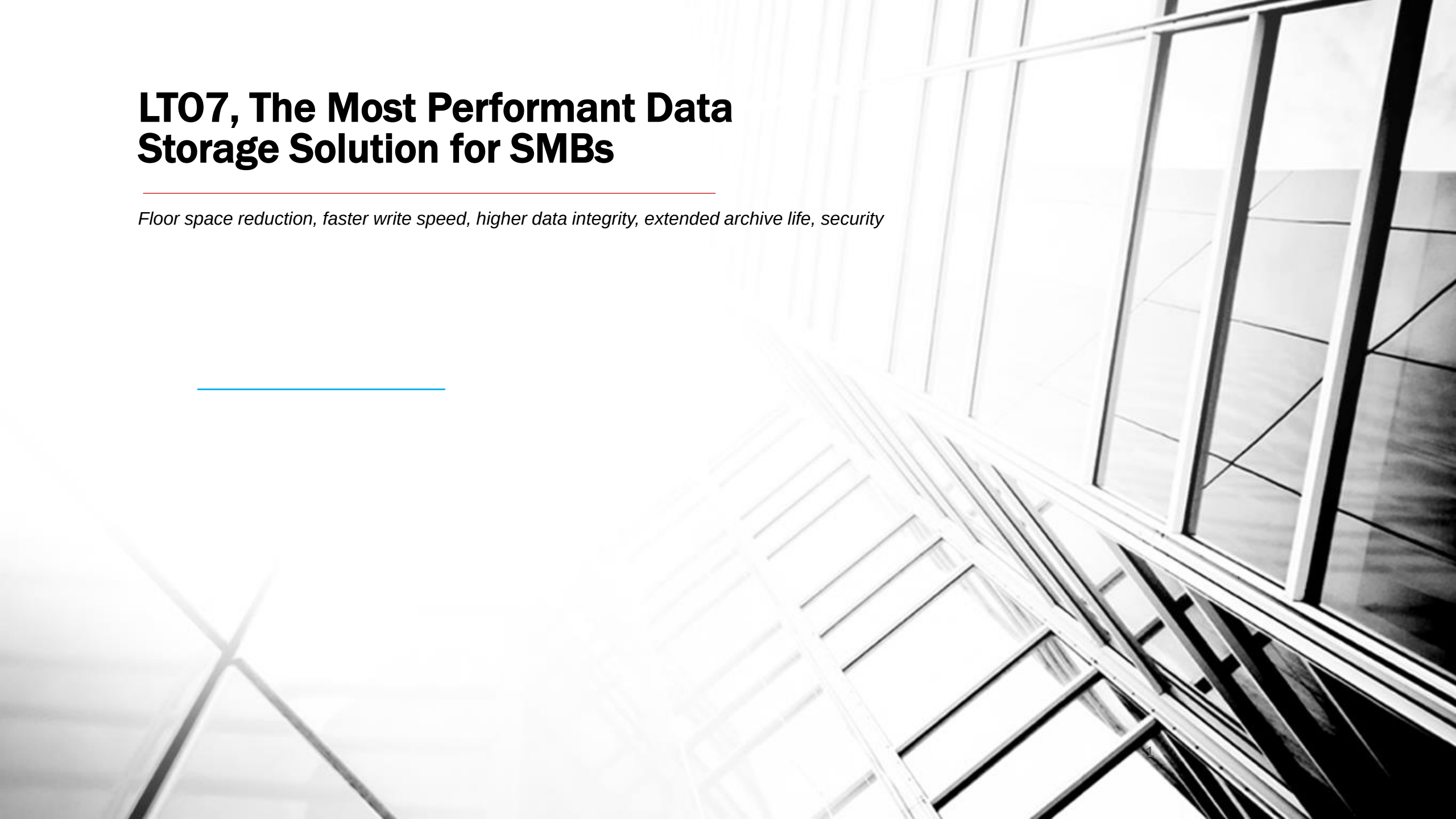
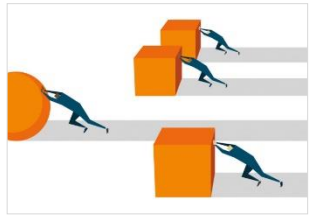
LTO7, The Most Performant Data Storage Solution for SMBs

Floor space reduction, faster write speed, higher data integrity, extended archive life, security



Archive life

Data Integrity



Performance / speed

Floor space reduction

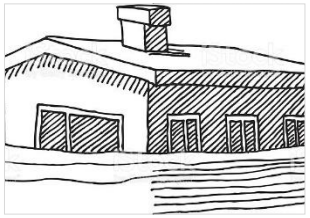
The future of the technology

Protection vs Hackers
or Virus

Ecological footprint

Scalability

Portability



Disaster recovery

Access time to Data

TCO / cost

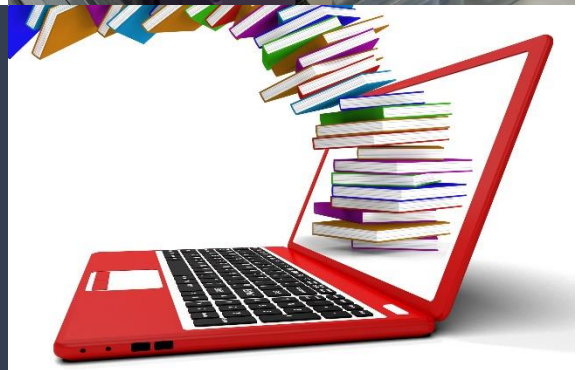
FUJIFILM

Tape has become the standard format for long-term data retention

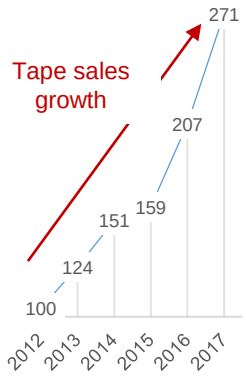
The performance level of a tape based solution is higher than that of hard disk

Tape achieves an unprecedented technological leap in the history of Data storage

It is a compact and easy-to-use solution



1) Tape has become the standard format for long-term data retention



These store their data on tapes:

- The vast majority of the Giants of the Web (GAFAM)
- The ministers
- TV channels
- Banks and Insurance Companies
- Hospitals
- Universities and schools
- The automobile industry
- Airlines, air freight
- The scientific research
- The remote sensing area (satellite images, drones etc)
- Town halls
- Nearly 80% of the global cloud
- Private e-mail providers
- Social networks
- The movie industry
- National archives
- Hairdressers, butchers, bakers and other small businesses

2) It's a more performant solution than hard disk

A 3U Rack size can hold 180TB of data

Retains data beyond 30 years

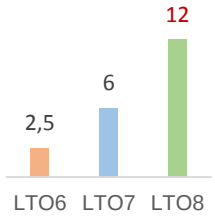
Tape's Data integrity is 10,000X higher than that of Hard Disk

Tape's write speed is 3X faster than that of the hard disk

And many other dvantages …

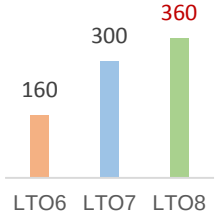
3) Tape achieves an unprecedented technological leap

In 6 years (2012-2018), and two generations, LTO technology has…



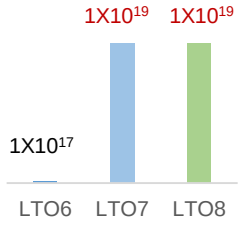
Native capacity in TB

…multiplied its storage capacity by **4.8**



Transfer rate in MB/s

…multiplied its write speed by **2.25**



Bit-Error-Rate (BER)

…improved its data integrity by **100**

4) It is a compact and easy-to-use solution

IBM's TS4300 library module

Floor space reduction
180TB of capacity for a 3U Rack size module

Reduced workload
Thanks to the actual software any end user can automate backups

What is an **LTO7 tape solution?**

What is an LTO7 storage system?

It's a modular rackable system like a NAS

It’s a backup system that integrates into your rack system, such as a NAS or a server.
It has 4 main features:

The ability to protect your data for over **30 years**

A more secure system (**data integrity**, virus etc.)

A **write speed** 3X faster than that of hard disk

An ecological footprint that is lower than hard disk

1) Exactly like a hard Disk or a NAS
With an additional option

You just need to load the cartridges into the library module

Then insert the library module into the Rack system

Backup Software: a tape system works with all backup software that is dedicated to storing digital data.

2) The extra option = a tape can be removable

" Standard" use: some companies use tape, just like hard disk. That is to say that without any physical contact with the cartridges over 5, 10, 15 years.

A more secured process: the majority of tape users benefit from the removability of the cartridge and make a second copy, which they keep at another location, for security purposes.

What is an LTO Tape Library? A Summary in One Slide….

A compact solution
180TB of capacity
(30 tape cartridges)

Anti-virus & Hackers
The system is decoupled from the network
(protection vs Virus and Hackers)

A future proof technology
A roadmap set for beyond 2030
(tapes of capacities over 100TB)

Easy-to-use
Automatic Backup process
(reduced workload)

Security
Data Integrity
10,000X higher than that of hard disk

TCO
430 Eu per month over 5 years for a 50TB user

Archive life
An LTO7 tape can protect data for more than 30 years.

Length = 48,1 cm

Height = 13,1 cm (3U)

An Oracle SL-150 tape library module (3U)

Easily rackable system

Fast
360 MB/s transfer rate
for 1GB files
(combined speed of 2 LTO7 drives)

Fast
600 MB/s transfer rate
for large files
(combined speed of 2 LTO7 drives)

Disaster Recovery
Tape is removable
It can be stored at a 2nd location.

Hotline
Free diagnostics and advice
(all over Europe)

FUJIFILM

Barium Ferrite

General Principles on Data Storage Backup ...

The main characteristic of Tape technology is that it places **the highest priority on data protection**

The combined technologies of Fujifilm & IBM (Barium Ferrite & Terzetto) have reduced the Write Error Rate on LTO tapes by X100 Between 2012 and 2015

Data integrity – write errors

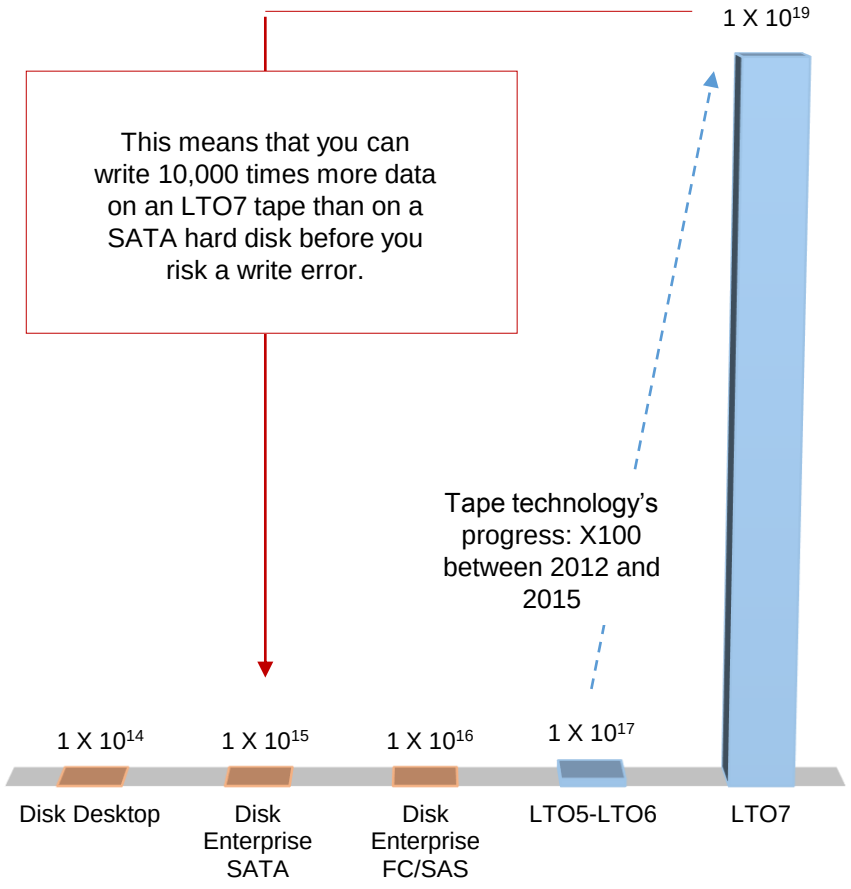
Barium Ferrite technology has been successful in extending the archive life of a Data Tape beyond 30 years in 2012

Long-term data retention

Tape is removable: the end user can make a second copy and leave it at another location, for safety purposes.

Protection against viruses & hackers

BER of Tape vs the BER of hard disk



Principle of the BER

1 X 10^X

A write error… … for… … 10^x data written

To put this into Data Storage terms…

LTO7: that would be 1 error event in 1.25 exabytes or every **200,000** LTO-7.

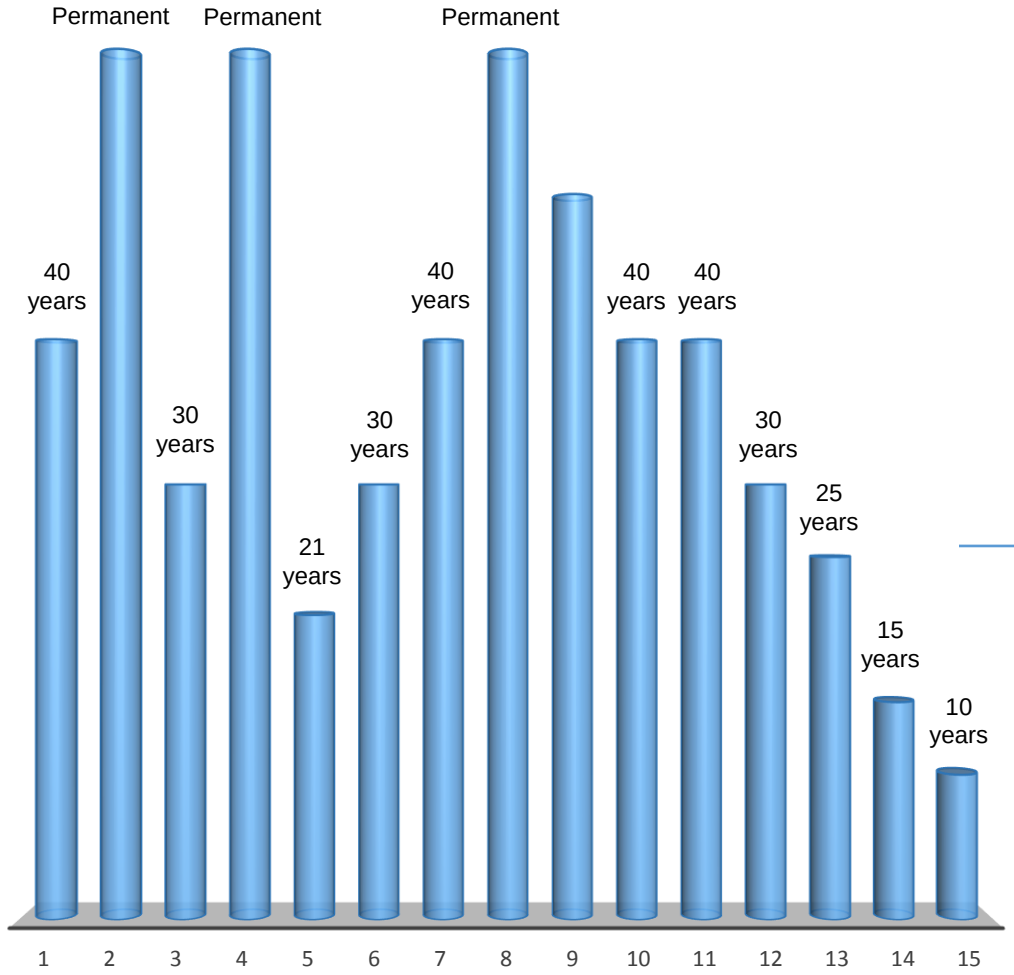
Hard disk: 1 error event in 125 TB or every **20** enterprise 6 TB SATA disks.

Headings of the regulations

1. Accidents from hazardous substances
2. Army medical records
3. Banks
4. Building records
5. Child records
6. Dental records
7. Employer Liability Insurance Certificates
8. Fingerprint and DNA for conviction
9. Health and Safety Radiation
10. Health and Safety re abestos
11. HR minutes of Trustee / work council meetings
12. Legal contracts and agreements
13. Maternity records
14. Medical Clinical trials
15. University Research

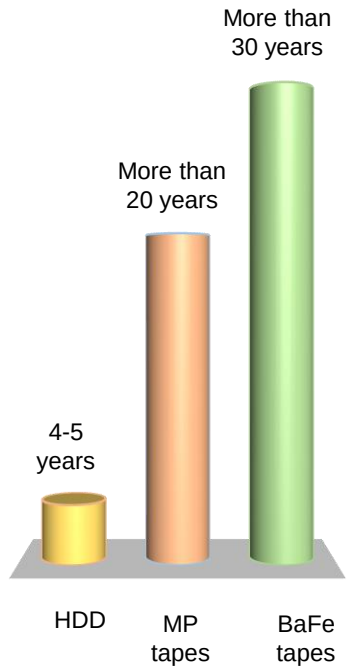
Barium Ferrite

How many years must we keep the data according to the law?



Read the heading of the regulations in the left column of this slide

How many years can we keep data?



Baby

1 year old

2 years old

3 years old

4 years old

5 years old

Wondering how you will keep your kids' pictures **for over 30 years?**

Well, as far as you're concerned, this is the job of the LTO7 tape in the professional environment

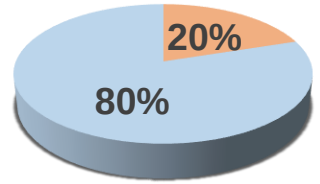
What Data Retention Policy for which Type of Data?

