Flash Memory Enables Modern Media and Entertainment Workflows

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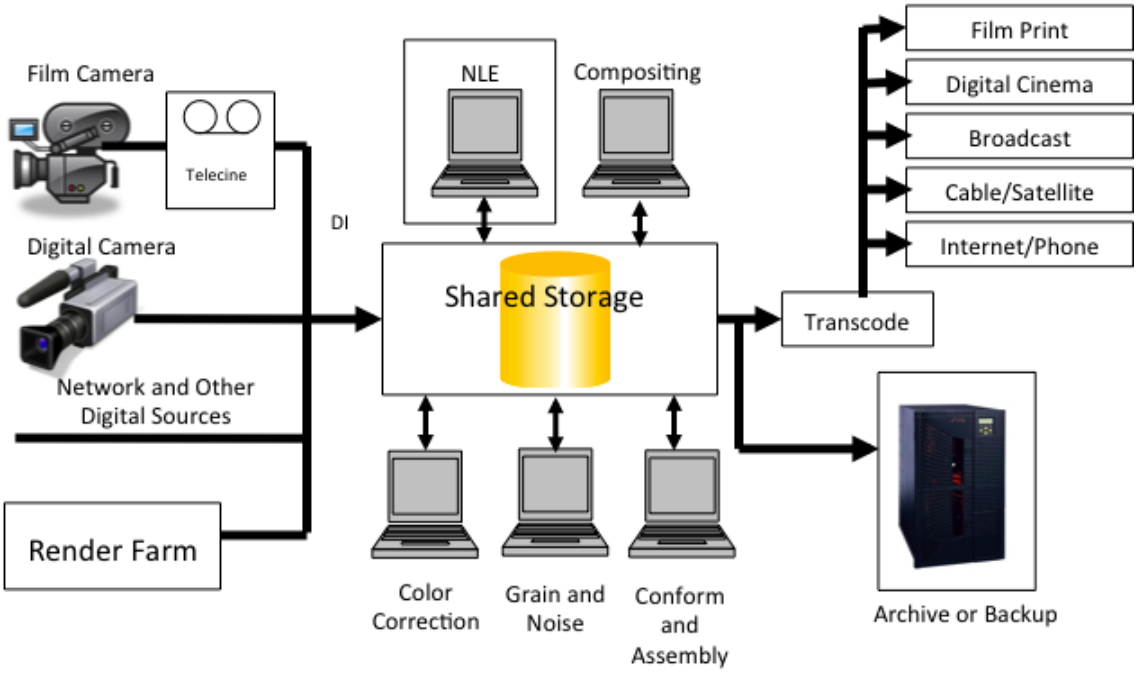
Introduction

Professional media and entertainment applications have a diverse set of digital storage requirements. Different professional media and entertainment applications, such as rendering and animation, resemble scientific and engineering modeling and high performance computing. Other aspects of media and entertainment have similarities to content delivery and general business archiving. However, for media and entertainment applications there is always a slight twist from traditional applications. **Figure 1** illustrates the sort of workflows used in professional media and entertainment[1].

Figure 1. Typical Digital Media Workflow



Although more expensive, on a native $/TB basis than hard disk drives or tape (by a factor of 5-10 for HDDs), flash memory is finding its way into more enterprise and client applications; this is also the case in the professional media and entertainment industry. Flash memory helps speed up applications and flash as a cache memory or for performance acceleration is becoming more popular. Flash memory

[1] 2015 Digital Storage for Media and Entertainment Report, Coughlin Associates, http://www.tomcoughlin.com/techpapers.htm.

I/O speeds are also driving development of higher speed internal and external storage speeds and in particular the use of PCIe, the computer memory bus, and the high speed Thunderbolt and USB interfaces. Higher speed SAS and SATA devices with speeds up to 32 Gbps support the data rates possible with flash memory. The recently introduced Gen 6 Fibre Channel interface, used in storage networking, has data rates as high as 128 Gbps. In this article we will look at the use of flash memory in today's media and entertainment workflows and in particular the use of flash memory in digital content capture, post-production and content distribution.

Content Capture—Flash is at the Tipping Point

In February through May of 2015 Coughlin Associates, Inc. conducted a survey of professional media and entertainment professionals on various digital storage topics. The survey was broken down into several segments: content capture, editing and post-production, content delivery as well as archiving and digital preservation. The Society of Motion Picture and Television Engineers (SMPTE), Digital Production Buzz, Hollywood Post Alliance, European Broadcast Union, Post Magazine, Postperspective.com and other organizations assisted by soliciting survey participants. The survey results provided insights into the use of digital storage in these markets. The survey follows up on previous surveys in 2009, 2010, 2012, 2013 and 2014.

