



2020 Digital Storage for Media and Entertainment Report

*-- Digital Storage for the Capture, Creation,
Editing, Archiving and Distribution of
Entertainment Content --*

Thomas Coughlin

Coughlin Associates



The Digital Storage for Entertainment and Media Report is published by:

Coughlin Associates
9460 Carmel Road
Atascadero, Ca. 93422

Tel (408) 202-5098

www.tomcoughlin.com

© 2020 Coughlin Associates

All rights reserved. No portion of this report may be reproduced in any form or by any means without permission from the publisher. Information in this report is believed to be reliable but cannot be guaranteed to be complete or correct.

Table of Contents

| | |
|---|------------|
| <i>Acknowledgements</i> | 11 |
| <i>The Author</i> | 12 |
| <i>Executive Summary</i> | 12 |
| Key Points | 13 |
| <i>Introduction</i> | 16 |
| <i>Cinema and Video Formats</i> | 21 |
| <i>Media and Entertainment Professional Storage Survey</i> | 35 |
| <i>Content Creation and Acquisition</i> | 37 |
| Feature Film Acquisition | 37 |
| TV Production | 55 |
| Film Scanning | 57 |
| Storage Capacity Projections for Digital Content Acquisition | 59 |
| <i>Post Production including Editing and Special Effects</i> | 65 |
| Non-Linear Editing (NLE) | 65 |
| Post Production Storage | 71 |
| Flash Memory for Editing | 73 |
| Editing and the Cloud | 79 |
| Special Effects and Other Post Production | 86 |
| Summary Post-Production Digital Storage Capacity Demand | 86 |
| Storage Capacity and Storage Revenue Projections for NLE, Special Effects and Other Post Production Activities | 87 |
| <i>Media and Entertainment Content Distribution</i> | 99 |
| Lower Bandwidth Richer Media Distribution Technology | 102 |
| Local Broadcast | 105 |
| Cable Distribution | 111 |
| Satellite Headend | 117 |
| TV Networks | 117 |
| Digital Cinema | 129 |
| Hard Disk Drives Used in Digital Cinema | 132 |
| Assumption for Digital Cinema Storage | 132 |
| Professional Media and Entertainment Internet Distribution | 138 |
| Video on Demand (VOD) | 150 |
| <i>Summary of Non-Archive Entertainment and Media Storage</i> | 159 |