Frequent access to data ← **What is the nature of your data?** → **Long-term data retention** *(data archiving)*

HOT

COLD

80% of the data recorded by a company is never accessed over time



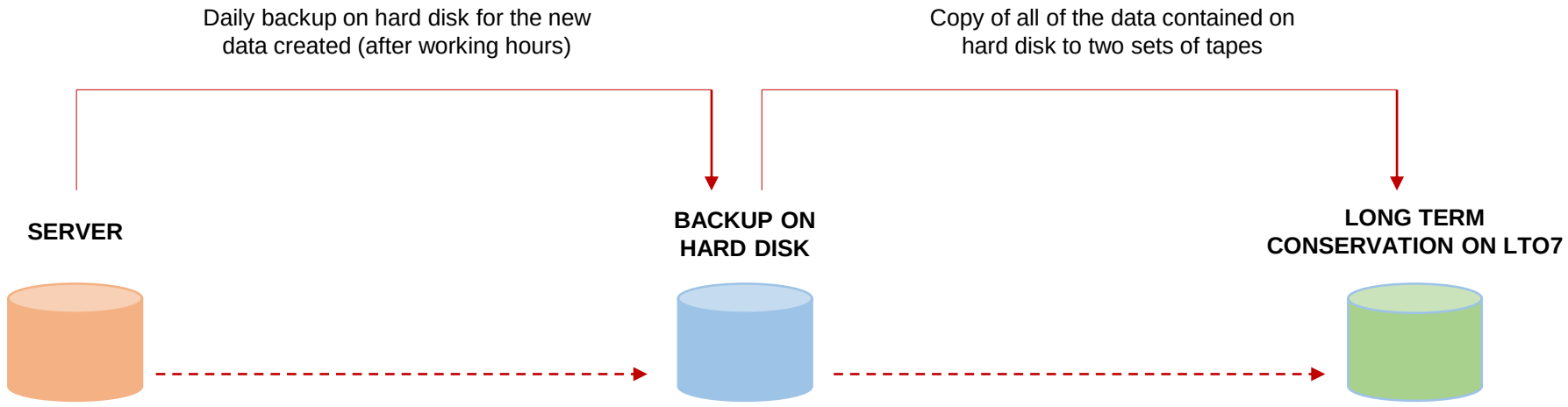
This data must still be kept over the long term

- HR Data
- Invoices, commercial contracts
- Financial statements, accounting data
- Catalogues, photos, marketing production
- Historical Archives
- Plans, Land Registry
- Medical Data
- Banking Data
- Insurance Policy
- Personal Documents

⇒ **In a nutshell, any data which you will still want to access in about fifteen years.**

- Tape's archive life goes beyond 30 years
- An error rate that is 10 000X lower than that of HDD
- A compact solution - high capacity cartridges – floor space reduction
- Does not require any proprietary software format
- Automatic configuration of backups
- A scalable solution
- A roadmap set for beyond 2030

LTO7 Tape library



PRINCIPLES OF SECURE BACKUP

1. **Hard disk is not designed to be the final destination of the data**:
* Its lifespan doesn't exceed 3-4 years.
* A hard disk can become defective at any moment: the risk of data loss is too important.

2. The most secure solution **is to transfer data from hard disk to an LTO tape**. In this case, the data is fully secure:
* The tape is a storage solution that is decoupled from the system outside of backup times. The data cannot, therefore, be attacked by viruses or hackers.
* The archive life of an LTO7 tape is greater than 30 years.

3. Users can decide, **according to their needs, which data they will keep on disk, after having made the copy on tape**. A large majority of users (such as Banks) keep the data on disk for a limited period of time (4-6 months), then erase it. Others select critical files, for which they leave an extra copy on hard disk.

4. Tape is more performant and more reliable than hard disk. On the other hand, the access time to data on hard disk is shorter than on tape. **85% of the data that a company must keep is not subject to frequent access**. This data doesn't need to be copied to disk. Keeping a copy on tape is more than enough and reduces the cost of the backup system.

Why is Hard Disk More Fragile than Tape? (I)

Hard disk works like a record player, **it will break**:

- if you use it for too long,
- if you use it intensively,
- or if you increase its operating speed

Hard disk requires short usage over time with moderate speed and intensity.

There is a chip on the hard disk, which is the "Controller" and contains the data directory.

- This controller knows the location of each data.
- When you connect to the hard disk, you have access to the inventory of your data through this controller.
- **If this controller breaks**, and even if your hard disk is in an acceptable physical state, you will not be able to access your data..

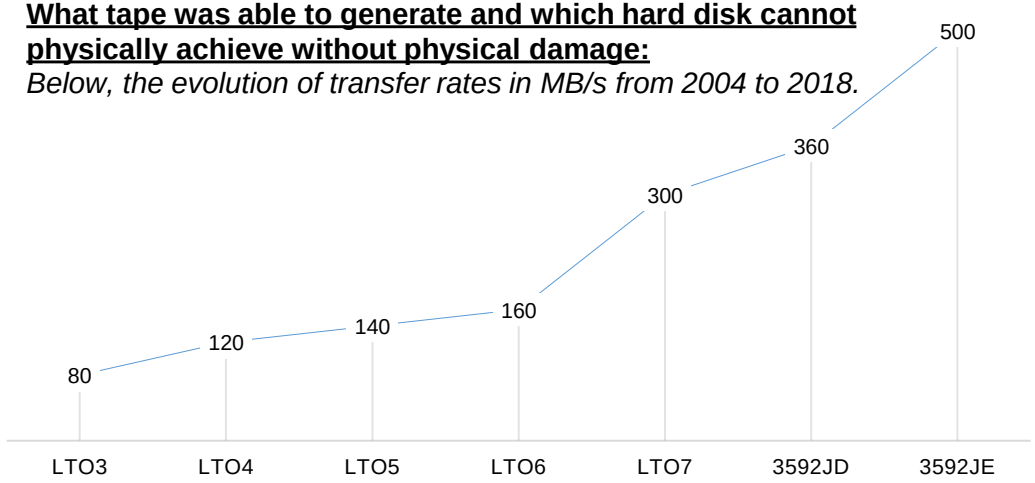
This same type of controller exists on a tape cartridge and the same data is contained in a chip, which is located within the tape cartridge. With this difference: if you lose the data on this controller, **you will still be able to access the directory of your data**, which is also saved on the tape.

Importance of the streaming:

- The question of the quality of the contact between the write/read head and the storage medium (disk or tape) is the major stake of development of storage products.
- In the early 2000s, hard disk used IBM's Magneto-resistive technology to increase both write speeds & capacity of their storage media. No significant improvement was made to the hard disk over the 2010s.
- This is where tape has invested the most in R & D – the ability to write more data, faster, and without losing in terms of quality, contact between the head and the tape: the innovations generated by IBM (Terzetto head , 32-channel) and Fujifilm (Barium Ferrite, vertical polarization, unprecedented magnetic output power).

What tape was able to generate and which hard disk cannot physically achieve without physical damage:

Below, the evolution of transfer rates in MB/s from 2004 to 2018.



‘’Largely mechanical , Hard Disk is and, this is not new, a fragile object whose life time is reduced. ’’ *internet site Cubic.fr.*

Composed of several moving parts, in its precision, the mechanics of hard disk mean it can be considered a mechanical timepiece.

Composed of an engine, various trays and the head arm containing a read/write head, hard disk is not only sensitive to shocks but also to the outside environment.

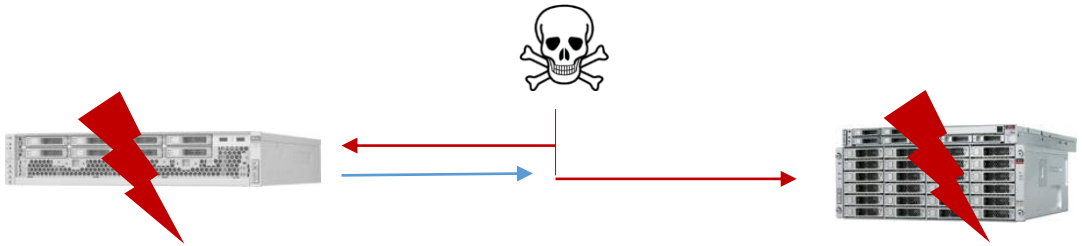
Put a strong magnet on a hard disk and all the data that it contains will be lost forever, as the process will demagnetize its platters.

An obvious and inevitable corollary of the systematic presence of an engine in traditional hard disk: they generally generate noise as they heat and obviously consume electricity .

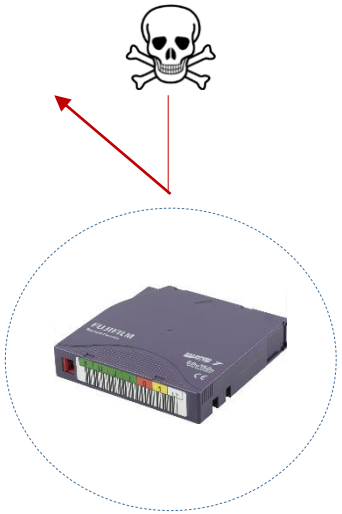
Category	1990s-2000s	2010 Onwards
Backup		
	 *Hard disk* • The widespread use of the PC has greatly contributed to the development of HDD. • The IT world became, in the 1990s, an easily accessible environment.	 *Hard disk or Flash* • The hard disk remains an excellent tool for short-term data backup. • SSD sales growth in the short-term backup segment at the expense of the hard disk. .
Long Term Conservation of the Data		
	 *Paper* • A vast majority of data is still in paper or Analog format (video) • The transition to digital has, however, begun.	 • From 2010 onwards there were multiple incidents and data losses on hard disk • **Hard disk is no longer seen as a way to preserve data over time.** • **Increase in demand for tape** technology (+ 30% between 2016 and 2017)
	The digital revolution *Data conversion into digital format*	 *LTO7 Tape*

Tape Users Refuse to Pay the Ransom of Hackers

A tape backup solution is, first and foremost, designed to secure data



The tape, as the final destination of data, is decoupled from the network



With an LTO or 3592 tape solution

- The tape system (library - drive - cartridge) is turned off when the backup is completed
- Therefore, the system is decoupled from the network
- In the case of external aggression, the data is out of reach of the virus

Tape users refuse to pay the ransom of hackers

OPTIONAL
The higher level of security

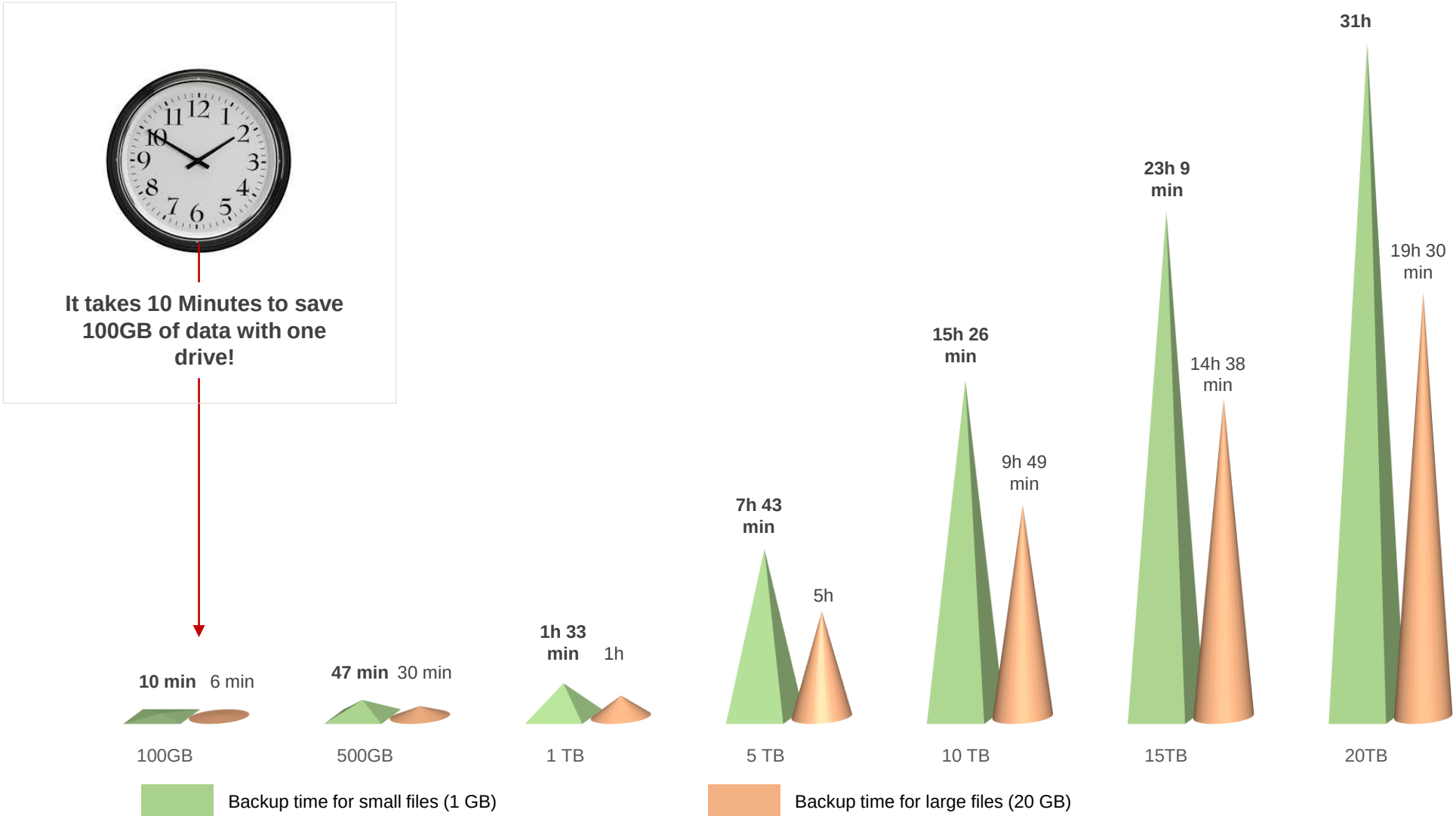
Users who fear:

- a fire
- a flood
- natural disasters
- burglaries
- or attacks
- etc…

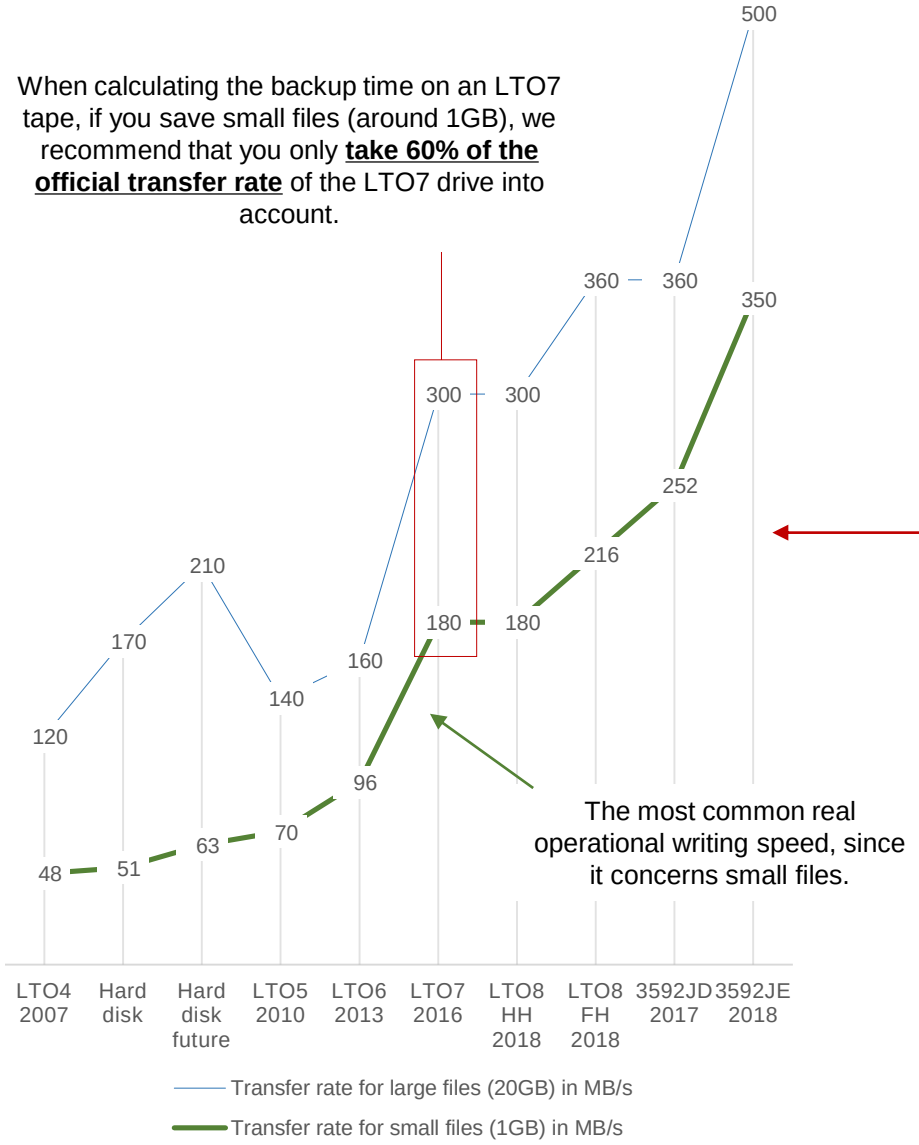
…remove cartridges from their libraries…

…and keep them at a second site.

Speed
(Write Speed and
Access Time to Data)


It takes 10 Minutes to save 100GB of data with one drive!
6s
10 min
6 min
47 min
30 min
1h 33 min
1h
7h 43 min
5h
15h 26 min
9h 49 min
23h 9 min
14h 38 min
31h
19h 30 min
1GB
100GB
500GB
1 TB
5 TB
10 TB
15TB
20TB
Backup time for small files (1 GB)
Backup time for large files (20 GB)

When calculating the backup time on an LTO7 tape, if you save small files (around 1GB), we recommend that you only **take 60% of the official transfer rate** of the LTO7 drive into account.



The most common real operational writing speed, since it concerns small files.

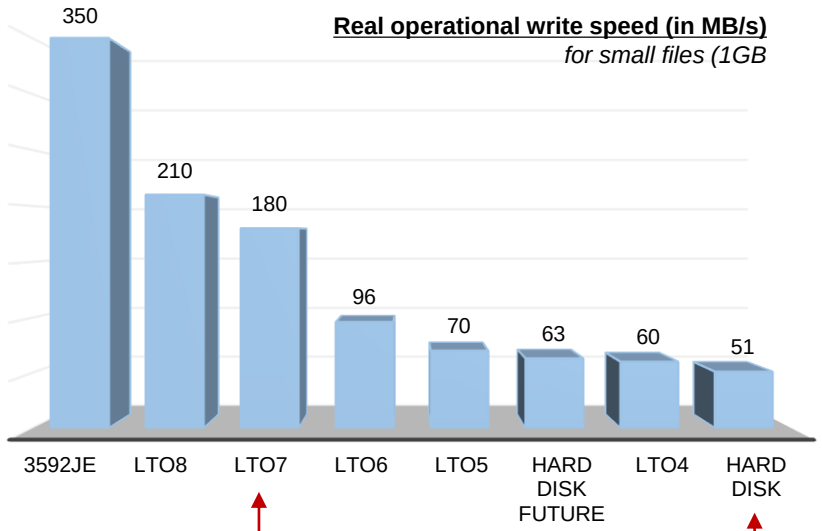
Please note: it is very rare to be able to save data with the full transfer rate indicated on the storage media you have purchased (tape or hard disk).

