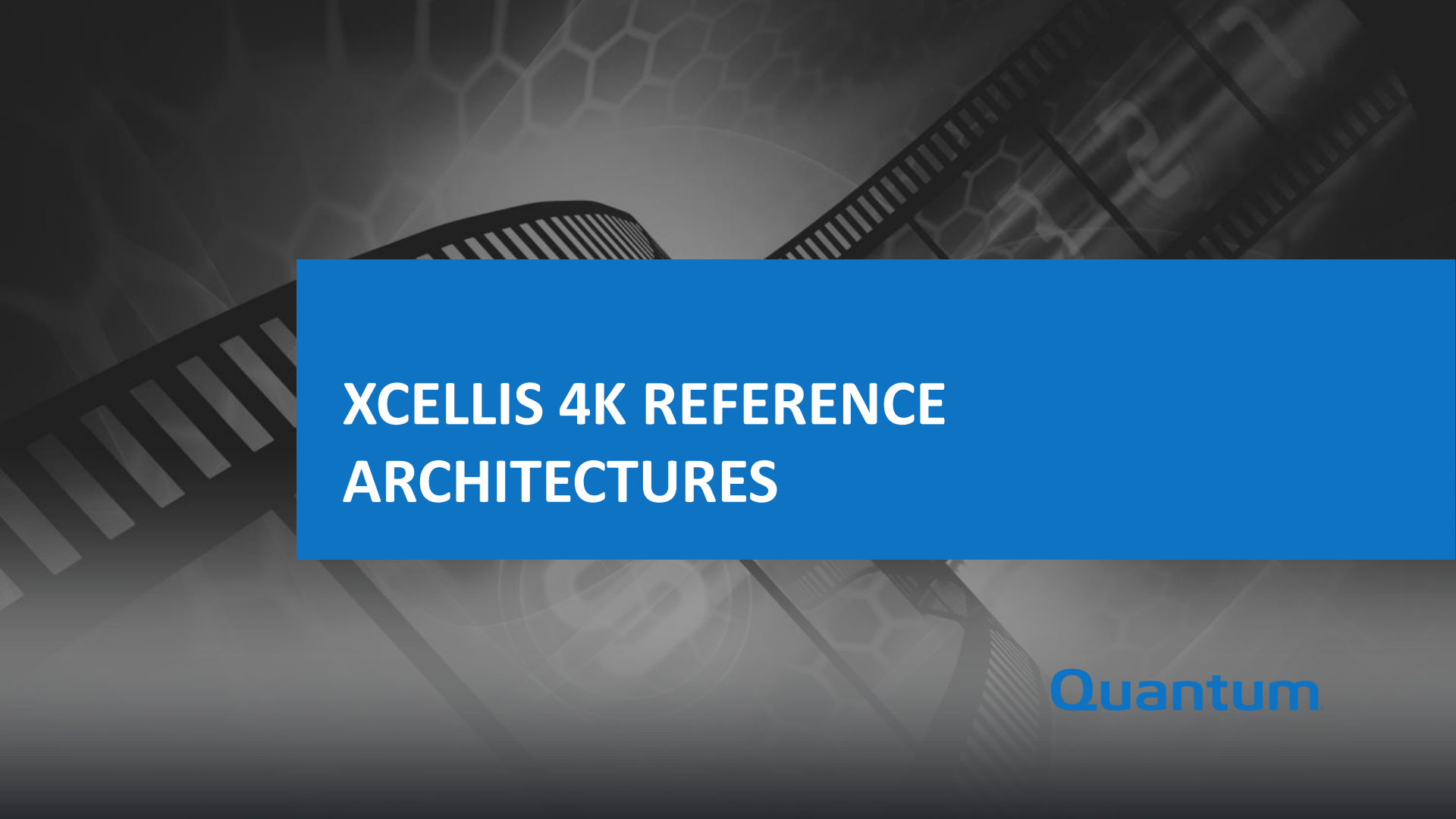
		Uncompressed											
		4K Quad HD (10-bit) 24 fps				4K Full (10-bit) 24 fps				4K Quad HD (10-bit) 60 fps			
		0% Fill		85% Fill		0% Fill		85% Fill		0% Fill		85% Fill	
		Write	Read	Write	Read	Write	Read	Write	Read	Write	Read	Write	Read
QXS-6	QXS-648 RAID	6	6	5	5	3	4	3	3	2	2	2	2
	QXS-648 RAID + Expansion	6	8	6	9	4	5	4	6	2	2	2	3
	QXS-656 RAID	6	6	5	6	3	4	3	4	2	2	2	2
	QXS-656 RAID + Expansion	6	11	6	7	4	8	4	5	2	4	2	2
QXS-4	QXS-456 RAID	3	3	4	4	3	3	3	2	2	1	2	1
	QXS-456 RAID x2	10	8	8	8	7	6	5	5	3	3	3	3
	QXS-424 RAID	3	3	2	2	2	2	2	1	1	1	1	1
	QXS-424 RAID + Expansion	5	5	4	4	3	3	2	2	2	2	2	1
	QXS-424 RAID x2 + Expansion x2	10	9	10	7	7	7	5	5	3	3	2	2
	QXS-412	2	1	2	1	1	0	1	0	0	0	0	0
	QXS-412 + Expansion	4	3	2	2	2	2	2	2	1	1	1	1

