

The background of the slide is a deep space image featuring a large, glowing spiral galaxy in the upper half and a smaller, more distant galaxy in the lower half. The galaxies are composed of bright yellow and orange light, with intricate patterns of stars and dust. The surrounding space is a deep black, punctuated by numerous small, distant stars and nebulae. The overall effect is one of vastness and cosmic scale.

Explosive Growth of Content in Professional Media and Entertainment- A Paradigm for Enterprise Storage Growth

Tom Coughlin, Coughlin Associates

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About the Presenter

Thomas M. Coughlin, President, Coughlin Associates is a widely respected storage analyst and consultant. He has over 30 years in the data storage industry. Dr. Coughlin has many publications and six patents to his credit. Tom is also the author of Digital Storage in Consumer Electronics: The Essential Guide, published by Newnes Press. Tom publishes the *Digital Storage Technology Newsletter*, the *Digital Storage in Media and Entertainment Report*, and other reports.

Tom is active with SMPTE, SNIA, the IEEE, and other professional organizations. He is VP of Future Directions for the IEEE Consumer Electronics Society as well as Director Elect for IEEE Region 6. He is serving his third term as a member of the CE Society BoG and was Vice President of Operations for three years. Tom is the founder and organizer of the Annual Storage Visions Conference, a partner to the International Consumer Electronics Show, as well as the Creative Storage Conference. He is the general chairman of the annual Flash Memory Summit. nnesota as well as a BS in Physics from the same school.

Outline

- Why We Should Care about Digital Storage
- Media and Entertainment Storage Survey
- Digital Storage in Content Capture
- Post-production Digital Storage
- Digital Storage in Content Delivery
- Content Preservation and Archiving
- Breakdown of Storage Capacity and Revenue for Media and Entertainment Applications

Example resolution, data rates and storage capacity requirements for professional media standards

Format	Resolution (width X height)	Frame Rate (fps)	Data Rates (MBps)	Storage Capacity/Hour (GB)
SDTV (NTSC, 4:2:2, 8-bit)	720 X 480	~30	31	112
HDTV (1080p, 4:2:2, 8-bit)	1920 X 1080	24	149	537
Digital Cinema 2K (4:2:4, 10-bit) YUV	2048 X 1080	24	199	716
Digital Cinema 4K (4:4:4, 12-bit) YUV	4096 X 2160	48	1,910	6,880
Digital Cinema 8K (4:4:4, 16 bit) ¹	7680 X 4320	120	23,890	86,000

8K Ultra-HD may use more than 100X capacity of HD!

8K X 4K based upon “Super Hi-Vision” Video Parameters for Next Generation Television, SMPTE Motion Imaging Journal, May/June 2012, P. 63-68

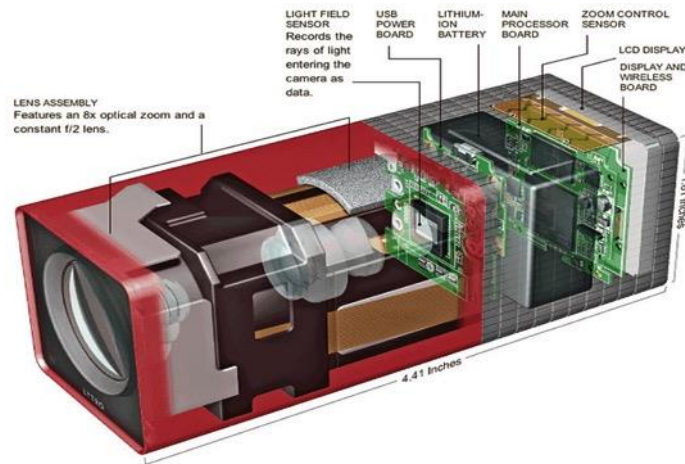
Richer Images = more storage

- Frame rates for movie content are increasing from the historical 24 frames per second (fsp) to 48 or 60 fps and may eventually be as high as 300 fps.
- Cameras are now available that can support 120 fps (even up to 3,000 fps)
- 4K production is commonplace but 6K and even 8K movie production starting in professional video projects.
- Video resolutions of 16K and even higher are contemplated in the future.

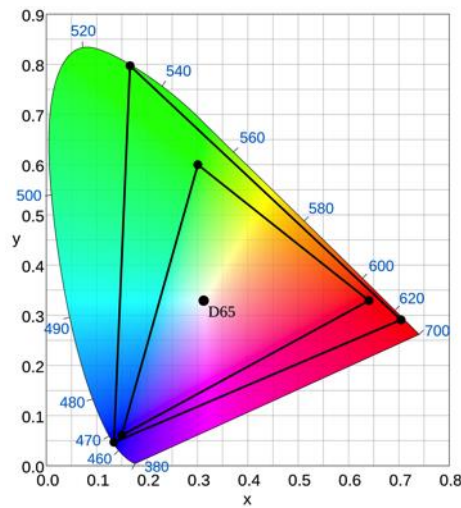




Free View Point Video



Lytro
Light-field
Camera



Increase in
Color Gamut,
Dolby Vision

New Views

- KDDI and some European players have performed “free viewpoint” demonstrations with content captured using 4-30 4K video cameras simultaneously.
- Light-field imaging could allow even more immersive 2D and 3D video (greater image depth possible) and would increase required storage capacity by at least 3X conventional images
- Color gamut increases as well as better contrast and extended luminance levels

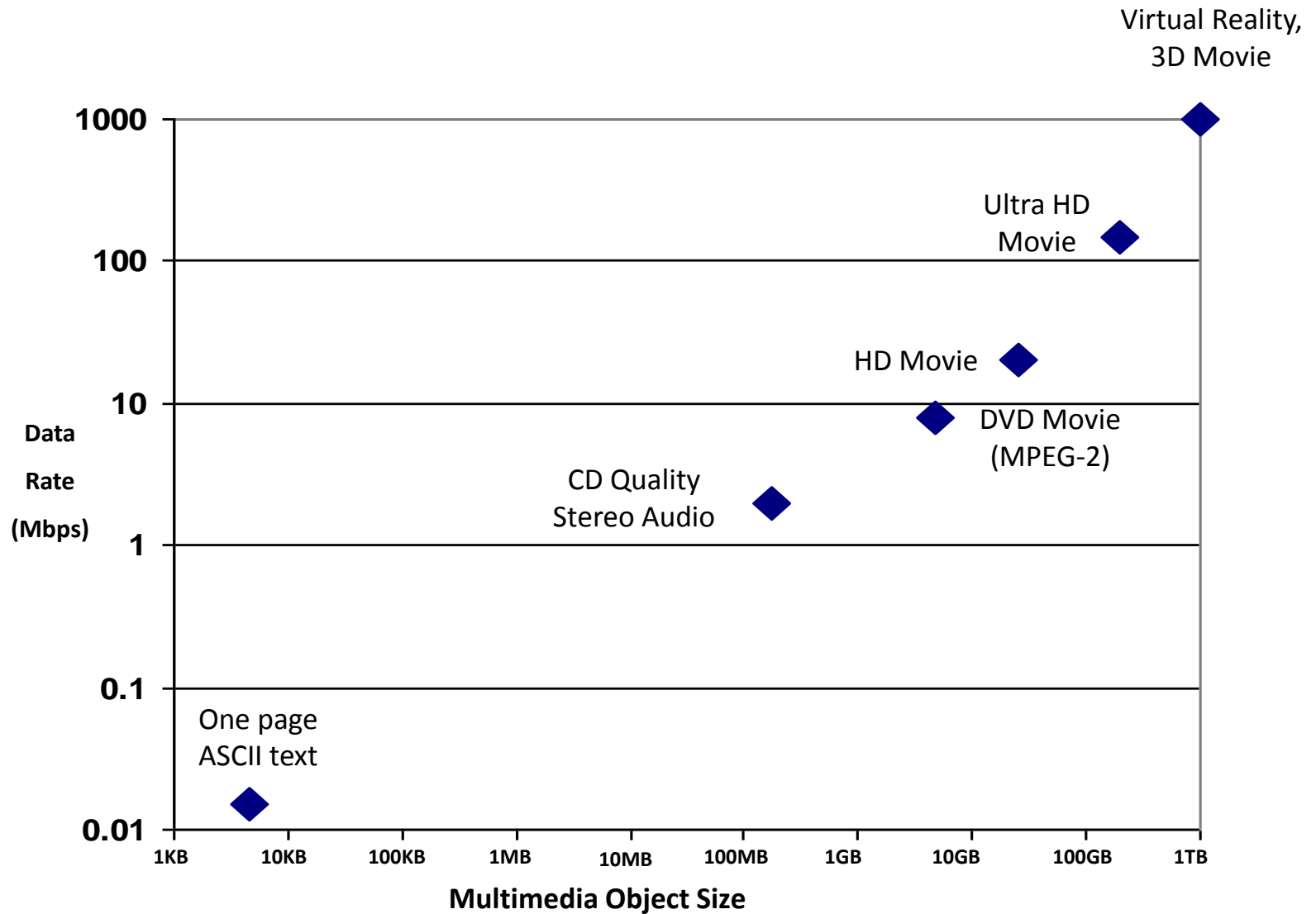
Panoramic Video and VR (2015 IBC)