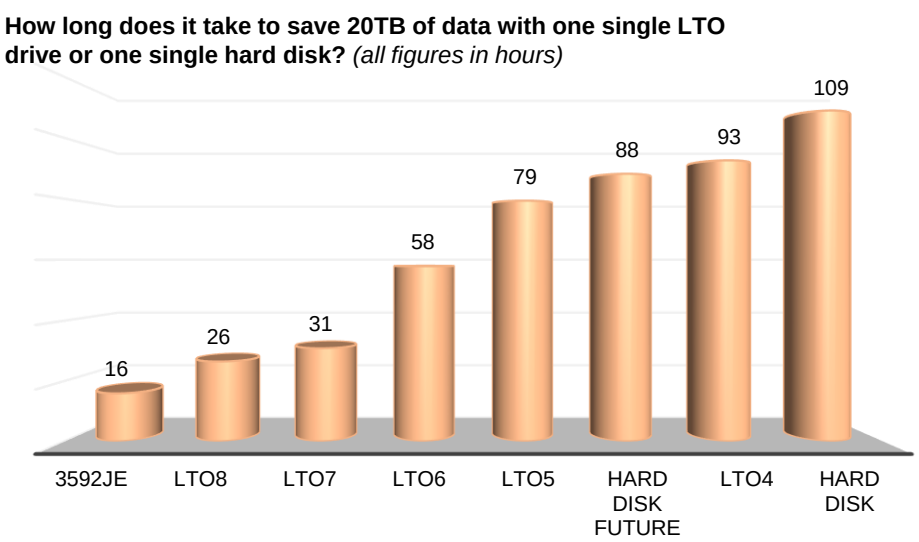
Saving small and medium sized files causes regular stops during the writing process.

Each system must prepare a file before the writing process (title, date, description etc ...). When the file is small, the tape drive or hard disk will write these files quickly, wait for the next file to be ready for the writing etc….**if fine the backup time is much longer than expected.**

When calculating the backup times, we advise users to consider the following operational transfer rates (please see the green line of the graph on the left side of this page).

Tape drives contain buffers that reserve files for backup, in order for the drive to continue saving data even when confronted to write stops. Hard disks also contain this type of buffer, but with a much lower capacity and performance than on tape.

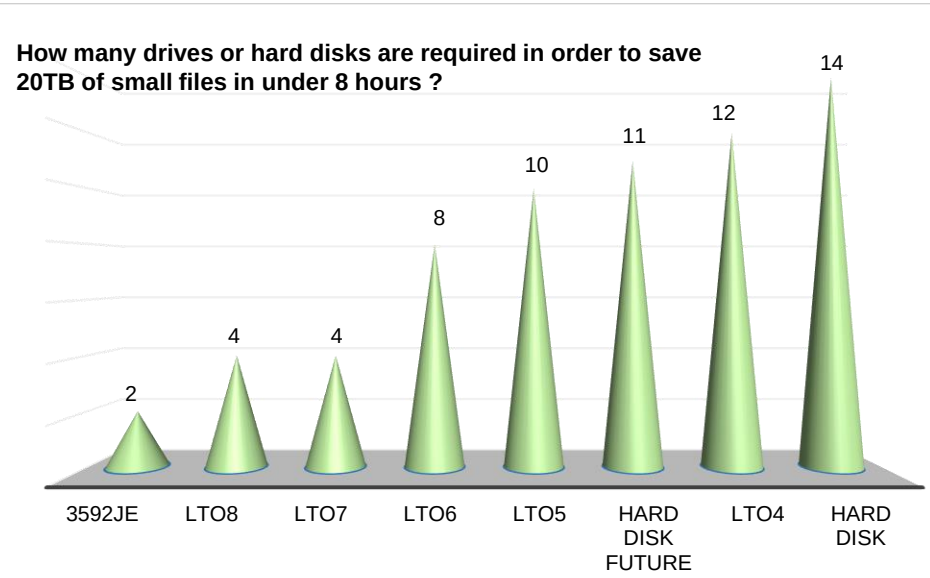




3X An LTO7 drive writes data more than 3.5X faster than a hard disk.

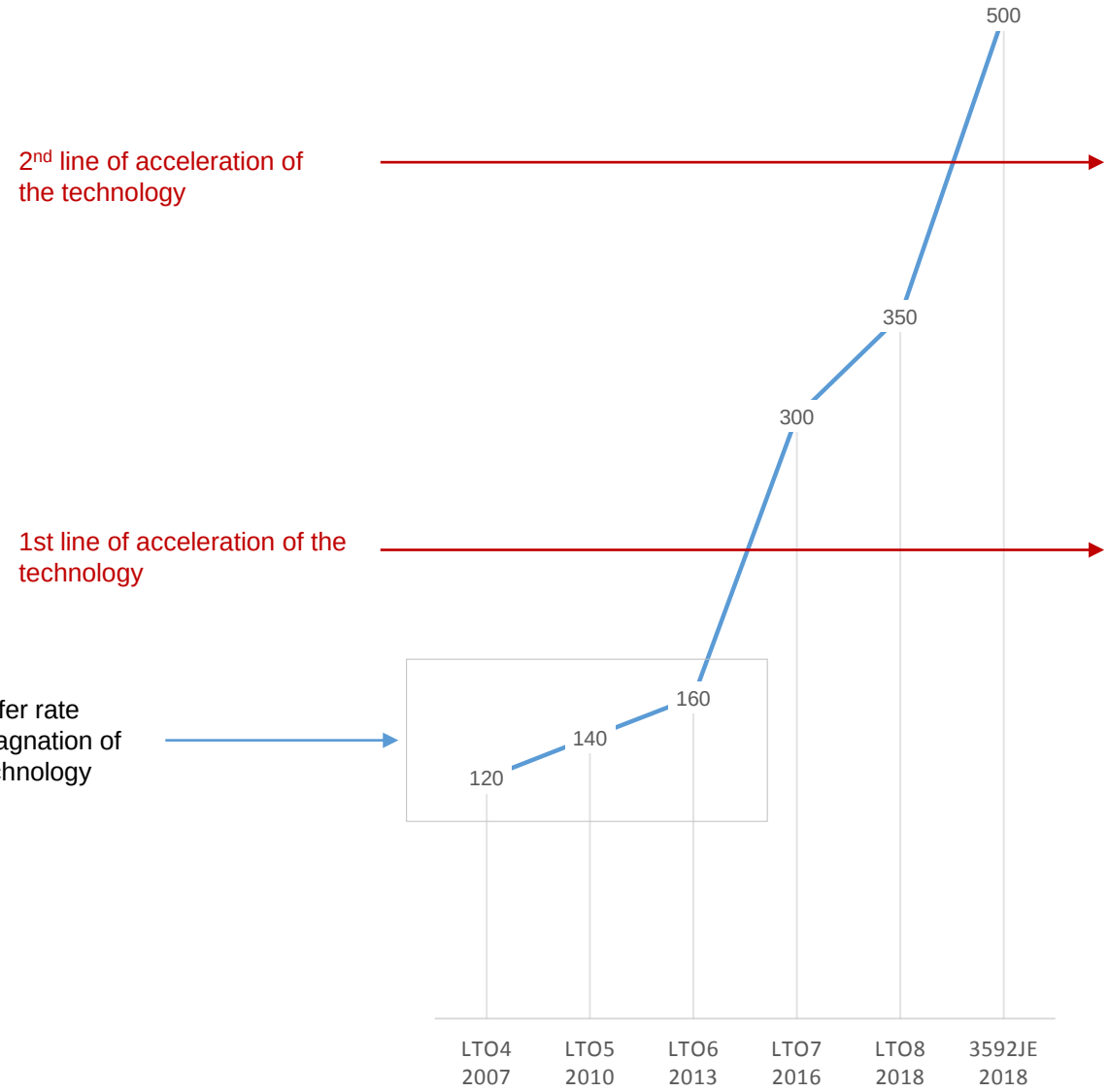
3X It is, therefore, necessary to buy a larger quantity of hard disks in order to reach a speed equivalent to that of LTO7.

$$ The lower performance of hard disk generates extra purchases, unnecessary monetary spending and a greater space occupancy.



Barium Ferrite Tapes **=**
an Unprecedented Technological Leap in the History of Data Storage

Evolution of the Transfer Rates of the Main Tape Generations (all figures in MB/s)



2nd line of acceleration of the technology

- Development of the new IBM TMR-Terzetto head
- Smaller Barium Ferrite particles and improved polarization
- Increasing the speed of the tape pass

1st line of acceleration of the technology

- Use of a 32-channel head
- SNR gain thanks to IBM's Terzetto head
- Generalization of Barium Ferrite = improved recording stability

Weak transfer rate growth = stagnation of the tape technology

How did we Increase the Write Speed of the LTO7 Tape Drive?

LTO7
Improvement of the write speed

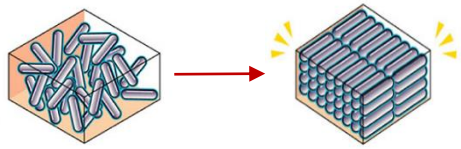
Progress achieved on tape media

Barium Ferrite is a new technology that has revolutionized the performance of tape Media

Vertical polarization of particles

Barium Ferrite technology is used to manufacture the majority of LTO6 and LTO7 tapes. Barium Ferrite particles are the first to emit signals directly in the direction of the drive's head - signals are picked up faster and more clearly.

An improved dispersion of particles on the tape surface



Nanocubic Barium Ferrite technology has significantly improved the dispersion of particles on the surface of a tape. The tape is now smoother and thinner: Nanocubic technology contributes to a more stable writing process => this generates write speed gains.

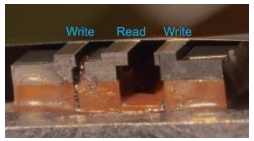
Progress achieved on the drive

Two major innovations

The use of 32-channel heads

LTO7 drives use 32 write channels - these are just like 32 pens that write on the tape at the same time. LTO6 drives use only 16 write channels: **this progress is the major factor in the achievement of the increase in the writing speed by LTO7 drives.**

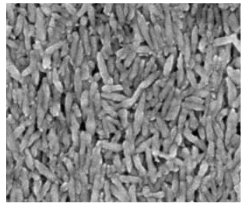
IBM's Terzetto head



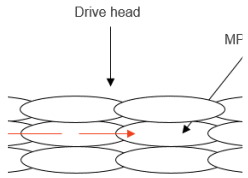
IBM's Terzetto head increases the magnetic properties of the write and read heads by specializing each head in a specific function (write or read). Therefore, it achieves significant performance gains, both in terms of writing and reading.

FUJIFILM

WHAT CAN HURT THE SNR …



MP Particles

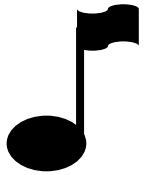


Horizontal polarization

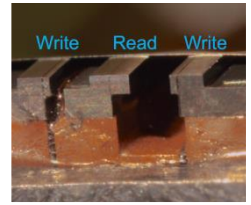
Time (long-term)

High speed

SIGNAL-TO-NOISE RATIO

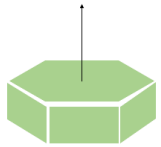


WHAT CAN IMPROVE THE SNR …

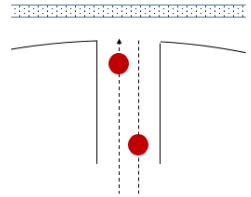


IBM's Terzetto head

Barium Ferrite tapes



Vertical polarization



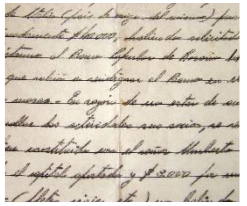
Bring the tape close to the head

CONSEQUENCES OF A LOW SNR

Capacity Loss

Low Read/Write speed

Lifespan of the Hardware



Read & Write errors

How did we Improve the Data Integrity of LTO Technology?

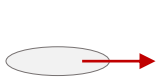
LTO7
Improved data integrity

The progress generated on the tape

Barium Ferrite: a new technology that has revolutionized tape performance

The progress generated on the drive

The vertical polarization of Barium Ferrite particles



MP particles (old)
Horizontal polarization

BaFe particles (new)
Vertical polarization

- Barium Ferrite technology is a revolution in the field of SNR, and consequently, when it comes to the quality of perception of magnetic signals by the tape drive
- The vertical polarization of Barium Ferrite particles increases the output power of the tape system
- The horizontal polarization of the old MP technology generates a chaotic sound within the drive and could interfere with the proper perception of the magnetic signals.

IBM's Terzetto head

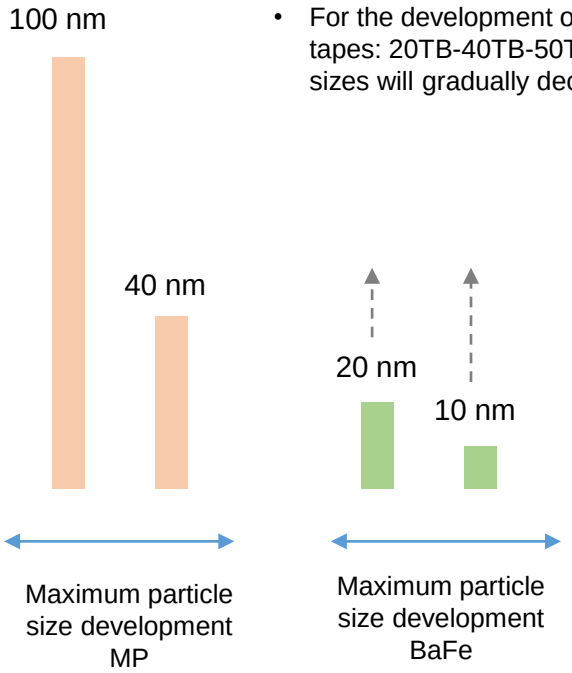
- The other major innovation in the field of SNR comes from IBM's Terzetto drive head.
- Thanks to the Terzetto head, each head (writing and reading) will now specialize in its own function.
- The write head must send magnetic field on the tape - its function is comparable to the image of a volcano, or a tube of toothpaste.
- The read head must receive the signals transmitted by the tape: it must, therefore, use sensors.

- Before the Terzetto head, the write and read heads had to perform the same function, which significantly reduced the performance of the head in both areas.
- The specialization of the heads included on the Terzetto improves the performance in both processes: improved writing quality + better reading quality => a significantly higher level of SNR.

How did we Manage to Increase the Capacity of Tape Cartridges?

Particle size **must be reduced in order to increase the capacity** of a tape cartridge.

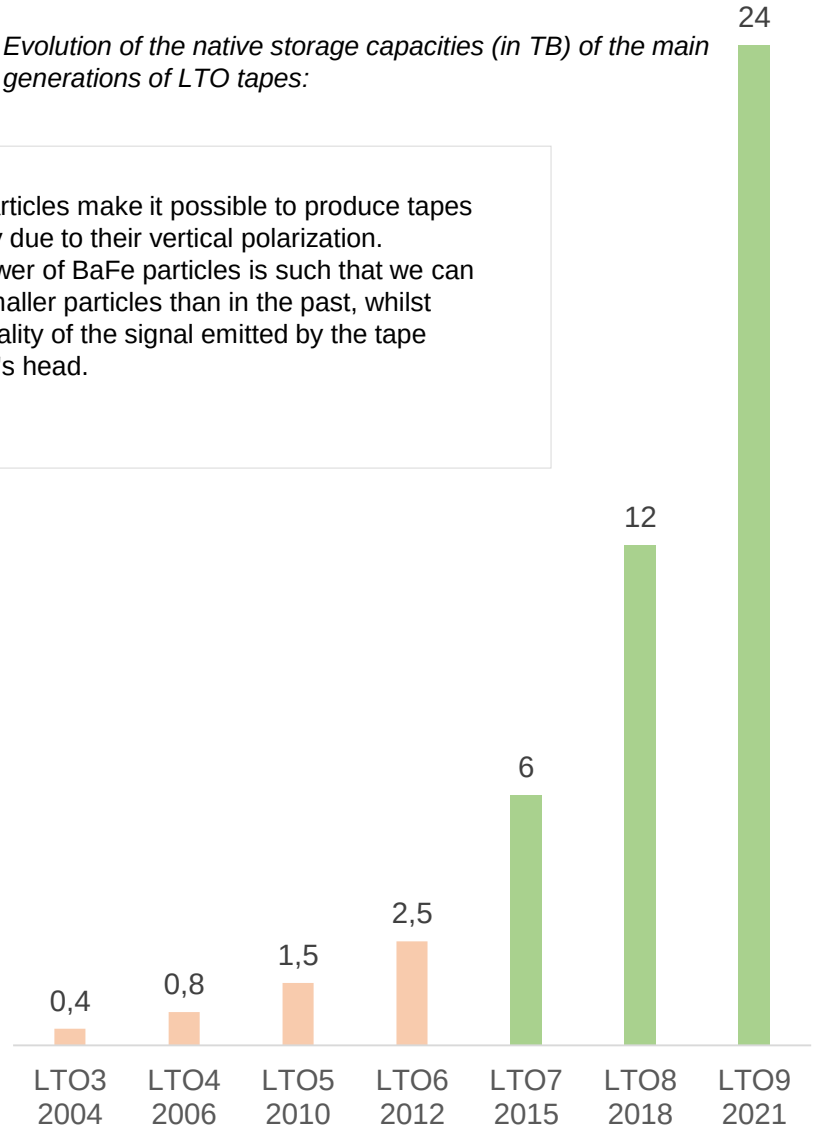
- The largest BaFe particle size is large enough to manufacture LTO7 tapes
- For the development of higher capacity tapes: 20TB-40TB-50TB, BaFe particle sizes will gradually decrease to 10nm