Archiving and Digital Preservation..... 172

Hard Disk Drives 172

Magnetic Tape 174

Optical Discs 179

Cloud and Object Archive Storage 182

Survey Archive Results..... 189

Digital Conversion of Older Analog Content 194

Costs of Digital Conversion 194

Costs of Long-Term Storage 195

Archiving of Digital Created Content 196

Total Archive and Preservation Storage Projections 197

Archiving Storage: Off-line, Near-Line, in the Cloud..... 197

Uses of Archived Content—Making an Archive ROI 205

Migration of Content to Avoid Format Obsolescence 205

Capacity Requirements by Market Segment 207

Storage Revenue Estimates by Market Segment..... 216

Storage Media Projections 226

Touch Rate Versus Response Time 226

 Response time definition 226

 Touch rate definition 226

 Touch rate vs. response time 227

 Technology regions 228

 IO Object size curve 229

Media Projections for Media and Entertainment 231

Conclusions..... 243

Some Media and Entertainment Market Companies 250

NEWSLETTER SUBSCRIPTIONS 253

Table of Figures

| | |
|---|----|
| Figure 1. Digital Entertainment Content Value Chain (An Accelerating Positive Feedback Loop)..... | 16 |
| Figure 2. Digital Entertainment Content Workflow..... | 17 |
| Figure 3. Hybrid Motion Picture Production and Post-Production using Digital Intermediates..... | 18 |
| Figure 4. Report Assumptions for High End Movie Resolutions over Time | 25 |
| Figure 5. Statistics for Ang Lee’s Billy Lynn’s Long Halftime Walk | 27 |
| Figure 6. Ang Lee’s Data Center | 27 |
| Figure 7. Setup and Application of Canon’s Free Viewpoint Video System..... | 30 |
| Figure 8. Video Resolution Comparisons | 31 |
| Figure 9. Content is made up of Essence plus Metadata | 32 |
| Figure 10. Uses and Flow of Metadata in the Entertainment Content Process | 33 |
| Figure 11. Spheracam VR Video Camera Setup | 39 |
| Figure 12. Jaunt One Video Camera Rig..... | 39 |
| Figure 13. Spherical Image Display | 40 |
| Figure 14. ARRI Mini LF 4K S35 Camera and SSD Recording Media | 41 |
| Figure 15. Canon C300 DSLR Used for Professional Video | 42 |
| Figure 16. For-A Super Slo-Mo Camera..... | 42 |
| Figure 17. LG 8K X 4K LCD Display | 43 |
| Figure 18. NHK 8K Portable Camera..... | 44 |
| Figure 19. NHK 8K Portable Camera Schematic..... | 44 |
| Figure 20. Sharp 8K Portable Camera..... | 45 |
| Figure 21. Red MONSTRO 8K VV Sensor for Weapon Cameras | 46 |
| Figure 22. Percentage of recording media in professional video cameras. | 46 |
| Figure 23. FOR-A Video Archive Recorder | 48 |
| Figure 24. Content Shot for an Hour of Completed Work..... | 49 |
| Figure 25. Panasonic Micro P2 Flash Module and Adapter..... | 50 |
| Figure 26. Sony SxS Flash Memory Camcorder Modules..... | 50 |
| Figure 27. Sony External Video Recording SSD | 51 |
| Figure 28. Angelbird CFast Compact Flash Card..... | 51 |
| Figure 29. Angelbird SD Cards for Professional Video Camera | 52 |
| Figure 30. ProGrade SFEXPRESS 1.0 1 TB Memory Card | 52 |
| Figure 31. Atmos Master Caddy..... | 53 |
| Figure 32. LaCie 2big Dock Thunderbolt 3 Drive..... | 54 |
| Figure 33. NHK Super High Vision Equipment Roadmap..... | 56 |
| Figure 34. Percentage Scanned into Different Digital Resolutions | 58 |
| Figure 35. Digital Content Generation Capacity Projections | 63 |
| Figure 36. Annual Storage System Capacity Growth for Digital Content Acquisition | 64 |
| Figure 37. Professional Non-Linear Editing Model System | 65 |
| Figure 38. DAS vs. Shared Storage and Number of People in a Post Facility (2017 survey)..... | 68 |
| Figure 39. Physical Distribution Media for Proxies or Completed Post Work | 70 |
| Figure 40. Seagate Lyve Drive Data Platform..... | 73 |
| Figure 41. Pixit Media Excelero 8K+ Workflow | 75 |