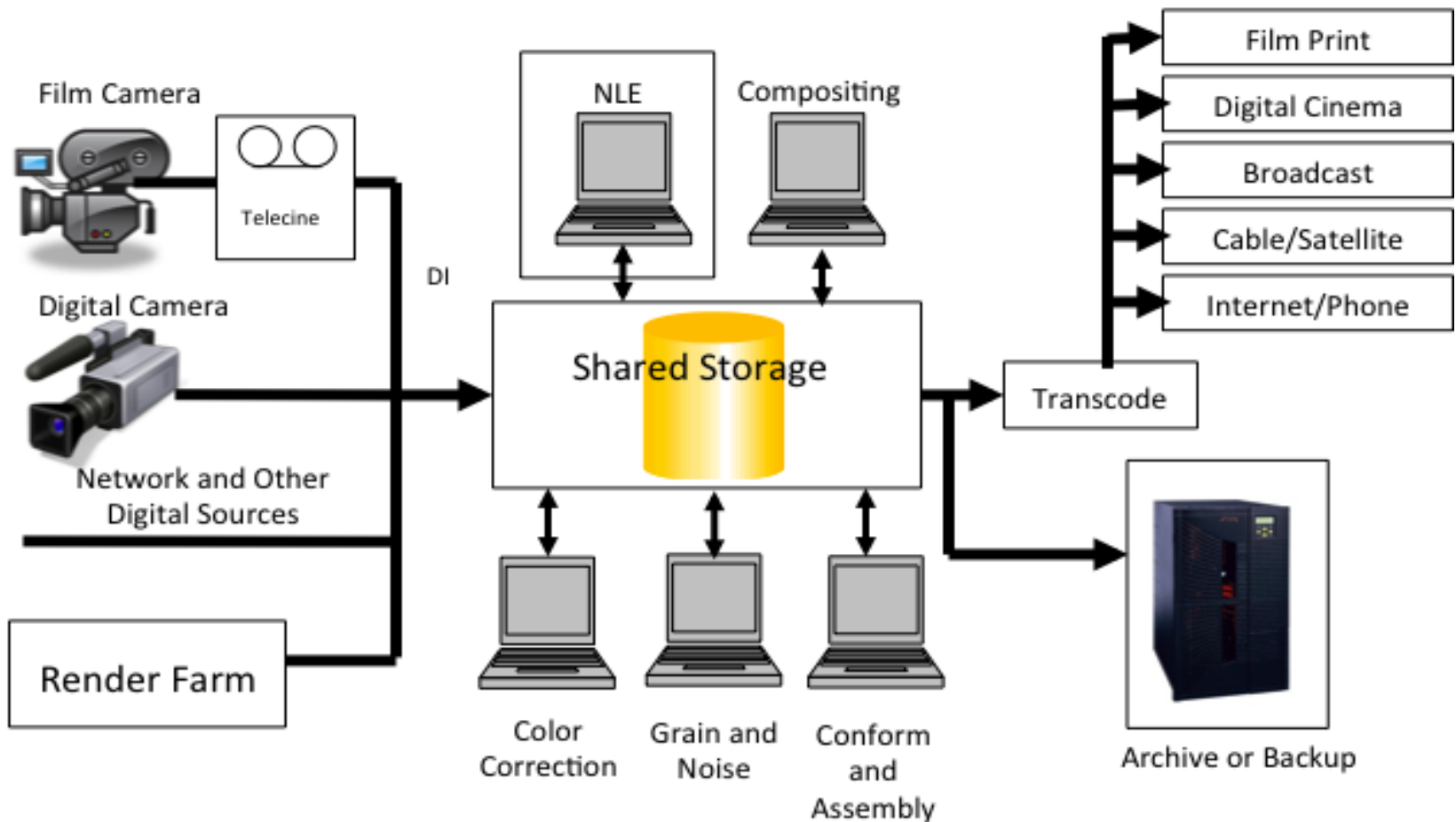
How Long Until Exabyte Video?

- As video resolution and frame rate increase, camera image complexity increases and stereoscopic projects multiply, the storage capacity and bandwidth performance requirements becomes staggering.
- A calculation shows that 16,000 X 8,000 pixel resolution, 24 bits/pixel, 300 fps raw video content could require **115 GB/s data rates and 414 TB/hour**. If 4 cameras were used to create data for a “free viewpoint” presentation the raw data would be **1.66 PB for an hour of content**
- Truly the bandwidth and capacity requirements to work with future rich media formats are staggering!

Media Content Size Trends



Digital Entertainment Content Workflow.

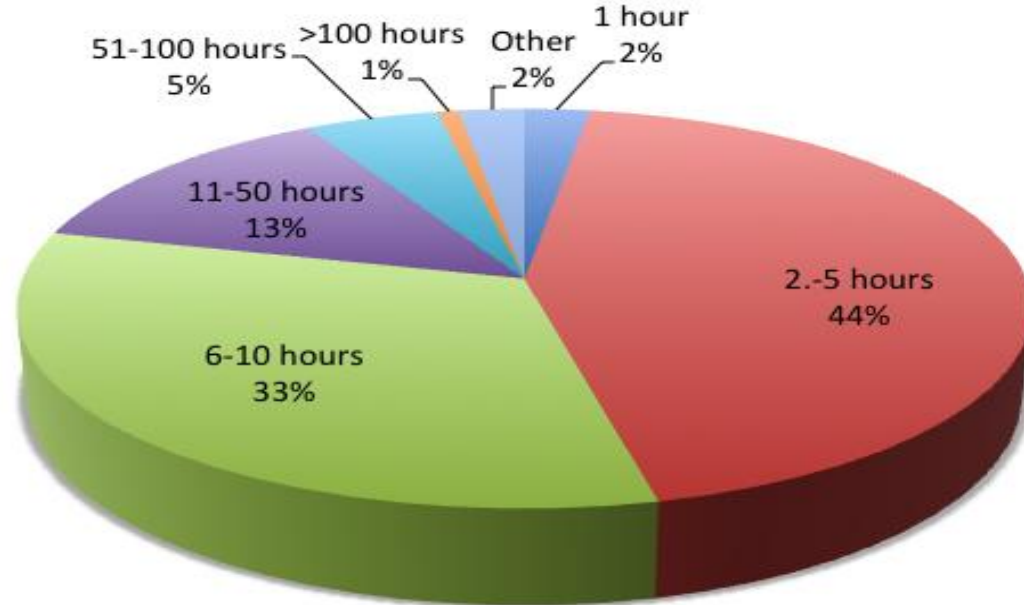


Content Acquisition (2)

Percent Born Digital

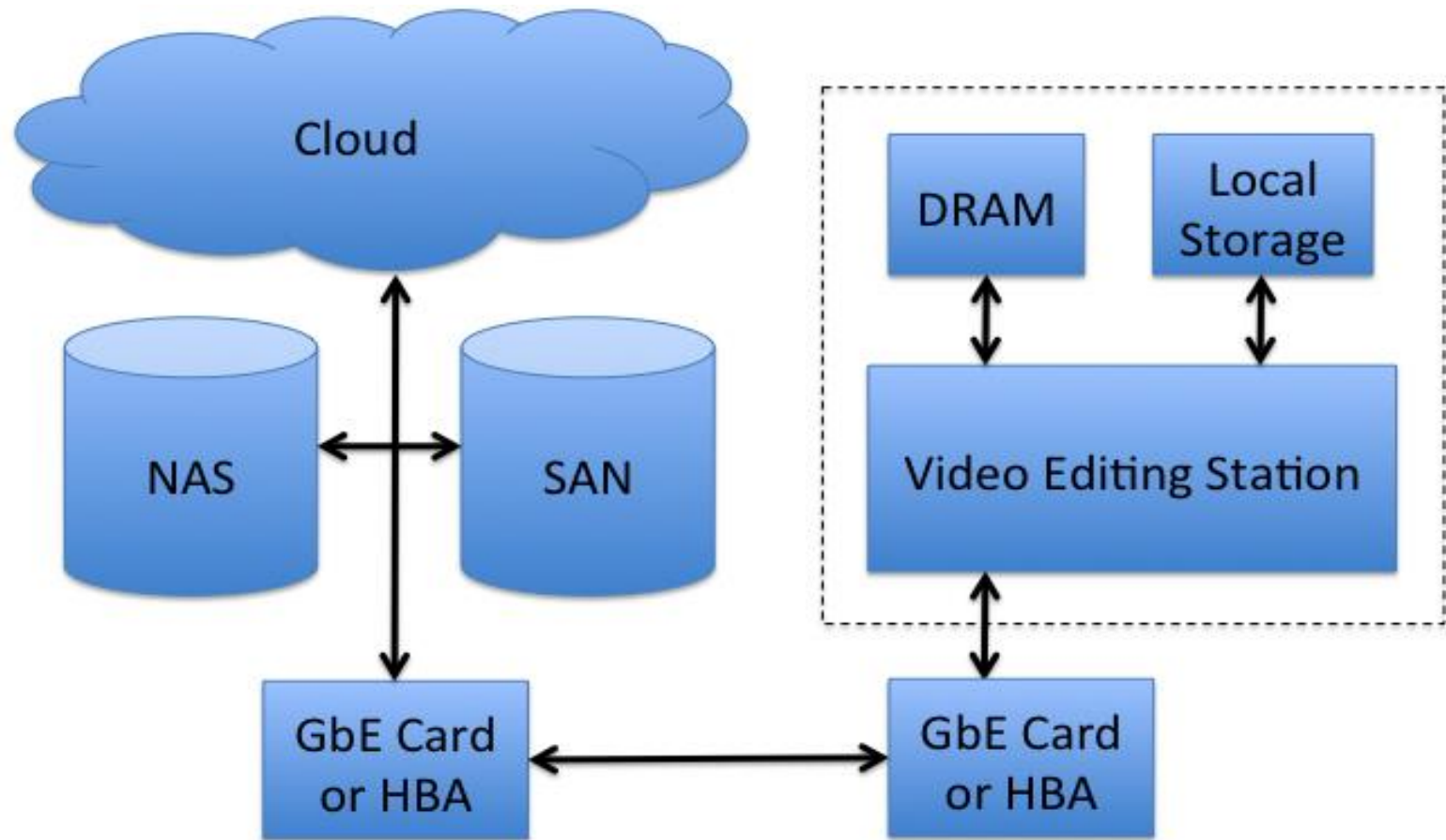
	2010	2012	2013	2014	2015
<10%	3.9%	0.9%	1.1%	0.0%	0.0%
11% to 20%	1.3%	0.4%	0.0%	1.1%	1.6%
21% to 30%	3.2%	0.0%	0.0%	1.1%	1.6%
31% to 40%	3.2%	2.6%	1.1%	2.1%	1.6%
41% to 50%	5.2%	2.2%	3.3%	2.1%	0.8%
51% to 60%	5.2%	1.7%	2.2%	1.1%	1.6%
61% to 70%	5.8%	3.1%	6.5%	4.2%	1.6%
71% to 80%	8.4%	8.3%	10.9%	7.4%	5.7%
81% to 90%	16.1%	10.9%	15.2%	15.8%	7.3%
91% to 100%	47.7%	69.9%	59.8%	65.3%	78.0%