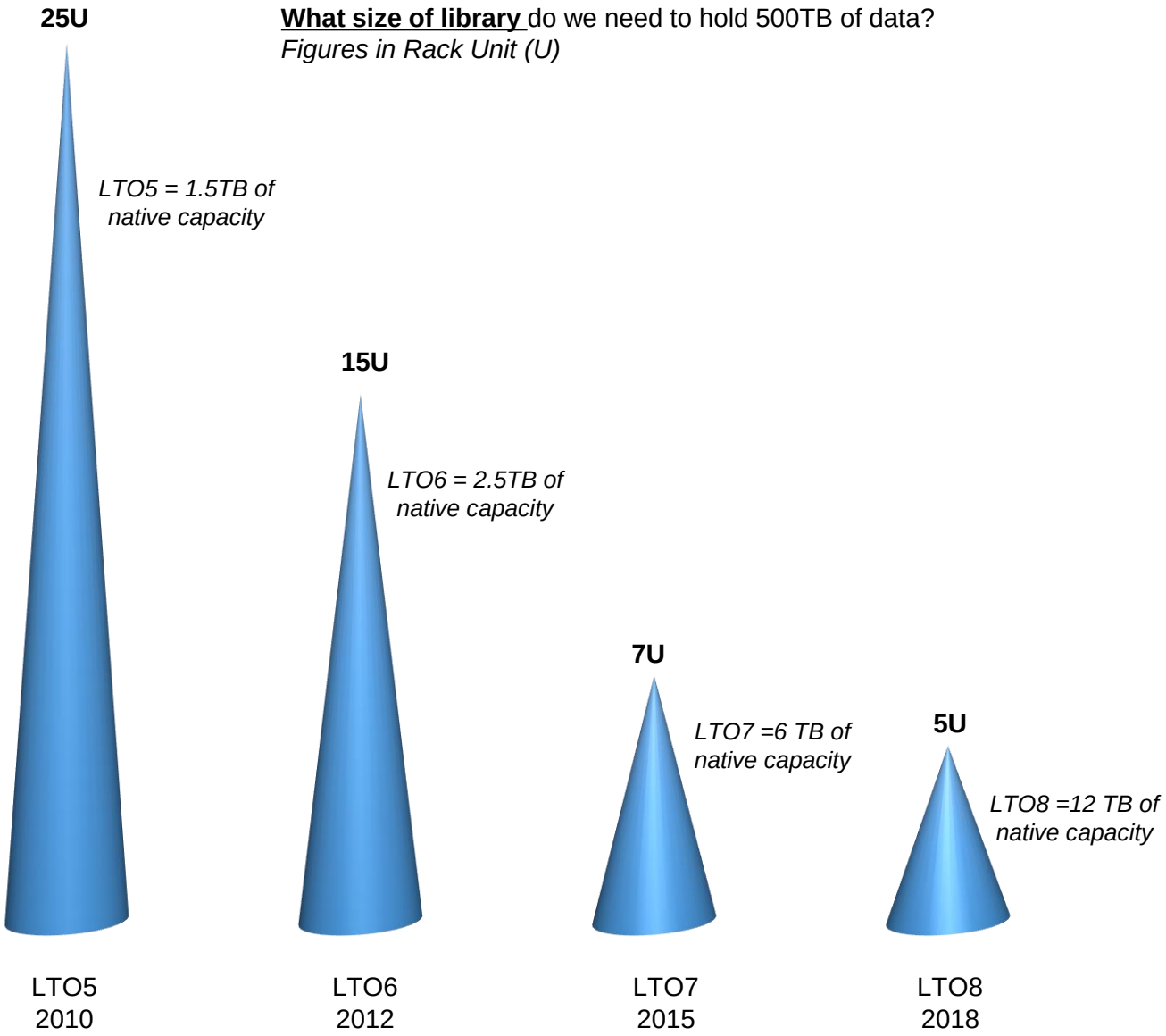
BaFe particles

- Barium Ferrite particles make it possible to produce tapes of higher capacity due to their vertical polarization.
- The magnetic power of BaFe particles is such that we can produce much smaller particles than in the past, whilst increasing the quality of the signal emitted by the tape towards the drive's head.

Evolution of the native storage capacities (in TB) of the main generations of LTO tapes:



What size of library do we need to hold 500TB of data?
Figures in Rack Unit (U)



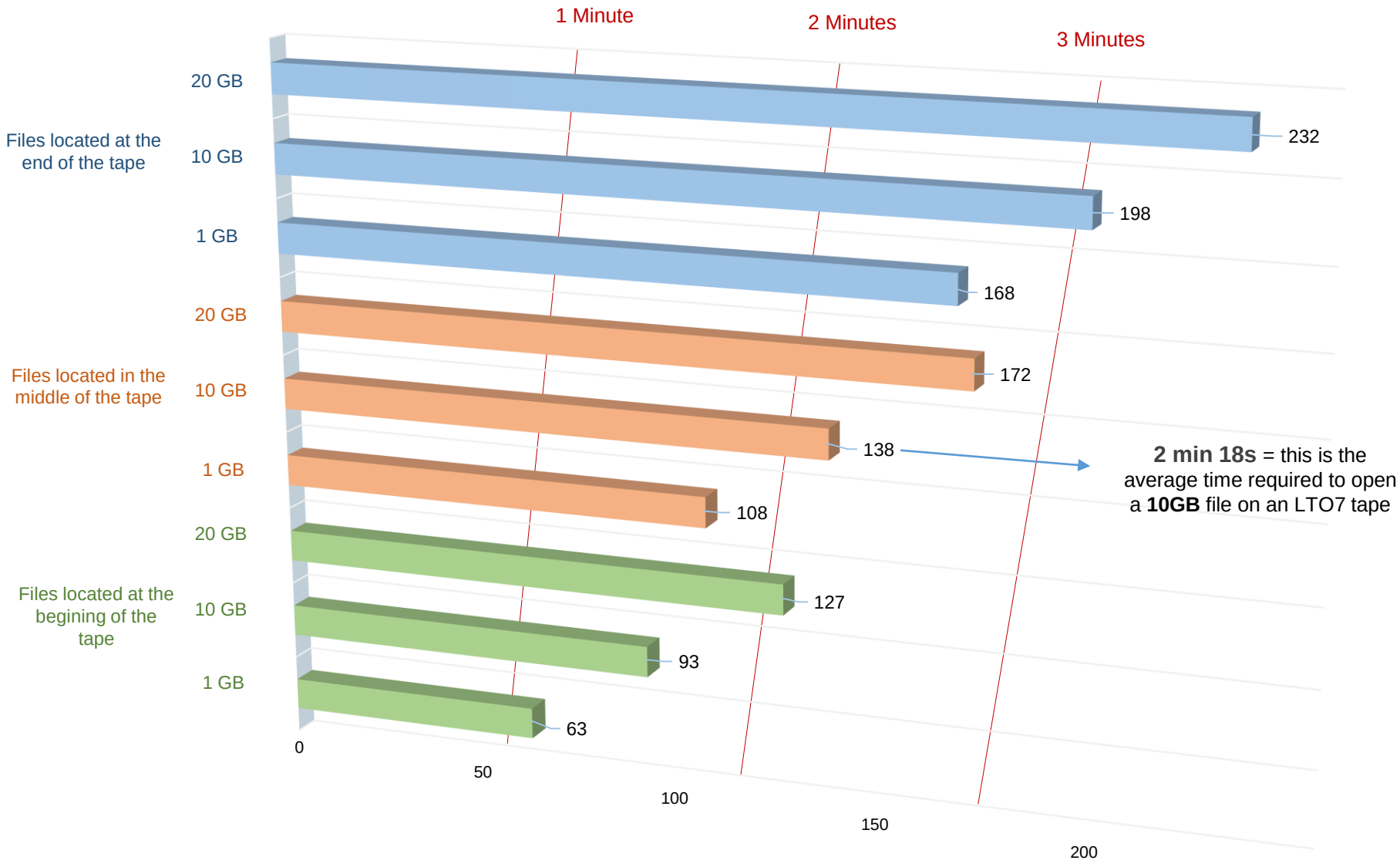
The increase in capacity of the tape cartridges **reduces the scale of your storage solution**

This allows users to leave all of their tapes within the library and **reduce the number of physical interventions** on their system.

Access Time to Data

Please note: this calculation is only valid when the file is saved on a tape cartridge, which is constantly stored within the library.

- It is for this reason that the most common solution is to keep a copy of the data within the library, in order to have quick access to the files and
- to keep a second copy at another location for security purposes.



1

The loading time of the cartridge into the drive
The library arm must load the tape cartridge into the drive - it can be considered that the cartridge loading time rarely exceeds 30 seconds. We can also give an estimate of the loading time for very large libraries of more than 1000 cartridge slots, if required.

30 seconds

2

The waiting time when loading the cartridge
When the cartridge is brought to the drive, there will be a few seconds of waiting. This latency varies accordingly to drive generations: 15 seconds for LTO7 drives, 12 seconds for previous generations (LTO6 or LTO5).

15 seconds
for an LTO7 drive

3

The time to locate the file- tape rewind
Depending on the location of the file, the drive will have to rewind the cartridge to position itself on the file. It takes 60 seconds to rewind an LTO7 HH tape cartridge to the middle. On a LTO7 FH drive, the time to rewind to the middle of the tape is 56s.

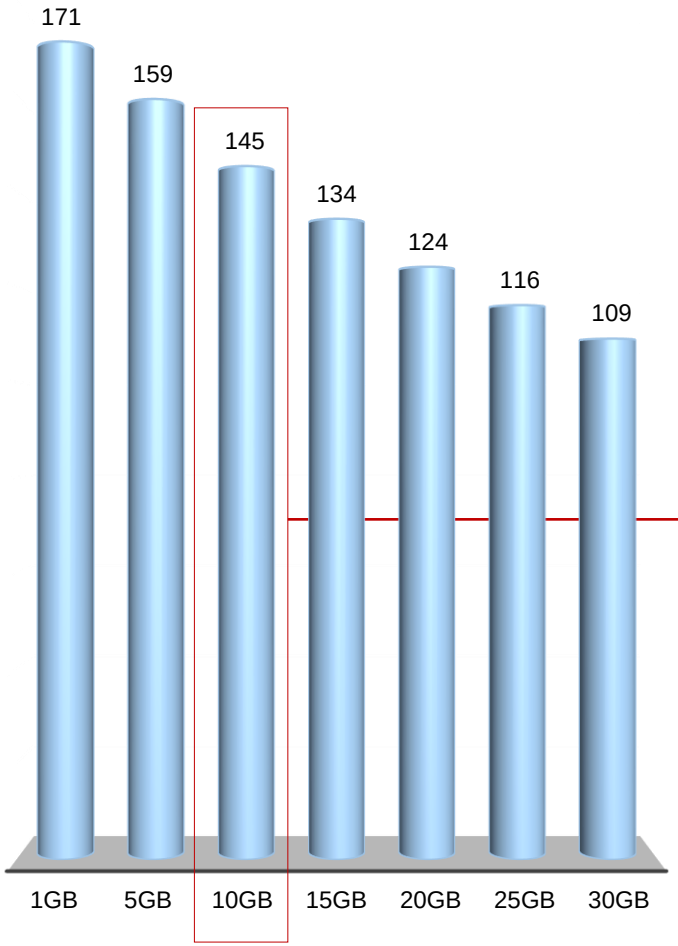
60 seconds
to reach the middle of an LTO7 tape

4

The opening time of the file
This depends on the drive's transfer rate. This operation is the only one in common with hard disk. The three operations above do not exist on a hard disk, which explains why the access time is shorter than on a tape.

Less than 6 seconds
For a 1GB file on an LTO7 drive

How many files can you open with **a single LTO7 drive** in **8 hours**?



IBM LTO7 Drive

A single LTO7 drive can open a 10GB file **145 times** in one day (8h)

It's easy to work online with an LTO7 library

To do this, you simply need to keep a copy of all of the data inside the library

High-capacity tapes make it easier than before to keep a copy of all data in the library

A small **9U-sized library**, such as the SL-150 can hold **720TB** of data on LTO7.

Example of an LTO7 tape user

- We can use the case of a 300TB user, who creates 60TB new per year, and will, therefore, see their capacity grow up to 600TB over the next 5 years.
- This user wants to migrate to LTO7 and have easy and frequent access to data.

The purchase of a library of 120 slots will allow this user to contain a copy of all of their data within the library over these 5 years.

9U

The user will pay 46 300 Eu, so under 772 Eu on average per month for 5 years.

This price covers all the needs of the user for 5 years:

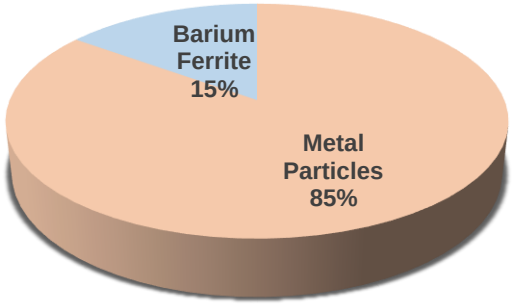
- The library (120 slots)
- Two LTO7 tape drives
- 200 LTO7 tape cartridges
- The 5 year maintenance contract
- The installation
- All necessary cables and plugs

And the ability to access **145 files of 10GB** in the space of a working day.

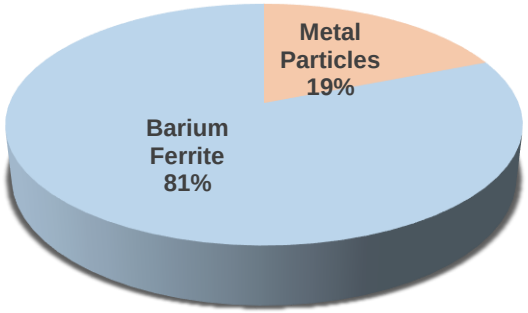
The Future of the Technology

Which tape coating technology is the most requested?
Shown below are the global manufacturing shares of magnetic tapes per technology - *all figures are in share % of delivered storage capacity.*

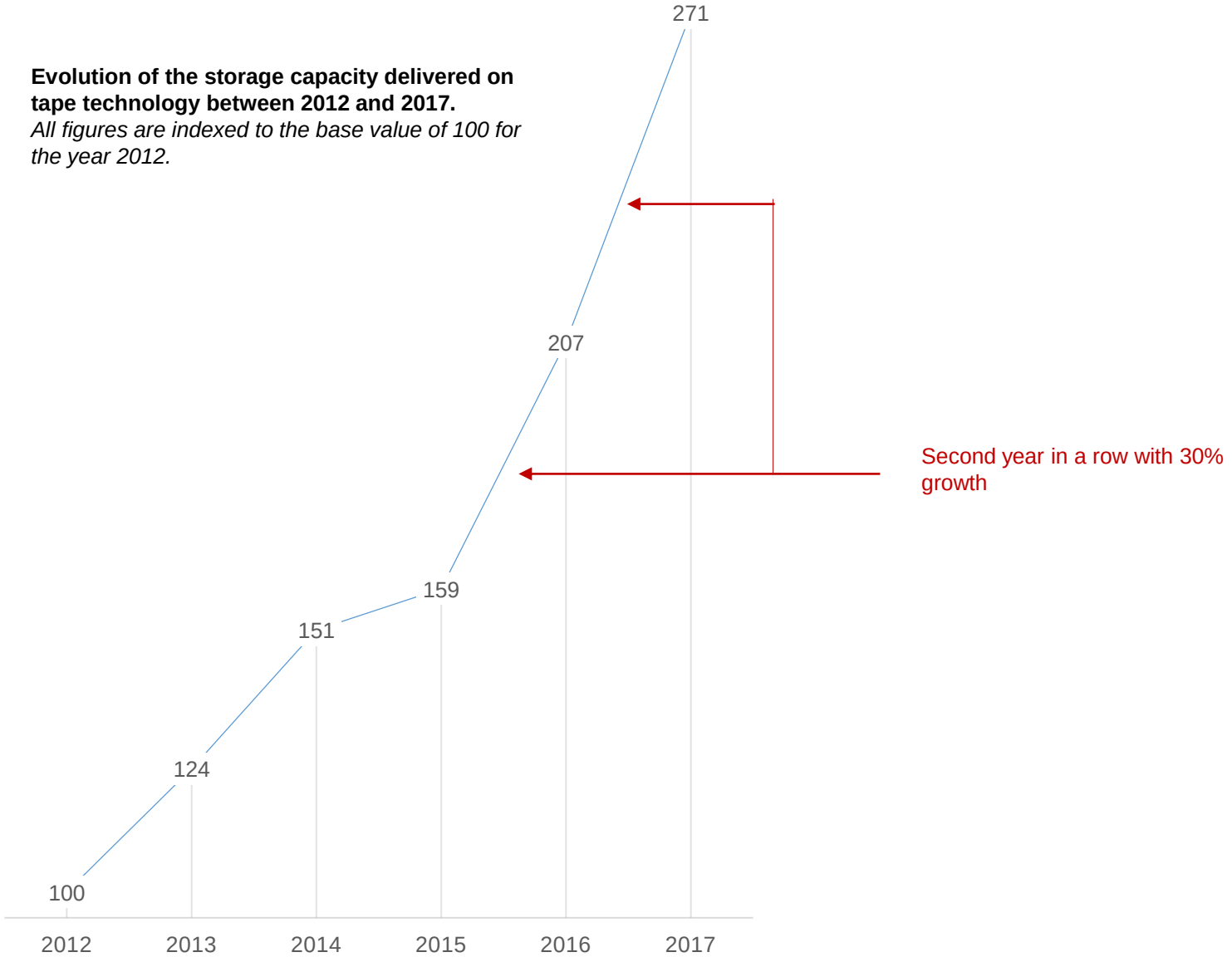
In 2012



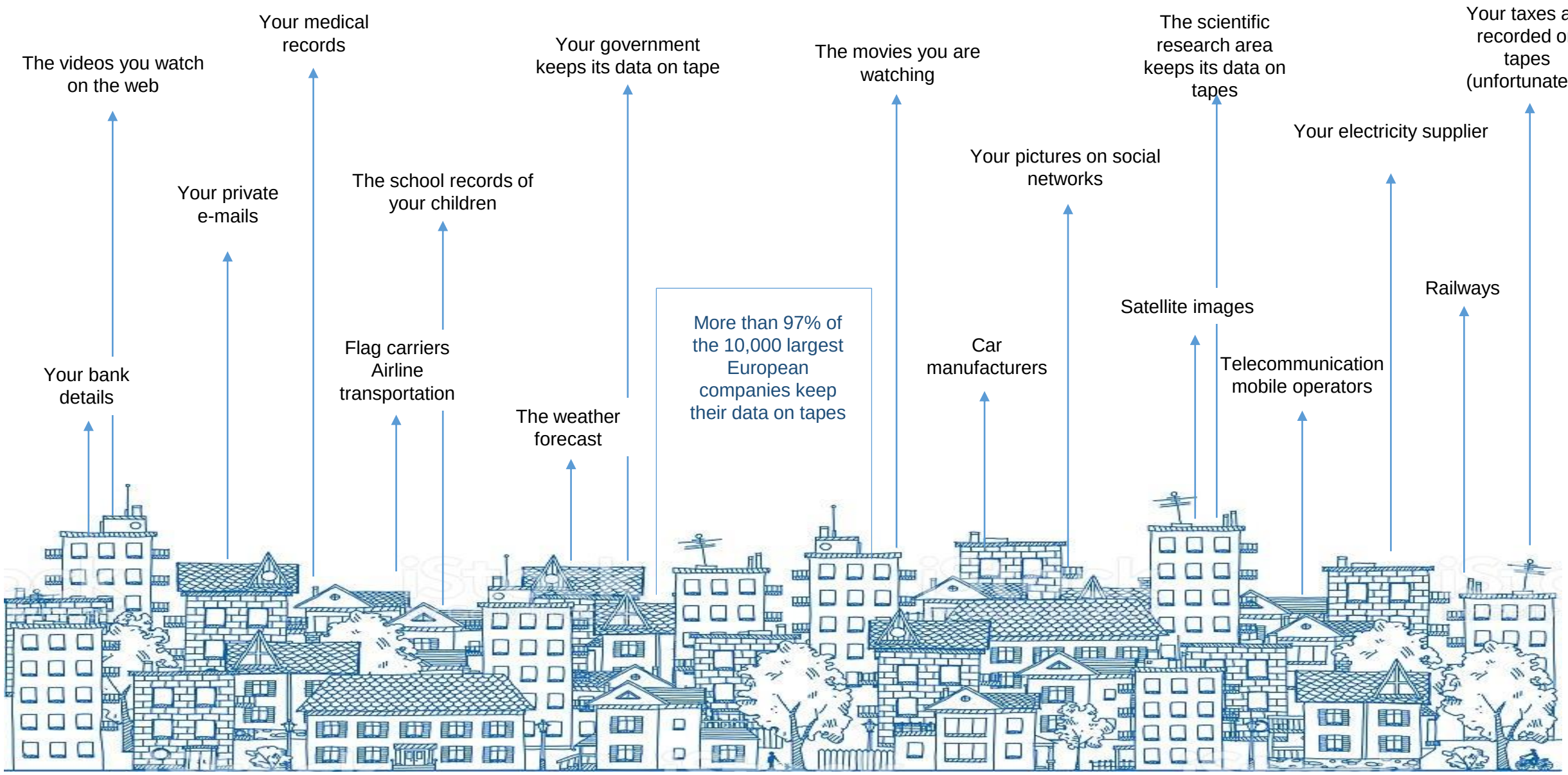
In 2017



Evolution of the storage capacity delivered on tape technology between 2012 and 2017.
All figures are indexed to the base value of 100 for the year 2012.



