2014 Digital Storage for Media and Entertainment Report

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

Thomas Coughlin
Coughlin Associates

Digital Entertainment Series
Coughlin Associates
408-978-8184
www.tomcoughlin.com
Table of Figures

Figure 1. Digital Entertainment Content Value Chain (An Accelerating Positive Feedback Loop) ................................................................. 14
Figure 2. Digital Entertainment Content Workflow .................................. 15
Figure 3. Hybrid Motion Picture Production and Post-Production using Digital Intermediates ................................................................. 18
Figure 4. Video Resolution Comparisons .................................................. 22
Figure 5. Content is made up of Essence plus Metadata ................................ 23
Figure 6. Uses and Flow of Metadata in the Entertainment Content Process .... 23
Figure 7. ARRI ALEXI Stereoscopic Video Camera Setup ................................ 28
Figure 8. Canon C300 DSLR Used for Professional Video ......................... 29
Figure 9. For-A Super Slo Mo Camera .................................................... 29
Figure 10. BBC Image of an HNK Super Hi-Vision Camera ....................... 30
Figure 11. Sharp 8K X 4K LCD Display at 2012 CES .................................. 31
Figure 12. NHK 8K SHV Field Camera .................................................... 31
Figure 13. Percentage of Various Recording Media in Professional Video Cameras .................................................................................. 32
Figure 14. FOR-A Video Archive Recorder ............................................. 33
Figure 15. Content Shot for an Hour of Completed Work ........................ 34
Figure 16. Panasonic Micro P2 Flash Module and Adapter ......................... 35
Figure 17. Panasonic P2 and Sony SxS Flash Memory Camcorder Modules ... 36
Figure 18. Sony SR Memory Flash Memory Camcorder Module ................ 36
Figure 19. Maxell ivDR Storage Module on a Sony Professional Camera ..... 37
Figure 20. Do you Reuse your Digital Camera Recording Media? ............... 38
Figure 21. NHK Super High Vision Equipment Roadmap ................................ 39
Figure 22. Percentage Scanned into Different Digital Resolutions .............. 40
Figure 23. Digital Content Acquisition Storage Capacity Projections .......... 46
Figure 24. Annual Storage Capacity Growth for Digital Content Acquisition .. 47
Figure 25. Professional Non-Linear Editing Model System ....................... 48
Figure 26. DAS vs. Shared Storage and Number of People in a Post Facility .... 53
Figure 27. Example Render Farm Layout ............................................... 55
Figure 28. Pixar Render Farm ................................................................. 56
Figure 29. Physical Distribution Media for Proxies or Completed Post Work .... 61
Figure 30. Post Production Storage Capacity Annual Demand (TB) ............ 69
Figure 31. Projections for Post Production, CGI/ Special Effects New Storage Requirements ..................................................................... 71
Figure 32. Price of Storage/GB for Facility Niche ....................................... 72
Figure 33. Projection of HE/MR NLE Facilities Network Storage TAM ($M) ..... 75
Figure 34. Bit Rate Reduction Curve Showing Big-Rate Savings between H.264 and HEVC (Horizontal Axis indicates Quality Target Resolution) .......... 78
Figure 35. Local Broadcaster Content Distribution Storage Capacity Analysis .. 84
Figure 36. Estimate of Local Broadcaster Distribution Network Storage TAM ($M) .............................................................................. 85
Figure 37. Cable Head End Distribution Storage Capacity Analysis ............. 91
Figure 38. Estimate of Cable Head End Network Storage TAM ($M) ...............92
Figure 40. Satellite Head End Distribution Storage Capacity Analysis ..........98
Figure 41. Estimate of Satellite Headend Network Storage TAM ($M) ..........99
Figure 42. TV Network Delivery Storage Capacity Analysis .....................103
Figure 43. Estimate of TV Networks Local Near-Line and Cloud Storage Capacity (TB) .................................................................104
Figure 44. Estimate of TV Networks Network Storage TAM ($M) .............105
Figure 45. USB Hard Drive For Movie Distribution to Theatre (Mercado Theatre in Santa Clara, CA) .................................................106
Figure 46. Schematic of a Play-To-Screen Server with Functional Blocks (Thompson Grass Valley) ......................................................108
Figure 47. Digital Cinema Projector ......................................................109
Figure 48. Annual New Storage Capacity for Digital Cinema .....................113
Figure 49. Estimate of Digital Cinema Storage TAM ($M) .......................114
Figure 50. Internet Content Distribution System (CDN) ........................115
Figure 51. Level 3’s Content Delivery Network ......................................116
Figure 52. Internet Content Delivery Storage Capacity Analysis ..............123
Figure 53. Estimate of Internet Content Delivery Network Storage TAM ($M) 124
Figure 54. IBM Flash-based Content-Delivery Servers ............................126
Figure 55. Video on Demand Total Storage Capacity Model ....................131
Figure 56. Estimate of Cloud and Conventional VOD Storage Capacity ....132
Figure 57. Annual Growth in Video on Demand Storage Capacity ..........133
Figure 58. Estimate of VOD Storage TAM by Category ($M) ....................134
Figure 59. Non-Archive Media and Entertainment Annual Network Storage TAM Estimate ..................................................136
Figure 60. Non-Archive On-Line Network Annual Storage TAM Estimate ....137
Figure 61. Non-Archive Near-Line Network Annual Storage TAM Estimate ...138
Figure 62. Non-Archive Direct Attached and Local Storage Annual TAM Estimate ..........................................................139
Figure 63. Total Non-Archive Storage Annual TAM Estimate ....................140
Figure 64. Non-Archive Network Storage Capacity Annual Demand Estimate 141
Figure 65. Non-Archive On-Line Network Storage Capacity Annual Demand Estimate ..................................................142
Figure 66. Non-Archive Near-Line Network Storage Capacity Annual Demand Estimate ..................................................143
Figure 67. Non-Archive Direct Attached Storage and Local Storage Capacity Annual Demand Estimate ........................................144
Figure 68. Non-Archive Total Storage Capacity Annual Demand Estimate ....145
Figure 69 HDD Cartridge Products (iVDR and RDX) ...............................146
Figure 70. LTO Projected Tape Generations .........................................148
Figure 71. LTO-6 Tape Cartridge .........................................................148
Figure 72. Uses for LTFS Tape in Media and Entertainment Workflows .......150
Figure 73. Sony/Panasonic Optical Archive Roadmap .............................151
Figure 74. Sony Blu-Ray Optical Disc Cartridge and Drive .......................152
Figure 75. Panasonic Optical Disc Cartridge and Library .......................152
Figure 76. XenData Tape and Optical Disc Library ................................153
2014 Digital Storage for Media and Entertainment Report

