IBM Storage

Sustainable und Cyber Resilience Storage mit IBM Tape

TAPE $AVES: COST • ENERGY • DATA • COMPANY

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Storage Scale

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Warum Tape wichtig für jedes Datacenter ist?

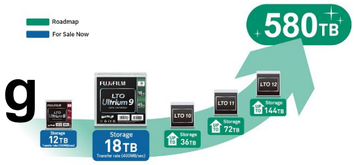
Cost

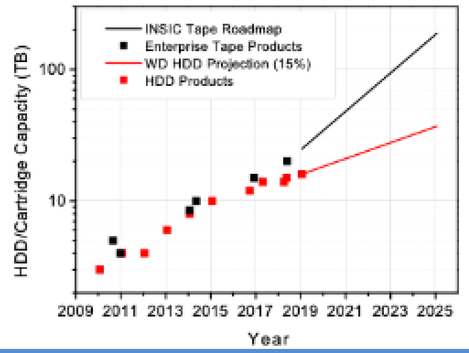
@Hyperscale

HDD Cost 3,7 x Tape

Ref: MS Azure 2016

Scaling





INISIC Tape Capacity

Scaling 40% CAGR

vs HDD less than 10% CAGR

Sustainable Data Center

664 Millionen Tonnen CO2 weniger durch Tape

- 97% weniger Energie
- 95% weniger Kühlung
- 17x weniger RZ-Fläche

Security

AirGap

Encryption / Quantum Safe

- Tape ist offline
- Daten können nicht geändert werden

IBM Safeguarded Tape

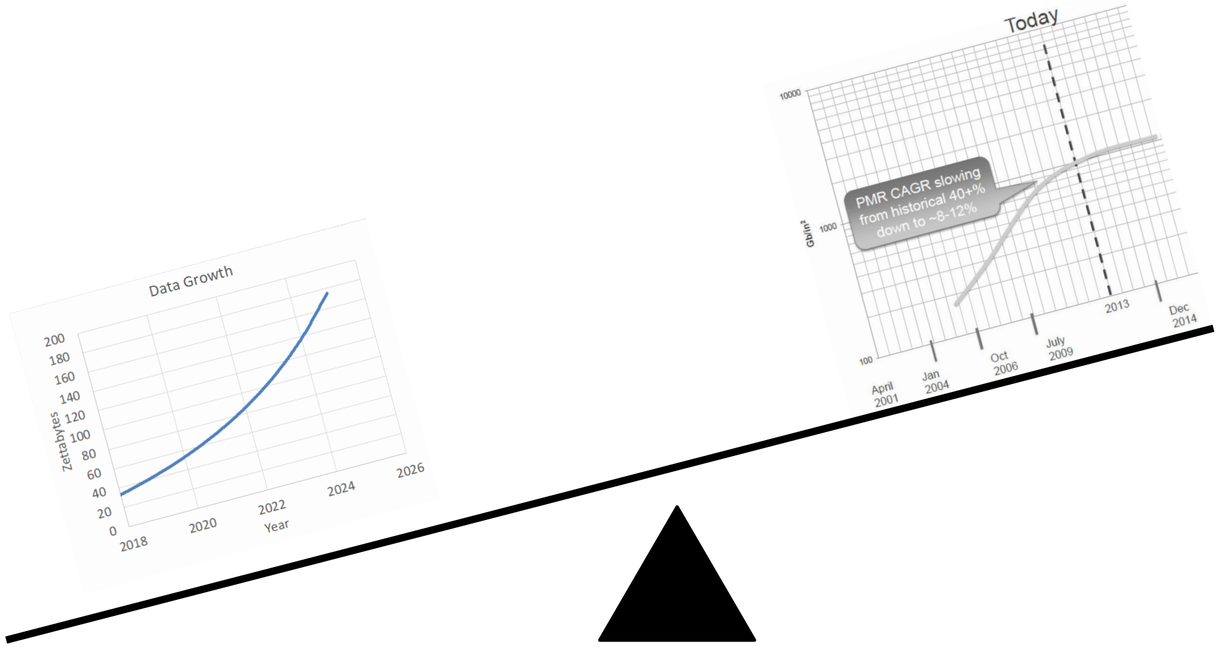
Tape Storage

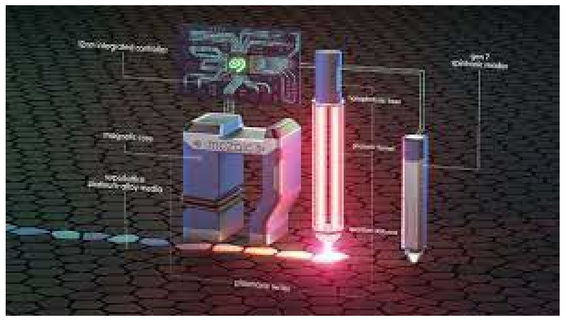
- 1952: 1,4 MB -> 2023: 50 TB

- Tape Media ca 1100 m lang, ½ Zoll breit => ca 14 m² „Speicher“-Fläche (vs 0,02 m² HDD)
- Sequentielle Aufzeichnung
  - 32 Tracks parallel (32 Schreib/Lese-Köpfe) -> Zukunft 64 Tracks
  - Aufzeichnung vom Anfang des Bandes bis zum Ende und wieder zurück -> 500x
  - Tape ist langsam?
    - Schreib/Lese-Geschwindigkeit 400 MB/sec nativ (bis zu 900 MB/sec) pro Laufwerk
      12 m/sec
    - Mittlere Zugriffszeit ca 45 sec
      16 m/sec
- Trennung von Schreib/Lese (Laufwerk) und Speicher (Kassette)
  - Native/Physikalischer Air-Gap !!
- Erhöhung der zukünftigen Kapazität durch Track-Density auf der Kassette
- Verbesserung der Schreib/Lese-Geschwindigkeit durch Erhöhung der Schreib/Lese-Köpfe im Laufwerk
- Skalierung der Kapazität und der Performance (im Gesamtsystem) erfolgt unabhängig voneinander
- Laufwerk ca 50W, Library ca 200W, Kassette = 0W

