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Digital Preservation Final  
LTO Tape for Long-Term Preservation

In the 2007 Joint Technical Symposium, leaders in the preservation and restoration of audiovisual materials discussed the growing need for the digitization and storage of media held in archives. While experts at the symposium did not agree on which storage medium is best, it was noted that archives “cannot afford to wait around for the ideal”<sup>1</sup>. This statement alone proves that LTO tape is the best storage medium for digital preservation. With its improving storage capacity with each generation, interoperability between two generations, and quality controlled by the LTO Consortium, it was the best medium for long-term digital preservation in 2007 and still is today.

The desire for quality tape that stores information digitally is clearly demonstrated by the LTO Consortium held back in 1997. The goal of this initiative was to make linear tape technology an open standard. Three leaders in the tape storage industry (Hewlett-Packard, IBM, and Seagate) recognized consumer demand for tape storage and sought to consolidate “state-of-the-art technologies from numerous sources”<sup>2</sup>. This would allow for the best possible tape storage for customers with specifications available to all manufacturers in the industry. Without the popularity of tape storage in the first place, there would be no need or perhaps possibility of this joint initiative; clearly Hewlett-Packard, IBM, and Seagate saw a big demand for tape storage in the future. Thus followed the creation of LTO tape (Linear Tape – Open). To make the format truly open, technical specifications for tape drives and storage cartridges were also made

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<sup>1</sup> Kara Van Malssen: Joint Technical Symposium 2007: Audiovisual Heritage and the Digital Universe, University of Toronto, June 28-30, 2007. *The Moving Image: The Journal of the Association of Moving Image Archivists*, Vol. 8, No. 2 (FALL 2008), p. 79.

<sup>2</sup> “LTO Program: The First Year,” *Ultrium LTO*. 2000, p. 2.

available through open licensing.<sup>3</sup> By collaborating to make the best possible tape storage, these three manufacturers were also bolstering the longevity of the tape storage industry.

By 1998, HP, IBM, and Seagate (also referred to as the LTO Technology Provider Companies) released the first official LTO tape format, known as “Ultrium”.<sup>4</sup> Soon after, thirteen companies joined the initiative by becoming licensees of the technology.<sup>5</sup> The more companies join, the easier it will be for the user; one can buy one brand’s Ultrium tape and another’s drive without worrying about compatibility. However, just because a company has acquired an LTO program license, does that guarantee adherence to its specifications? How would the tape storage industry not fall back into old patterns of proprietary and incompatible technology as companies compete? This issue was addressed from the program’s earliest days with the “LTO Program Compliance Verification” process.<sup>6</sup> This is essential to the survival of an open tape storage technology, because it preserves its interchangeability across drives and cartridges.<sup>7</sup> Only those products that achieve compliance will be marked with a verification trademark, reading “Ultrium LTO”.<sup>8</sup> If an LTO tape brand is to be interchangeable across all drives and cartridges, then it stands to reason it must also be of a certain quality; companies need to adhere to certain technical specifications during design and production.

While the LTO Program Compliance Verification ensures a minimum level of quality of any brand of LTO tape, the verification process promotes increased quality through competition. Although brands must be Ultrium compliant, a certain level of variability is allowed between

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<sup>3</sup> Ibid, 3.

<sup>4</sup> Ibid, 2.

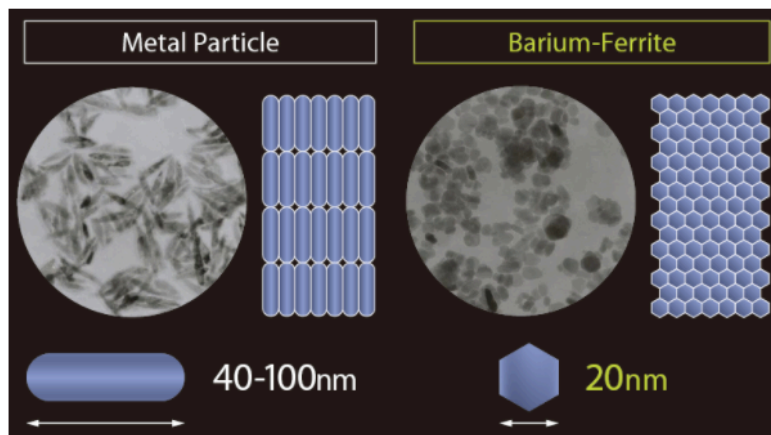
<sup>5</sup> Ibid.

