Hewlett Packard Enterprise

The future direction of tape media

Technical white paper

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Introduction

We are now three years into the life of LTO-6 Ultrium, the sixth-generation of the most successful tape format in existence. Over 3 million Hewlett Packard Enterprise LTO-6 cartridges have been sold to date, to add to the 80 million Hewlett Packard Enterprise Metal Particle cartridges shipped to customers since the format was launched in 2000. For that reason, LTO-6 has already surpassed its predecessor LTO-5, in terms of adoption rates.

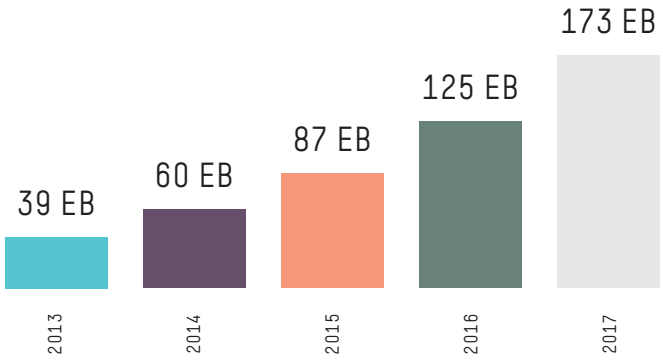
Demand for LTO tape continues to grow: in the final quarter of 2014, new cartridge sales achieved a record high of over 6,400 PB (more than 6 billion GB) of tape capacity.

And now, with the launch of LTO-7, tape storage technology is accelerating backup and archiving further in terms of capacity and performance, with 15 terabyte capacity cartridges (assuming 2.5:1 compression) and native transfer speeds capable of reaching 1.1 TB/hr.

It's a good moment, therefore, to look at these trends in more detail. And who better to discuss what the future may hold for tape than the market leader in branded tape devices and tape media: Hewlett Packard Enterprise.

The future role of tape

As we know, data is growing at an unprecedented rate in terms of velocity and distribution.



Source: Worldwide File and Object-Based Storage 2013 – 2017 Forecast, IDC, July 2013.

This puts tape and other storage technologies in the forefront for budget and resource planning for companies across the globe. In a recent study by analysts ESG, 92% of companies indicated they would be increasing or maintaining their storage and backup budget in 2014. Over 35% identified backup and recovery as a business challenge; 11% said it was their primary focus.

Storage for the idea economy

Major computing shifts require a new approach to backup and archiving. Hewlett Packard Enterprise's approach helps customers transform their backup, recovery and archive infrastructure. There are three broad types of data that need managing and protecting in this rapidly changing environment:

- Critical data for business survival, which tends to have Service Level Agreements associated with it: Recovery Time Objectives, Recovery Point Objectives and so on.
- Operational data that is typically worked on daily.
- Legacy data, which is data that is not accessed often and may or may not have value but which the business decides, or is required, to keep.

Hewlett Packard Enterprise StoreEver Tape is the ideal solution for safe, scalable and low cost archiving of vast quantities of legacy data. It complements the other pieces of HPE's storage portfolio – Hewlett Packard Enterprise 3PAR StoreServ, StoreVirtual and StoreOnce – to address the challenge of managing data to the end of its life cycle.

Preserving the digital universe

With 90% of all data never being accessed again once it has been archived[1], tape represents the ultimate last line of defence and repository for a business's deep store of content. Off-site, offline data stored on tape is immune to all threats from human error, software corruption, hackers and viruses. With a shelf life of at least 30 years and minimal costs for power, cooling and management[2], tape remains the supreme archiving technology. And these benefits underpin the impressive market figures witnessed for LTO-6 Ultrium.

Tape is the cloud – ask Google

In summary, although some commentators speculate as to when tape will be replaced by cloud technology, in Hewlett Packard Enterprise's opinion this is the wrong question. Tape can't be replaced by cloud because tape is the cloud. Even the most notable companies associated with cloud services use tape. When Google's Gmail service was badly disrupted by a corrupt software patch in 2012, the only way of recovering the accounts of more than 40,000 customers was through backups stored offline on LTO Ultrium.