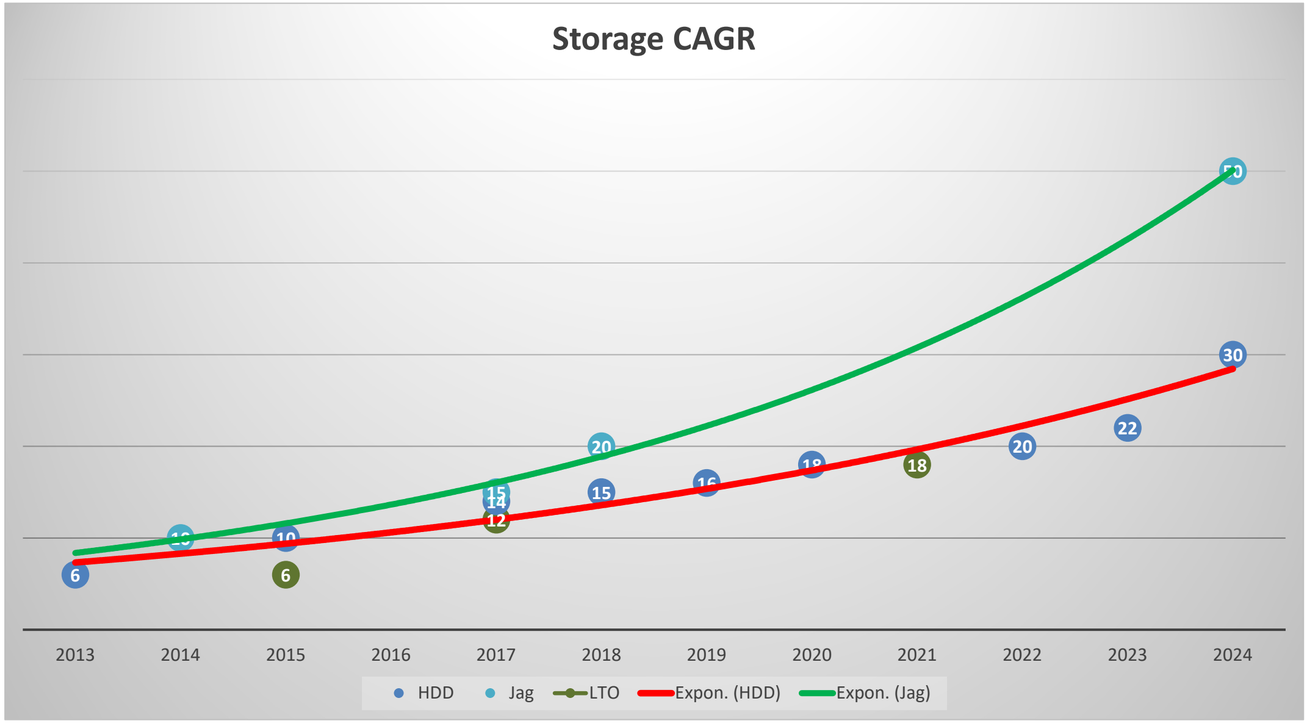
Datenwachstum vs Storage-Technologie

- Exponentielles Wachstums vs. HDD Kapazitätswachstum abflacht

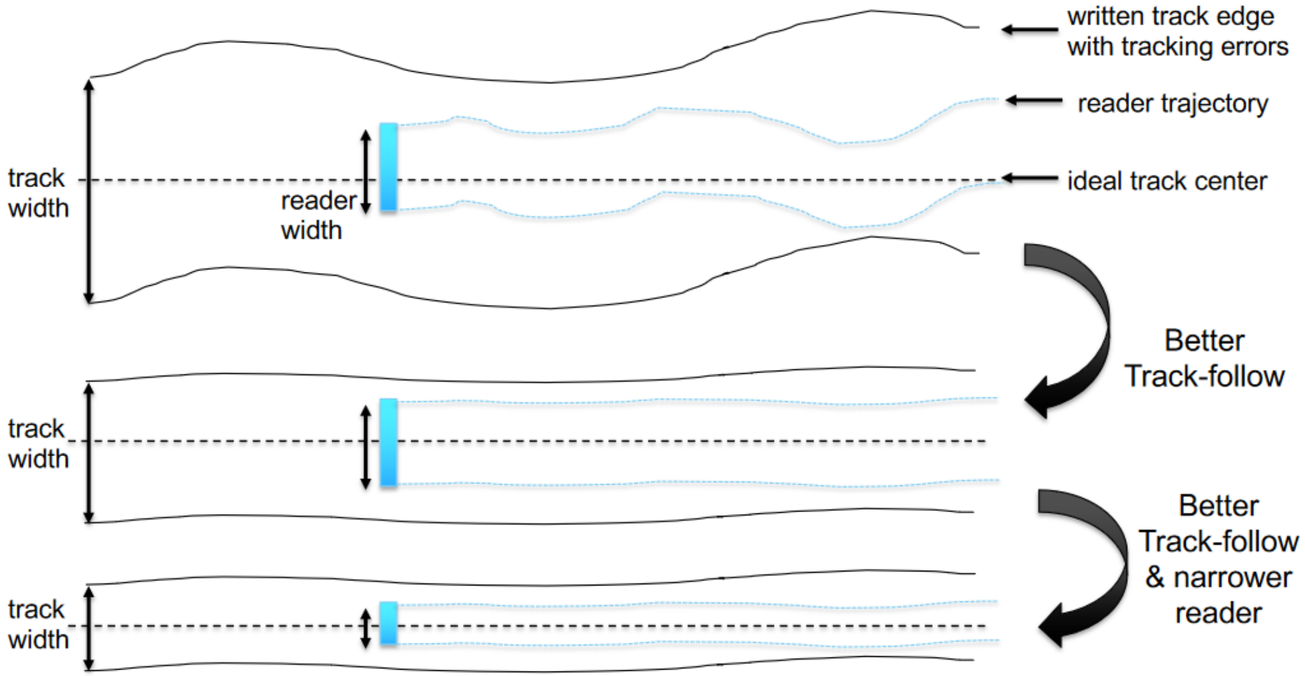




- WD 6TB (2013) 6 platters
- HGST 10TB Drive (2015) 7 platters - CAGR 29%
- 14 TB 9 platters (2017) – CAGR18%