<sup>6</sup> “LTO Program Format Compliance Verification Testing - Focus on Interchange,” *Ultrium LTO*. 2000, p. 2.

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

models. So, how does one brand set itself apart from another? Fujifilm announced its patented NANOCUBIC technology with the introduction of LTO-6 at the end of 2012.<sup>9</sup> As pictured below, the technology uses Barium Ferrite (BaFe), “a new type of magnetic particle which can be greatly reduced in size to improve recording density.”<sup>10</sup>



The image, provided by Fujifilm, shows a comparison of the composition Fujifilm’s tape to that of other LTO 5 tapes (although these other brands remain nameless). The reduced size of the metal particles, as well as their shape are noteworthy. The hexagonal BaFe particles lock together, similar to a brick wall, reducing particle loss, and thus data loss. The increased number of particles would also decrease the rate of data loss over time due to wear and tear or degradation. A study conducted by Fujifilm shows that in accelerated conditions, BaFe particles

<sup>9</sup> “Barium Ferrite: Overview,” *Fujifilm*. 2015.

<sup>10</sup> *Ibid.*

<sup>11</sup> *Ibid.*

lasted as long, or longer than metal particle.<sup>12</sup> Even if Fujifilm's NANOCUBIC technology cannot be proven to be more reliable for long-term preservation than the tradition metal particle makeup of other LTO tapes, it demonstrates how the technology is actively being worked on and improved.

A key part of the LTO program from its inception was the idea of generations of tapes, with the assumption that the technology would continue to improve. In their white paper "LTO Program: The First Year", Ultrium outlines the first four generations of the tape, with the goal of doubling the tape's capacity with each generation and releasing a new generation every two years.<sup>13</sup> LTO generations 1 through 7 are able to read tapes from two generations back and write to tapes from one generation prior.<sup>14</sup> Having generations as part of the model allows for advancements in the technology, particularly with respect to growing data capacity. Allowing the interoperability between generations help mitigate the problem of obsolescence while the tape technology continues to improve.

It should be noted that while researching for this paper, specifications for LTO 8 were released. Unlike the other generations, LTO-8 drives cannot read tapes from two generations prior, but can only read and write to LTO-7 drives.<sup>15</sup> With its relatively new release at the end of 2017, we do not yet know the effects this change has had on the popularity of LTO tape as a medium for long-term storage.

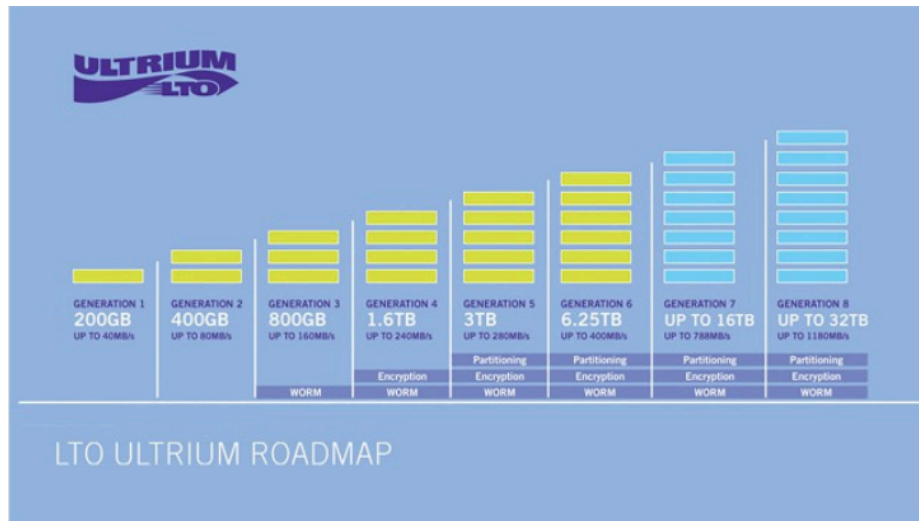
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<sup>12</sup> Katayama, Kazutoshi & Chinda, Yuka & Shimizu, Osamu & Mikami, Tatsuo & Suzuki, Mayumi & Noguchi, Hitoshi. (2016). Long-Term Stability of Magnetic Tape for Data Storage Under an Accelerated Condition. *IEEE Transactions on Magnetics*. 52. 1-1. 10.1109/TMAG.2016.2529007.