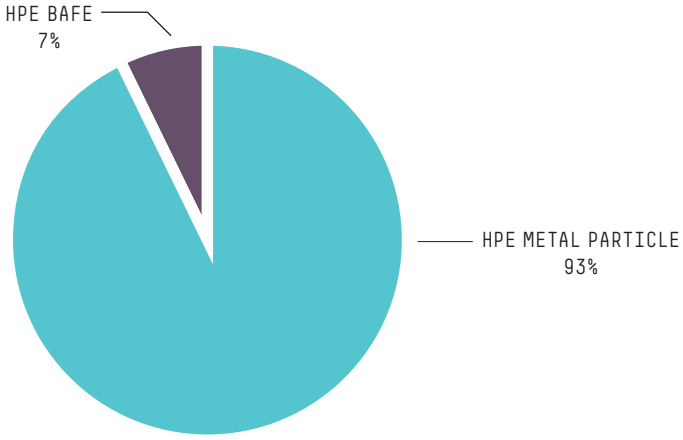
In the intervening period, and in the years to come, no other technology is emerging that would provide an alternative to this 'when all else fails' scenario.

> "We use tapes, still, in this age because they're actually a very cost-effective way as a last resort for Gmail. The reason why we put it in is not physical data loss, but once in a blue moon you will have a bug that destroys all copies of the online data and your only protection is to have something that is not connected to the same software system, so you can go and redo it."
>
> – Urs Hölzle, Senior Vice President of Technical Infrastructure and Google Fellow at Google

LTO-6 Ultrium

Uniquely, LTO-6 was the first tape format to be available in different types: Metal Particle and Barium Ferrite. Hewlett Packard Enterprise is the only supplier to sell both types of LTO-6 storage media and is in the best position to summarise the differences between the two options.

HP LTO-6 Lifetime Sales (November 2015)



[1] 2008 study by University of California Santa Cruz looking into disk access patterns for the network of a large local business over 22 TB of disk-based data.

[2] www.clipper.com/research/TCG2015006.pdf

One format, two types of LTO-6 media

Until LTO-6, 100% of Ultrium data cartridges were manufactured using advanced Metal Particle (MP) technology. MP offers robust, tried and tested data protection and has been the bedrock of successful backup and archiving for millions of LTO Ultrium customers since 2000. Over 275 million MP data cartridges have shipped in that time. And since launching LTO-6, during which time Hewlett Packard has been the market leader for the whole category, over 90% of all Hewlett Packard Enterprise LTO-6 data cartridges have been of the MP type. MP remains the dominant technology in use today.

Barium Ferrite (BaFe) is a newer formulation. It was first used for LTO with the launch of LTO-6 and will be the only type of media for LTO-7. Although the BaFe media is manufactured in a similar way to MP tape, with magnetic particles suspended in a coating on a substrate, BaFe particles are smaller in size than MP particles. That means they have superior magnetic potential which becomes significant as the areal density – and hence the capacity – of the media increases.

What is the difference between format and formulation?

It's important to be mindful that LTO Ultrium is a very tightly defined storage format. The three inventors, or Technology Provider Companies, of LTO (Hewlett Packard Enterprise, IBM and Quantum) define the standards and specifications that all companies, both hardware and media, must abide by. This is at the heart of the open standard philosophy behind LTO Ultrium format: that products manufactured or supplied by different manufacturers are guaranteed to work together without any compatibility or interchangeability issues. Only Hewlett Packard Enterprise, IBM and Quantum can define the future roadmap of LTO Ultrium. All other companies, like media vendors or other hardware OEMs, are licensees and must follow the path prescribed by the TPCs.

Neither MP nor BaFe are formats, but rather they are two different materials used to manufacture media: providing technical solutions to achieve the same goal, namely compliance with the LTO Ultrium specification itself. In much the same way as nylon and cotton are two perfectly acceptable materials to use for making a shirt, so long as the materials meet the specification, they can be sold as an LTO product.