Figure 77. Elements in an AXF Object Wrapper ................................................. 155
Figure 78. Percentage of Digital Long-Term Archives on Various Media ........... 158
Figure 79. Percentage of Tape Formats Used in Digital Archiving .................. 160
Figure 80. Example Workflow for Analog to Digital Video Conversion .......... 162
Figure 81. Comparison of Estimated Annual Cost to Save 1 PB for 20 Years . 164
Figure 82. Total Annual Digital Storage Demand Projections for Archiving and Digital Content Conversion & Preservation ........................................... 170
Figure 83. Annual Near-Line and Off-Line Digital Storage for Content Archiving ................................................................. 171
Figure 84. Cloud vs. Local Archive Storage ....................................................... 172
Figure 85. Schematic Showing Workflow for Archiving, Accessing and Using Archived Content in Distribution ...................................................... 174
Figure 86. Media and Entertainment Cloud Storage Capacity Projections ...... 182
Figure 87. Media and Entertainment Cloud Storage Revenue Projections ....... 190
Figure 88. Media Annual Revenue Estimate Summary ($M) ......................... 194
Figure 89. Tape Cartridge Annual Unit Shipment Projections ....................... 199
Figure 90. Flash and Optical Disk Unit Annual Unit Shipment Projections ...... 200
Figure 91. HDD Annual Unit Shipment Projections ........................................ 201
Figure 92. Distribution of Storage Capacity for Entertainment Creation, Archiving, and Distribution Segments (2013) ............................................. 202
Figure 93. Distribution of Storage Capacity for Entertainment Creation, Archiving, and Distribution Segments (2019) ............................................ 203
Figure 94. Media and Entertainment Market Storage Revenue Share by Segment (2013) ................................................................. 204
Figure 95. Media and Entertainment Market Storage Revenue Share by Segment (2019) ................................................................. 204
Figure 96. Market Share of Storage Media by Storage Capacity Shipped (2013) ............................................................................. 205
Figure 97. Market Share of Storage Media by Storage Capacity Shipped (2019) ............................................................................. 205

List of Tables

Table 1. Example Resolution, Data Rates and Storage Capacity Requirements for Professional Media Content .................................................. 19
Table 2. Feature Film Metrics (24 fps, 16-bit color, 4K Bayer Format) .......... 20
Table 3. Percentage of Survey Participants in Content Market Segments ...... 25
Table 4. Survey Participant Location ............................................................... 25
Table 5. Uncompressed Format Assumptions for 1 Hour of Full Resolution Raw Content ........................................................................... 26
Table 6. Comparison of Professional Video Camera Media Trends ............... 32
Table 7. Survey Question: What % of your Content is Born Digital .......... 33
Table 8. Comparison of 2010, 2012, 2013 and 2014 Hours Shot for an Hour of Completed Content ......................................................... 34
Table 10. Feature Film Projection Assumptions ............................................ 43