- 15 TB 9 platters (2018) – CAGR 7,1%
- 16 TB 9 platters (2019) – CAGR 6,6%
- 18 TB (2020) – CAGR 8%
- 20 TB (2021) - CAGR 11%
- 22 TB (2022) - CAGR 10%
- 30 TB (2024)



Tape-Entwicklung für die Zukunft



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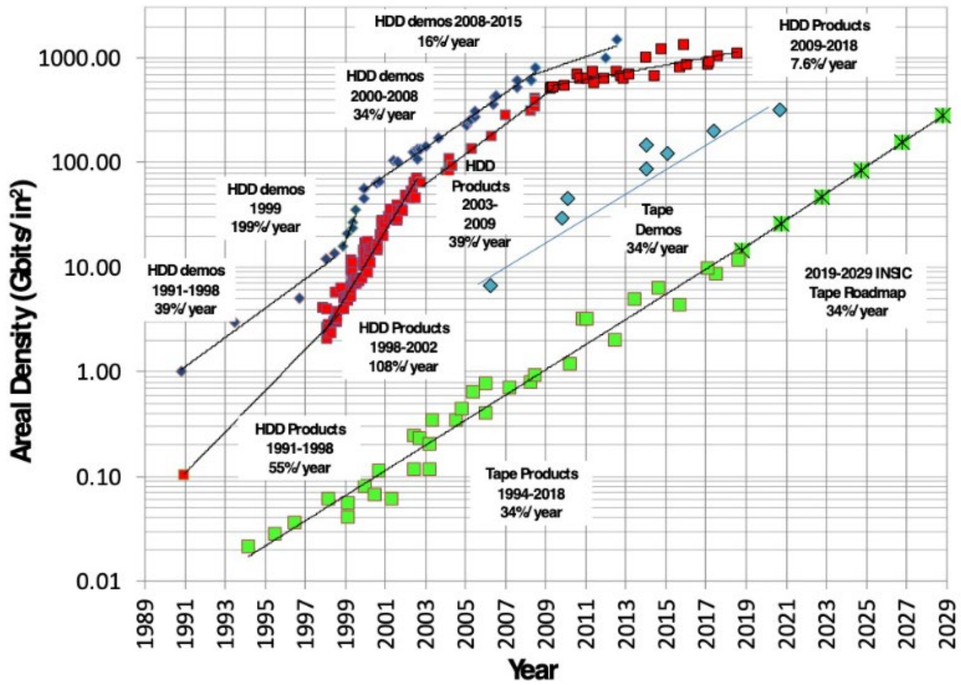
Areal Density Scaling

