Tape Technology Update

March 24th, 2025, Presented at Designing Storage Architecture Conference at The Library of Congress

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FUJIFILM North America Corp., Data Storage Solutions

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Agenda

1. Tape Media Technology
2. Tape Capacity Roadmap
3. Innovation in Tape Libraries
4. TCO Advantage
5. Energy Advantage
6. Tape Recycling
7. Long Term Outlook

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IBM/Fujifilm Tech Demos

New Material

Future — Higher Capacity

2020 — 317GBPSI /580TB

2015 — 123GBPSI /220TB

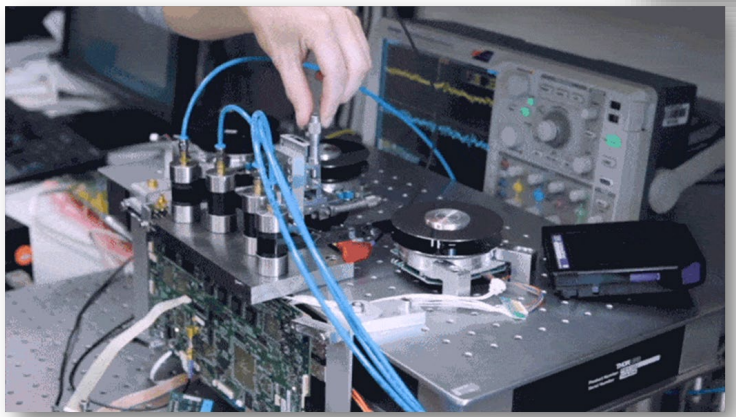
2014 — 85.9GBPSI /154TB

2010 — 29.5GBPSI /35TB

2006 — 6.6GBPSI / 8.0 TB

Barium Ferrite

Strontium Ferrite



- IBM Zurich, 580 TB demo testing

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IBM TS1170 – 50 TB Tape

Barium Ferrite + Strontium Ferrite

- **Launched September 2023**
- **Tape formula blends Fujifilm's BaFe with SrFe**

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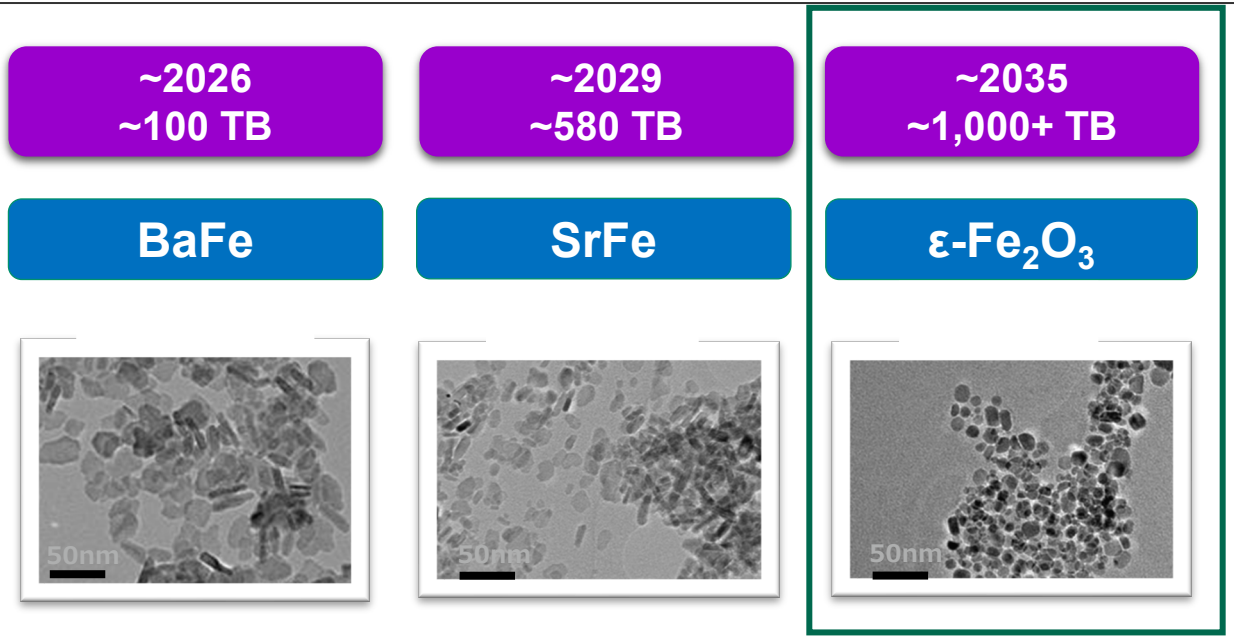
Beyond BaFe and SrFe: Epsilon Ferrite