Hours captured for an hour of final content

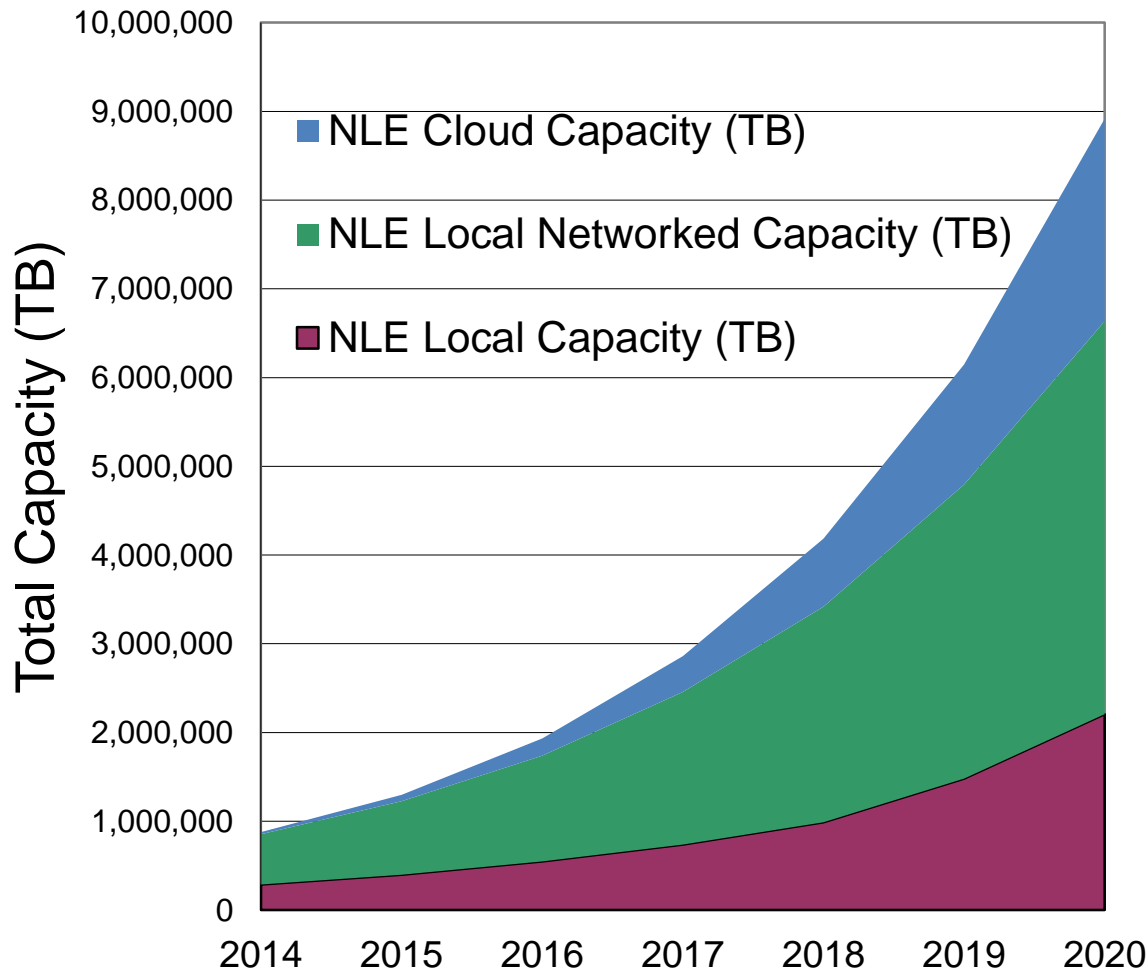


54.6% of Respondents said they capture 6 or more hours of content for 1 hour of finished work

Professional Non-linear Editing Model System

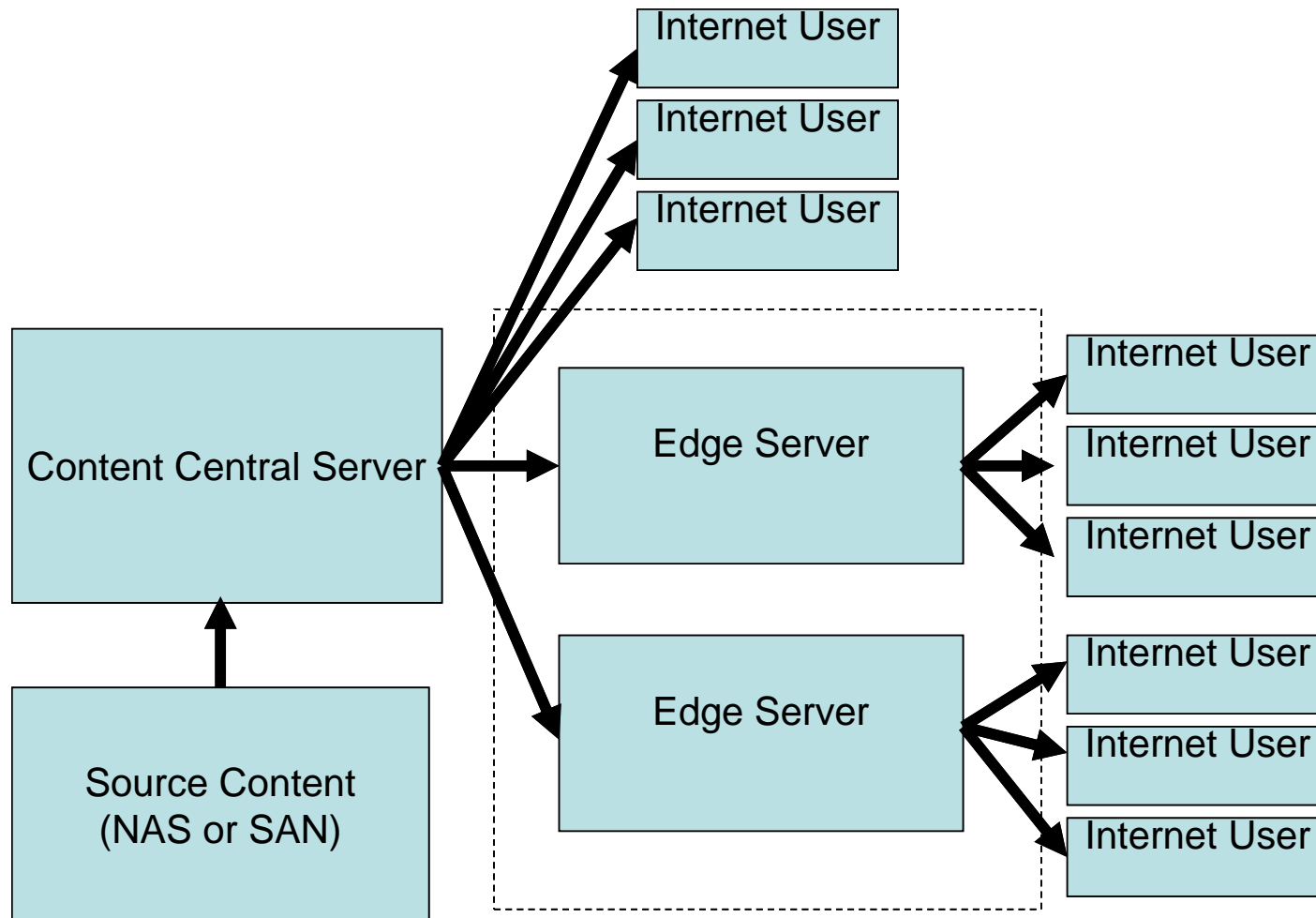


Post Production



- In 2015 30.2% of responding participants said they used cloud-based storage for post production versus 25.6% in 2014, 24.7% in 2013 and 15.1% in 2012.
- In 2015 32.9% of the respondents said that they had 1 TB or more storage capacity in the cloud vs. 28.1% in 2014 and 23% in 2013.