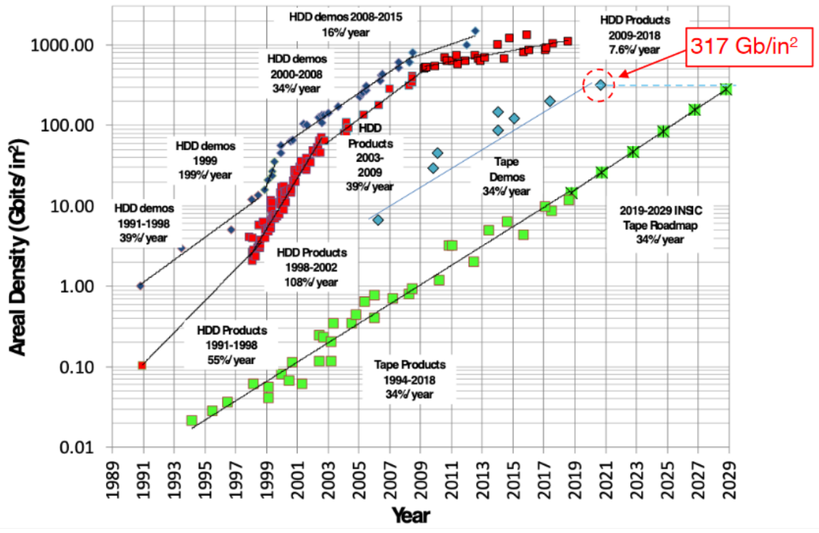


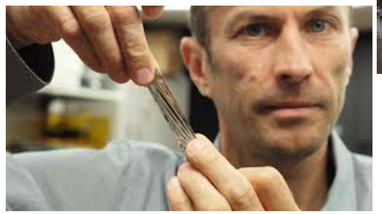
IBM Research Rüschlikon: Tape Technology Demonstration December 2020

Areal recording density :
317 Gb/in^2

→ 580 TB cartridge capacity

317 Gb/in2 demonstrates the sustainability of the INSIC Tape Roadmap
34% CAGR in Areal Density for the next decade

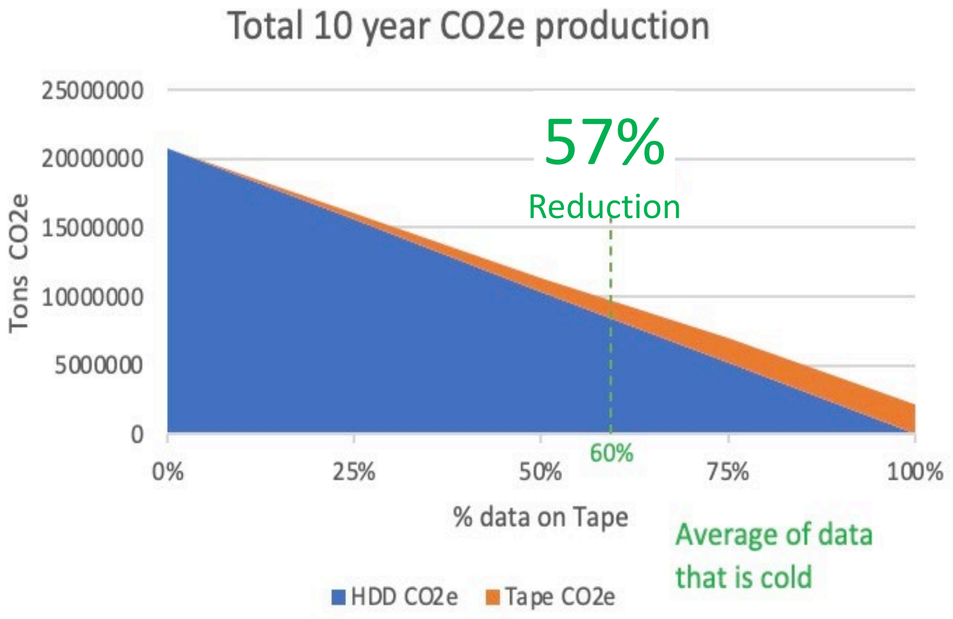




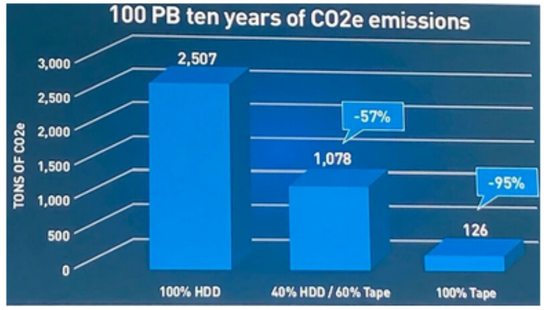
Cost advantage of tape will increase in the next few years!