The benefit of open standards

This example highlights one very important distinction that has been crucial to the success of LTO compared to older legacy formats like DLTtape and Advanced Intelligent Tape (AIT). The benefit of an open standard is that it gives companies the freedom to approach the format from multiple directions, based on their technical skills, target audiences, cost structure and other factors. These are the bedrocks of competition that have enabled LTO Ultrium to become the pre-eminent solution in backup and archiving. Ultrium is not, and never will be, proprietary technology and not even the TPCs themselves can change the format to suit their own expertise or bias. Put simply, Hewlett Packard Enterprise, IBM and Quantum must follow the rules just like everyone else.

What's in a name? Nothing unless it meets the specification

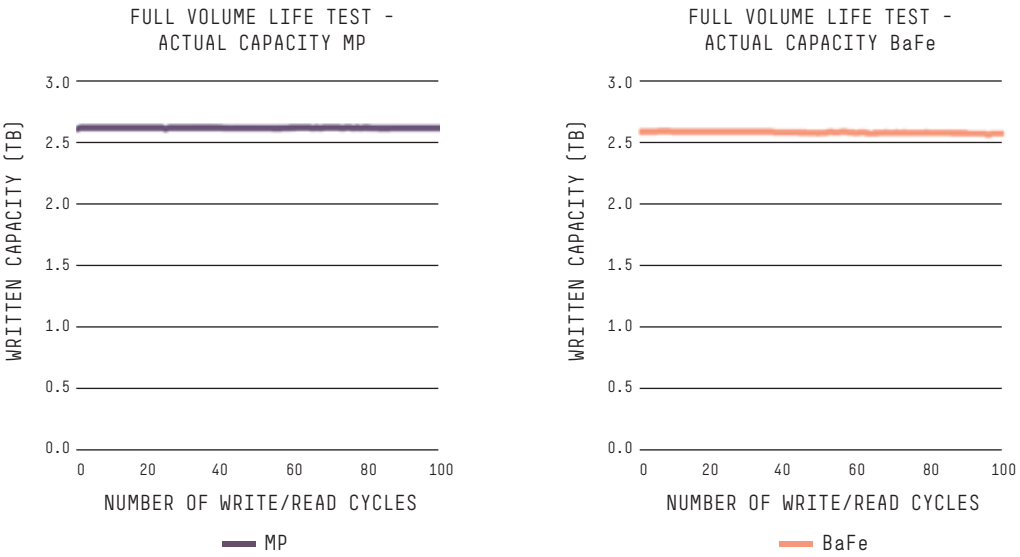
Naturally, in an open market, one expects competition and the intervening years have seen very healthy and vigorous rivalry between some of the world's leading data storage companies. Brand names like Nanocubic, Neosmart, Dternity and StoreEver are familiar to IT decision makers. But customers should never lose sight of the fact that ultimately, all these terms are marketing names to identify a particular vendor's solution for meeting the LTO Ultrium specification.

In the world of LTO tape media, MP and BaFe are like the nylon or cotton of the earlier example. They enabled companies to fulfil the LTO-6 format and have been marketed using a variety of brand names. But underneath the marketing, they are all LTO-6 format compliant products.

So which is the better tape? Neither (and here's the proof!)

The reason why both exist is because different vendors chose alternative paths to achieving compliance. Unlike every other tape company, Hewlett Packard Enterprise sells both types of media because it realised some customers would prefer MP and some would prefer BaFe. But based on HPE's exhaustive testing, for LTO-6 users, neither version offers any advantages in terms of performance, reliability, durability or cost.

As an example of just one of those tests, Hewlett Packard Enterprise continues to conduct Full Volume Life Testing in two different environments to examine and ensure the performance of both MP and BaFe tapes across a broad spectrum of conditions. Both ambient and 29°C 80% R.H. (hot/wet) conditions are used.



Although Hewlett Packard Enterprise is aware that some vendors have positioned BaFe as a more desirable technology, the test data shows there is no performance difference when using either media type. User capacity and transfer rates consistently show excellent results throughout the tests (e.g. Extended Green Tape Tests completed using 2,000 cartridges of MP and 2,000 cartridges of BaFe media). The reason for switching to BaFe is driven by the need to increase coercivity and magnetic strength as particles become smaller, not by concerns about reliability.