Internet Content Distribution System (CDN)



Content Distribution

- Average hours on central content delivery system was about 4,182 hours in 2015
- There were 492 hours ingested monthly in 2015
- In 2015 43% of respondents had more than 5% of their content on edge servers
- About 20% used flash memory on their edge servers

Digital Cinema (Mercado Theatre, Santa Clara)



Digital Cinema Projector



**USB hard drive For movie
distribution to theatre**

Content Archiving Media

Optical
Disc



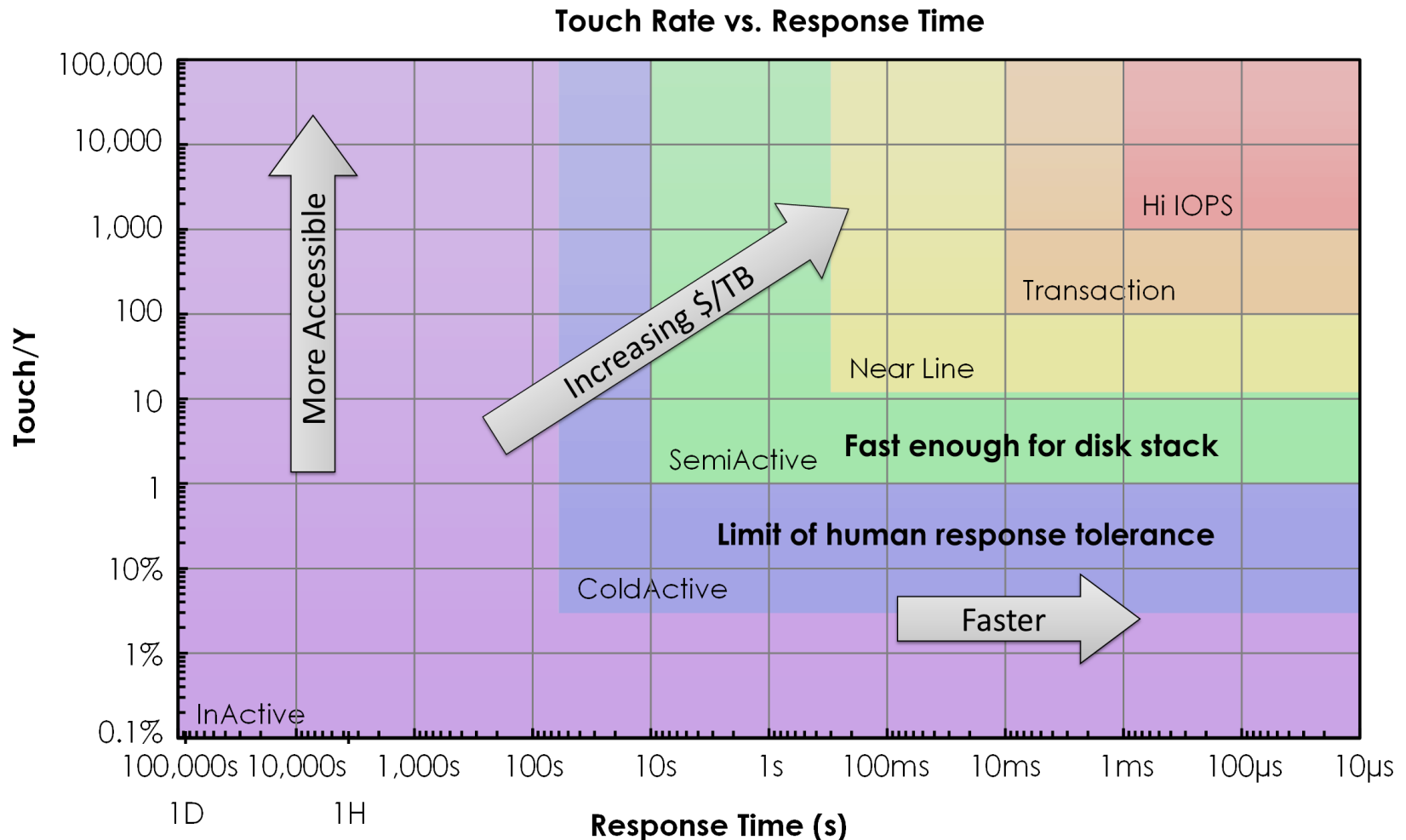
HDDs



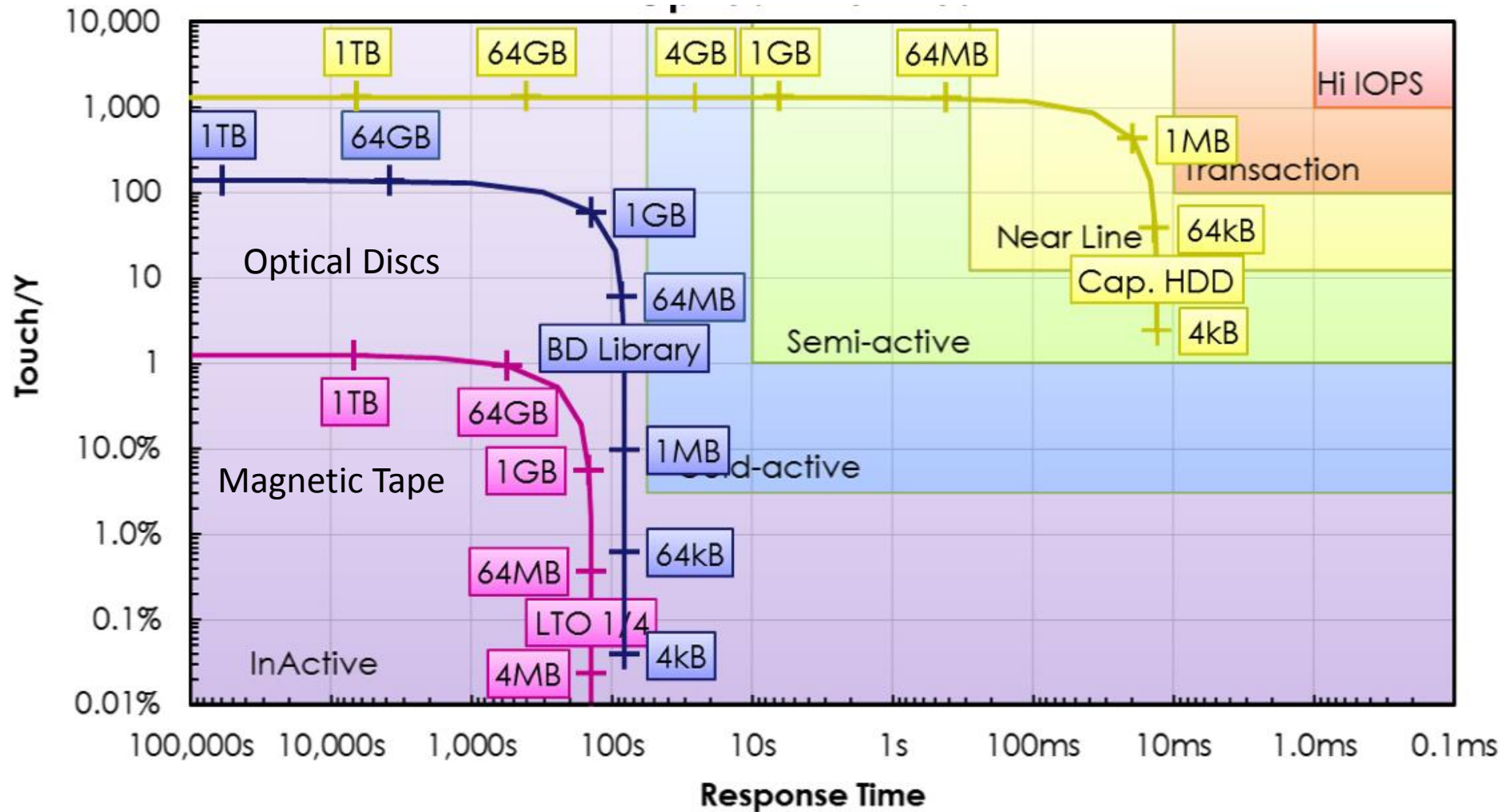
Magnetic
Tape



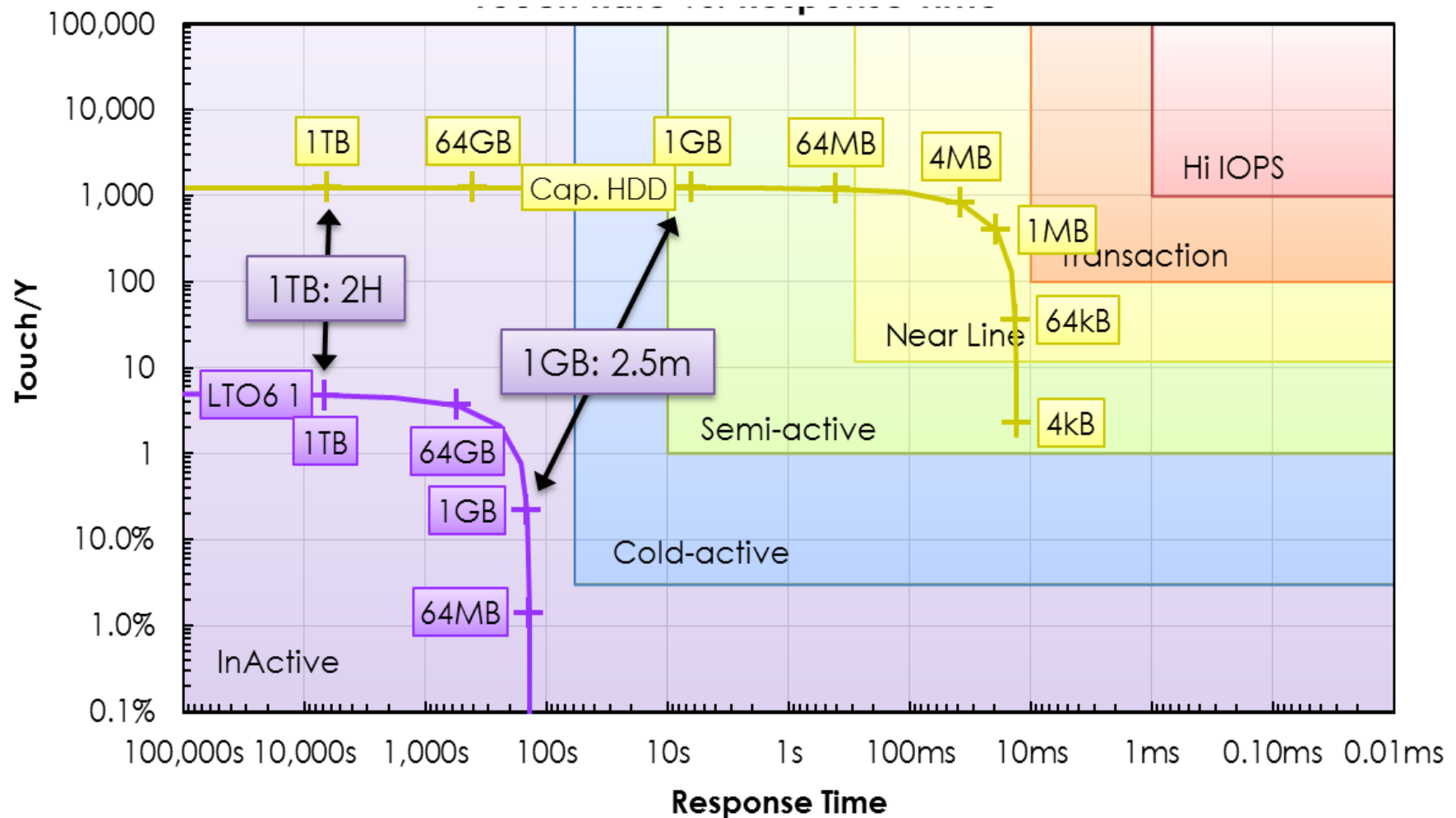
Touch rate versus response time indicating various types of uses



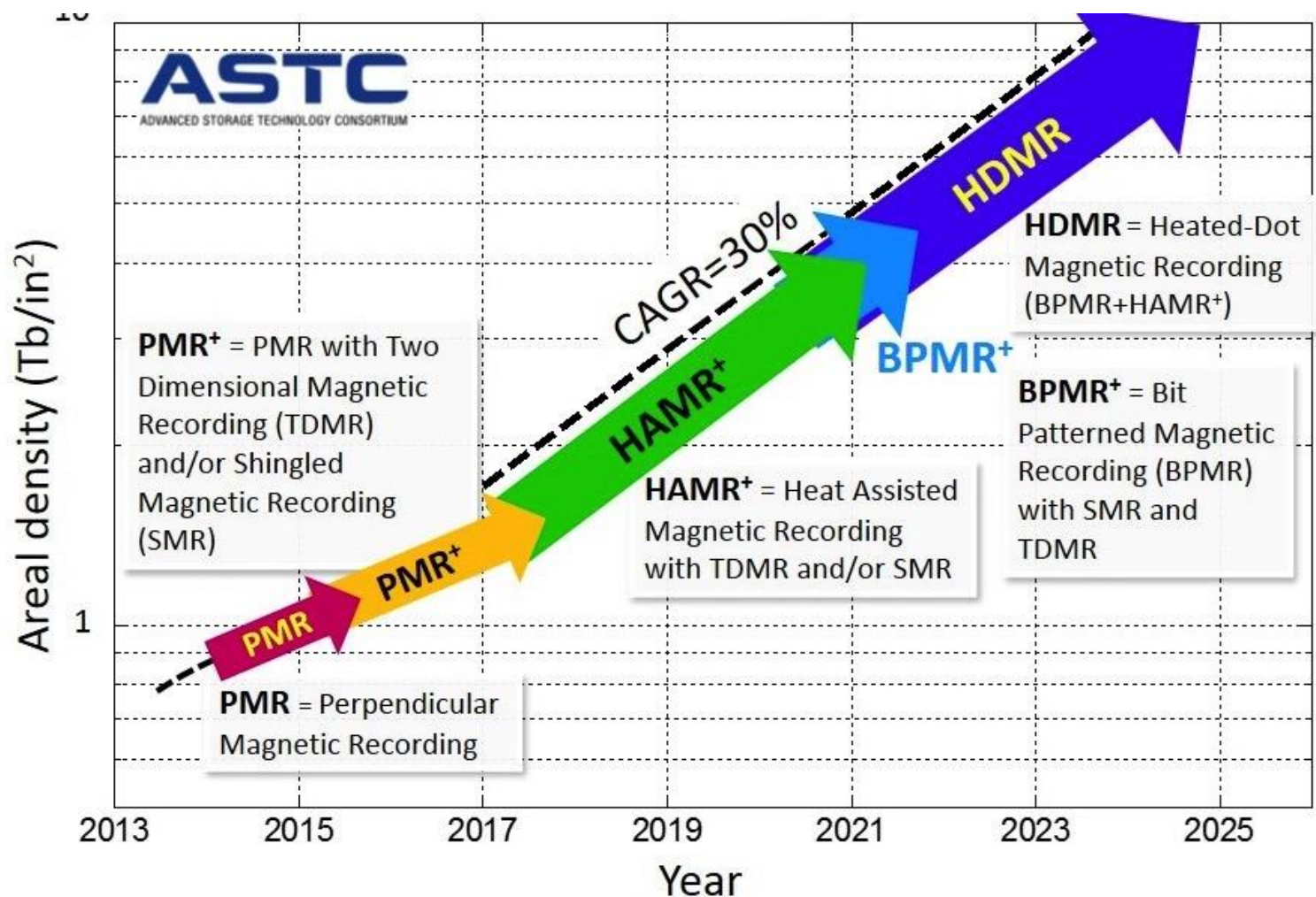
Comparison of archive storage



Hybrid tape and HDD system (Tape NAS)