Nachhaltigkeitsvergleich: HDD und Tape

- 97% weniger Energieverbrauch
- 95% weniger Kühlung notwendig
- 17x größere Storagekapazität (Density)



Tape spart Kohlendioxid



Der Vergleich zeigt: Der Kohlendioxidausstoß einer Tape-Speicherung ist sehr viel geringer als der von Festplatten. SSDs würden noch schlechter abschneiden.
(Bild: ETH Zürich/Rüdiger)

https://www.storage-insider.de/viele-argumente-fuers-speicherband-a-826c85b3b82f3380840dc580096682d0/

Steiger: „Hard Disks erzeugen nach Daten von Seagate 2,32 Kilo Kohlendioxid pro Terabyte und Jahr. Bei Band sind es 114 Gramm." Den negativen Spitzenreiter gibt die SSD: Bei ihr sind es 5,7 Kilo Kohlendioxid-Äquivalente pro TB und Jahr. Was die Daten bedeuten, wenn man sie auf größere Speichermengen hochrechnet, zeigt ein Beispiel.

>87%

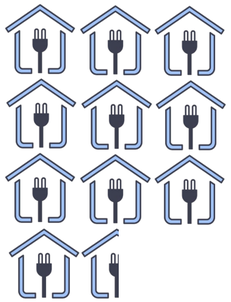
Verringerung CO2

Physical **Tape**
CO_2e Report

https://www.ibm.com/downloads/cas/YE5WAQ0B

Breakdown of the CO_2e and Other Positive Sustainability Impacts of IBM Physical Tape Products
The Product Life Cycle