There is no evidence that customers using MP media are disadvantaged in drive performance if they choose MP LTO-6 media rather than BaFe media. The archival life of their data will not be different (see the white paper 'The Benefits of Tape for Archiving'). Furthermore, end users with prior investments in LTO Ultrium tape continue to rely on MP technology because they have LTO-5 and LTO-4 cartridges that need to be used inside their LTO-6 devices. And LTO-5 tapes are read compatible with LTO-7 drives.

Consider the following facts:

- Even before LTO-6 was launched, Hewlett Packard had already completed over half a million hours of testing for MP and BaFe media, pulling over 500,000 miles of tape.
- In 2013, Hewlett Packard pulled over 200,000 miles of MP and BaFe LTO tape through HP and non-HP devices.
- In 2013, Hewlett Packard pulled over 100 million yards of MP tape to demonstrate the reliability of the GMR heads in Hewlett Packard StoreEver tape drives.

In summary, the reasons for promoting BaFe as better, or even as being somehow fundamental to the LTO-6 format, are entirely down to branding and marketing and not in any way related to the TPC specification or to a customer's likely actual experience.

Hewlett Packard Enterprise feels able to make this distinction because we are one of the TPCs; we have sold more LTO-6 tapes and media than any other company; and, to reiterate, over 90% of HPE LTO-6 media to date has been of the MP variant.

LTO-7 and beyond. What next for tape?

But what of the future? Will we see a continued divergence between MP and BaFe in LTO-7 and next generation LTO devices?

The straightforward answer to that question from Hewlett Packard Enterprise's perspective is 'no'.

To meet the 15 TB capacity of LTO-7 and the extended capacities set out in the LTO roadmap – up to 120 TB by generation 10 – it is necessary to reduce the size of the particles used to manufacture the recording surface of the tape. Shrinking MP particles further isn't the right way forward because they lose their coercivity and magnetic strength, which can ultimately lead to data corruption.

Tape drives work by magnetically changing the position of the particles in a pattern that corresponds to computer bytes; the north or south polarities of the particles represent the 1's and 0's of binary data. In simple terms, therefore, the particle count is a cornerstone of how much data can actually be stored on a tape. Increasing their quantity has a direct bearing on capacity. The more particles you can change, the more bytes you can store. This is known as areal density.

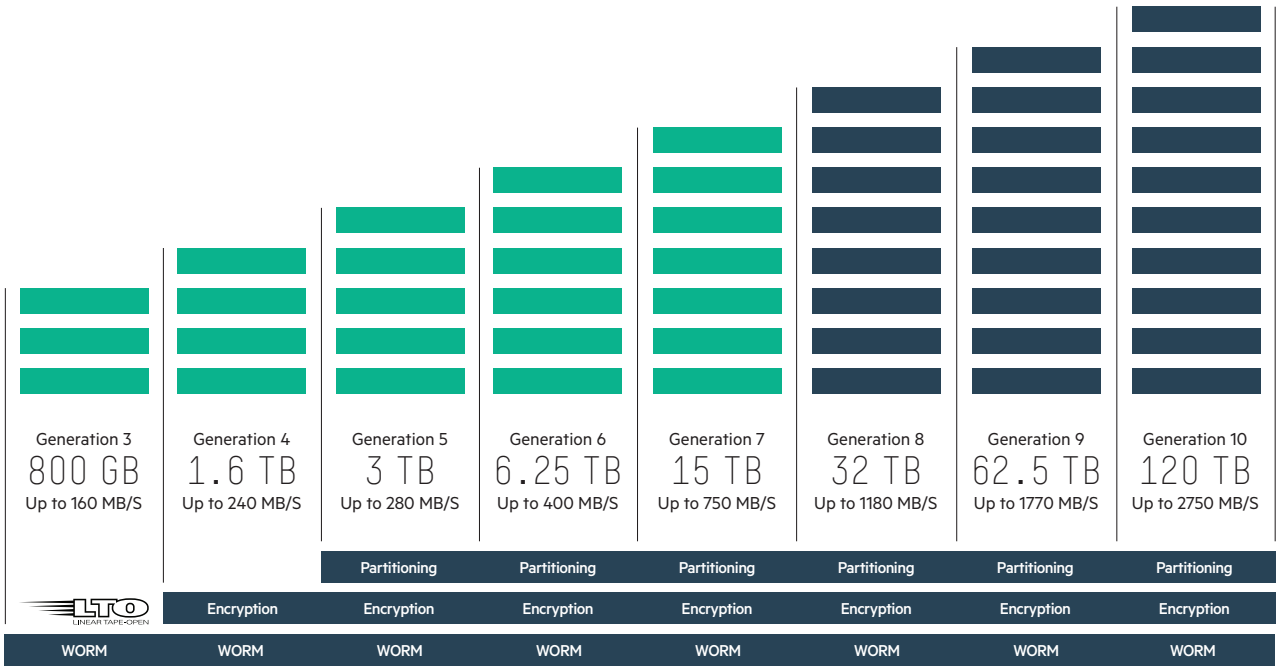
But packing more particles into a physical space that is defined by the LTO format specification brings technical challenges. Because of the need for backwards compatibility, the tape cartridge cannot increase in size and this in turn limits the amount of tape that can be wound onto the reel inside the shell. One method for increasing capacity is to make the particles smaller, which in turn requires ingredients with higher levels of coercivity.