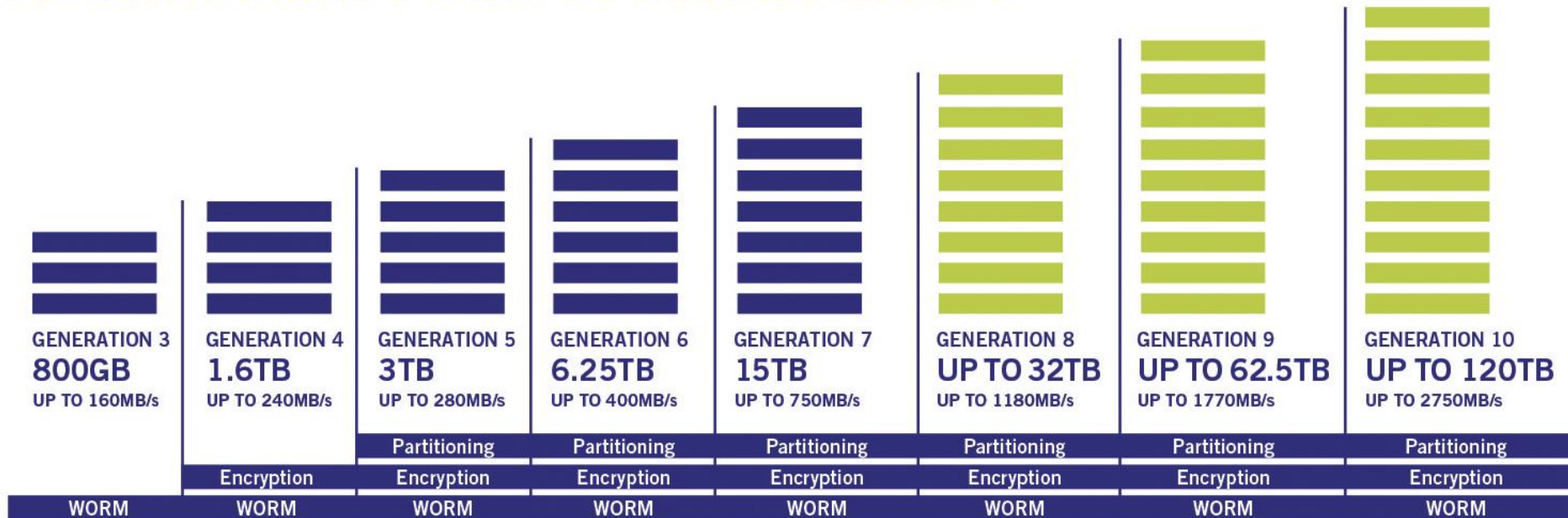


HDD Roadmap



LTO Projected Tape Generations

LTO ULTRIUM ROADMAP ADDRESSING YOUR STORAGE NEEDS



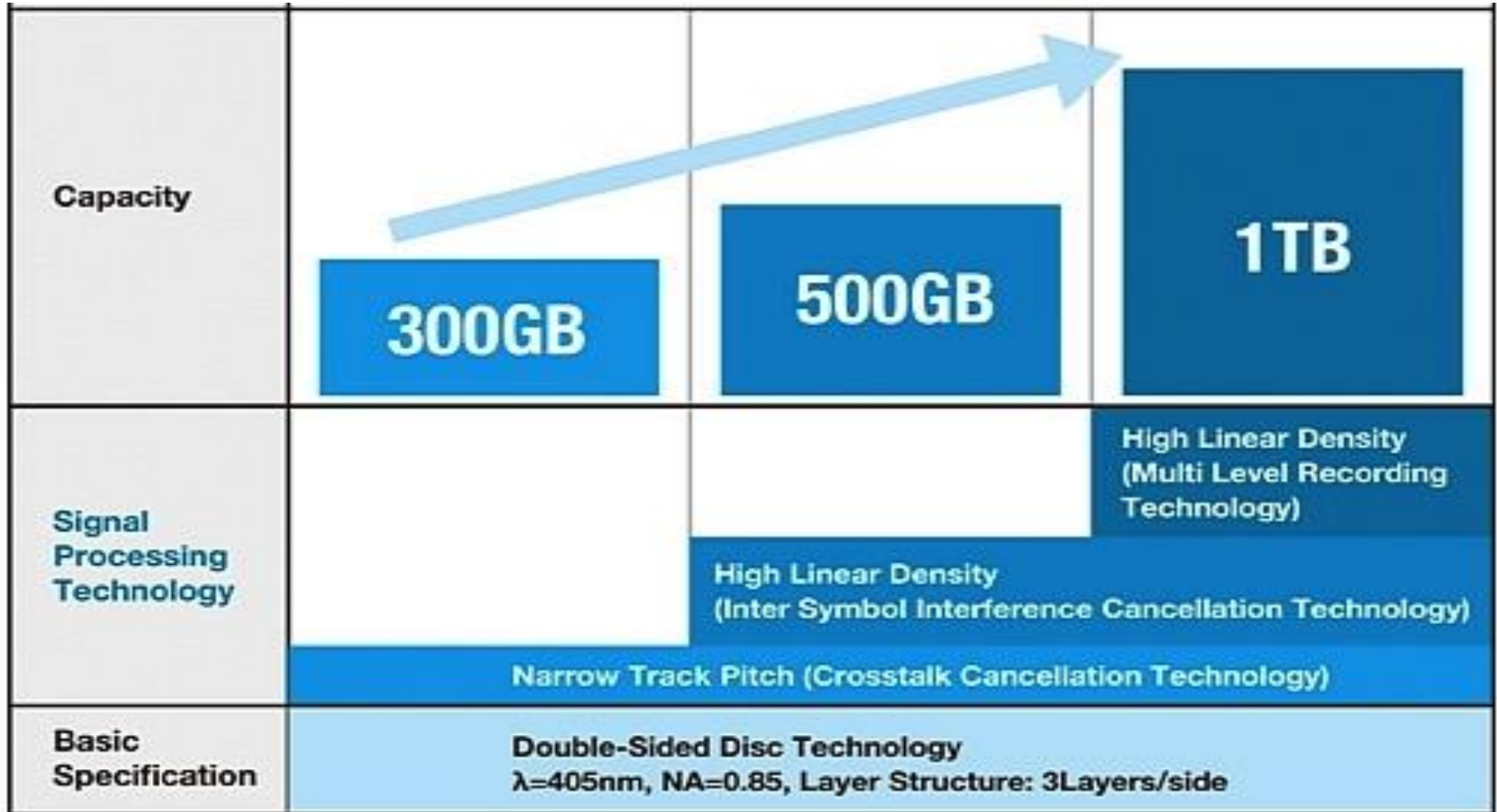
Note: Compressed capacities for generations 1-5 assume 2:1 compression. Compressed capacities for generations 6-10 assume 2.5:1 compression (achieved with larger compression history buffer).

Source: The LTO Program. The LTO Ultrium roadmap is subject to change without notice and represents goals and objectives only.

Linear Tape-Open, LTO, the LTO logo, Ultrium, and the Ultrium logo are registered trademarks of HP, IBM and Quantum in the US and other countries.

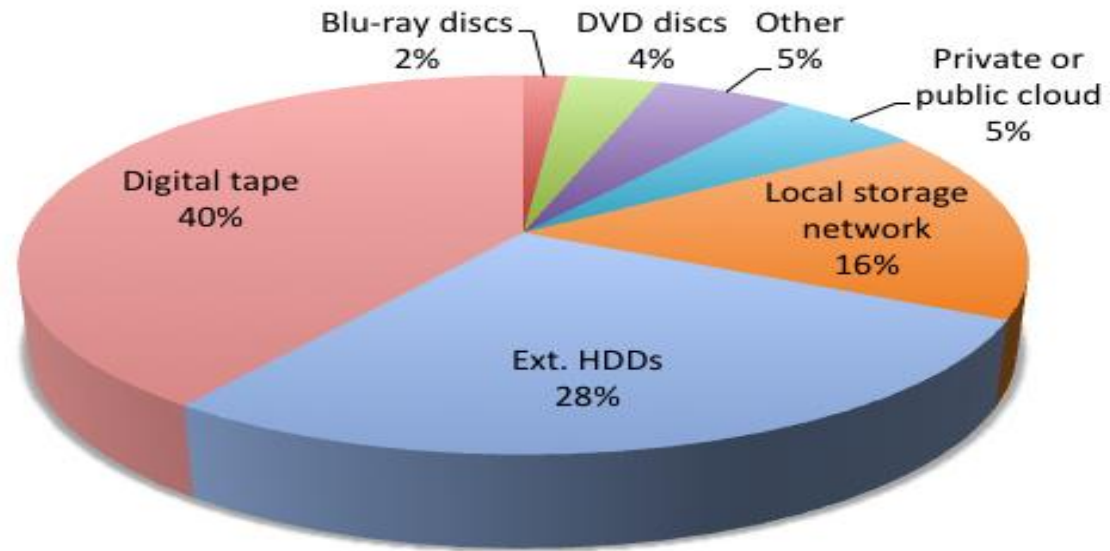
Note that capacity CAGR for Tape between 2015 with LTO-7 and 2021 with LTO-10 is 41.2%, greater than AD growth rate for HDDs

Sony/Panasonic Optical Archive Roadmap



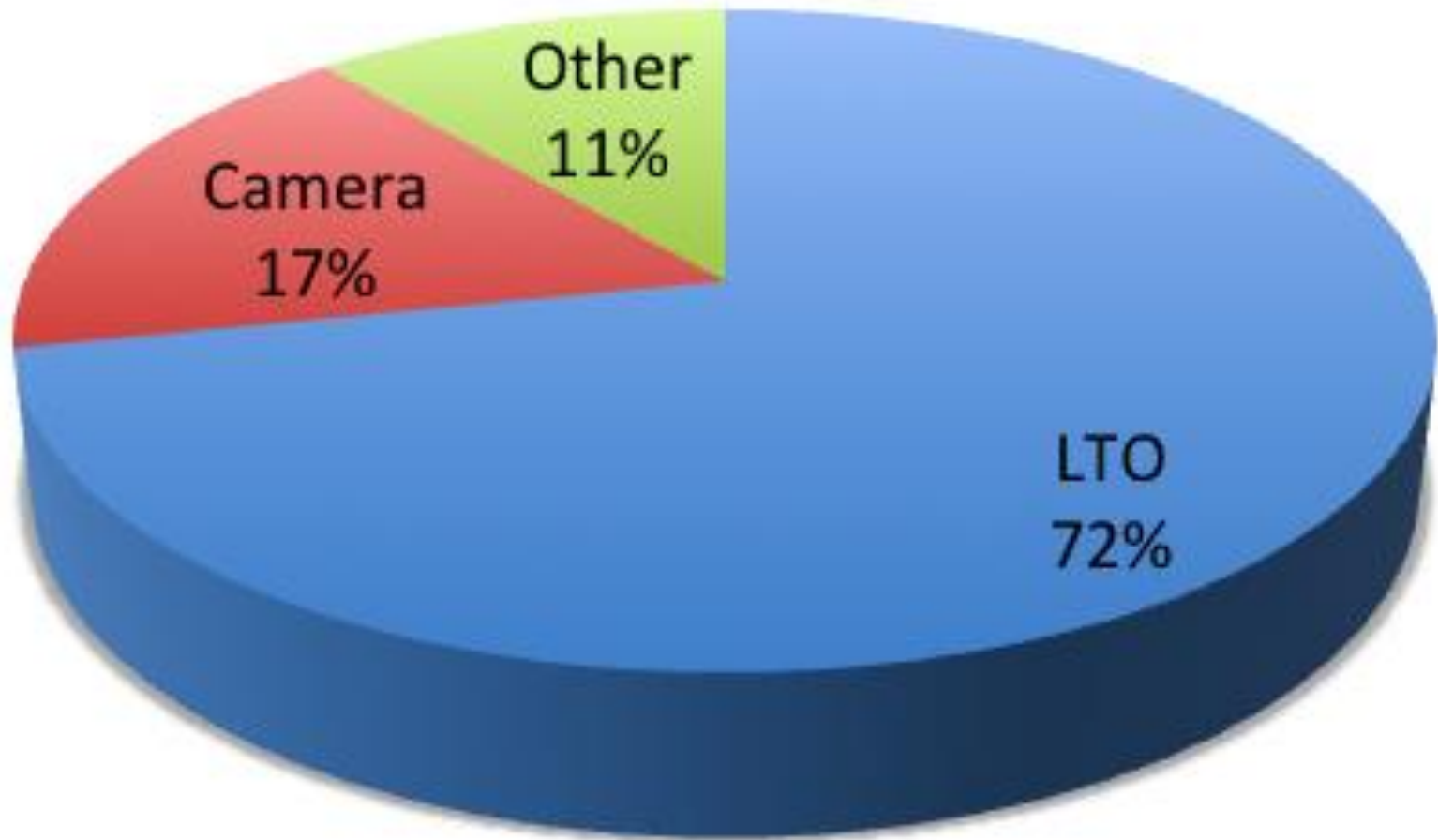
More 2015 Archive Survey Results

- About 46.4% never update their digital archives
- About 45.2% copied and replaced their digital long term archives every 10 years or less
- 43% said that they would use a private or public cloud for archiving content