© 2014 Coughlin Associates
Table 47. Annual New Direct Attached and Local Storage Capacity Projections by Media and Entertainment Market (Petabytes) .................................................. 177
Table 48. Annual New Total Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes) .......................................................... 178
Table 49. Annual New On-Line Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes) .................................................. 179
Table 50. Annual New Near-Line Networked Storage Capacity Projections by Media and Entertainment Market (Petabytes) .................................................. 180
Table 51. Annual Cloud Storage Capacity Projections by Media and Entertainment Market (Petabytes) .......................................................... 181
Table 52. Total Entertainment and Media Storage Revenue Estimate ($M) .... 184
Table 53. Direct Attached and Local Storage Entertainment and Media Storage Revenue Estimate ($M) .............................................................................................. 185
Table 54. Total Network Storage Entertainment and Media Storage Revenue Estimate ($M) .............................................................................................. 186
Table 55. On-Line Network Storage Entertainment and Media Storage Revenue Estimate ($M) .............................................................................................. 187
Table 56. Near-Line Network Storage Entertainment and Media Storage Revenue Estimate ($M) .............................................................................................. 188
Table 57. Off-Line Storage Entertainment and Media Storage Revenue Estimate ($M) .............................................................................................. 189
Table 58. Media Unit Storage Capacity and Price Assumptions .................. 193
Table 59. Detailed Annual New Media Unit Breakdown by Application .... 195
Table 60. Annual New Media Unit Summary ............................................. 198
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: Amberfin, Aspera, Atempo, ATTO, Avid Technologies, BitCentral, Cache-A, DataDirect Networks, CET, Chosun Group, Dell, Discovery Channel, Dolby, EBU, Edit Share, EFILM, ESPN, Facilis, Fox, Front Porch Video, G-Tech (part of Western Digital), Harmonic, HDS, IBM Media and Entertainment Division, IMT, Iron Mountain, Isilon/EMC, LaCie, LSI, LTO Consortium, Maximum Throughput, Mediakive, Media Technology Market Partners, NetApp, NASCAR, NBC Universal, NetApp, Panasonic, Paramount, Plastecity Digital Post, Promise Technology, Qlogic, Quantum, Rorke Data, SeaChange, Seagate Technology, SGI, Sony, SpectraLogic, Sun/Oracle, Technicolor, Turner Broadcast, Versus, Warner Bros, Xendata. We also thank all the speakers who’s presentations have influence this report from the Creative Storage Conference, SMPTE Conferences, the NAB show and the Storage Visions Conference.

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, David Crosthwalt, David Trumbo, Fred Fourcher, Geoff Stedman, Nicholas Lim, Jim Lindner, John Morgan, Felix Poulin, Pete Fasciano (for much discussion on earlier editions), 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.

The Author

Tom Coughlin, President, Coughlin Associates has been working for over 30 years in the data storage industry at companies such as Ampex, Polaroid, Seagate, Maxtor, Micropolis, Syquest, 3M and other companies. He has over 60 publications and 6 patents to his credit. Tom is active with IDEMA, the IEEE Magnetics Society, IEEE Consumer Electronics Society, SNIA, SMPTE and other professional organizations. He is the
founder and organizer of the Annual Storage Visions Conference (before the International CES) as well as the Creative Storage Conference. He is also the general chairman of the Flash Memory Summit. Coughlin Associates provides market and technology analysis, technical reports and white papers, as well as Data Storage Technical Consulting services. For more information go to www.tomcoughlin.com.

Executive Summary

This report is the twelfth report on data storage and emerging applications and the tenth report on data storage and 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, 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-camrea images there is increasing demand for high capacity storage devices. 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. Hard disk drives as well as enterprise SSDs are also used in high performance storage applications where storage cost factors must be combined with performance requirements.

For applications requiring rugged field use or fast playback response flash memory either as cards or solid state drives (SSDs) are becoming more popular.

Due to input form from industry groups, SMPTE, HPA, EBU (and other media and entertainment workers) survey results and discussions with industry end users and equipment providers we have adjusted some of our models for future growth. We have modifications to the 2013 and earlier report assumptions to better model current market conditions. Some areas have gained in capacity and revenue while some have declined vs. earlier editions of this report.