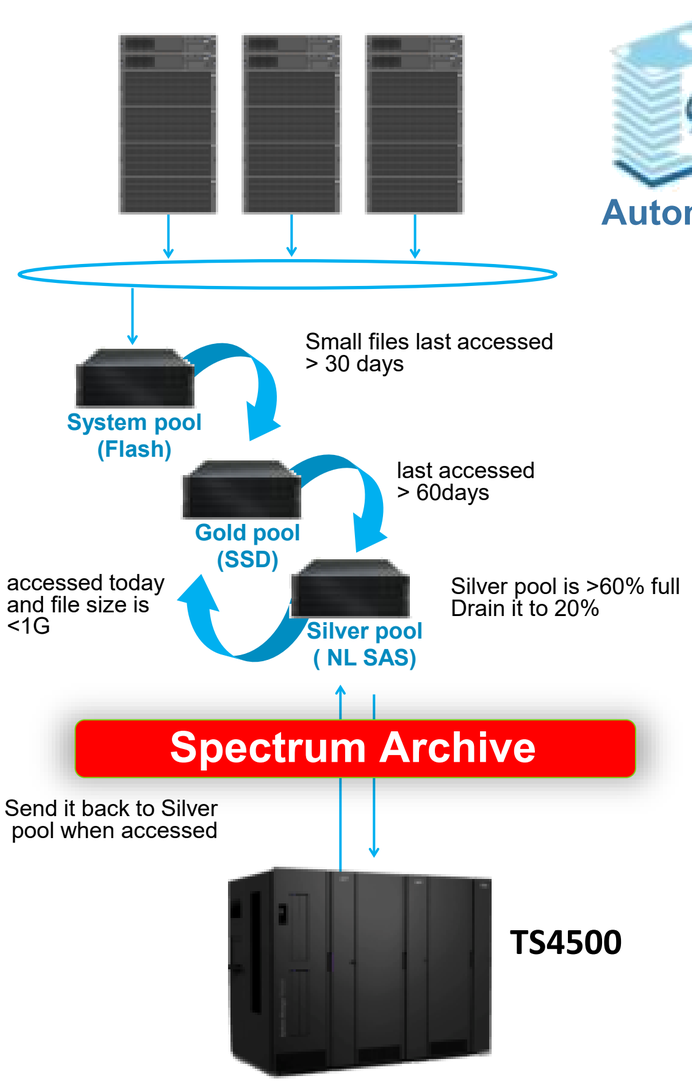
Bryce Canyon HDD System by Facebook



96% CO_2e Reduction

IBM Ultra-Dense Tape

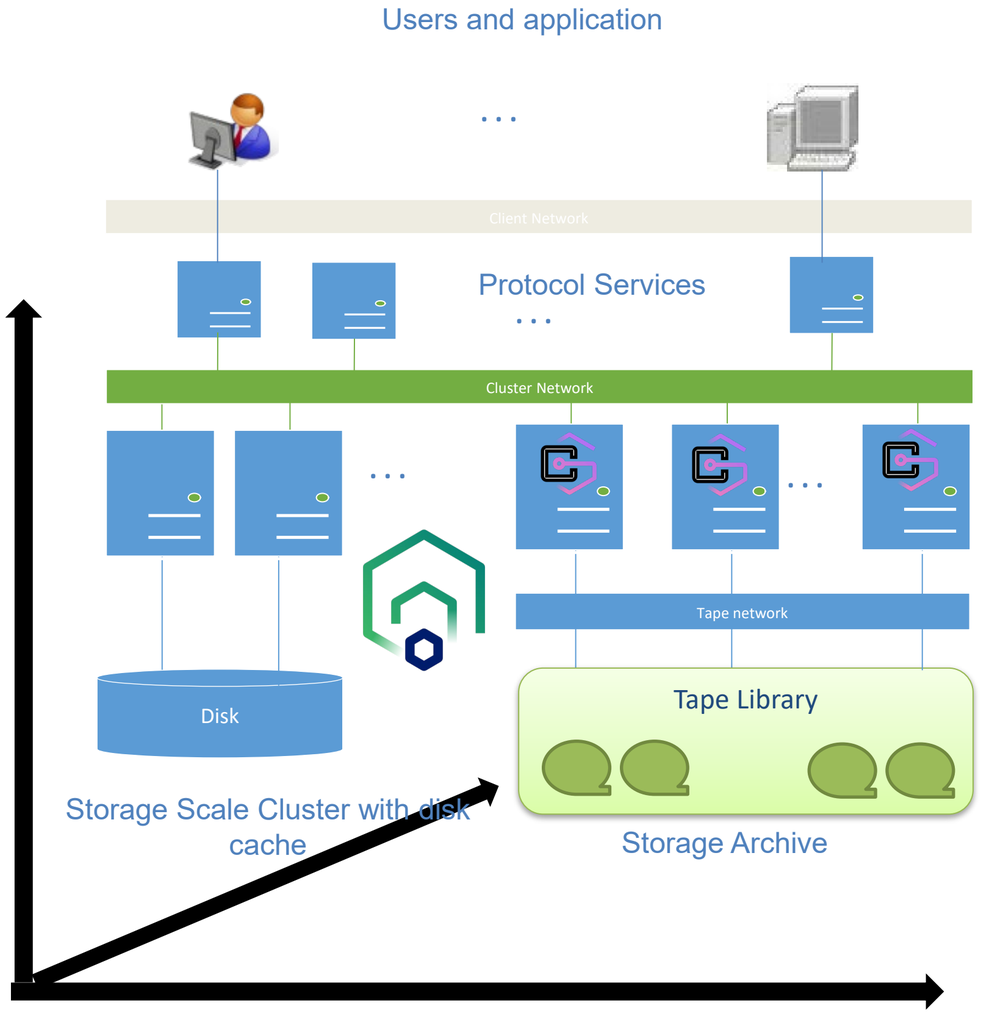
IBM Storage Scale & Archive: Policy-basierende Kostenoptimierung