Figure 2 shows the percentage of various recording media used by the survey participants in professional video cameras in 2015.

Figure 2. Percentage of Various Recording Media in Professional Video Cameras

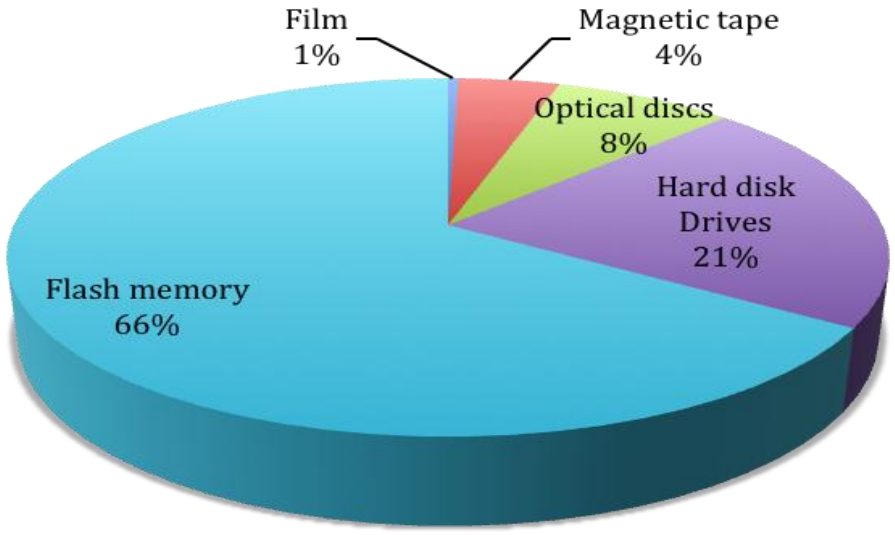


Table 1 compares the results from the 2009, 2010, 2012, 2013 and 2014 surveys with those from 2015. Flash memory is the clear leader in professional video camera media, increasing from 19% in 2009 to 66% in 2015 while magnetic tape shows a consistent decline over the same period, in particular, magnetic tape declines from 34% to 4%. Optical discs use between 2009 and 2015 bounced around between 7% and 17%. Film shows a general decline with 15% usage in 2009 to 1% in 2015 The trend with declining film use follows the trend towards completely digital workflows.

Table 1. Comparison of Professional Video Camera Media Trends

Flash Memory Enables Modern Media and Entertainment Workflows

Year	Magnetic Tape	HDD	Optical	Flash Memory	Film
2009	34%	23%	9%	19%	15%
2010	25%	22%	17%	28%	8%
2012	20%	22%	12%	44%	2%
2013	15%	18%	7%	59%	1%
2014	7%	24%	10%	57%	2%
2015	4%	21%	8%	66%	1%

The physical storage media for professional cameras is undergoing rapid evolution as film and magnetic digital tape (used for many years in professional video cameras) is impacted by the rapid file access and ruggedness of flash-based solid-state storage.. Indeed flash memory is now the majority camera storage media and is poised to become an even more dominant professional digital camera storage media.

Flash in Post-Production and Content Distribution

The high-end of professional media content requires expensive components to support bandwidth and latency requirements for 2K, 4K, 6K up to 8K content. Bandwidth requirements for uncompressed 2K and 4K are shown in **Table 2**. Note that DRAM has often been used as a buffer in various parts of the non-linear editing (NLE) system to reduce the impact of system latencies. Buffering and caching in NLE and other post-productions systems are starting to use NAND flash as well as DRAM and there are several storage system suppliers offering NAND flash enhanced post-production equipment in the last few years.

Table 2 Professional NLE Bandwidth Requirements

Uncompressed Format	Real Time Bandwidth
2K NLE Bandwidth	300 MBps
4K NLE Bandwidth	1,200 MBps

Post-production is also an area where higher speed interfaces are important. Since flash memory storage actually uses the bandwidth available with these interfaces we expect its use to increase for these applications with time. In the last couple of years several companies have begun to offer SSD-based Direct Attached Storage (DAS) external storage devices using the Thunderbolt 2 interface with data rates as high as 20 Gbps. HDD-based storage devices could not provide the data rate to fully utilize the Thunderbolt 2 channel, however flash-memory devices can.

SSD-based products taking advantage of the speed of Thunderbolt 2 include LaCie's Little Big Drive and Promise Technology's Pegasus2 M4 SSD with capacities up to 2 TB. **Figure 3** shows the PROMISE Technology product, which also comes with a carrying case for use in the field.