| | |
|---|-----|
| Figure 42. OWC ThunderBlade | 77 |
| Figure 43. WD G-Drive Mobile SSD-R..... | 78 |
| Figure 44. AWS Snowball Data Transport Solution..... | 83 |
| Figure 45. Example Render Farm Layout..... | 84 |
| Figure 46. Pixar Render Farm | 85 |
| Figure 47. Post Production Storage Capacity Annual Demand (TB)..... | 93 |
| Figure 48. Projections for Post Production, CGI/FX New Storage Requirements..... | 95 |
| Figure 49. Price of Storage/GB for Facility Niche | 97 |
| Figure 50. Toshiba On-Air Max Flash | 101 |
| Figure 51. Bit Rate Reduction Curve Showing Big-Rate Savings between H.264 (AVC) and HEVC (Horizontal Axis indicates Quality Target Resolution) | 103 |
| Figure 52. Local Broadcaster Content Distribution Storage Capacity Analysis | 109 |
| Figure 53. Estimate of Local Broadcaster Distribution Network Storage TAM (\$M) | 110 |
| Figure 54. Cable Head End Distribution Storage Capacity Analysis | 115 |
| Figure 55. Estimate of Cable Head End Network Storage TAM (\$M)..... | 116 |
| Figure 56. Satellite Head End Distribution Storage Capacity Analysis..... | 121 |
| Figure 57. Estimate of Satellite Headend Network Storage TAM (\$M) | 122 |
| Figure 58. TV Network Delivery Storage Capacity Analysis..... | 126 |
| Figure 59. Estimate of TV Networks Local Near-Line and Cloud Storage Capacity (TB) | 127 |
| Figure 60. Estimate of TV Master Networks Network Storage TAM (\$M)..... | 128 |
| Figure 61. USB Hard Drive for Movie Distribution to Theatre (Mercado Theatre in Santa Clara, CA) | 129 |
| Figure 62. Schematic of a Play-To-Screen Server with Functional Blocks (Thompson Grass Valley) | 130 |
| Figure 63. Digital Cinema Projector | 130 |
| Figure 64. Schematic Digital Projector Showing IMB Containing Content Storage (a) and with content storage external to the IMB (b) | 131 |
| Figure 65. Integrated Media Block Containing HDDs..... | 132 |
| Figure 66. Annual New Storage Capacity for Digital Cinema..... | 136 |
| Figure 67. Estimate of Digital Cinema Storage TAM (\$M)..... | 137 |
| Figure 68. Internet Content Distribution System (CDN)..... | 138 |
| Figure 69. Eluv.io’s Content Fabric..... | 140 |
| Figure 70. Level 3’s Content Delivery Network..... | 141 |
| Figure 71. Internet Content Delivery Storage Capacity Analysis | 148 |
| Figure 72. Estimate of Internet Content Delivery Network Storage TAM (\$M)..... | 149 |
| Figure 73. IBM Flash-based Content-Delivery Servers..... | 151 |
| Figure 74. Video on Demand Total Storage Capacity Model | 155 |
| Figure 75. Annual Growth in Video on Demand Storage Capacity..... | 156 |
| Figure 76. Estimate of VOD Storage TAM by Category (\$M)..... | 157 |
| Figure 77. Estimate of Cloud and Conventional VOD Storage Capacity | 158 |
| Figure 78. Non-Archive Media and Entertainment Annual Network Storage TAM Estimate | 160 |
| Figure 79. Non-Archive On-Line Network Annual Storage TAM Estimate | 161 |
| Figure 80. Non-Archive Near-Line Network Annual Storage TAM Estimate..... | 162 |
| Figure 81. Non-Archive Object Storage Annual TAM Estimate..... | 163 |

Figure 82. Non-Archive Direct Attached and Local Storage Annual TAM Estimate..... 164

Figure 83. Total Non-Archive Storage Annual TAM Estimate 165

Figure 84. Non-Archive Network Storage Capacity Annual Demand Estimate 166

Figure 85. Non-Archive On-Line Network Storage Capacity Annual Demand Estimate 167

Figure 86. Non-Archive Near-Line Network Storage Capacity Annual Demand Estimate 168

Figure 87. Non-Archive Object Storage Capacity Annual Demand Estimate 169

Figure 88. Non-Archive Direct Attached Storage and Local Storage Capacity Annual Demand Estimate..... 170

Figure 89. Non-Archive Total Storage Capacity Annual Demand Estimate..... 171

Figure 90. HDD Cartridge Products (iVDR and RDX) 172

Figure 91. Spectra Logic SMR HDD Archive Storage System 173

Figure 92. ATSC HDD Technology Roadmap..... 174

Figure 93. LTO Projected Tape Generations 175

Figure 94. LTO-8 Tape Cartridges and Drive..... 176

Figure 95. Uses for LTFS Tape in Media and Entertainment Workflows 179

Figure 96. Sony/Panasonic Optical Archive Roadmaps 180

Figure 97. Sony Blu-Ray Optical Disc Cartridge and Drive 181

Figure 98. XenData Tape or Optical Disc Library 181

Figure 99. Elements in an AXF Object Wrapper..... 184

Figure 100. Percentage of Digital Long-Term Archives on Various Media 191

Figure 101. Percentage of Tape Formats Used in Digital Archiving..... 193

Figure 102. Example Workflow for Analog to Digital Video Conversion..... 195

Figure 103. Total Annual Digital Storage Demand Projections for Archiving and Digital Content Conversion & Preservation..... 201