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

• Creation, Distribution & Conversion of video content creates a huge demand driver for storage device and systems manufacturers
• As image resolution increases and as stereoscopic (and even more immersive) 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) compression.
• The slow down in areal density growth for HDDs will slow the historical $/GB decline probably through the projection period.
• Activity to create capture and display devices for 8K X 4K content is occurring with planned implementation in common media systems by the next decade
• Active archiving will drive increased use of HDD storage for “archiving” applications, supplementing tape for long term archives
• Optical storage developments for Blu-ray optical cartridges are expected to slow the decline in optical archive storage
• Flash memory dominates cameras and will find wider use in content distribution systems
• From 2013 to 2019 entertainment and media digital storage TAM (without archiving and preservation) will increase by about 2.7X (from $2.2 B to $6.0 B).
• Between 2013 and 2019 media and entertainment storage revenue is expected to grow 2.3 X (from $4.2 B to $9.6 B).
• In 2013 archiving and preservation is estimated to have been 47% of the total storage revenue followed by post-production (25%), content distribution (24%), and content acquisition (4%).
• In 2019 the projected revenue distribution is 38% archiving and preservation, 33% post-production, 26% content distribution, and 3% content acquisition.
• Between 2013 and 2019 we expect about a 5.4 X increase in the required digital storage capacity used in the entertainment industry and about a 3.8 X increase in storage capacity shipped per year (from 14,449 PB to 50,649 PB).
• The greatest storage capacity demand in 2013 is for digital conversion and preservation as well as archiving of new content (96.5%). Content distribution follows in size with acquisition and post-production using less storage.
• By 2019 we expect 64% of archived content to be in near-line storage, up from 43% in 2013.
• In 2013 we estimate that 44.5% of the total storage media capacity shipped for all the digital entertainment content segments was in HDDs with digital tape at 41.7%, 13.4% optical discs and flash at 0.4%.
• By 2019 tape has been reduced to 34.1%, HDDs shipped capacity is 61.7%, optical disc capacity is down to about 3.4% and flash capacity percentage is at 0.8%.
• Media revenue is expected to increase about 23% from 2013 to 2019 ($426 M to $524 M).
• 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.
• Over 50 Exabytes of digital storage will be used for digital archiving and content conversion and preservation by 2019.
• Content distribution and post-production will drive the growth of network and direct attached/local storage in the projection period.
• Storage in remote “clouds” is playing an important role in enabling collaborative workflows.
• Overall cloud storage for media and entertainment is expected to grow 37 X between 2013 and 2014 (322 PB to 11,904 PB).
• Cloud storage revenue will exceed $1.5 B by 2019.
• Digital cinema conversion is wide-spread, driving the growth of storage to support it.
• Silver halide film as a content distribution media will vanish before the end of the decade.
• There is a pressing need to develop policies and procedures for format conversion to combat format obsolescence.
• Several petabytes of storage may be required for a complete stereoscopic digital movie production at 4K resolution and there is some production work as high as 8K.
• By the next decade total video captured for a high end digital production could be hundreds of PB, approaching 1 exabyte.
• 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.
• ATA HDD arrays are becoming the dominant mode for readily retrievable fixed content storage.
• Magnetic tape will remain as an archival media although use in other applications is in decline, particularly content capture.
• Flash memory appears to be reaching tipping point in professional video cameras with survey results showing about 40% utilization in 2014.
• 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.
Go to www.tomcoughlin.com for the latest report and ordering information

HDD Infrastructure Series

- Hard Disk Drive Capital Equipment Market and Technology Report

Digital Entertainment Series

- Digital Storage for Media and Entertainment Report

Other Reports and Customer White Papers Also Available

To order these products or the Digital Storage Technology Newsletter ($199 annually with a $100 discount on Storage Visions Conference and Creative Storage Conference registration) visit the Coughlin Associates web site at http://www.tomcoughlin.com/techpapers.htm or call 408-978-8184.
Consulting

Tom Coughlin, President, Coughlin Associates, is available for technical and market consulting on digital storage devices, systems and applications.

Tom Coughlin has been working for over 30 years in the data storage industry. His consulting clients have included: Ampex, LSI, Network Appliance, Pillar Data, PriceWaterhouseCoopers, Quantum, Seagate Technology and many other companies. He has over 100 publications and six patents to his credit. Tom is active with IDEMA, the IEEE Magnetics Society, IEEE CE Society, SMPTE, SNIA, and other professional organizations. Tom is an active volunteer in the IEEE and is currently leading Future Directions for the IEEE Consumer Electronics Society and is Director Elect for IEEE Region 6.

He is the founder and organizer of the Annual Storage Visions Conference, a partner to the annual Consumer Electronics Show as well as the Creative Storage Conference. He is also the General Chairman of the annual Flash Memory Summit. Coughlin Associates provides market and technology analysis, written reports and white papers as well as Data Storage Technical Consulting services. He is the author of several reports including Digital Storage for Entertainment and Media Report, Capital Spending for the HDD Industry Report and several others. He publishes a quarterly newsletter: Digital Storage Technology Newsletter. He is also the author of Digital Storage in Consumer Electronics: The Essential Guide published by Newnes Press (a division of Elsevier) For more information go to www.tomcoughlin.com
This updated and expanded report is the ninth 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.