Figure 3. PROMISE Technology Pegasus2 M4 SSD Thunderbolt 2 RAID Storage Device

In addition to DAS SSD devices, some storage companies serving the media and entertainment industry are providing network storage systems that can utilize SSDs, including the EditShare XStream Field 2. This system, shown in **Figure 4**, is luggable and fits into an overhead airplane bin. It can be configured with HDDs or with SSDs for a very high performance light-weight and rugged network storage system for working in the field. According to the company, a*n eight-drive Field 2 with SSDs can support nearly 50 streams of ProRes 422 or Avid DNxHD 145, or over 140 streams of 25-Mbit video such as DV25 or XDCAM-EX 25.*

Flash memory is being used for metadata servers in professional media storage where it provides fast access to metadata databases for a media asset management system (MAM). This capability is important in collaborative workflows for local access and even where cloud storage is used to enable post-production work that spans continents and time zones.

Figure 4. EditShare Field 2 Storage System for Field Work Can Use SSDs

Distribution of professional video content has many channels. It can use physical media for getting content to digital cinemas or to consumers or it can be done electronically using broadcast, cable or satellite transmission. Distribution can also be done through the internet or mobile phone networks. **Table 3** gives responses for the percentage of physical media used by the survey respondents for professional content distribution in 2010 through 2015.

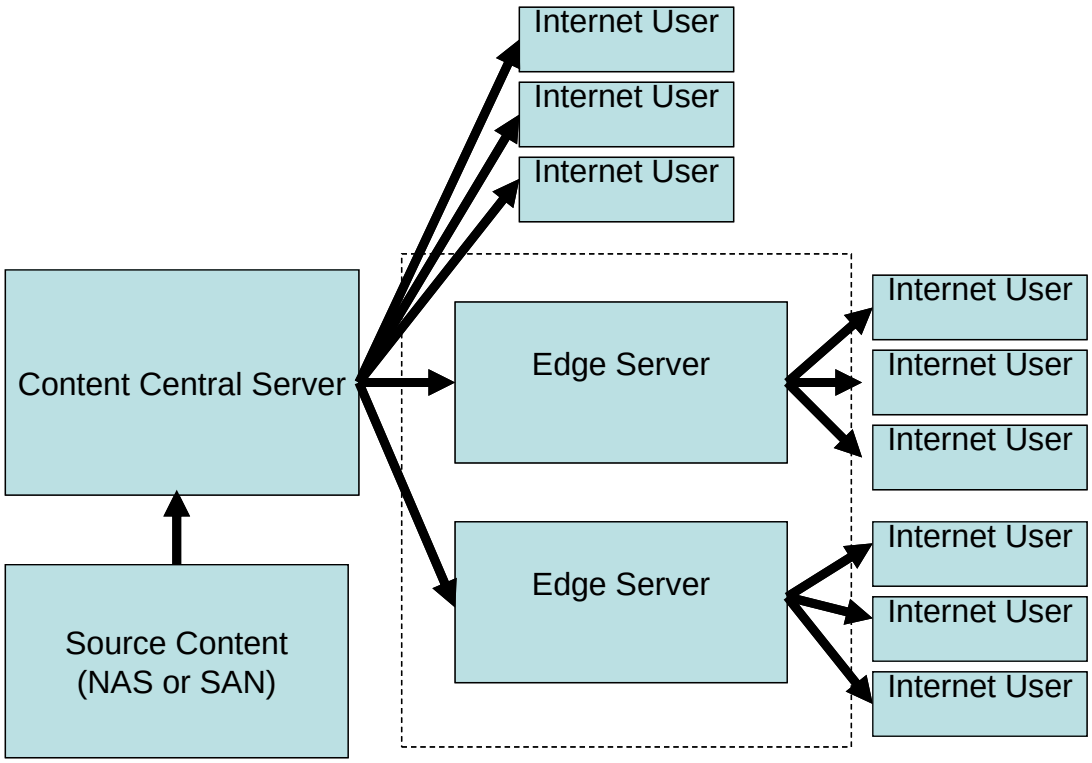
Table 3. Trends on Physical Media for Professional Content Distribution

Media	2010	2012	2013	2014	2015
Digital tape	59%	34%	32%	20%	9%
CD or VCD discs	13%	18%	23%	4%	6%
DVD discs	48%	79%	67%	51%	63%
Blu-ray discs	18%	24%	10%	21%	18%
Hard disk drives	45%	51%	55%	52%	62%
Flash memory or SSDs	25%	24%	22%	28%	24%

Note that these are the average for the survey population giving their percentage for each physical media and do not and should not be expected to add to 100%. HDDs and optical discs (DVD and Blu-ray) are the highest percentage (62% and 81% respectively in 2015 vs. 45% and 79% respectively in 2010). Nevertheless flash memory has had a respectable amount of use for physical content distribution in the professional media and entertainment industry over the survey years and was 24% in 2015.