SSD Stream Count by Product

		Compressed											
		Apple ProRes 422 HQ 30 fps				Apple ProRes 422 HQ 60 fps				Apple ProRes 4444 XQ 30 fps			
QXS SSD	QXS-424 RAID ALL SSD	24	49	35	49	16	24	15	24	10	22	14	22
	QXS-648 with 24 SSDs	32	49	36	54	15	28	15	27	13	25	17	18
	QXS-648 with 24 SSDs	41	67	39	66	20	32	19	32	18	30	17	30
Seagate SSD	Seagate 5825 AFA 24x400GB 12Gb	42	55			20	27			18	26		
	Seagate 4825 AFA 24x400GB 12Gb	42	54			20	27			18	25		

		Uncompressed											
		4K Quad HD (10-bit) 24 fps				4K Full (10-bit) 24 fps				4K Quad HD (10-bit) 60 fps			
QXS SSD	QXS-424 RAID ALL SSD	4	6	4	6	2	3	3	3	2	2	1	2
	QXS-648 with 24 SSDs	4	7	5	7	3	4	2	4	2	3	1	3
	QXS-648 with 24 SSDs	5	9	5	9	3	6	3	6	2	3	2	3
Seagate SSD	Seagate 5825 AFA 24x400GB 12Gb	6	6			4	4			2	2		
	Seagate 4825 AFA 24x400GB 12Gb	4	6			3	4			2	2		

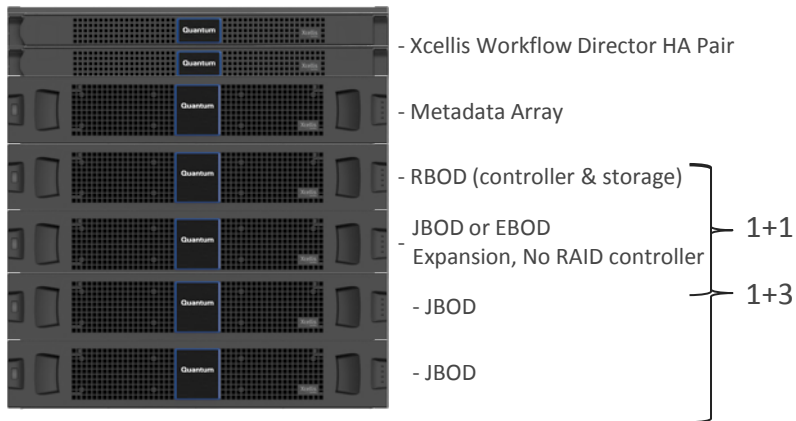
- Consistent measurement environment
- Performance testing is never ending
 - Continue to test/learn about
 - New drives
 - Arrays
 - Configurations
- In the queue
 - Ethernet (NAS/DLC) testing over 1GbE, 10GbE, 40GbE network (streams counts)
 - Q-tier testing with live Maya renders over a 40 core render farm (nearly complete)
 - Additional AFA testing with Seagate and NetApp e-series arrays
- Continue to work with vendor partners to identify areas of improvement

The background features a dark, abstract composition with overlapping geometric shapes, including hexagons and circular patterns. A prominent blue horizontal bar spans the middle of the image, serving as a backdrop for the title text.