Hewlett Packard Enterprise LTO-7 media uses BaFe technology, which exhibits excellent magnetic properties. The improved signal to noise ratio (SNR) of BaFe technology helps support the increased recording densities needed for the 15 TB LTO-7 cartridges. The same is likely to be true for delivering the next generations of the LTO roadmap.

Coercivity – and why it's important

So what is coercivity and why does it matter? Coercivity is the resistance of the particles to having their position changed. A higher coercivity is needed for higher capacity tapes because as the bits get more tightly packed, the magnetic forces between them become more intense, which can lead to their individual signal strength becoming weak and blurry. Because it is an oxide, BaFe and similar compounds are less susceptible to the demagnetisation that can occur between these densely arranged particles. This ensures that data is not only saved with a low and reliable error rate, but also that once it has been captured, it stays captured, exactly as it was written.

Compared to MP, BaFe media has better magnetic properties, which means improved Signal to Noise Ratio (SNR) and Bit Error Rate (BER). Although this is irrelevant to customers buying LTO-6 today, it was an important consideration for LTO-7 and will continue to be so for LTO-8 and beyond.



Conclusion

In conclusion, therefore, tape demand is extremely robust. LTO-6 has ramped faster than its predecessor and the amount of capacity being shipped on tape products is at an all time high. LTO-7 will accelerate the demand for tape capacity that has been increasing throughout the last decade.

As the market leader for branded LTO tape drives, low and mid-range automation, as well as storage supplies, Hewlett Packard Enterprise has put its StoreEver portfolio at the heart of its vision for storage for the new style of business. This is the infrastructure that companies are migrating to in order to manage the demands of an explosion of data.

Although MP technology has been an outstanding solution for companies seeking the most reliable backup and archiving products, LTO-6 will be its final application. But it is going out on a high note, with performance and reliability metrics that deliver the same outstanding customer performance as the newer, emerging particle technologies.

Backwards compatibility guaranteed regardless of media type

Also, it is important to remember that since Hewlett Packard Enterprise and the other TPCs control the format, backwards compatibility (one gen write, two gen read) is assured for investment protection. The material used to make the media has no bearing upon this and no media company or single supplier can 'break' backwards compatibility if they still want to use the LTO logo.

That means all new LTO-7 drives will need to work with the millions of MP LTO-5 and LTO-6 tapes that still exist as new models come to market.

In Hewlett Packard Enterprise's opinion, as the market leader in LTO Ultrium and as a TPC, this freedom at the heart of the format is not just good for innovation and good for tape, it's squarely in the best interests of the customer. The future is bright; the future is tape.

Learn more at
hpe.com/storage/storagemedia

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