Content delivery over the Internet is usually done with a content delivery network (CDN). A CDN combines content delivered from a central server with some local storage but usually fed by a library of content on network storage (see **Figure 5**).

Figure 5. Internet Content Distribution System (CDN)



In a CDN there is a central content source that can use edge servers located in geographically separate areas for delivering local copies of static web site content to end-users. These edge servers have local storage containing copies of frequently accessed content. Since the edge servers will be closer to the end user, content can be delivered faster (lower latency) than would be the case if all content came from the central server. This also reduces the workload on the central server and thus provides a better user experience.

Cable operators, video internet distributors such as Netflix and other content providers are expanding their offerings for video on demand (VOD) The popularity of VOD combined with increasing video resolution drive digital storage demand for this application.

Following are survey observations for electronic content distribution (such as video on demand).

- Average hours on central content delivery system was about 4,182 in 2015. In 2014 this was 1,142 hours, in 2013 and in 2012 this was 2,275 and 1,894 hours respectively. It was 700 hours in 2010 and 200 hours in 2009).
- There were 492 hours ingested monthly in 2015 (this was 688 hours in 2014, 837 hours in 2013, 500 hours in 2012, 200 hours in 2010 and 150 hours in 2009). The 2013 and 2014 data is skewed high by some very high survey participants.
- In 2015 43% of respondents had more than 5% of their content on edge servers (this compares to about 43% in 2014, 42% in 2013 and 24% in 2012)
- About 20% used flash memory on their edge servers in 2015 (this was 21% in 2014, 12% in 2013, 14% in 2012, 16% in 2010 and 20% in 2009)

Note that edge servers to support VOD delivery using flash memory-based SSDs are produced by several storage and media server vendors. Such systems provide more reliable remote edge operation with good read performance rates.

Flash's Role in Content Archiving

Although flash memory does not provide the low cost per TB of storage that HDDs or magnetic tape do, it can offer much faster access to content. Several companies have started to use the speed of flash memory to accelerate reading and writing archive systems.

In 2013 Spectra Logic, a leading tape library company, introduced its RESTful interface to tape, Deep Simple Storage Service (DS3). This enables object-based access to data on tape enabling what the company calls "deep storage." Spectra Logic's BlackPearl SSD storage deep storage appliance leverages the DS3 object-based interface for digital tape storage to support active management and protection of large libraries of archived content. DS3 allows using standard open HTTP type commands and APIs that make integration of tape storage a similar operation as a cloud based HDD implementation. The Black Pearl currently supports IBM TS tapes as well as LTO tapes.

The SSDs in the BlackPearl allow fast operations to support the streaming speed of magnetic tape libraries. This capability is important because when magnetic tape cartridges are mounted and spun up they can write and read data extremely rapidly due to the parallel tape channels. Other archive companies, such as XenData, have also introduced their own versions of flash memory-based archiving caching appliances that can speed up content access with magnetic tape.

Flash memory can also be used in a media metadata database allowing fast search and retrieval of archived content stored in a tape or HDD-based library. Thus flash memory is a useful cache or metadata storage media for content archiving applications. There have even been advocates for using

very low performance, low endurance flash memory for archiving purposes, although the economics of this approach don't seem to make sense at this point in time.

Conclusions

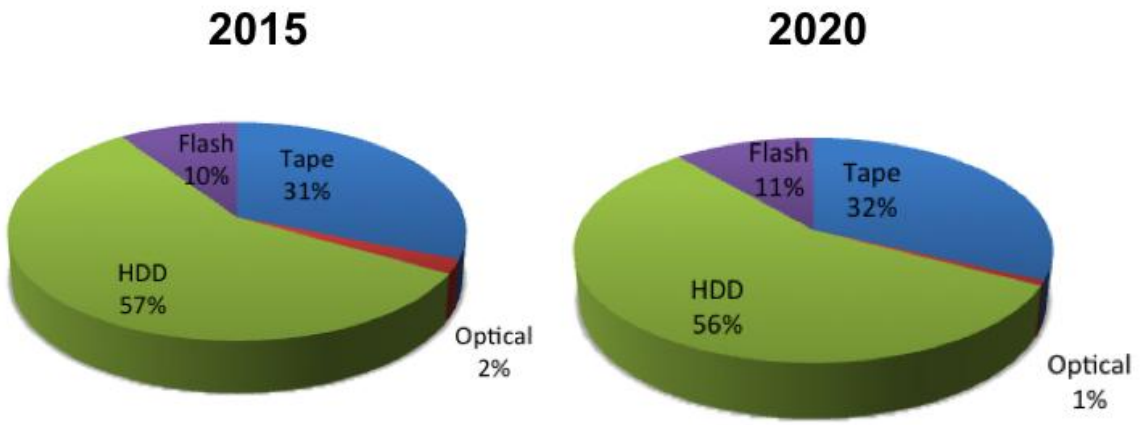
Flash memory can provide data rates to and from storage at much greater speeds than conventional storage devices such as hard disk drives, optical discs and magnetic tape. The high performance of flash memory storage systems, provided with decreasing costs per GB of flash is increasing the use of flash memory in many professional media and entertainment applications. The high bandwidth of flash memory is also enabling the use of high-speed data interfaces such as Thunderbolt II, USB 3.2, 32 Gbps SAS, up to 128 Gbps Fibre Channel as well as SATA, flash memory on computer memory busses and PCIe storage devices and systems.