XCELLIS 4K REFERENCE ARCHITECTURES

Quantum

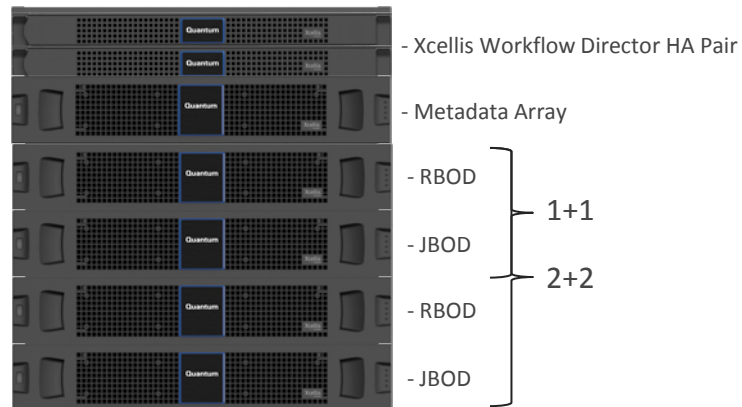
How StorNext Scales



“Scale-up”

Adding storage to an existing controller/storage (RBOD) chassis

- Capacity upgrade with slight increase in performance from additional spindles
- Too many spindles can saturate the controller



“Scale-Out”

Adding RBOD chassis to existing RBOD chassis (with or without expansion)

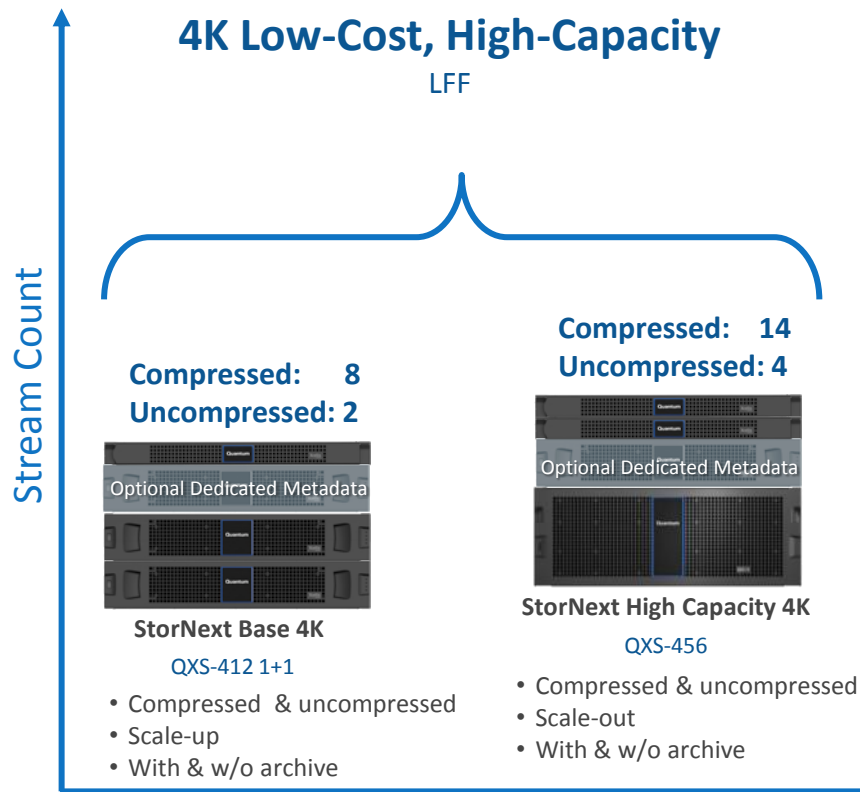
- Simultaneous performance and capacity upgrade
- Performance nearly doubles on 4-series controller