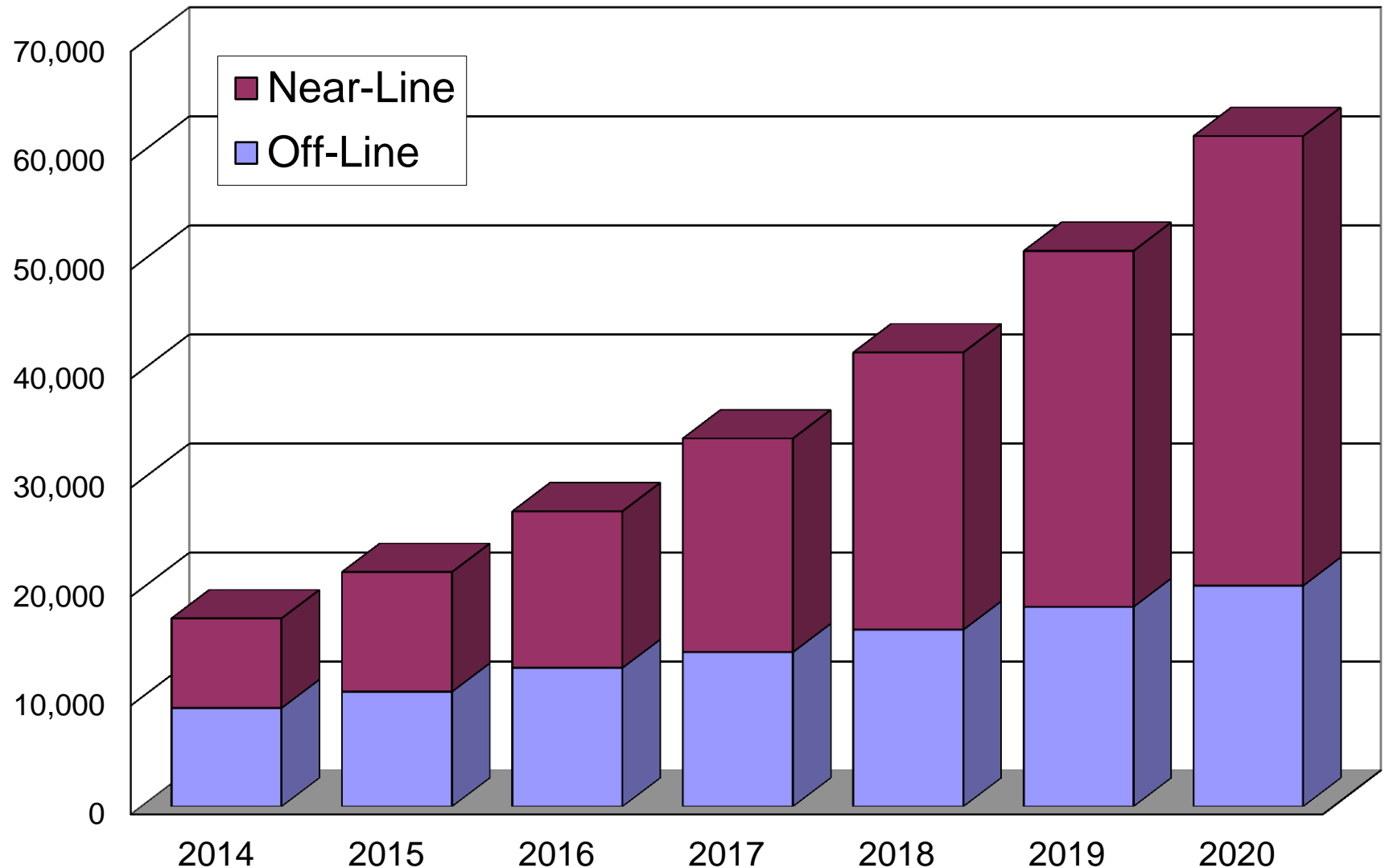


Growth Rate for
Digital Tape in
2015 is 59.2%

Percentage of Tape Formats used in Digital Archiving

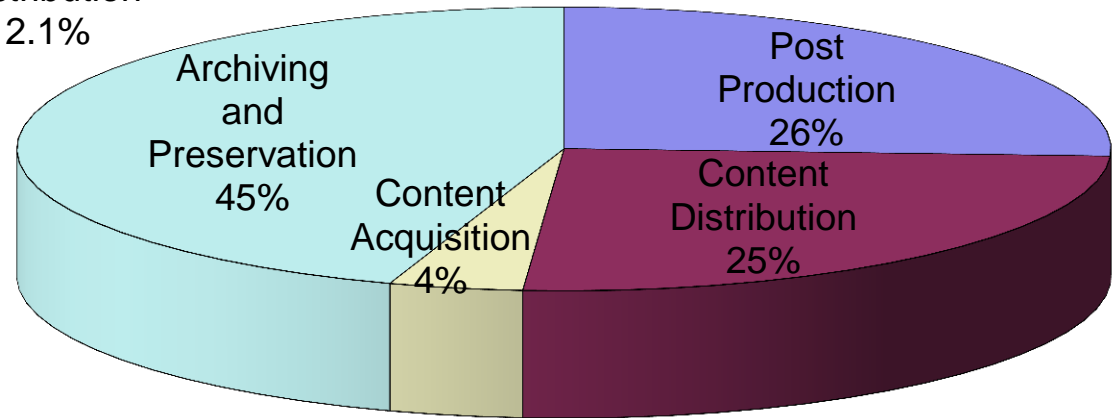
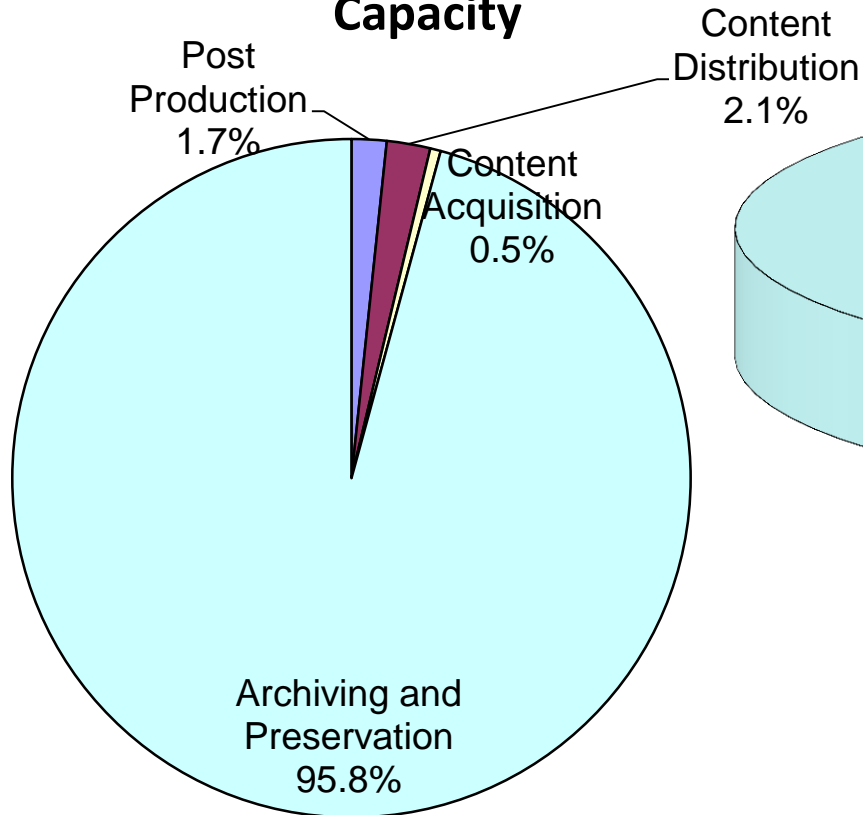