Figure 104. Annual Growth in Near-Line and Off-Line Digital Storage for Content Archiving 202

Figure 105. Annual Archive Object Storage for Content Archiving..... 203

Figure 106. Cloud vs. Local Archive Storage..... 204

Figure 107. Relationship Between Archive Content and Multiple Real-Time and Non-Real-Time Distribution Content..... 205

Figure 108. Media and Entertainment New Cloud Storage Capacity Projections 214

Figure 109. Media and Entertainment New Object Storage Capacity Projections 215

Figure 110. Media and Entertainment Cloud Storage Revenue Projections..... 224

Figure 111. Media and Entertainment Object Storage Revenue Projections 225

Figure 112. Touch rate versus response time indicating various types of uses 228

Figure 113. Digital storage technologies regions overlaid on the Touch Rate/Response Time chart..... 229

Figure 114. Touch/Y and response time for 100% random IO in a 4 TB capacity HDD 230

Figure 115. Touch/Y and response time for 4 TB capacity HDD, LTO Tape and Blu-ray Discs..... 231

Figure 116. Media Annual Revenue Estimate Summary (\$M)..... 235

Figure 117. Tape Cartridge Annual Unit Shipment Projections..... 240

Figure 118. Optical Disk Unit Annual Unit Shipment Projections..... 241

Figure 119. HDD & Flash Annual Unit Shipment Projections 242

Figure 120. Distribution of Storage Capacity for Entertainment Creation, Archiving, and Distribution Segments (2019)..... 243

Figure 121. Distribution of Storage Capacity for Entertainment Creation, Archiving, and Distribution Segments (2025)..... 244

Figure 122. Media and Entertainment Market Storage Revenue Share by Segment (2019) 245

Figure 123. Media and Entertainment Market Storage Revenue Share by Segment (2025) 245

Figure 124. Market Share of Storage Media by Storage Capacity Shipped (2019) 246

Figure 125. Market Share of Storage Media by Storage Capacity Shipped (2025) 246

Figure 126. Market Share of Storage Media by Revenue (2019)..... 247

Figure 127. Market Share of Storage Media by Revenue (2025)..... 247

Figure 128. M&E Flash Memory Revenue by Application (2019) 248

Figure 129. M&E Flash Memory Revenue by Application (2025) 248

List of Tables

Table 1. Example Resolution, Data Rates and Storage Capacity Requirements for Professional Media Content (assumes no chroma subsampling) 23

Table 2. Some 4K and Beyond Camera Codecs 24

Table 3. Feature Film Metrics (24 fps, 10-bit color, 4K Bayer Format)..... 25

Table 4. Percentage of survey participants in content market segments. 35

Table 5. Survey participant locations. 36

Table 6. Uncompressed Format Assumptions for 1 Hour of Full Resolution Raw Content..... 37

Table 7. Comparison of Professional Video Camera Media Trends..... 47

Table 8. Survey Question: What % of your Content is Born Digital 48

Table 9. Comparison of 2010, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019 and 2020 Hours Shot for an Hour of Completed Content..... 49

Table 10. Comparison of 2010, 2012-2020 Scanned Resolutions..... 58

Table 11. Feature Film Projection Assumptions 60

Table 12. TV Broadcast Assumptions..... 61

Table 13. TV Episodic Assumptions..... 61

Table 14. General Assumptions for Movie & TV Content 61

Table 15. Feature Film Scanning Digital Storage Requirements..... 62

Table 16. Assumptions for Film Scanning Projections 62

Table 17. Assumptions for Storage Systems Capacity Projections 62

Table 18. Proxy Distribution Media Trends 70

Table 19. Professional NLE Bandwidth Requirements 87

Table 20. Professional Post-Production Storage Assumptions..... 88

Table 21. Professional Post Production Storage Projections (High End)..... 89

Table 22. Special Effects and Other Special Production Activities Storage Projections..... 92