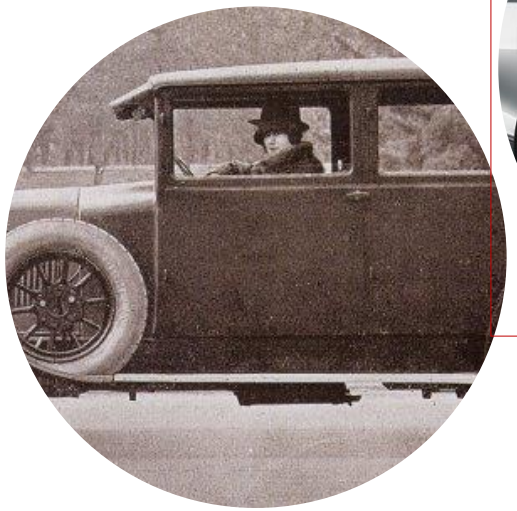
Which Companies Keep their Data on Tapes?



Maximum level of performance ... **and this is just the beginning** ...

Yesterday

The period prior to Barium Ferrite: LTO4, LTO5, LTO6 until 2012.



Today

Beginning of the Barium Ferrite era: 6TB (LTO7) for SMEs, 15TB (3592JD) for large companies.

Tomorrow

Breaking new records at the end of 2018 with the 3592JE: 20TB and 500MB/s.

The day after tomorrow

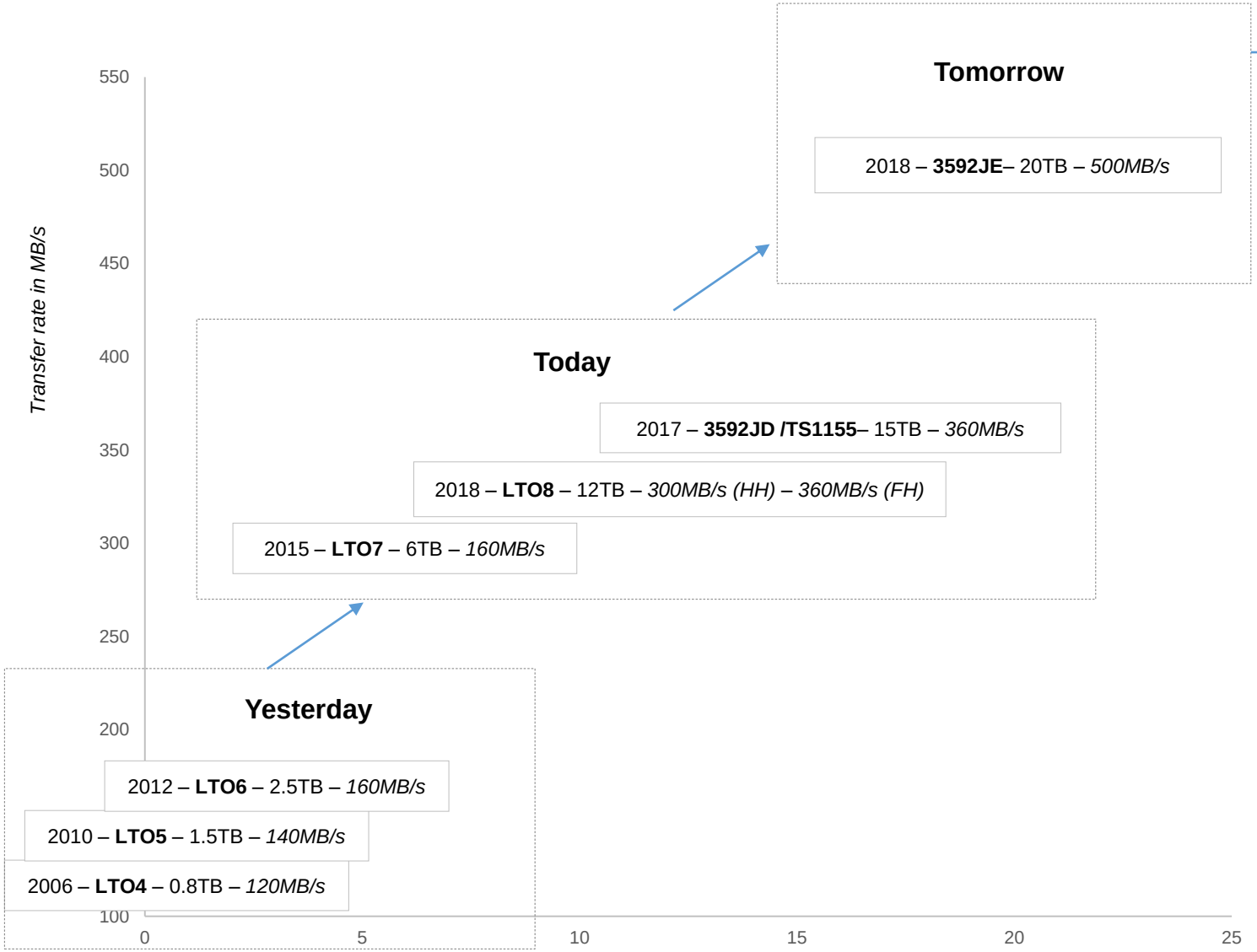
Development of tapes of more than 50TB-60TB, planned for 2022-2023.

The 2030s

Use of Strontium Ferrite technology: tapes of native capacities above 100TB!

A significant Advantage of Tape = The Future is already Developing in our R & D Centres

FUJIFILM



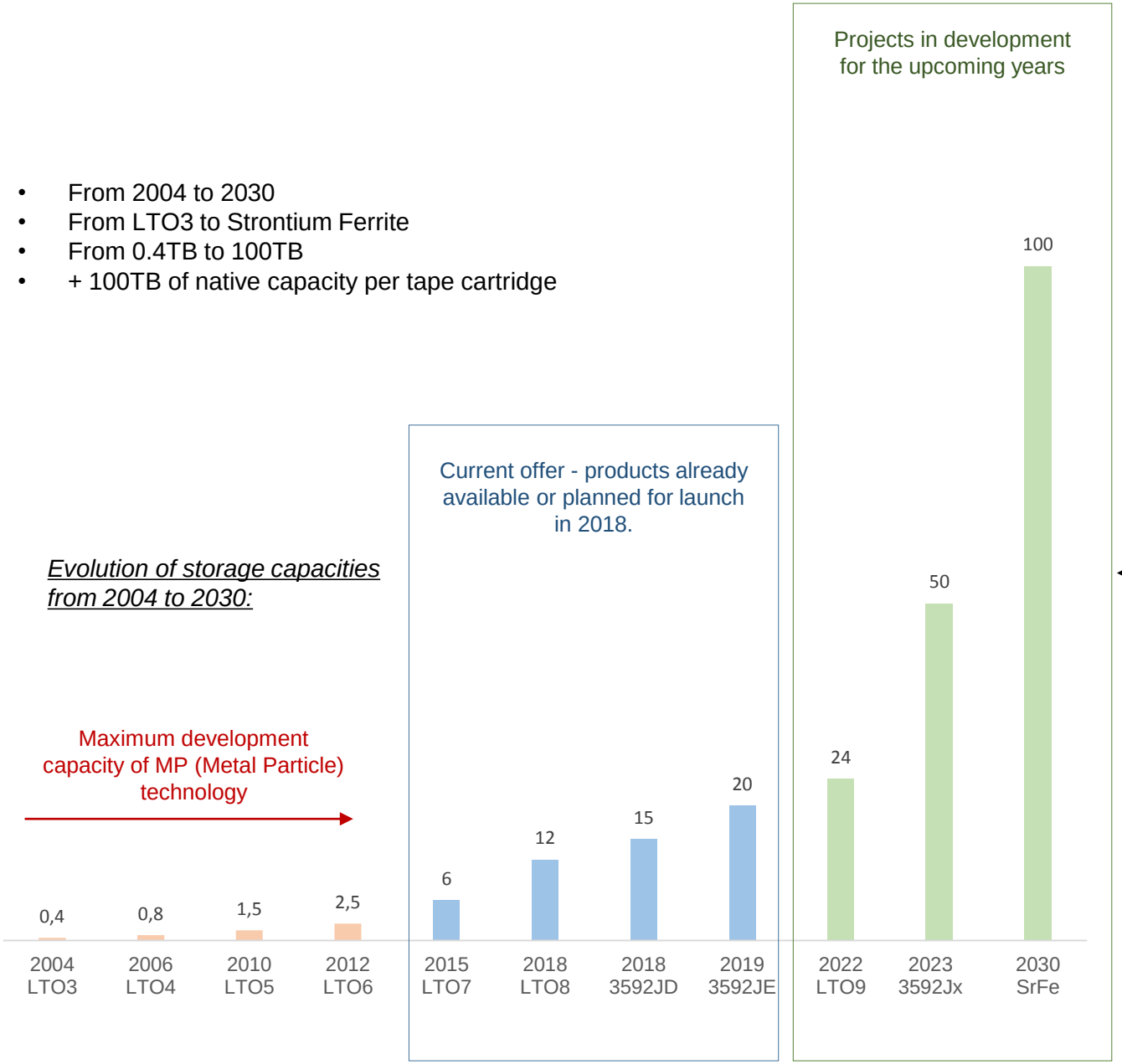
The day after tomorrow

- The LTO9 tape will be launched in 2021 and could offer a capacity of 24 TB.
- Tapes of capacities beyond 50TB-60TB are already in development. They're planned for launch around 2022-2023, and are manufactured for large users (new particle sizes + new drive heads).
- The new Strontium Ferrite Technology will succeed Barium Ferrite and will produce tapes with native capacities of above 100TB.

We are already working on tape storage technologies that companies will use in the 2030s.

- From 2004 to 2030
- From LTO3 to Strontium Ferrite
- From 0.4TB to 100TB
- + 100TB of native capacity per tape cartridge

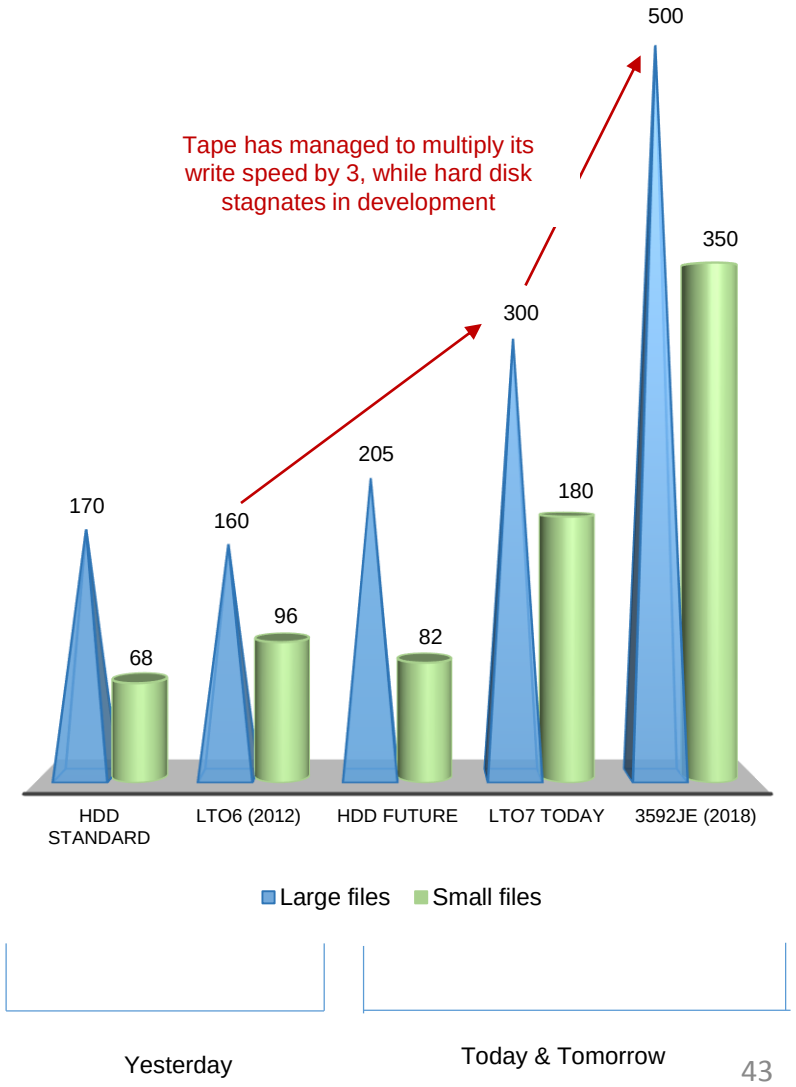
Evolution of storage capacities from 2004 to 2030:



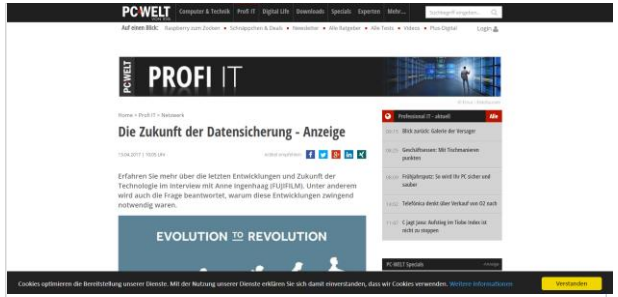
Warning: all information on products in development (date, capacity, name and ...) must be confirmed by rights holders of different technologies.

Product family	*Industrial Development Prospects*	*Remarks*
 **Tape**		What other backup technology has ever managed, within a few years, to: • Increase its capacity by 17.5TB? • Increase its write speed by 340 MB/s? • Multiply its data integrity by X1000? *(from LTO6 in 2012 to 3592JE in 2018)* **Tape achieves technological innovation that no other technology can produce.**
 **SSD**		The rumour suggests that a new SSD manufacturer **could help increase production**, and thus put an end to the successive shortages that have marked the storage market. SSD competes with hard disk at a different level than tape - it is not a long-term data backup tool.
 **Hard disk**		**It is not the intention of major hard disk vendors to invest in developing better formats.** Most developments on hard disk rely primarily on software applications. The 2011 shortage - flood in Thailand - has proven that the real production is concentrated on too few manufacturers. SSD is a priority vector of development for hard disk manufacturers.

The write speed is a perfect example of the technological innovation gap between tape and disk – *below is the evolution of the operational transfer rates of disk and tape in MB/s.*



Tape Technology in the IT Press



www.pcwelt.de

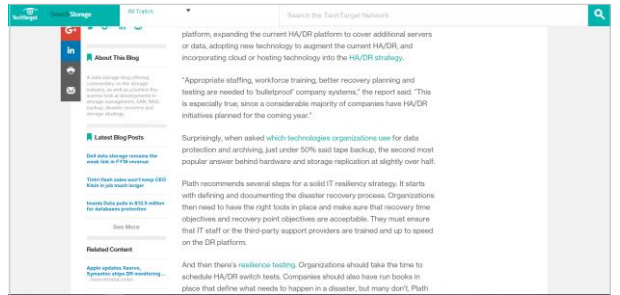
www.informationsecuritybuzz.com

www.networkcomputing.co.uk

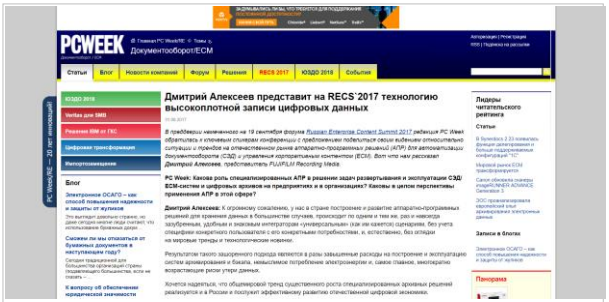
www.panoramaaudiovisual.com

www.hpctoday.com

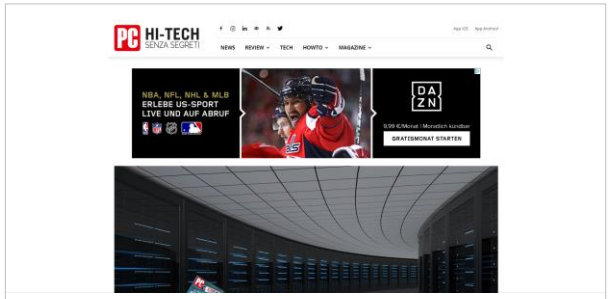
Tape is presented as the storage technology of the future in the IT press



searchstorage.techtarget.com

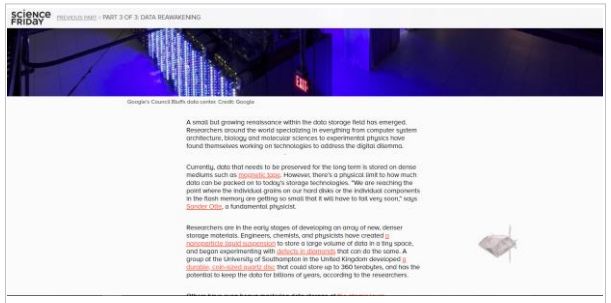


www.itweek.ru



www.pcprofessionale.it

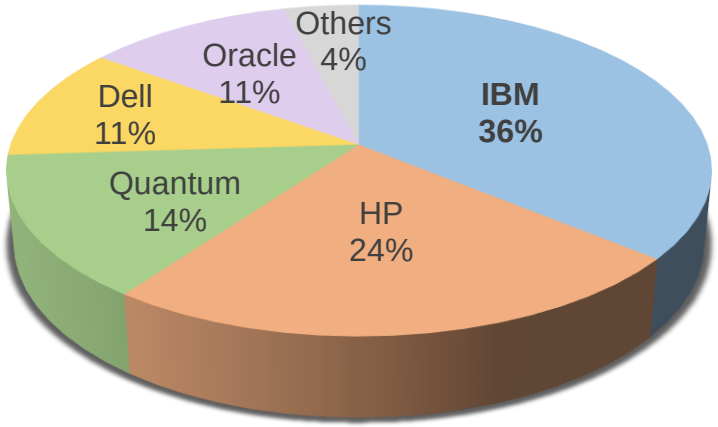
www.mediakwest.com



apps.sciencefriday.com

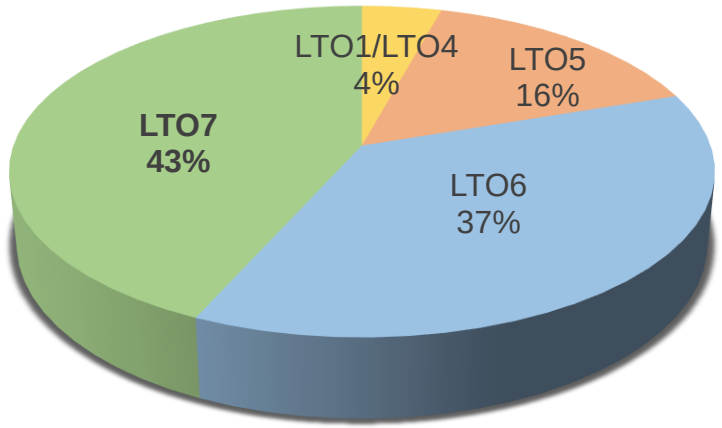
How to Buy a Tape Solution?
(Configuration, price, general information etc ...)