- **Epsilon Ferrite** enabled by Focused Millimeter Wave–Assisted Magnetic Recording (**F-MIMR**)*

* The present research was supported in part by the "Advanced Research Program for Energy and Environmental Technologies / Development of a millimeter wave assisted magnetic recording method for magnetic tapes" project (Ohkoshi Laboratory, **The University of Tokyo** / Nakajima Laboratory, **Osaka University** / Recording Media Research Laboratories, **FUJIFILM Corporation**) commissioned by NEDO of METI. https://www.chem.s.u-tokyo.ac.jp/~ssphys/english/research.html, Oct. 2020

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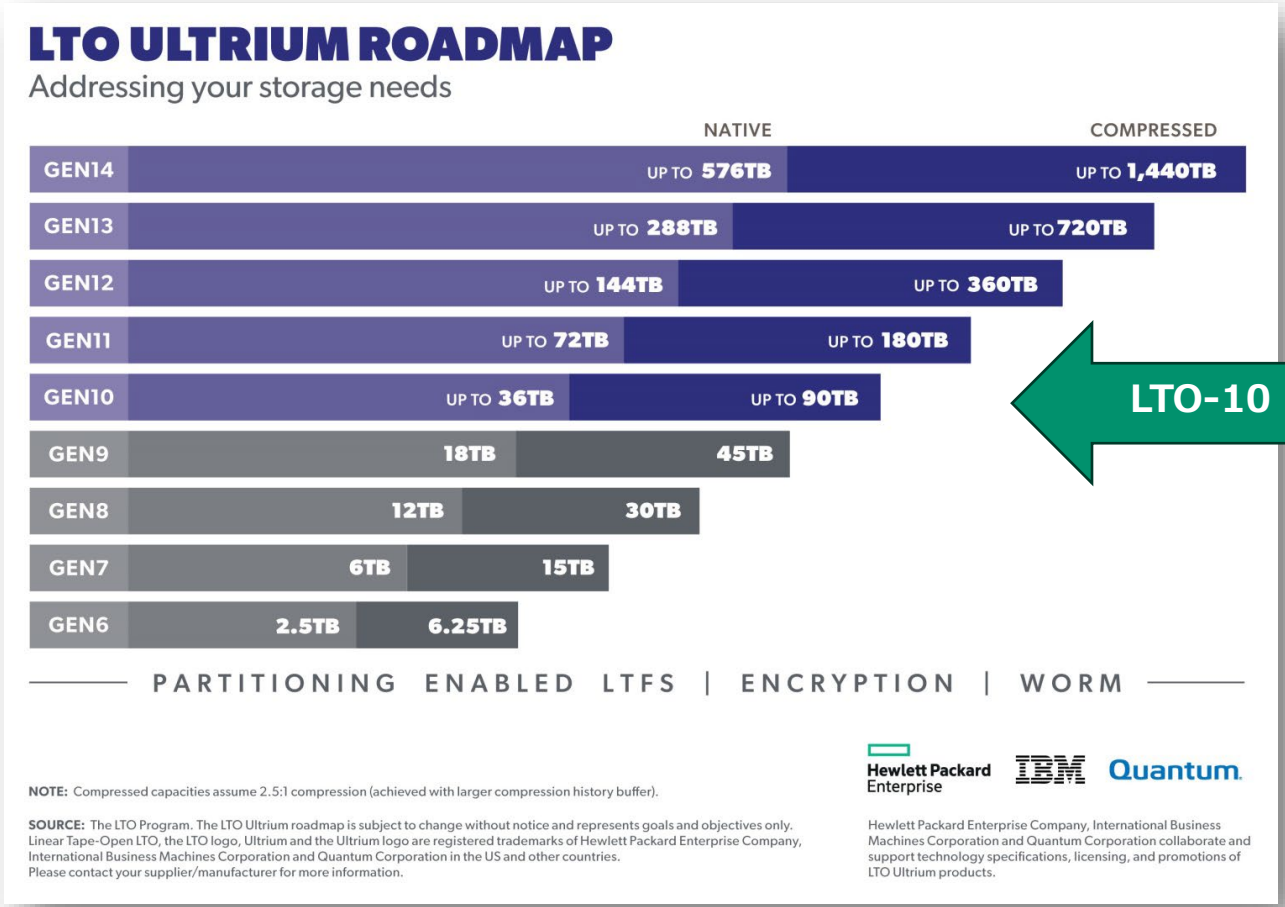
LTO Roadmap