Table 23. World-Wide Post Facilities Capacity Growth Estimates (On-Line, Near-Line and DAS/Local) 94

Table 24. Post-Production Facility Spending Assumptions (\$/GB)..... 96

2020 Digital Storage for Media and Entertainment Report

| | |
|--|-----|
| Table 25. World-Wide HE/MR NLE Facilities Network Storage Spending Estimates | 98 |
| Table 26. Average Percentage content on physical media for professional content distribution..... | 100 |
| Table 27. Comparison of Costs for Streaming Content with HDDs and SSDs (from Quantum)..... | 102 |
| Table 28. Additional Assumptions on Local Broadcast Content..... | 106 |
| Table 29. Estimate of WW Local Broadcast Storage Capacity Requirements and Spending..... | 107 |
| Table 30. Cable Head End Assumptions..... | 112 |
| Table 31. Estimate of WW Cable Head End Storage Spending..... | 113 |
| Table 32. Satellite Headend Assumptions..... | 118 |
| Table 33. Estimate of WW Satellite Head End Storage Spending..... | 119 |
| Table 34. TV Master Network Assumptions..... | 123 |
| Table 35. Estimate of WW TV Master Network Storage Spending..... | 124 |
| Table 36. Digital Cinema Storage Estimate Assumptions..... | 134 |
| Table 37. Digital Cinema Storage Estimate..... | 135 |
| Table 38. Internet Content Delivery Assumptions..... | 145 |
| Table 39. Estimate of WW Internet Content Delivery Storage Spending..... | 146 |
| Table 40. VOD Capacity Model Assumptions..... | 152 |
| Table 41. Video on Demand Storage Capacity Model..... | 153 |
| Table 42. Simplified percentage growth rate of various archival media types..... | 192 |
| Table 43. 2006 Estimated Costs for Archiving Motion Picture Materials on HDD Arrays and a Tape Library for Year 1 (1 TB) ²⁸ | 196 |
| Table 44. Assumptions for Archiving and Digital Preservation..... | 199 |
| Table 45. Archiving and Digital Conversion and Preservation Storage Projections..... | 200 |
| Table 46. Annual New Capacity Projections by Media and Entertainment Market (Petabytes)..... | 208 |
| Table 47. Annual New Direct Attached and Local Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 209 |
| Table 48. Annual New Total Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 210 |
| Table 49. Annual New On-Line Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 211 |
| Table 50. Annual New Near-Line Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 212 |
| Table 51. Annual New Object Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 213 |
| Table 52. Annual New Cloud Storage Capacity Projections by Media and Entertainment Market (Petabytes)..... | 213 |
| Table 53. Total Entertainment and Media Storage Revenue Estimate (\$M)..... | 217 |
| Table 54. Direct Attached and Local Storage Entertainment and Media Storage Revenue Estimate (\$M)..... | 218 |
| Table 55. Total Network Storage Entertainment and Media Storage Revenue Estimate (\$M)..... | 219 |
| Table 56. On-Line Network Storage Entertainment and Media Storage Revenue Estimate (\$M)..... | 220 |

2020 Digital Storage for Media and Entertainment Report

Table 57. Near-Line Network Storage Entertainment and Media Storage Revenue Estimate (\$M) 221

Table 58. Object Storage Entertainment and Media Storage Revenue Estimate (\$M) 222

Table 59. Off-Line Storage Entertainment and Media Storage Revenue Estimate (\$M) 223

Table 60. Media Unit Storage Capacity and Price Assumptions..... 234

Table 61. Detailed Annual New Media Unit Breakdown by Application 236

Table 62. Annual New Media Unit Summary 239

Acknowledgements

These reports are the result of extensive interviews with many people and companies from throughout the entertainment content value chain as well as in-depth analysis of historical trends and future technology drivers. Companies contacted included storage component and systems companies as well as companies that incorporate storage into their content creation applications. The list of companies contacted is extensive and the data we gathered over several months is pretty comprehensive, not all of it is included in this report. Our thinking and projections were shaped by many inputs.