IBM is the # 1 manufacturer of libraries and tape drives



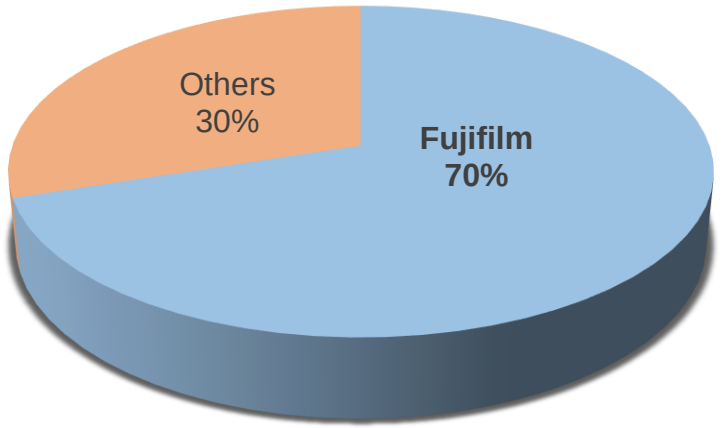
Revenue share % for tape libraries by major manufacturers in 2016

LTO7 tape has become the standard format



Market share per LTO generation : figures in share % of storage capacity delivered on Q4 2017

Fujifilm is the # 1 tape cartridge manufacturer



Tape cartridges manufacturing share

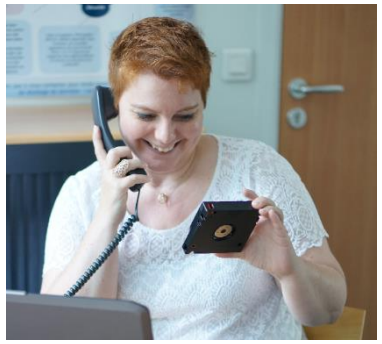
Please bear in mind that in terms of market share per brand, in the LTO tape segment, HP is No. 1, IBM No. 2 and Fujifilm No. 3.

Some famous tape hardware brands

Where to Buy Tape Librairies?

We recommend a major player in the field of tape technology in Europe, whose details are shown below.

dyadem



Carole Paternoster
Data Storage Manager at Dyadem
E-Mail: carole.paternoster@dyadem.fr
Phone : +33 1 46 33 11 08
Web : www.dyadem.fr

Dyadem in few points:

- *Official Fujifilm Hotline in France for LTO and 3592 tapes*
- *Specialized in tape hardware solutions*
- *More than 6000 pcs of tape cartridges in stock*
- *A full data storage product range (HDD, NAS, SSD, optical discs etc ....)*
- *10,000m2 of stock - more than 50 items available on stock*
- *French specialist in printing solutions*
- *55 Million Eu revenue in 2017*
- *Provides more than 3,000 companies with IT products*

Tape Storage Solution

=

1-A Library

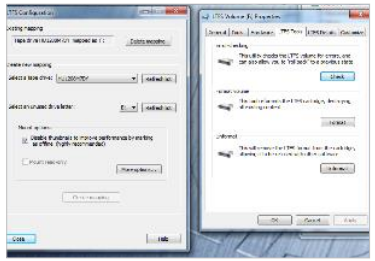
+

2-Tape Drives

+

3-Tape Cartridges

+



4-Backup Software

+

5-Technical Support

You Need 5 Elements In Order to Build a Tape Storage Solution (II)

IBM, HP, Oracle, Dell and Quantum account for over 90% of tape hardware market

The rights of the high-end 3592 tapes belong to IBM. The rights of the LTO technology belong to the Consortium (IBM, HP, Quantum)

Fujifilm accounts for 70% of the global tape manufacturing.

HP, IBM and Fujifilm share more than 70% of the global market share for LTO tape cartridges.

These are, in general, the same as those used on hard disks and they work the same way as with the hard disk

1-A Library

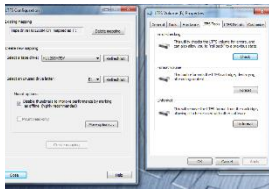
+

2-Tape drives

+

3-Tape cartridges

+



4- Backup software

+

5- Technical Support

=

A storage solution on tape

The library contains tape drives and cartridges. **In order to reduce the workload**, you can automate your backup and reduce the number of physical interventions on the system.

The drive writes and reads the data written on the cartridge. Its number depends on the operational speed desired by the user.

The tape cartridges are the tool on which the data is written and stored. **You can either leave them in the library for 5-10 years, or remove** them in order to keep them at another location for security reasons.

It allows you to configure the system once for a whole year by giving the order of the backup frequencies

Technical support refers to the hardware vendor's maintenance contract and Fujifilm's technical diagnostic center.

Larger storage capacity

Floor space reduction

Money saving

Below, the maximum capacities and speeds available per Rack size in U

4 Modules – 9U Rack size
Capacity = 714TB
Write speed = 1.44GB/s

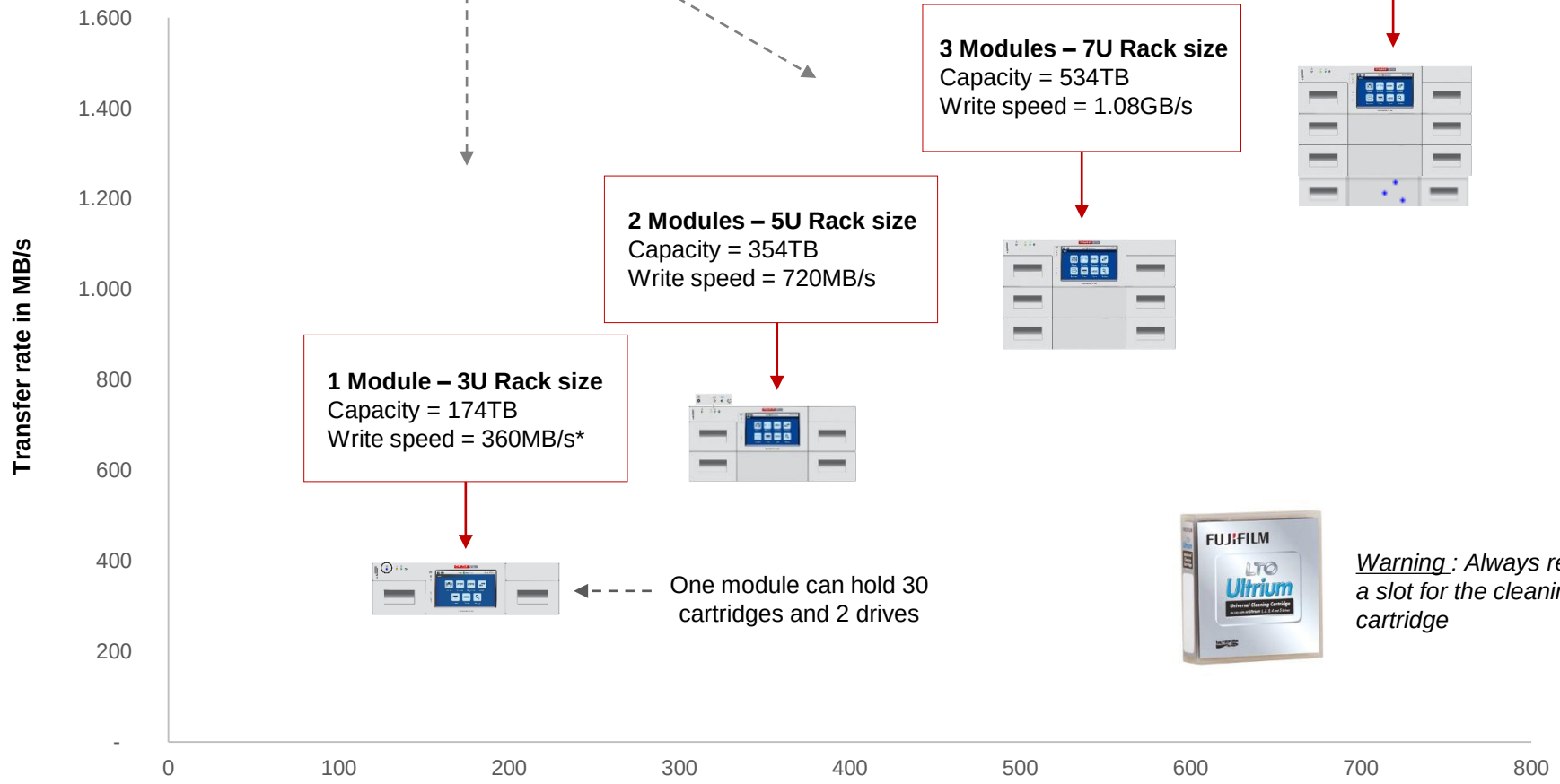
3 Modules – 7U Rack size
Capacity = 534TB
Write speed = 1.08GB/s

2 Modules – 5U Rack size
Capacity = 354TB
Write speed = 720MB/s

1 Module – 3U Rack size
Capacity = 174TB
Write speed = 360MB/s*

One module can hold 30 cartridges and 2 drives

Warning : Always reserve a slot for the cleaning cartridge



**Real operational speed for saving small files*

Examples of TCO for LTO7 Tape Solutions (Total Cost Over 5 Years)

For a 50TB user
with 20% annual data growth

Total cost over 5 years
25 900 Eu
That's 432 Eu on average per month

This price includes…

1 Module (30 slots) - 3U + 2 LTO7 SAS drives +
42 LTO7 tape cartridges (2 copies)
+ 1 cleaning cartridge + Installation + 5 years maintenance contract + cables & power supply

2 weeks of new data recorded in less than 80 minutes with only 1 single drive.

For a 100TB user
with 20% annual data growth

Total cost over 5 years
32 010 Eu
That's 534 Eu on average per month

This price includes…

2 Modules (60 slots) - 5U (3U+2U) + 2 LTO7 SAS drives +
84 LTO7 tape cartridges (2 copies)
+ 1 cleaning cartridge + Installation + 5 years maintenance contract + cables & power supply

2 weeks of new data recorded in 2 hours 30 minutes with one single drive.

For a 200TB user
with 20% annual data growth

Total cost over 5 years
40 200 Eu
That's 670 Eu on average per month

This price includes…

3 Modules (90 slots) - 7U (3U+2U+2U) + 2 LTO7 SAS drives +
166 LTO7 tape cartridges (2 copies)
+ 1 cleaning cartridge + Installation + 5 years maintenance contract + cables & power supply

2 weeks of new data recorded in 5 hours with one single drive.

For a user who stores 100TB of data

A solution that is too expensive ... ----→ and the least secure

Daily backup on hard disk

Archiving of the data on hard disk

- Power consumption
- Needs too many hard disks in order to reach tape's performance in terms of write speed
- Multiplication of security copies in the hope of avoiding data loss due to the short life of the hard disk
- The maintenance cost of the hardware is too high

=> Studies show that hard disk is too expensive (see: Clipper Group, Wikibon etc ...)

A solution that is too expensive ... ----→ and secure

Daily backup on hard disk

100TB

Archiving the data on LTO7

100TB

The error that some users make: in addition to buying a tape solution, **they retain the same hard disk storage capacity as before.**

This becomes an expensive solution and is absolutely not necessary

And affordable solution… ----→ and secure

Daily backup on hard disk

15TB

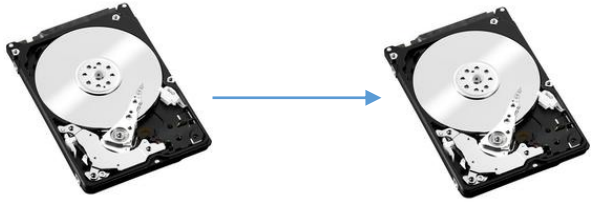
Archiving the data on LTO7

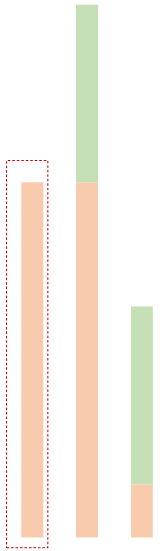
100TB

The definition of data to keep on tape: it is data **that we will not access every day**, but **to which we want to access in 10-15 years**.

For a user who stores 100TB of data

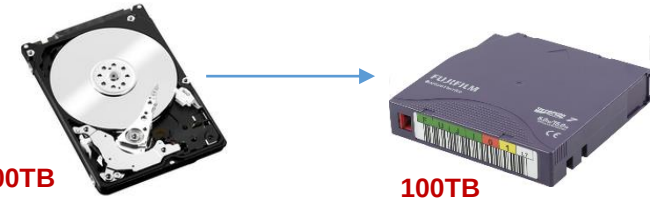
A solution that is too expensive ... ----→ and the least secure

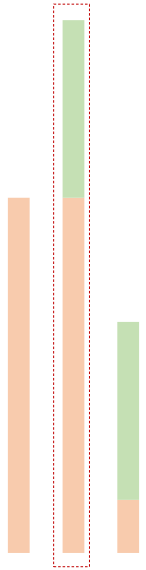




Hard disk is an excellent tool for data processing, it must be accompanied by a data archiving solution.

A solution that is too expensive ... ----→ and secure



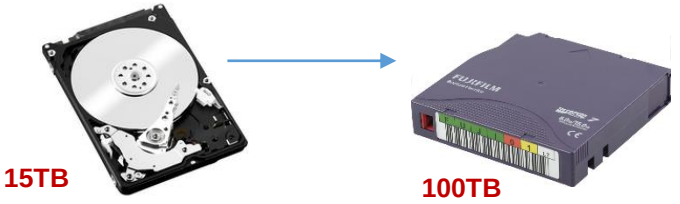


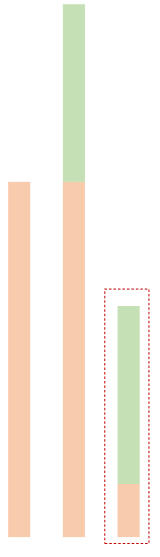
A hard disk crashes in 3-4 years

↓

It is strongly recommended that users who buy tape solutions, **<u>should set up a protocol for reducing the hard disk space over time</u>**, in order to reduce the total cost of the data storage system.

And affordable solution… ----→ and secure





In general, only 15%-20% of a company's data needs frequent access.

↓

This 15%-20% is the hard disk capacity that's necessary for the proper functioning of a company. **<u>Other data is only likely to be archived over time on an LTO tape.</u>**

How many **library modules**, and therefore, **library slots** do we need?

- *We can take, for example, the case of a company who stores 200TB of data on hard disk and that considers that archiving data on hard disk represents a danger.*
- *This company will generate 4TB of new data per month - and would like to have an estimate of the best configuration and the total cost of use for 5 years.*

Year	Total accumulated capacity in TB	New data created in TB
Year 0	200	
Year 1	248	48
Year 2	296	48
Year 3	344	48
Year 4	392	48
Year 5	440	48

It will take 74 LTO7 tape cartridges to store all of the 440TB that the user will have created in 5 years

It will take 74 library slots to contain these cartridges
+ a slot reserved for the cleaning cartridge
+ 1 or 2 additional slots for those who want to generate a second copy to store at a second site = this user will need close to 80 slots.

An Oracle SL-150 tape library consists of 30 slot modules.

The first module, the base module, is the central body of the library => it is of 3U in rack size

Any other module will be of 2U of Rack size

This company will, therefore, need 3 modules of an SL-150 library. This will give them access to 90 available slots, which will be more than enough to cover their needs for 5 years.

Remarks:

*In the event of strong data growth after 5 years, instead of buying a new library, or new modules, the user will be able to purchase new generations of LTO tapes, which will reduce their needs in terms of space within the library.

*We recommend to all users that they make a second external copy for security reasons. One or two slots to carry out the second copy for a 200TB-400TB user is more than enough, as they will need to generate a second copy of an average of 1TB per week (most of the time this will be over the week-end).

*We notice a growing number of users who leave both copies in the library over the entire 5 years. In this instance, the user would opt for a library that could contain 2 X 74pcs LTO7 = 148 tapes, therefore, 148 slots. This would make a 6 module SL-150 library (180 slots).

*Please note: we always advise the purchase of a number of slots slightly larger than the real needs of the user.

How many **LTO7 drives** do we need?

1) For the daily work of data backup

On the previous page, we saw that the user generates 4TB of new data per month. Therefore, we must calculate the backup time of the equivalent of two weeks' of work with a single LTO7 drive.