4K Reference Architectures

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4K Low-Cost, High-Capacity

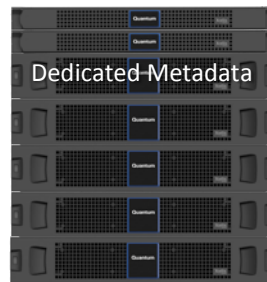
LFF



4K Performance

SFF

Compressed: 28
Uncompressed: 7



StorNext Performance Disk 4K

QXS-424 2+2

- High compressed stream count
- Low, multiple uncompressed stream count
- Scale-out or scale-up
- Archive-ready

4K High-Performance

SFF SSD

Compressed: 66
Uncompressed: 9



StorNext All Flash 4K

QXS-648 w/ SSDs

- Very high compressed stream count
- Multiple, uncompressed stream count
- Scale-out or scale-up
- Archive-ready

Price

4K Low-cost, optional archive support



Converged or Dedicated Metadata with 3.5" drives

QXS-412

- Single RAID, compressed only
- Must scale-up for uncompressed support
- 4TB or 6TB HDDs for 48 or 72TB per chassis
- Add 12x900GB 10K for dedicated MD
 - Dedicated MD needed Storage Manager archiving
 - Optional upgrade to 400GB or 800GB SSDs



Xcellis Workflow Director
Dedicated Metadata
Xcellis Workflow Director HA Pair
Metadata
User Storage

Power of ² Expansion = add 1 JBOD
for uncompressed

Power of ² Expansion = add 3 JBODs
for multi-stream uncompressed

Xcellis System	4K Support	ProRes 422 HQ 30 fps	ProRes 4444 XQ 60 fps	Full AP (10 bit) 24 fps	UHD (10 bit) 60 fps	Capacity (4TB Drives)
QXS-412	Low, compressed stream count	6	3	N/A	N/A	48
QXS-412 1+1	Low compressed stream count, two uncompressed	8	4	2	1	96
QXS-412 1+3	Multi-compressed stream count, two uncompressed	15	6	2	1	192

4K Low-cost, optional archive support



Converged or Dedicated Metadata with 3.5" drives

► QXS-456

- Uncompressed (DPX) capable
- Scale-Out Only: 448 or 672TB w/ 2xRBODs
- 4TB or 6TB for 224/336TB capacity w/ 1xRBOD
- Add 12x900GB 10K for dedicated MD
 - Dedicated MD needed for SNSM archiving
 - Optional upgrade to 400GB or 800GB SSDs



Xcellis Workflow Director HA Pair

Dedicated Metadata

Converged Metadata

RAID expansion only, no JBOD
x2

Xcellis System	4K Support	ProRes 422 HQ 30 fps	ProRes 4444 XQ 60 fps	Full AP (10 bit) 24 fps	UHD (10 bit) 60 fps	Capacity (4TB Drives)
QXS-456	Multi-stream compressed, two uncompressed	14	6	2	1	224
QXS-456x2	High compressed stream count, multi-stream uncompressed	24	17	6	2	448

4K Performance, archive ready



Dedicated metadata array w/ 2.5" drives

- QXS-424 1+1
 - Dedicated 900GBx12 MD, optional SSD
 - High compressed and multi-stream uncompressed
 - 1.2TB/1.8TB drives for 29/43TB per chassis
- Add 1+1
 - Total Capacity 115/172TB
 - Scale to 28 compressed/5 uncompressed
- Super High-Density QXS-448 option
 - 58/86TB per chassis



Xcellis Workflow Director HA Pair

Dedicated Metadata, Archive Ready

RBOD + JBOD for high compressed stream counts and multi-stream uncompressed

Add 1+1 for high stream counts to multiple rooms or dual stream uncompressed to multiple rooms