In particular we would like to thank the following companies and organizations for their help and information over the years: Active Storage, Amazon, Apple, Aspera, Atempo, ATTO, Avere, Avid Technologies, Backblaze, BitCentral, Broadcom, Buffalo, DataDirect Networks, CET, Chosun Group, Cisco, Cloudian, Ctera, DDN, Dell, Discovery Channel, Disney, Dolby, Dot Hill (now part of Seagate), Dream Works, Drobo, EBU, Edit Share, EFILM, Eluv.io, ESPN, Exascend, Facilis, Fox, Front Porch Video, Google, G-Tech (part of Western Digital), Harmonic, Hedvig, HGST (part of Western Digital), Hitachi Vantara, IBM, Imation, IMT, Iron Mountain, Isilon/EMC, LaCie (part of Seagate), LSI, LTO Consortium, Maximum Throughput, Mediakive, Media Technology Market Partners, Mellanox (now part of nVidia), Micron, Microsoft, Mozy, NASCAR, NBC Universal, NetApp, Netgear, Nexenta, Object Storage, Open Drives, Oracle, Overland Storage, Penasas, Panasonic, Paramount, PBS, Pixar, Plastercity Digital Post, Promise Technology, Qualstar, Quantum, Qlogic, QNAP, Rorke Data, SanDisk (part of Western Digital), Scale Logic, SeaChange, Seagate Technology, SGI, Sony, SpectraLogic, Sun/Oracle, Supermicro, Symplivity, Synology, Technicolor, Tegile, Trinti, Turner Broadcast, Versus, Warner Bros, Western Digital, Xendata and Zadaro.

Also thanks to the following individuals for their help over the years—and the total list is much more extensive than this: Al Kovalik, Alex Grossman, Brad Giles, Brad Winett, Clyde Smith, Colin Dixon, David Baril, Frank Chen, David Crosthwait, David Trumbo, Fred Fourcher, Geoff Stedman, Nicholas Lim, Jim Lindner, Scott Miller, John Morgan, Felix Poulin, Molly Presley, Pete Fasciano, Randall Dark, Rob Kobrin, Ron Tarasoff, Claus Trelby, Jim Wheeler, Joe Wojdacz, Steve Zivanic, Paul Koopman, Scott Rinehart, Steve Canepa, Tom Inglefield, and Wayne Arvidson. We also thank all the speakers whose presentations have influence this report from the Creative Storage Conferences, HPA retreats, SMPTE Conferences, the NAB show, IBC and the Storage Visions Conferences.

The Author



Tom Coughlin, President, Coughlin Associates is a respected digital storage analyst and consultant. He has over 39 years in the data storage industry with multiple engineering and management positions at digital storage companies.

Tom has many publications and six patents to his credit. Tom is also the author of Digital Storage in Consumer Electronics: The Essential Guide, which is in its second edition with Springer. Coughlin Associates provides market and technology analysis (including reports on several digital storage technologies and applications and a newsletter) as well as Data Storage Technical Consulting services. He publishes the ***Digital Storage for Media and Entertainment Report*** as well as other reports. Order information on these reports can be found at: <https://tomcoughlin.com/tech-papers/>.

Tom is active with SMPTE (Journal article writer and Conference Program Committee), SNIA (including a founder of the SNIA CMSI (formerly SSSI), the IEEE, (he is past Chair of the IEEE Public Visibility Committee, Past Director for IEEE Region 6, Past President for IEEE-USA and active in the Consumer Electronics Society) and other professional organizations. Tom founded and organized the long-running Storage Visions Conferences (www.storagevisions.com) as well as the Creative Storage Conferences (www.creativestorage.org). He was the general chairman of the annual Flash Memory Summit for 10 years. He is a Fellow of the IEEE and a member of the Consultants Network of Silicon Valley (CNSV). For more information on Tom Coughlin and his publications and activities go to www.tomcoughlin.com.