LTO-10 Mid-2025

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Innovation in Tape Libraries *S3 Compatible Object Tape for Hybrid Cloud*

IBM Diamondback

Capacity* per 8.0 sq.ft.
LTO-9: 69.7 PB
** Based on 1,548 carts with 2.5:1 compression*

Spectra Cube

Capacity* per 11.3 sq.ft.
LTO-9: 75 PB
** Based on 1,670 carts with 2.5:1 compression*

Quantum i7 Raptor

Capacity* per 9.0 sq.ft.
LTO-9: 90 PB
**Based on 2,008 carts with 2.5:1 compression*

BDT S3 Orion

Capacity* per 19" rack
LTO-9: 43.8 PB
**Based on 974 carts w/ 2.5:1 comp.*

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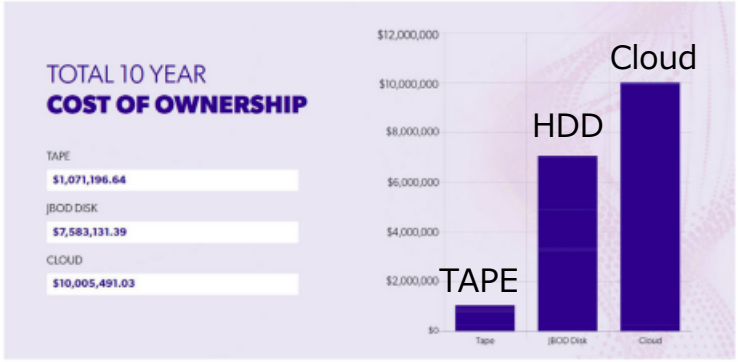
TCO Advantage for Tape

TCO Calculations Underscore the Reason to Move Low Activity Data from HDDs to Tape

Effectively addressing the storage optimization challenge of "getting the right data, in the right place, at the right time, and at the right cost" presents the single biggest total return for storage managers. To meet this challenge, the strengths of tiered storage combining intelligent software, SSDs, HDDs, and tape must be leveraged. As most data ages, access frequency drops off rapidly and data typically reaches archival status between 90–180 days, eventually becoming cold data. Much archival data continues to live on HDDs (too) long after it reaches archival status, a residence with expensive energy costs for such cold data. Using the highly versatile LTO Ultrium TCO Calculator, organizations can compare the TCO, energy, floorspace, and emissions to existing storage alternatives. The TCO for a HDD and cloud solution is compared to a tape solution using LTO-9 tape media and drives in the chart above. The calculator example indicates that the TCO of 20 PB of data growing at 25% per year would cost over $10 million if stored in the cloud, $7.5 million if stored on JBOD disk (on premise) and just $1.07 million if stored on tape. The compelling benefits of tape become obvious.



Source: LTO.org

Clearly, the greatest economic benefits are realized when the tape tier is used. Intelligent data management software from a variety of suppliers that moves data from disk to tape is a key component to implement an optimized tiered storage infrastructure. Look for AI to play a more significant role in data management decisions going forward and to do the re-location of data to the optimal location for the user. Remember—adding disk is tactical and very costly, adding tape is strategic and much more cost-effective.

Source: https://asset.fujifilm.com/www/us/files/2025-01/c1e7c7e9c707409b75b757464ab06e1e/Horison-Tape-Market-Outlook-Jan-2025.pdf, page 9.