Xcellis System	4K Support	ProRes 422 HQ 30 fps	ProRes 4444 XQ 60 fps	Full AP (10 bit) 24 fps	UHD (10 bit) 60 fps	Capacity (1.2TB Drives)
QXS-424 1+1	Multi-stream compressed, two uncompressed	17	7	2	1	57.6 TB
QXS-424 2+2	High compressed stream count, multi-stream uncompressed	28	13	5	2	115.2 TB

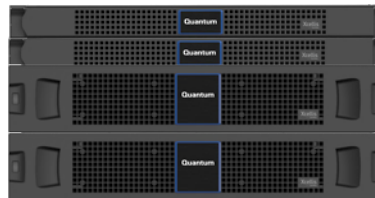
4K High Performance, archive ready



Dedicated metadata array, SSD

QXS-424 All Flash Array

- Scale-Out Only: 2U24 and 2U48 chassis
- QXS-4 or QXS-6
- 400GB, 800GB, 1600GB SSDs
- Always use dedicated MD
 - 900GB HDD or SSD based MD array
 - Optional upgrade to 400GB or 800GB SSDs



Xcellis Workflow Director HA Pair

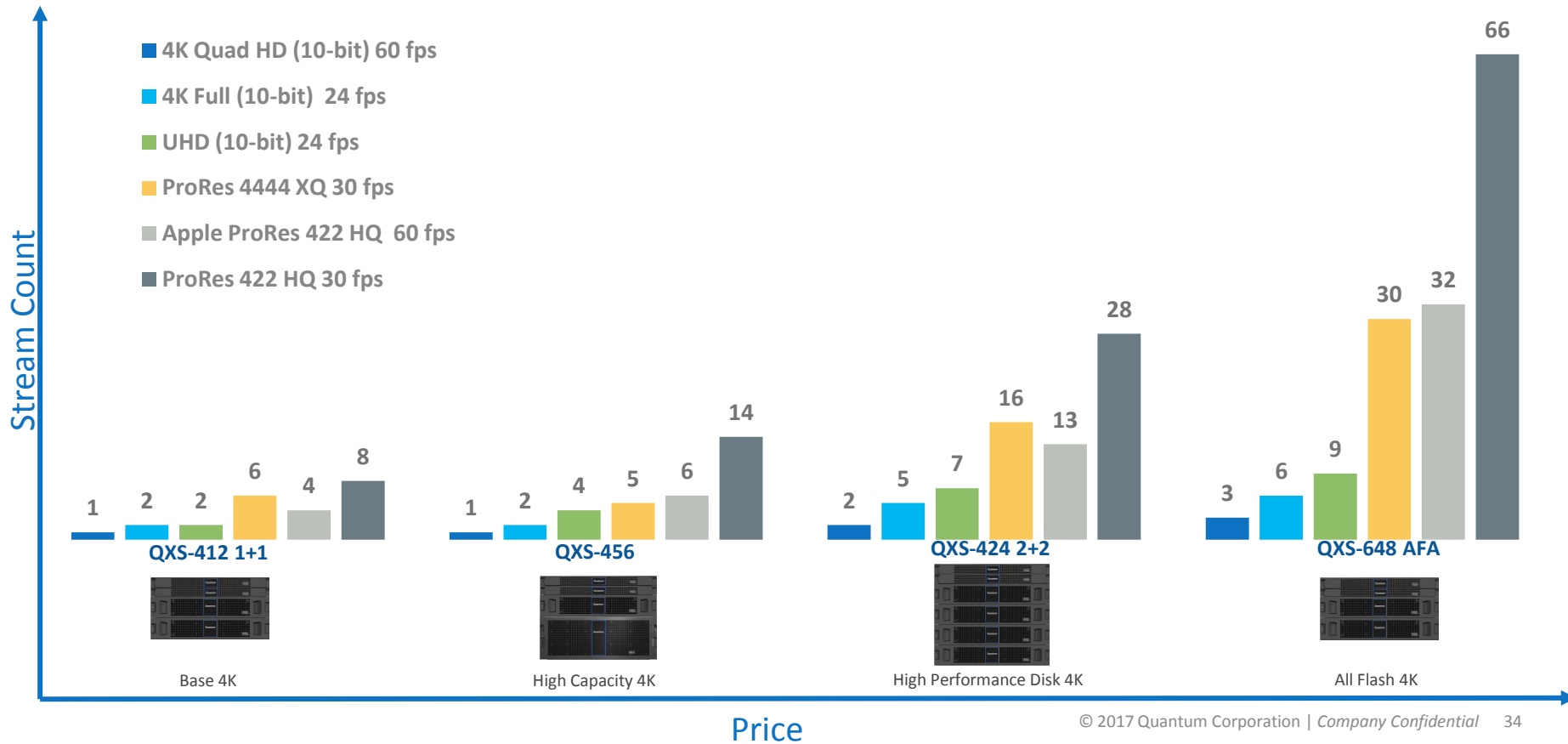
Dedicated Metadata, Archive Ready

RBOD + with 24 400 TB SSDs for multi-stream uncompressed

Xcellis System	Target	ProRes 422 HQ 30 fps	ProRes 4444 XQ 60 fps	Full AP (10 bit) 24 fps	UHD (10 bit) 60 fps	Capacity (400GB Drives)
QXS-424 RAID All Flash	Very high compressed stream count, multi-stream uncompressed	49	24	3	2	9.6TB
QXS-648 RAID All Flash	Very high compressed stream count, multi-stream uncompressed	66	32	6	3	19.2TB

4K Reference Architectures