Executive Summary

This report is the eighteenth report on data storage and emerging applications and the sixteenth report on data storage in the entertainment and media market published by Coughlin Associates.

Data storage is a key element in the digital transformation of content creation, editing, distribution and reception. Data capacity and communication speed increases, changing form factors, lowered product prices and the growing familiarity with digital editing, digital intermediates and various forms of digital distribution are key components in the continued growth and development of entertainment.

Because of the large file sizes required for high resolution and multi-camera images there is increasing demand for high capacity storage devices as well as high performance

storage. The entire content value chain of content creation, editing, archiving, distribution as well as consumer electronics content reception devices, provide an accelerating feed-forward mechanism. This drives growth in data storage for all entertainment content applications.

For many archiving and distribution applications where content is relatively static, low cost/high capacity SATA HDD storage, optical discs and tape-based storage libraries will predominate, with some flash memory used for caching and metadata. Note also that many active archive systems may also be hard disk drive based and will often include magnetic tape and SSDs for caching. Hard disk drives as well as SSDs are also used in high performance storage applications where storage cost factors must be balanced with performance requirements.

For applications requiring rugged field use or fast playback response, flash memory either as cards or solid-state drives (SSDs) are now standard fare.

Due to input from industry groups, SMPTE, HPA, EBU (as well as media and entertainment publications and websites) survey results and discussions with industry end users and equipment providers we have continued to adjust many of our models for current storage estimates as well as future growth in 2020 and beyond. In addition, we have expanded the continued impact of solid-state storage in our projections based upon expected lower flash memory storage costs and also increased our cloud and object storage projections.

We list some key points of the report in the following list.

Key Points

- The Covid-19 pandemic in 2020 will have a big impact on content creation in 2020 and likely into 2021, except for broadcast acquisition
- Spending for digital cinema in 2020 and 2021 will also be impacted by the pandemic
- Creation, Distribution & Conversion of video content creates a huge demand driver for storage device and systems manufacturers
- As image resolution increases and as stereoscopic VR video becomes more common, storage requirements explode
- The development of 4K TV and other high-resolution venues in the home and in mobile devices will drive the demand for digital content (especially enabled by high HEVC (H.265) and VVC (H.266) compression and even greater standards for compression to enable 8K and higher resolution and frame rate workflows.
- HDD areal density increases are slower but flash memory growth has increased and the price declined. This, plus the growth in higher resolution and higher frame rate content, is causing more applications to use flash memory
- Activity to create capture and display devices for 8K X 4K content is occurring with planned implementation in common media systems in this decade

- Active archiving will drive increased use of HDD storage for “archiving” applications, supplementing tape for long term archives
- Optical storage developments for higher capacity write-once Blu-ray optical cartridges will create higher capacity discs and this may help slow the reduction in optical disc archiving
- Flash memory dominates cameras and is finding wider use in post-production and content distribution systems
- From 2019 to 2025 entertainment and media digital storage TAM (without archiving and preservation) will increase by about 1.8 X from \$7.3B to \$13.3 B
- The growth in storage capacities will result in a total media and entertainment storage revenue growth of about 1.6 X between 2019 and 2025 (from \$10.3 B to \$16.5B)
- Overall annual storage capacity demand for non-archival applications is expected to increase over the period from 2019 to 2025 by 5.0X from 24.3 EB to 122.4 EB
- Between 2019 and 2025 we expect about a 3.0 X increase in the required digital storage capacity used in the entertainment industry and about a 3.4 X increase in storage capacity shipped per year (from 70.8EB to 241EB)
- In 2019 content distribution is estimate at 31% of total storage revenue followed by archiving and preservation at 29%, post-production at 22% and content acquisition at 18%.
- In 2025 the projected revenue distribution is 33% content distribution, 25% post production, 23% content acquisition and 19% archiving and preservation.
- By 2025 we expect about 56% of archived content to be in near-line and object storage, up from 48% in 2019
- In 2019 we estimate that 74.7% of the total storage media capacity shipped for all the digital entertainment content segments was in HDDs with digital tape at 19.0%, 2.7% optical discs and flash at 3.5%
- By 2025 tape capacity shipment share has been reduced to 13.0%, HDDs shipped capacity is 76.4%, optical disc capacity is down to about 0.5% and flash capacity percentage is at 10.1%
- Media revenue is expected to increase about 1.2X from 2019 to 2025 (\$1.8B to \$2.2B).
- The single biggest application (by storage capacity) for digital storage in the next several years as well as one of the most challenging is the digital conversion of film, video tape and other analog formats and its long-term digital preservation
- Over 116 Exabytes of new digital storage will be used for digital archiving and content conversion and preservation by 2025
- Storage in remote “clouds” is playing an important role in enabling collaborative workflows, content distribution and in archiving
- Overall cloud storage capacity for media and entertainment is expected to grow over 13X between 2019 and 2025 (2.2 EB to 29.0 EB)
- Overall object storage capacity for media and entertainment is expected to grow about 3.7 X between 2019 and 2025 (14.3 EB to 52.7 EB)