The ruggedness and speed of flash memory has made it the dominant storage media in professional video cameras. Caching and buffering, as well as metadata searching are other obvious areas where flash memory is playing a valuable role in video content post-production, content delivery and even in archiving. In content distribution flash memory has been used in edge servers for VOD content and Content Delivery Networks and in new archiving applications. Eventually we may also see flash memory used in central content delivery systems.

Flash memory growth in all media and entertainment applications (content creation, post-production, content distribution and archiving) is increasing as shown in **Figure 6**. These pie charts are for expected revenue. Overall Shipped storage capacity of all these technologies is expected to increase as the capacity of the technologies increases and the prices per bit decline. As can be seen flash memory, HDDs and magnetic tape are still expected to play a dominant role for the next few years. By 2020 the percentage of total media and entertainment flash memory capacity will increase by 50% from 2015 and be responsible for 11% of total media and entertainment storage revenue.

Professional media and entertainment applications use a variety of storage technology for use in capturing, processing, delivering and archiving video content. This will drive a storage hierarchy that will include flash memory for important applications and uses. As is often the case, the increased use of flash memory can increase media workflows and thus will likely lead to more content needing to be stored on less expensive HDDs and magnetic tape. In the end, professional media needs all types of digital storage.

Figure 6. Storage Media Revenue



"About the SNIA

The Storage Networking Industry Association (SNIA) is a not–for–profit global organization, made up of member companies spanning the global storage market. SNIA's mission is to lead the storage industry worldwide in developing and promoting standards, technologies, and educational services to empower organizations in the management of information. To this end, the SNIA is uniquely committed to delivering standards, education, and services that will propel open storage networking solutions into the broader market. For more information, visit http://www.snia.org.

About the Solid State Storage Initiative

The SNIA Solid State Storage Initiative (SSSI) fosters the growth and success of the market for solid state storage in both enterprise and client environments. Members of the SSSI work together to promote the development of technical standards and tools, educate IT communities about solid state storage, perform market outreach that highlights the virtues of solid state storage, and collaborate with other industry associations on solid state storage technical work. SSSI member companies represent a variety of segments in the IT industry (see http://www.snia.org/forums/sssi/about/members).

For more information on SNIA's Solid State Storage activities, visit www.snia.org/forums/sssi and get involved in the conversation at http://twitter.com/SNIASolidState.

Sources for this Article

2015 Survey of Storage for Professional Media and Entertainment Applications

2015 Digital Storage for Media and Entertainment Report

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Tom Coughlin, President, Coughlin Associates is a widely respected storage analyst and consultant. He has over 30 years in the data storage industry with multiple engineering and management positions at high profile companies.

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, which was published by Newnes Press. Coughlin Associates provides market and technology analysis as well as Data Storage Technical Consulting services. Tom publishes the *Digital Storage Technology Newsletter, The Media and Entertainment Storage Report*, and other industry reports

Tom is active with SMPTE, SNIA, the IEEE (he is Director Elect for IEEE Region 6 and active in the Consumer Electronics Society) and other professional organizations. Tom is Education and former Marketing Chairman for the SNIA Solid State Storage Initiative (SSSI). Tom is the founder and organizer of the Annual Storage Visions Conference (www.storagevisions.com), a partner to the International Consumer Electronics Show, as well as the Creative Storage Conference (www.creativestorage.org). He is the general chairman of the annual Flash Memory Summit. He is a Senior member of the IEEE, Leader in the Gerson Lehrman Group Councils of Advisors and a member of the Consultants Network of Silicon Valley (CNSV). For more information on Tom Coughlin and his publications go to www.tomcoughlin.com.

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