U.S. Data Center Power Consumption Percent of U.S. Total

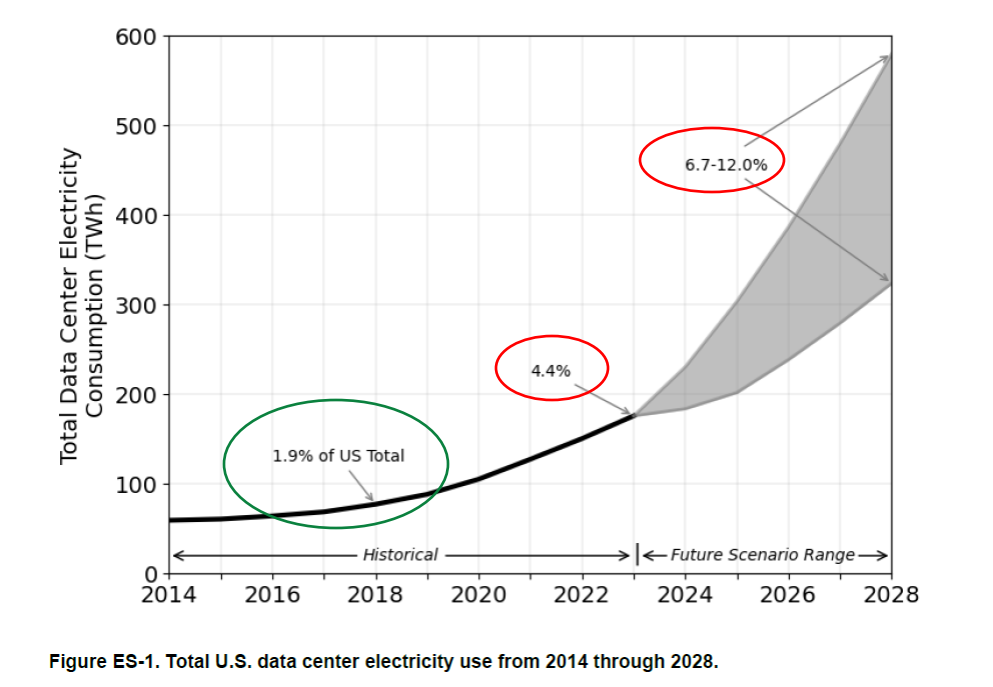


Figure ES-1. Total U.S. data center electricity use from 2014 through 2028.

Source: Lawrence Berkeley Nat'l Lab, 2024 US DC Energy Usage Report, Dec. 2024

- Historically we recognized US data centers at around 1.5 – 2.0% of total electrical demand and LBNL shows this at **1.9% in 2018.**
- But it appears the % has jumped up to 4.4% in 2023 and may exceed 6.7% in 2028!
- *Key drivers are digital transformation, crypto currency and AI.*
- ***Will this be allowed to happen from a cost and ESG perspective?***

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Modern Data Archive Comparison

Client HDD Archive Dell PowerScale® A3000		IBM Storage Deep Archive on Diamondback
		
• Floor Space – 18 sqft	— 50% →	• Floor Space – 9 sqft
• aTEC – 146,335 kWh/yr	— 93% →	• aTEC – 10,204 kWh/yr

aTEC = average yearly total energy consumption

*27PB, 10-year data retention, 16TB HDD, 5-year HDD refresh, market pricing, $0.12 kWh, CO2e based on 2022 sustainability compare report.

10,204 kWH/yr = 1.17 kW/hour for tape vs 146,335 kWH/yr = 16.7 kW/hour for HDD

Source: IBM, The Future of Tape, Sustainable Data Storage, Shawn Brume, Nov, 2024

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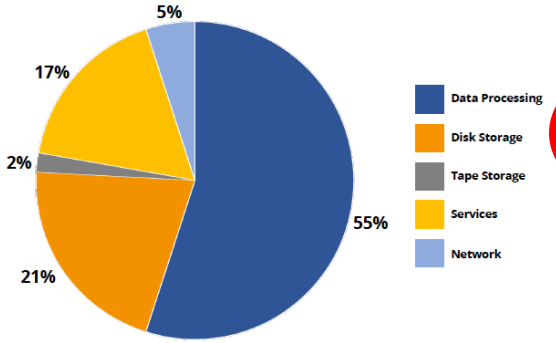
Why Tape? : Energy efficiency

- For comparable data quantities, tape storage requires 10x less energy than disk.

Increasing tape storage capacity can be done without increasing additional power.