2020 Digital Storage for Media and Entertainment Report

- Cloud storage revenue will be about \$3.7 B by 2025
- By our estimates, professional media and entertainment storage capacity represents about 5.8% of total shipped storage capacity in 2019.
- Professional media and entertainment consume about 28% of all tape capacity shipments, 4.9% of all hard disk drive shipments and 2.3% of all flash memory shipments in 2019. We estimate that media and entertainment spending was about 9% of total storage revenue in 2019.
- Digital cinema conversion complete in most countries with movement to 4K video wide-spread
- Silver halide film is in serious decline and only used in some special projects.
- AXF and other new standards may help format obsolescence
- Several petabytes of storage can be required for a complete stereoscopic digital movie production at 4K resolution and there is increasing production work at 8K or higher
- By the next decade total video captured for a high-end digital production could be hundreds of PB, approaching 1 Exabyte
- Movement to IP based workflows will reduce total costs for content management, including storage
- Non-linear editing requires high performance storage devices. Over the forecast period lower network storage costs and higher performing low cost storage networks will result in faster growth of network storage than direct attached and local storage
- ATA HDD arrays have become the dominant mode for readily retrievable fixed content storage, but flash memory is growing for this use as costs decline (NVMe using the PCIe bus will be the dominate flash interface)
- Magnetic tape will remain as an archival media although use in other applications is in decline, particularly content capture
- Flash memory is the clear majority storage media in professional video cameras with survey results showing about 62% utilization in the 2020 survey
- The continued need to storage for higher performance and high capacity workflows are driving strong storage growth in the projection periods— assuming no great negative economic trends.

The data presented in this report is subject to change as the content storage market develops. We have additional information that we have gathered in addition to that included in this published report. We will continue to monitor and develop our models of this market as time goes on. We would be glad to work with customers on specialized presentations or reports and in general to conduct research to answer specific questions on a project or ongoing basis.

2020 DIGITAL STORAGE FOR MEDIA AND ENTERTAINMENT REPORT

This updated and expanded report is the fourteenth 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 OTT 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 (including object storage), real-time as well as near-line network storage.

ORDER FORM FOR THE 2020 DIGITAL STORAGE FOR MEDIA AND ENTERTAINMENT REPORT (PDF)

NAME: _____
TITLE: _____
COMPANY: _____
ADDRESS: _____
CITY: _____ STATE: _____
ZIP: _____
TELEPHONE: _____
FAX: _____
E-MAIL: _____

Single User License \$7,500

Visa Mastercard American Express

Credit Card Number: _____
Expiration Date: _____
Signature: _____

Make checks payable to: Coughlin Associates
Mail to 1665 Willowmont Ave., San Jose, CA 95124
Telephone: 408-202-5098 Fax: 866-374-6345
Order On-Line at: <https://tomcoughlin.com/tech-papers/>
Email: info@tomcoughlin.com