Growth in Near Line and Off-Line Archive Storage



2014 Media and Entertainment Storage

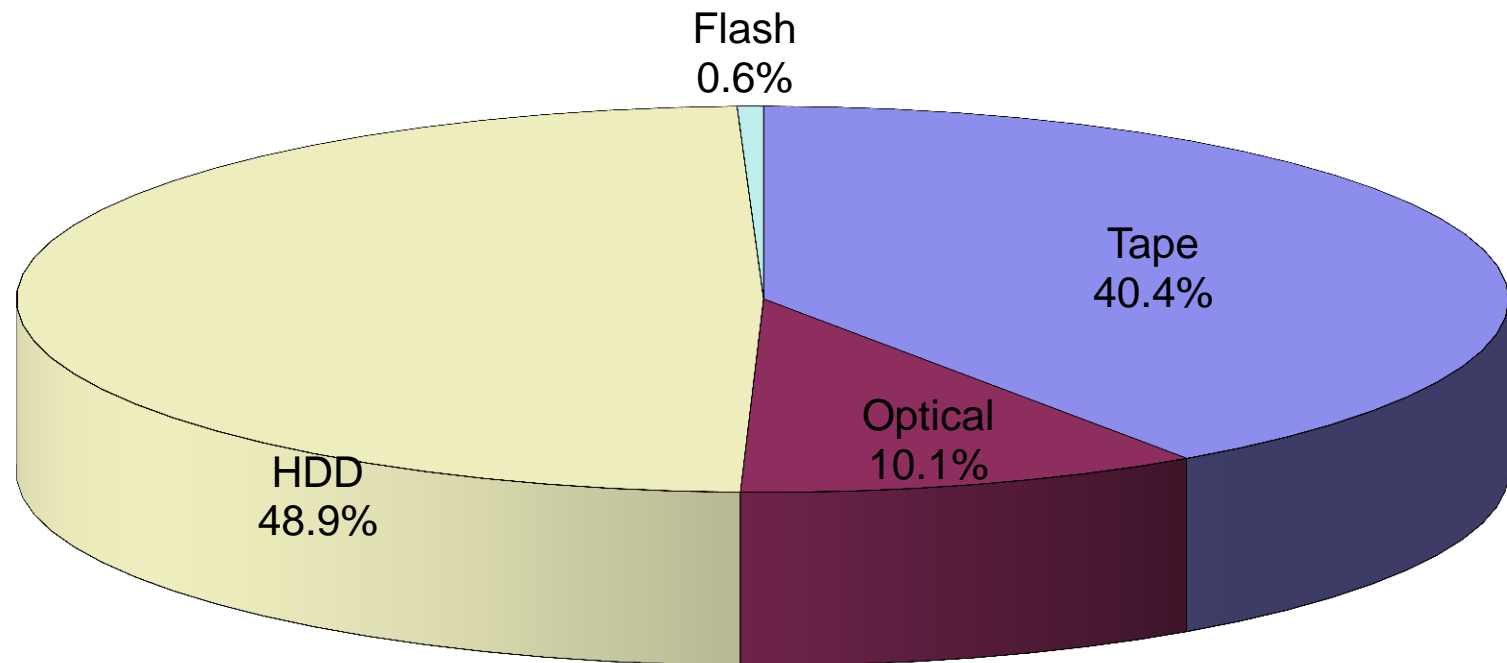
Distribution of Storage Capacity



Media and Entertainment Market Storage Revenue Share by Segment

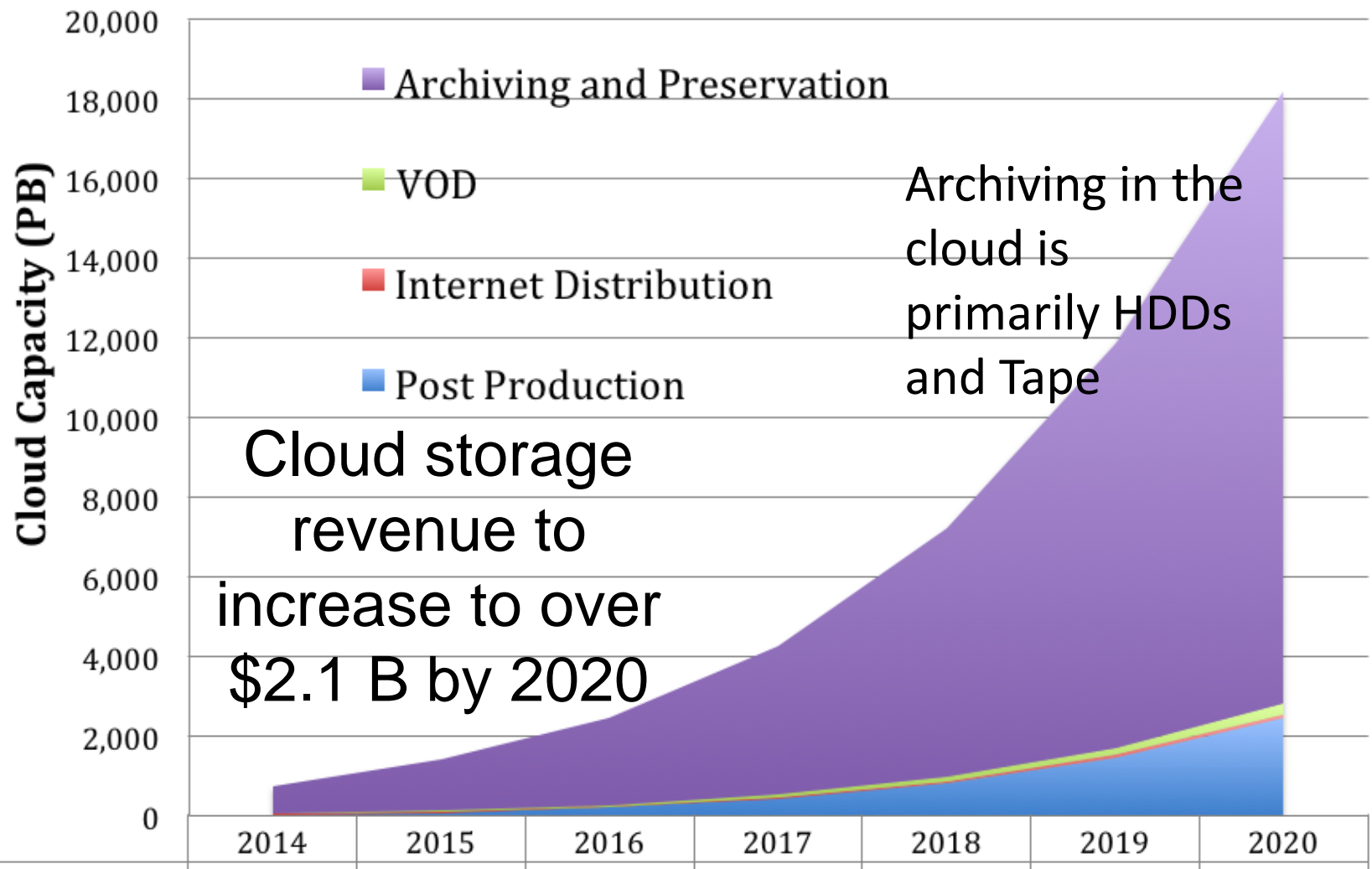
2015 Digital Storage for Media and Entertainment Report

2014 Total M&E Market Share by Capacity Shipped



2015 Digital Storage for Media and
Entertainment Report

Cloud Storage Capacity for M&E



2015 Digital Storage for Media and Entertainment Report



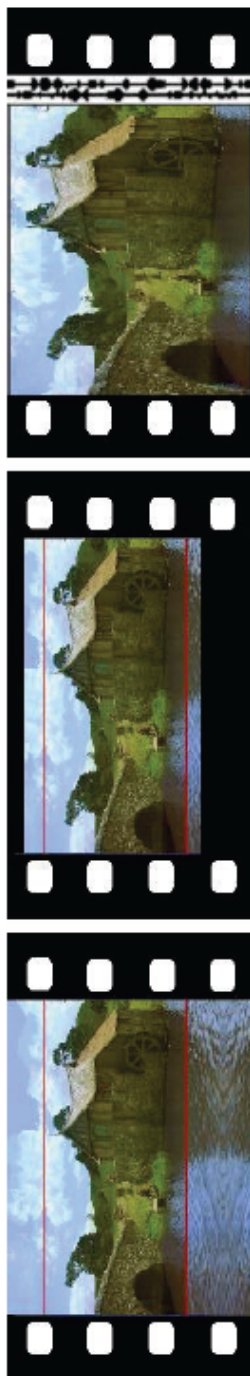
Conclusions



- Magnetic tape provides cost effective archival storage and when part of hybrid systems using HDDs and/or flash memory delivers the capabilities needed for M&E active archives.
- Digital storage in data centers (cloud storage) is playing a bigger role in media and entertainment to provide OTT content distribution and collaborative workflows.
- The increase in content resolution and the amount of content is driving performance and storage in content delivery systems and the growth of on-line distribution storage.
- Storage capacity and growth in professional media and entertainment and related industries show the size of digital content libraries while storage revenues reflect the value of the content where it is used.

References

- 2009-2015 Survey of Storage in Professional Media and Entertainment
- 2015 Digital Storage in Media and Entertainment Report, Coughlin Associates, <http://www.tomcoughlin.com/techpapers.htm>



2015 DIGITAL STORAGE FOR MEDIA AND ENTERTAINMENT REPORT

This updated and expanded report is the tenth annual comprehensive reference document on this topic. The report analyzes requirements and trends in worldwide data storage for entertainment content acquisition; editing; archiving and digital preservation; as well as digital cinema; broadcast; satellite; cable; network; internet and VOD distribution. Capacity and performance trends as well as media projections are made for each of the various market segments. Industry storage capacity and revenue projections include direct attached storage, cloud, real time as well as near-line network storage.

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