The formula for calculating the backup time is as follows:
Backup time = capacity to save / transfer rate

Warning: in the chapter on the write speed, we also saw (slide 23) that when saving files of small or medium sizes (1GB), it is better to take a share % of the official transfer rate into consideration, in order to avoid unpleasant surprises when calculating the backup operational time.
=> For writing small files, we recommend users to estimate their backup time on **LTO7 with a theoretical speed of 180MB/s**.

Backup time = 2 000 000 MB (or 2TB) / 180MB/s = **3.09 hours**

A single LTO7 drive is enough to record the equivalent of 2 weeks' of work within 3 hours.

2) For copying the 200TB originally stored on hard disk

- The time it will take to copy the 200TB of data stored on the hard disk data depends essentially on the will of the user.
- The backup time also depends on the number of drives that the user will purchase.

The backup time or conversion time for a single drive = 200,000,000 MB (or 200TB) / 180MB/s = 309 hours = **31 working days** with 10 hours of daily use of the drive.

- With a single drive dedicated to migrating data from the hard disk to the tape, it will take 31 days to fully generate the copy. This figure is generally suitable for European companies.
- Companies that want to perform a faster migration opt for the use of a greater number of drives: 2 drives dedicated to data migration could complete it in the space of 16 days etc .....…

How many **LTO7 drives** do we need? (II)

3) For accessing the data

Again, the access time to data depends on the needs of users:

- Most SMEs have very little access to data. In general, the data is mainly restored during audits, various controls or for other exceptional reasons.
- In the chapter on data access (slide 33), we saw that it takes, on average 2min20s to open a 10GB file, which is appropriate for the majority of LTO7 tapes users.
- However, we also have the case of users who reserve 3-4 drives solely for the data access.

- In general, we recommend that end users who are concerned with the access time to should reserve a drive just for that matter.
- This also reduces the amount of data that you need to keep on your hard disk, and reduces the cost of your storage system.
- That said, the sine qua non condition for a short access time on tape technology, is that the user must keep all their data on tape within the library. Keeping tapes on shelves far from the library can lengthen the access time.

4) An additional drive for security purpose.

*We strongly recommend to any user that they should always hold an additional drive for security reasons.
* In the case of failure, even if the hotlines of the drive manufacturers are reactive, you will still have to wait a few days in order to receive the new drive.
* In the case of the 200TB to 440TB user, they will not need an additional drive because he will still be able to use the drive that will have been used for the initial conversion of the 200TB data from disk to tape.

A summary of this company's needs in terms of the number of drives.
This user has opted for:

A drive for the daily requirements (for saving the new data) => it takes 3 hours to write/save 2TB with one drive (equivalent to 2 weeks of0 new data).

+

A drive for converting the initial 200TB from hard disk to tape (31 working days). This drive will then become the extra security drive.

+

A 3rd drive is exclusively reserved for the data retrieval, since this user is confronted to frequent accesses to the data.

In conclusion, this company has decided to use, over a period of 5 years:

3 tape library modules (90 slots)

+

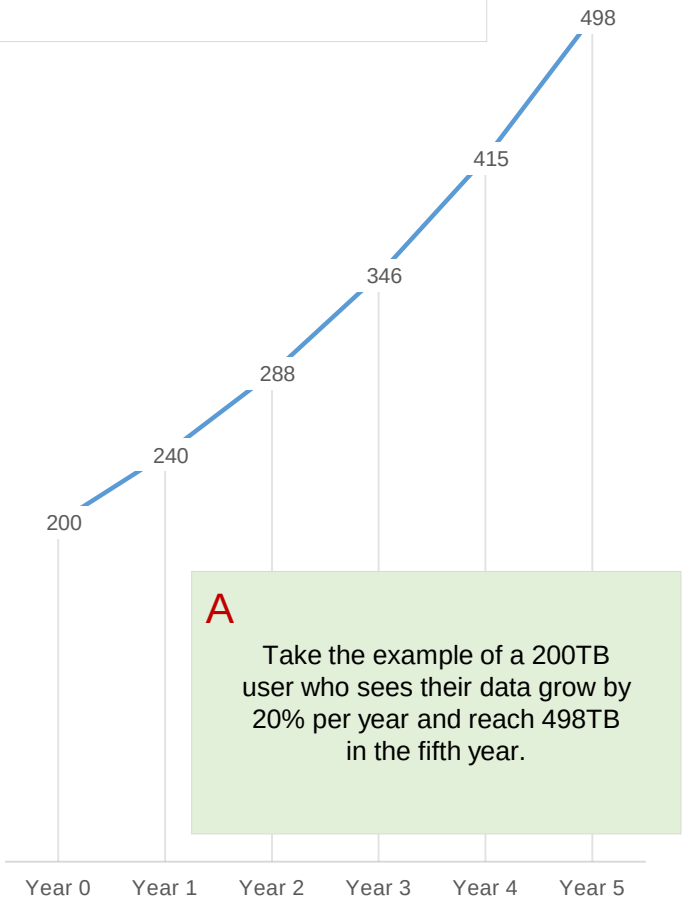
3 LTO7 drives

+

148 LTO7 tapes (2 copies)

B

In order to hold 498TB of data, a user needs 83 LTO7 tape cartridges.



A

Take the example of a 200TB user who sees their data grow by 20% per year and reach 498TB in the fifth year.

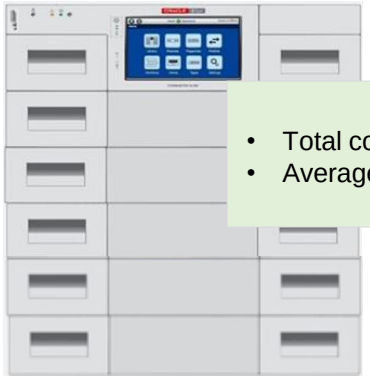
Option 1: the safest solution.

- 3 modules (90 slots)
- 7U of Rack size
- 166 x LTO7 tapes
- 2 x LTO7 SAS drives
- 2 cleaning cartridges
- Installation
- A 5 year maintenance contract

- Total cost over 5 years: 40 200 Eu
- Average monthly cost: 670 Eu

Option 2: the solution that requires the least workload

- 6 modules (180 slots)
- 13U of Rack size
- 166 x LTO7 tapes
- 2 x LTO7 SAS drives
- 2 cleaning cartridges
- Installation
- A 5 year maintenance contract



- Total cost over 5 years: 49 700 Eu
- Average monthly cost: 829 Eu

Option 3: the cheapest solution

- 1 module (30 slots)
- 3U of Rack size
- 166 x LTO7 tapes
- 2 x LTO7 SAS drives
- 2 cleaning cartridges
- Installation
- A 5 year maintenance contract

- Total cost over 5 years: 33 800 Eu
- Average monthly cost: 564 Eu

Option 1: the safest solution

- Total cost over 5 years: 40 200 Eu
- Average monthly cost: 670 Eu

Description: the user leaves the first copy in the library constantly over 5 years (83 tape cartridges), and stores the second copy at another location.

Advantages:
- This is the most used solution
- It is also the most secure solution, as the user keeps a second copy at another location in case of an accident in the IT room (fire, flood, burglary, earthquake, virus or hackers attack, terrorist attack etc).
- Ideal for disaster recovery.
- Can work online: fast access to data.

Remarks: taking a second copy to another location requires a weekly physical intervention.

Option 2: the solution that requires the least workload

- Total cost over 5 years: 49 700 Eu
- Average monthly cost: 829 Eu

Description: the user leaves both copies of tapes within the library over 5 years.

Advantages:
- This is the solution that requires the least physical intervention on the tape. No physical contact with the cartridges for 5 years.
- Can work Online: fast access to data.
- This solution is the closest configuration to the hard disk, but with much higher performance levels.

Remarks :
- This is the most expensive solution (160 Eu per month more expensive than option1).
- Less effective disaster recovery plan.
- It is a less secure solution than the one proposed in option 1.

Option 3: the cheapest solution

- Total cost over 5 years : 33 800 Eu
- Average monthly cost : 564 Eu

Description: the user will only use one module (30 slots) regardless of the capacity they have to store for 5 years.

Advantages:
- This is the most expensive solution (100 Eu per month less than option1).
- It is also the solution that occupies the least amount of space.

Remarks:
- The access time to data is considerably slower than on options 1 and 2.
- The workload is more important, as the library is even not able to contain all of the 200TB of the first year.
- The user will have to constantly free up space by removing the cartridges from the library.
- If the use of a single module is an obligation, it is recommended to use cartridges of higher capacities than the LTO7.

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Native capacity in TB

3 000
2 500
2 000
1 500
1 000
500
-

LTO7 Standalone drive
For capacities under 30TB

The maximum capacity of a library of **11U Rack size** (5 modules) = **900TB**

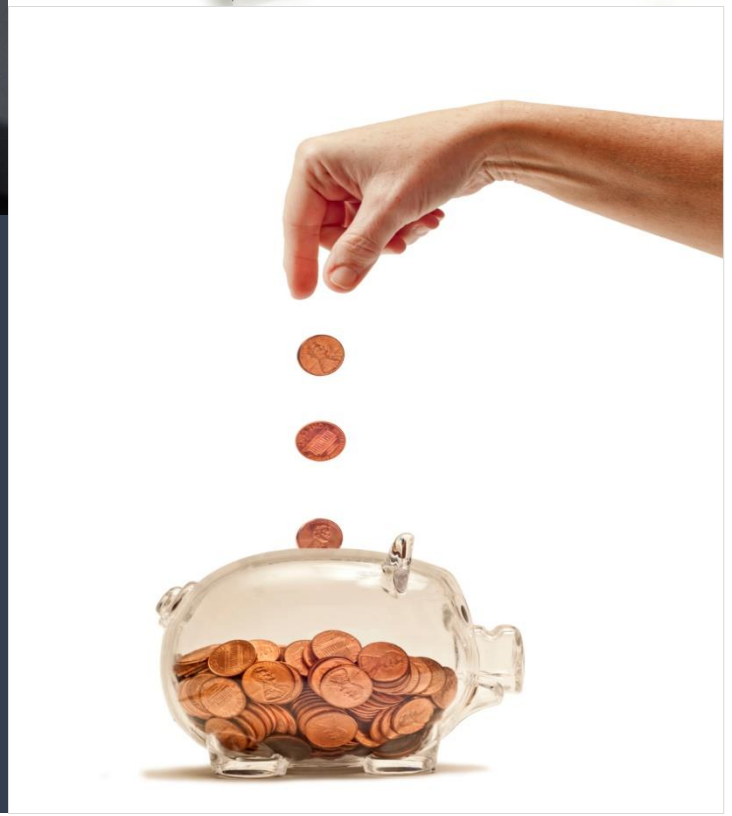
LTO7 Library
From 30TB to 1PB

The maximum capacity of a library of **11U Rack size** (5 modules) = **1.8PB**

LTO8 Library
From 300TB to 2PB

Maximum capacity: **several hundred PBs**

3592 Library
For capacities greater than 2PB

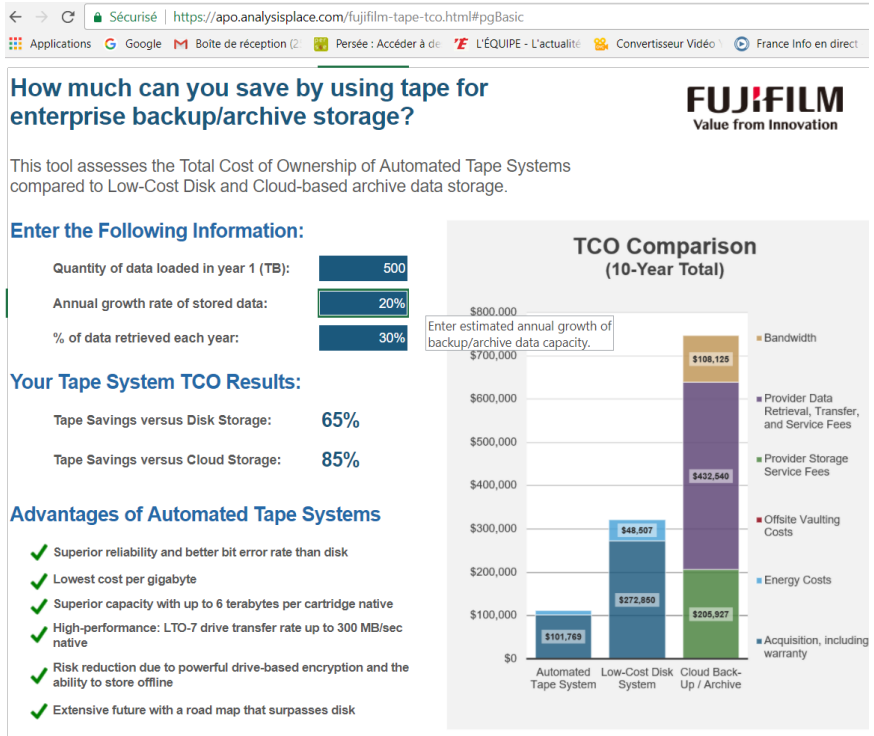


Three Studies that demonstrate that **tape is considerably cheaper to use** than hard disk

Fujifilm US has just released a comparative cost calculator for tape, hard disk and cloud usage

Please note: we must, of course, take any calculator very carefully as it doesn't take the specific needs of the user into account. Secondly, it can also not take market pricing fluctuations nor promotional offers into account. That said, this study demonstrates such a difference in price between tape and hard disk, that it is worth a go.

https://apo.analysisplace.com/fujifilm-tape-tco.html#pgBasic

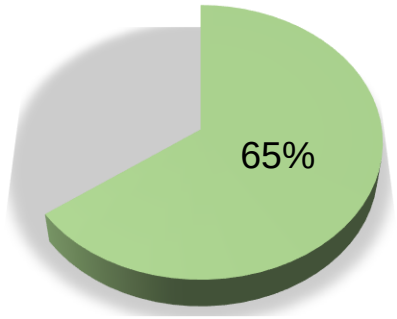


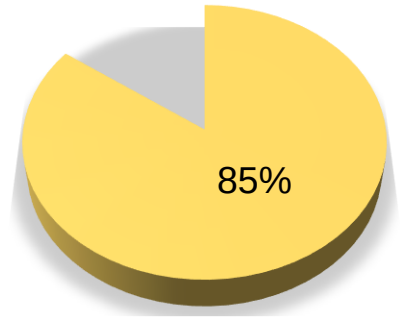
Examples of TCOs

Tape savings versus hard disk storage
(over 10 years).

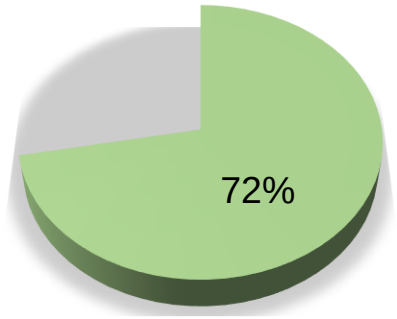
Tape savings versus Cloud storage
(over 10 years).

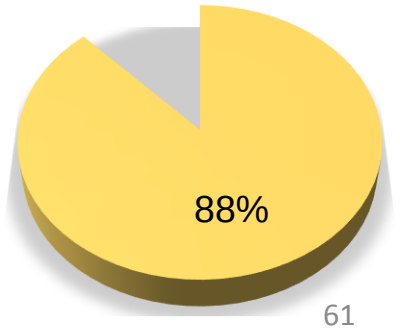
A) For a 500TB data user, with 20% annual growth and who will have access to 30% of their data each year.

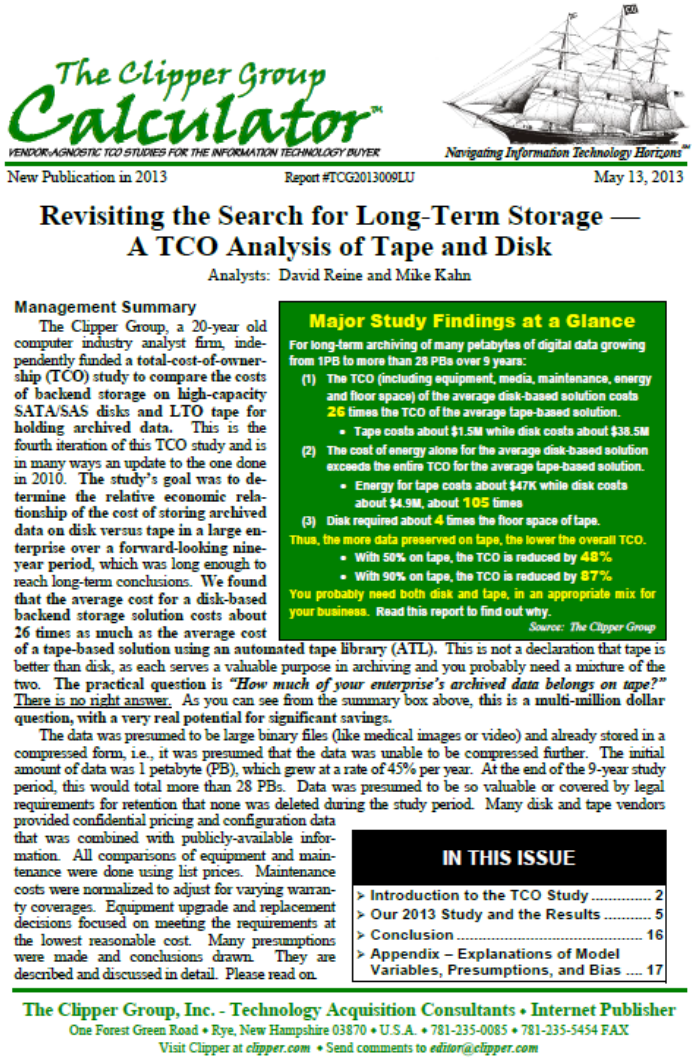




B) For a 1PB data user, with 20% annual growth and who will have access to 30% of their data each year.







The Clipper Group Calculator™
VENDOR-AGNOSTIC TCO STUDIES FOR THE INFORMATION TECHNOLOGY BUYER
Navigating Information Technology Horizons℠

New Publication in 2013 | Report #TCG2013009LU | May 13, 2013

Revisiting the Search for Long-Term Storage — A TCO Analysis of Tape and Disk

Analysts: David Reine and Mike Kahn

Management Summary

The Clipper Group, a 20-year old computer industry analyst firm, independently funded a total-cost-of-ownership (TCO) study to compare the costs of backend storage on high-capacity SATA/SAS disks and LTO tape for holding archived data. This is the fourth iteration of this TCO study and is in many ways an update to the one done in 2010. The study's goal was to determine the relative economic relationship of the cost of storing archived data on disk versus tape in a large enterprise over a forward-looking nine-year period, which was long enough to reach long-term conclusions. We found that the average cost for a disk-based backend storage solution costs about 26 times as much as the average cost of a tape-based solution using an automated tape library (ATL). This is not a declaration that tape is better than disk, as each serves a valuable purpose in archiving and you probably need a mixture of the two. The practical question is *"How much of your enterprise's archived data belongs on tape?"* There is no right answer. As you can see from the summary box above, this is a multi-million dollar question, with a very real potential for significant savings.