<sup>13</sup> "LTO Program: The First Year," *Ultrium LTO*. 2000, p.4.

<sup>14</sup> "Compatibility," *Ultrium LTO*. 2018.

<sup>15</sup> *Ibid.*



Many did complain of the difficulties on use with the earlier generations of LTO tape. However, the development of the Linear Tape File System, or LTFS, made tape storage more user friendly. Introduced with the fifth generation of the technology, this file system made tapes “as easy to use as a removable hard drive.”<sup>17</sup> The system allows users to see the directory and the files stored on the tape, allowing for “random-access” not possible with previous generations.

Another advantage for LTO tape as a medium for long-term preservation is its scalability. Independent filmmakers see the benefits of tape storage, particularly with the introduction of the 4K format.<sup>18</sup> On this end of the spectrum, consumers can buy standalone decks, with up to double tape capacity. An HP LTO-7 single deck tape drive on the market today is listed for \$2,750 on

<sup>16</sup> Divischek, Nic. “Have You Considered Tape Storage? LTO 7 Will Store 15TB Cheap for 30 Years,” *cinema5D*. 13 Oct 2015.

<sup>17</sup> D. Pease, A. Amir, L. V. Real, B. Biskeborn, M. Richmond and A. Abe, “The Linear Tape File System,” *2010 IEEE 26th Symposium on Mass Storage Systems and Technologies (MSST)*, Incline Village, NV, 2010, pp. 1-8.

doi: 10.1109/MSST.2010.5496989

<sup>18</sup> *Ibid.*

Amazon. Most of these drives use SAS, SCSI, or Thunderbolt connections. However, large media corporations like Netflix have incorporated backing up their (born-digital) original content to LTO tape to their workflows.<sup>19</sup> Netflix outlines:

“Archival of camera RAW footage, audio, and color information should maintain original directory structure, filenames, and metadata that were created by the cameras, audio recording devices, and dailies software to one or more of the following:

- LTO-5, LTO-6 or LTO-7 tape in LTFS format
- Netflix’s Content Hub (cloud-based)
- High-speed RAID-protected external hard-drive”<sup>20</sup>

While Netflix does rely on a combination of storage media for archiving its digital assets, the inclusion of LTO tape underscores the technology’s lasting relevance. With the amount of data Netflix produces, it most likely uses an LTO robot, meant for large-scale operations. These typically have a minimum capacity of 16 LTO tapes and allow LTO tapes to keep up in the age of big data.

A phone call with Marie Lascu, Crowing Rooster’s digital preservationist, revealed the advantages of LTO tape over disk storage. Crowing Rooster Arts is a non-profit media corporation that has been working to digitize its media assets for approximately the last five years.<sup>21</sup> With hard drives stacking up and cluttering work space, switching to LTO tape was chosen as a long-term solution for the preservation of the corporation’s digital assets. Letting

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<sup>19</sup> “Production Assets: Data Management.” *Netflix*. 2017. <https://backlohelp.netflix.com/hc/en-us/articles/360000581207-Production-Assets-Data-Management>.

<sup>20</sup> *Ibid*.

<sup>21</sup> Lascu, Marie. Telephone interview by author. October 9, 2016.

hard drives accumulate in office space, and not in a climate-controlled environment best for long-term preservation can lead to degradation, drive failure, and data loss.

Cloud storage also tackles the issues of the long-term physical storage of digital data. Services like Microsoft's Azure and Amazon's S3 are appealing to companies and individuals alike because of their ease of use. Cloud services typically ask for a monthly fee and any technical issues are in the hands of the IT department. While investing in LTO tape does not include customer support, it is a more stable investment. What happens to digital assets if a cloud service company goes out of business? What are the costs of retrieval, let alone storage? How secure is the data in the cloud, versus a physical building with security and lock and key? The physicality of LTO tape along with its impressive data capacity makes it a sounder choice for long-term digital preservation.

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