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The background features a dark, monochromatic composition of overlapping geometric shapes, including hexagons and circular patterns, creating a sense of depth and complexity. A solid blue rectangle is positioned horizontally across the middle of the image, serving as a backdrop for the text.

& BEYOND...

Quantum

Beyond 4K is 8K



8K UHD is on the way

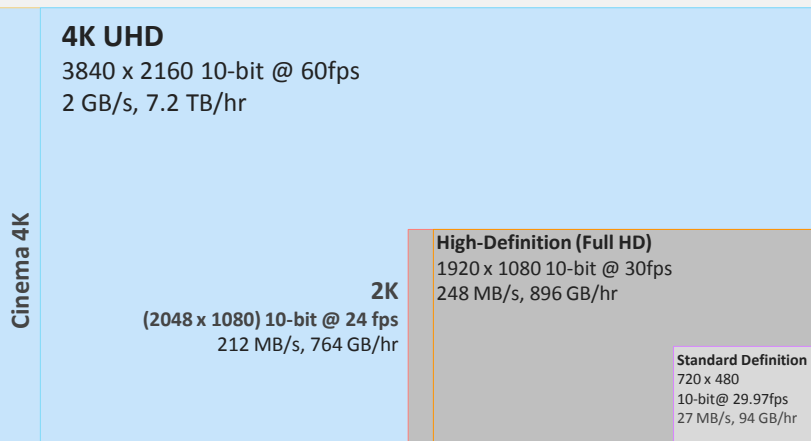
7680 x 4320 16-bit @ 60fps

12 GB/s, 12.9 TB/hr

The 4K Family

- Approx. 4X the horizontal resolution of HD
- 3840x2160, 4096x2160 most common
- 4096x3072, 4096x3112 variants
- All “4K”

4K DCI
(4096 x 2160) 10-bit @ 24fps
849 MB/s, 3.1 TB/hr



➤ 8K UHD Challenges

— Size

- 8K compressed ProRes 4444 (XQ) @ 24 fps = 902.38 MB/s per stream
- 8K uncompressed 10-bit RGB @ 24fps = 3.19 GB/s per stream
- 8K uncompressed 10-bit RGB @ 60fps = 7.96 GB/s per stream
- 8K uncompressed 16-bit RGBA @ 60fps = 15.93 GB/s per stream

• *How do you deliver this to the workstation, monitor, end user???*

➤ 8K UHD Challenges

— Infrastructure

- Fibre – only option with enough throughput & low latency
 - 16Gb – Minimum
 - 32Gb – Optimal, required for 60p
 - » 2x Celerity FC-322E per workstation for 60
- Storage – 10k SAS or SSD
- Backup / Archive – much larger files require LTO-7 or Object Storage
 - Object Storage – Optimal due to speed

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