Major Study Findings at a Glance

For long-term archiving of many petabytes of digital data growing from 1PB to more than 28 PBs over 9 years:

(1) The TCO (including equipment, media, maintenance, energy and floor space) of the average disk-based solution costs 26 times the TCO of the average tape-based solution.
- Tape costs about $1.5M while disk costs about $38.5M

(2) The cost of energy alone for the average disk-based solution exceeds the entire TCO for the average tape-based solution.
- Energy for tape costs about $47K while disk costs about $4.9M, about 105 times

(3) Disk required about 4 times the floor space of tape.

Thus, the more data preserved on tape, the lower the overall TCO.
- With 50% on tape, the TCO is reduced by 48%
- With 90% on tape, the TCO is reduced by 87%

You probably need both disk and tape, in an appropriate mix for your business. Read this report to find out why.

Source: The Clipper Group

The data was presumed to be large binary files (like medical images or video) and already stored in a compressed form, i.e., it was presumed that the data was unable to be compressed further. The initial amount of data was 1 petabyte (PB), which grew at a rate of 45% per year. At the end of the 9-year study period, this would total more than 28 PBs. Data was presumed to be so valuable or covered by legal requirements for retention that none was deleted during the study period. Many disk and tape vendors provided confidential pricing and configuration data that was combined with publicly-available information. All comparisons of equipment and maintenance were done using list prices. Maintenance costs were normalized to adjust for varying warranty coverages. Equipment upgrade and replacement decisions focused on meeting the requirements at the lowest reasonable cost. Many presumptions were made and conclusions drawn. They are described and discussed in detail. Please read on.

IN THIS ISSUE

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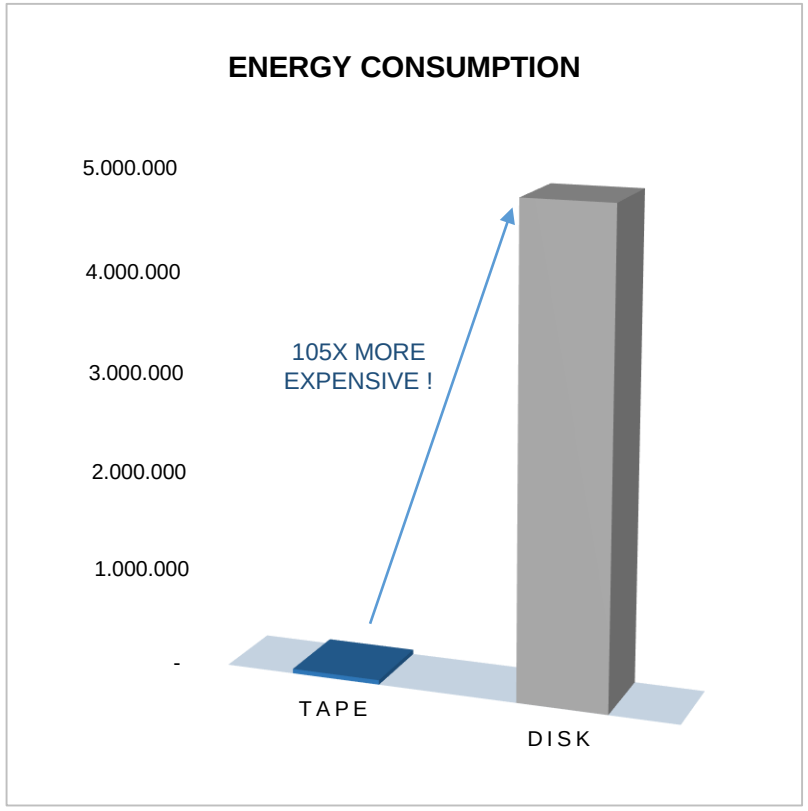
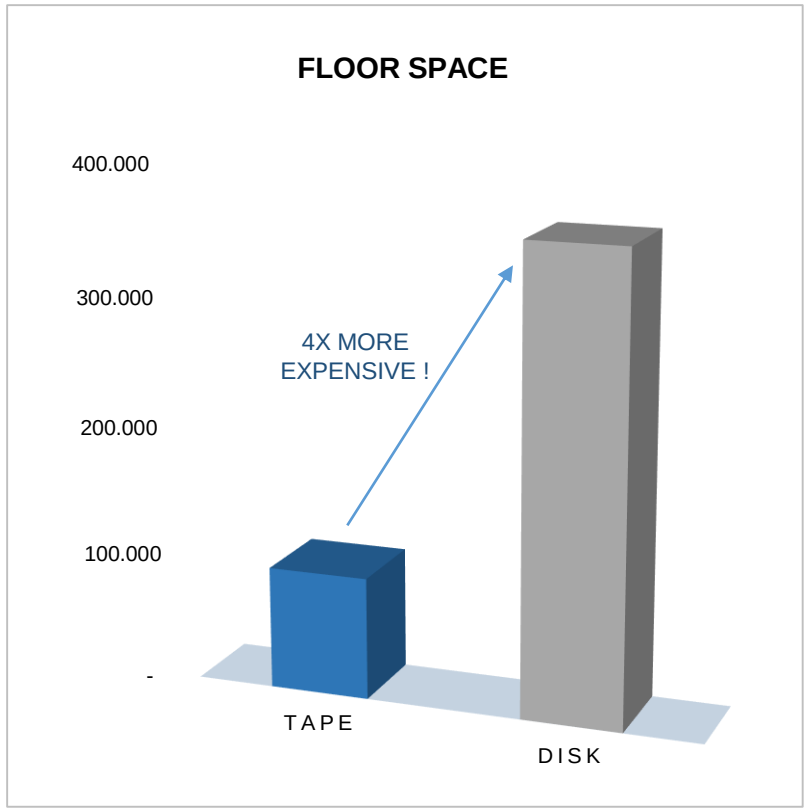
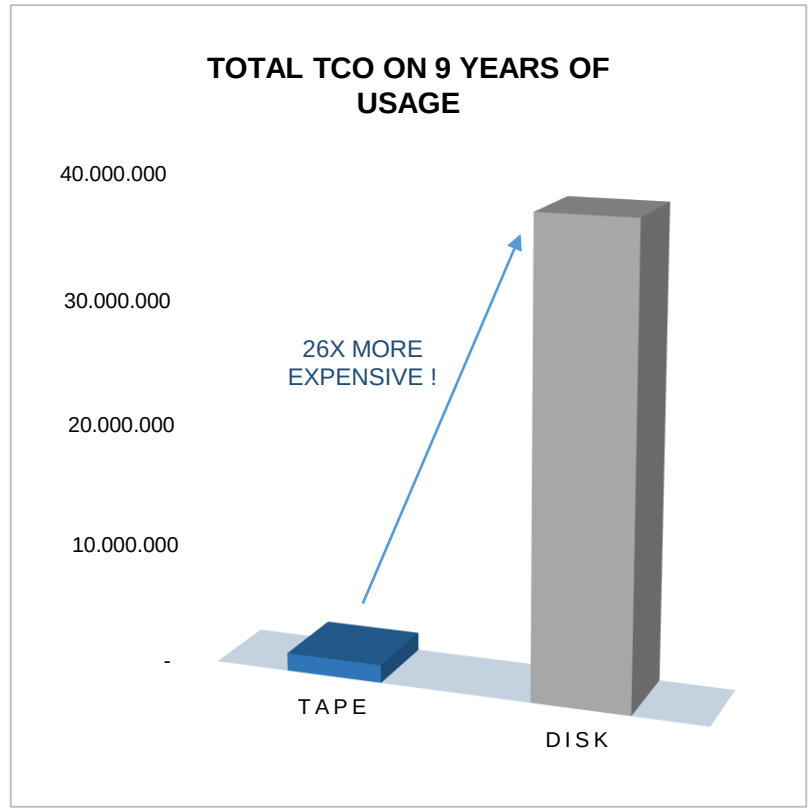
- The Clipper Group is an independent company
- Established in 1993 in Wellesley, Mass, and now in Rye, NH
- Technology acquisition consultants,
- Strategic advisors, and
- Internet publishers on enterprise-class information technology and infrastructure.
- The Clipper Group is specialized
  - in large servers
  - enterprise storage solutions
  - and enterprise software

In May 2013, The Clipper Group published the results of their survey comparing Tape's TCO to Disk's.







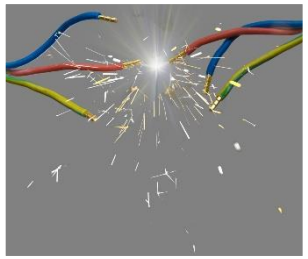
TOTAL COST OF OWNERSHIP IN $

Details of the Clipper Group survey:

- Storage system using from 1PB to 28PB over 9 years
- 45% average growth per year
- Incompressable data.
- Standard vendor price lists

TCO summary by expenditure category	Tape	Disk	Ratio Disk/Tape
Equipment Media & Maintenance	1 348 907	33 221 012	25
Energy	46 569	4 874 845	105
Floor space	95 106	358 800	4
Total TCO on 9 years of usage	1 490 582	38 454 657	26

Tape is a Greener Option than Disk



Unlike other storage media, tape does not draw power once the data has been written to it because it doesn't spin like a disk.

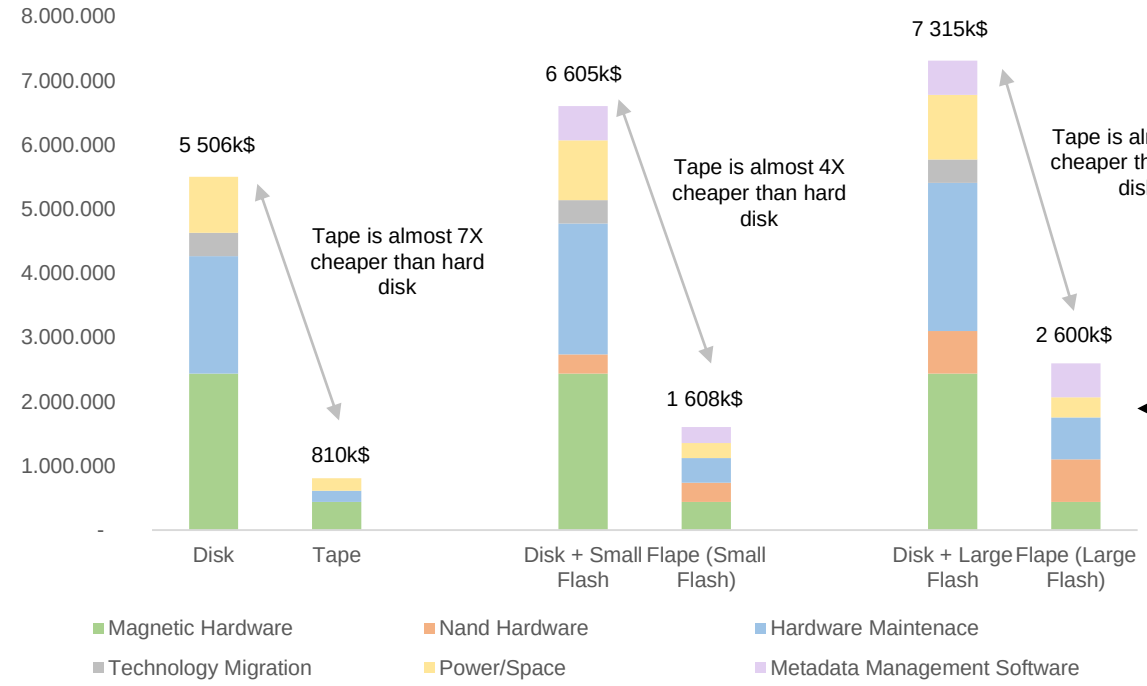
Tape media is able to store data whilst sitting on a shelf inside the library without consuming any power, until it's placed in a tape drive.

Half of the energy consumption of Disk comes from the cooling system. This cooling system is vital when it comes to longevity of the hard drive. Tape doesn't require such a cooling process.

In 9 Years, a tape solution saves over 34,000 megawatt-hours
of electricity

... eliminating more than 24,000 metric tons of CO2 emissions

... saving nearly $5 Million
in electricity costs vs the Disk based solution



	Disk	Tape	Disk + Small Flash	Flape (Small Flash)	Disk + Large Flash	Flape (Large Flash)
Magnetic Hardware	2 437 000	437 000	2 437 000	437 000	2 437 000	437 000
Nand Hardware	-	-	301 000	301 000	666 000	666 000
Hardware Maintenace	1 830 000	178 000	2 037 000	385 000	2 305 000	653 000
Technology Migration	368 000	-	368 000	-	368 000	-
Power/Space	871 000	195 000	930 000	236 000	1 007 000	312 000
Metadata Management Software	-	-	532 000	249 000	532 000	532 000
Total Hardware	5 506 000	810 000	6 605 000	1 608 000	7 315 000	2 600 000

The Wikibon survey
Cumulative cost over 10 years for long-term retention of data, starting from 1PB with a 30% annual growth.

Source:
http://wikibon.org/wiki/v/The_Emergence_of_a_New_Architecture_for_Long-term_Data_Retention

The cost analysis of the tape solution compared to the cost of the hard disk solution shows that:

- The cost of hard disk hardware is 5.5X that of the tape.
- The cost of maintaining the hard disk solution is 10X that of the tape solution
- The cumulative cost: floor space + energy consumption is 4.4X larger on hard disk.
- The total cost of using the tape is almost 7X cheaper than that of the hard disk.

7X

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Diagnostics and the Health Check of Tape Cartridges

Do you have trouble trying to read the data saved on your tape cartridges?

Do you have trouble trying to write data on your tape cartridges?

Your drive seems to not work in optimal conditions

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The Fujifilm technical centre provides diagnostics and analysis of your tape cartridges in order to make your life easier

You just need to contact the local Fujifilm team in order to submit your questions.

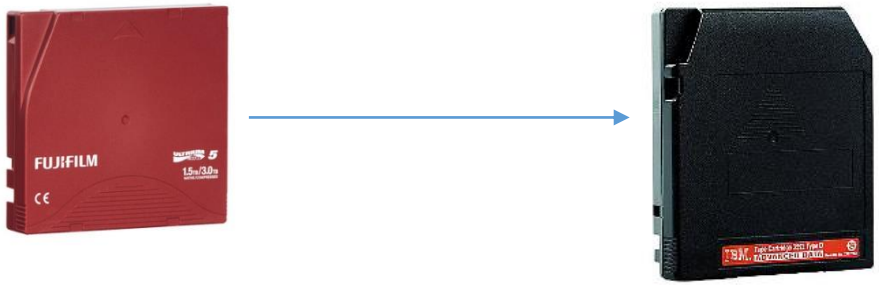
Some other services provided by **our technical centre** based in Kleve (Germany)

Our Cloud Datacenter offer for long-term data retention

The outsourcing of your tape cartridges, the preserving and managing of your tape cartridges

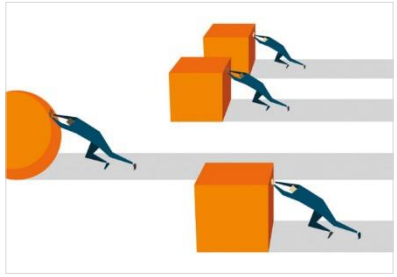
Data Recovery

Data Conversion – Data Migration



Archive Life

Data Integrity



Performance / Speed

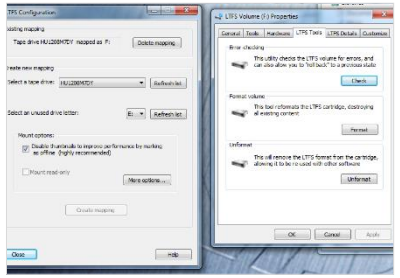
Ecological Footprint

Scalability

Disaster Recovery

Protection against Hackers and Virus

Cost of Use



Easy to Use

Sustainability of the Technology

Why is Tape Growing? A Comparison Chart

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Segment	Hard Disk	LTO5	LTO6	LTO7	LTO8	3592JE*
Native capacity in TB	Depends	1.5TB	2.5TB	6TB	12TB	20TB
Max capacity = future proof tech	12-16 TB?	Max capacity potential for tape technology = 220 TB				
Data Integrity	Disk SATA = 1 X 10^{15} FC & SAS = 1 X 10^{16}	1 X 10^{17}	1 X 10^{17}	1 X 10^{19}	1 X 10^{19}	1 X 10^{20}
Transfer rate in MB/s	Std HDD = 150 MB/s New HDD = 205 MB/s	140 MB/s	160 MB/s	300 MB/s	360 MB/s	500 MB/s
Buffer size in MB	Std HDD = 8MB New HDD = 128MB	512 MB for IBM FH 256 MB for HP FH	1GB for IBM FH 512 MB for HP FH	1GB	1GB	2GB
Archive life / longevity	3-4 Years	Less than 30 years	Over 30 years if Barium Ferrite	Over 30 years		
Security vs Virus & Hackers	Limited	The only decent security system vs virus attacks is to have: a) A removable storage device / b) A device that you can turn off				
Ecological footprint	Extremely high energy consumption	Very low - Tape uses electricity only during the Backup process + no cooling Clipper Group survey: 34K MW/h savings + 24K Metric tons savings with Tape vs Disk				
Access time to data	Good if no use of deduplication	Predictable access time to data as opposed to Dedupe on Disk / Access time to data = we can open over 140 times a 10GB file on LTO7 & LTO8 / Over 120 times on LTO5 & LTO6 / 3592JE will be launched by the end of 2018				

**All specifications are to be confirmed by the end of 2018*

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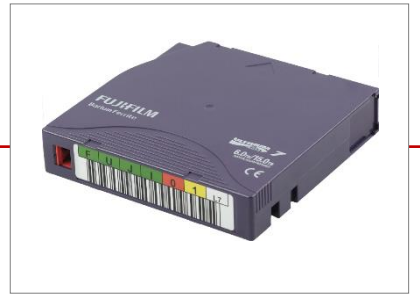
Tape has a longer archive life than Disk (30yr vs 4yr)

Tape consumes less energy

Tape's BER is 10 000 times better than Disk

Tape can protect data from Virus attacks or Hackers

Tape requires less floor space than disk



Backup and Archiving
10 reasons why Tape is superior to Hard Disk

Tape is removable : ideal against theft, natural disaster.

Tape is far cheaper than Disk

Roadmap & Technological Breakthroughs

Tape is more than 3X faster than Disk

Tape is Scalable = more flexibility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