CERN data center Power Consumption



2021 average power consumption (including cooling) was 4.11 MWh (= ~37 GWh / year)

24

4.11 MW per hour, x 24 hours, x 365 days = 36,003.6 MWh, or 36 ~37 GWh per year.

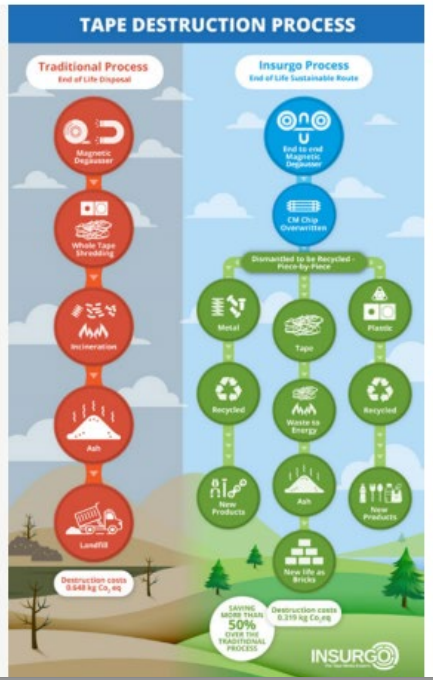
2% for tape vs. 21% for disk = 90% less energy for tape vs. disk

https://www.lto.org/wp-content/uploads/2024/01/CERN-IT-Storage-and-Data-Management-_Vladimir-Bahyl-Presentation.pdf

Insurgo Tape Recycling

Tape End-of-Life Disposal Innovations Reduce CO2 Impact by more than 50%

Beyond energy savings in the usage phase, innovative new solutions for tape cartridge disposal at end-of-life are now available that further enhance the eco-friendly nature of tape. These innovations consist of more energy efficient methods of data eradication, including the cartridge memory chip, with full traceability of the cartridge through the disposal process.
Once completely devoid of data, the cartridge enters into a material component recycling stream, resulting in a more than 50% reduction in CO2e compared to traditional degauss, shred, and incineration processes. As global warming and climate change continue to be of increasing concern among corporate stakeholders, sustainability best practices from cradle to grave will be demanded for all components of IT infrastructure.



https://insurgo.co.uk/secure-disposal-solutions/

Source: https://asset.fujifilm.com/www/us/files/2025-01/c1e7c7e9c707409b75b757464ab06e1e/Horison-Tape-Market-Outlook-Jan-2025.pdf, page 7.

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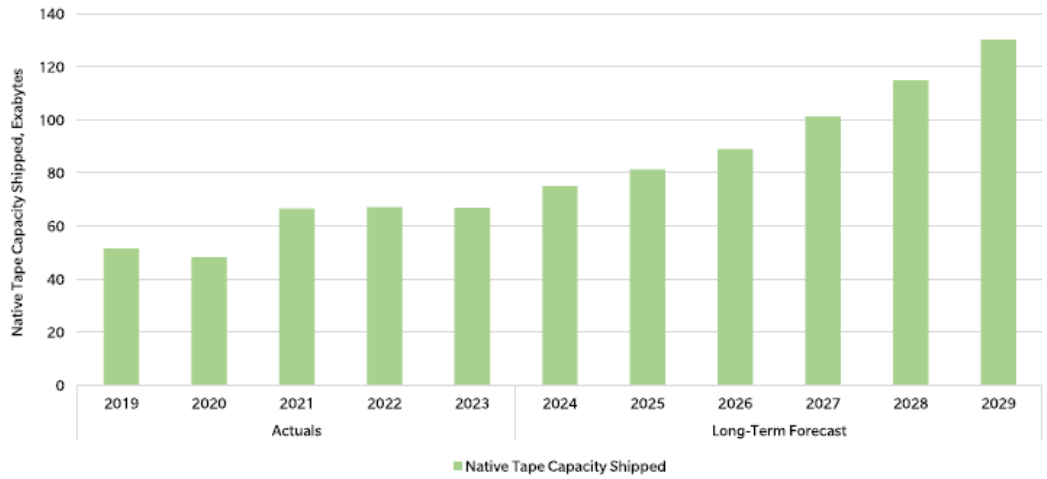
Tape Market Trend, Capacity Shipments, TRENDFOCUS, 12/23/24

Chart 1
Native Tape Capacity and Long-Term Forecast, Exabytes



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Thank You!

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