- **Storage Archive integriet sich in Storage Scale als „Tape Tier“**
  - Storage Scale stellt Global Name Space bereit
  - Storage Arcive migriert Daten zu Tape
  - Transparent für die End-User
- **Powerful Policy Engine**
  - Daten/Files werden von Disk to Tape (pre) migriert
    - Anhand von Policies (oder Filelists)
    - Unterstützt mehrere Kopien
- Daten/Files werden recalled bei Zugriff oder by Command
- **Transparenter Zugriff auf Daten-Tape mittels LTFS**

Storage Archive

- Verfügbar für Red Hat on x86 and Power LE and Storage Scale
- Unterstützt IBM Tape Libraries und LTO & Jaguar Drives
- Scale out Architektur mit Load-balancing über multiple Nodes und Tape Drives:
  - Archive Nodes
  - Tape Drives
  - Kapazität/Anzahl Kassetten



S3 Tape

- S3 ermöglicht einfachen Datentransfer
- Applikationen nutzen vermehrt S3 für Archiving und Air-Gaping der Daten
- Größer werdende Datenmengen erfordern Archiving and Tiering
- Steigende Kosten bei Off-Prem Archiving zwingen zu kostengünstigen On-Prem Lösungen

- Entstehung eines S3 Tape On-Prem Ecosystem
  - Verschiedene Lösungen für verschiedene Anforderungen
    - PoINT Archival Gateway, HPSS, Storage Protect, Storage Scale….Daimondback S3

Diamondback S3 – tape object storage

(Planned 2024)

- IBM Diamondback S3 stellt S3 Object Interface mit cost-efficient Tape Storage zur Verfügung
- Easy-to-use und easy-to-integrate solution
- Support für IBM Diamondback Tape Library
  - Bis zu 27 PB in einem 19” Rack
  - TS4500 und TS4300 in späteren Releases geplant
- Skalierung in späteren Releases geplant

- Kann direkt von bestehenden S3 kompatiblen Software genutzt werden um:
  - Cold Data kostengünstige und ohne Zugriffs/Transferkosten zu speichern
  - Physical Air-Gap für Backup-Daten

User and application using S3

Hosted Prototype:

A storage architect can sign up for a 14-day shared trial on a Diamondback S3 managed by IBM, so they can verify the behavior of S3 for tape **Sign-up Now!**

Levels von Air-GAP

Physical

TAPE

Tape ist das einzigste physical Air-Gap Medium. Es ist offline und kann leicht ausgelagert werden.

Logical

Object Storage

Ermöglicht patentierte SecureSlice Encryption und SEC 17a-4 Compliant WORM Immutable Storage (WORM = write once, read many media protects data from being over-written with malware*) und andere Zugriffsebene.

* true as of today

Immutable Storage & Safeguarded Copy

Ermöglicht WORM (“immutable” oder “append-only” Funktionen) Diese können nicht geändert, encrypted oder gelöscht werden.*

Safeguarded Copy
OR Spectrum ESS

* true as of today

Cloud

Sichern der Daten in die Cloud unterstützt die Trennung der Daten von verschiedenen Netzwerken.

IBM

amazon web services™

Microsoft Azure

Google Cloud

Tape ist das einzig Wahre Air-GAP!

- Tape ist offline
- Tape ist ein sequentielles Medium
  - Nur ein User/Job zur gleichen Zeit
- Daten auf Tape können nicht gelöscht werden
- Daten auf Tape können nicht geändert werden
- Daten auf Tape können nur überschrieben werden
  - Dauert pro Kassette zw. 8-14h

- „IBM Safeguarded Tape“

Ransomware has not attacked tape, because difficult to…
- Discover
- Access

Online disk data is exposed to corruption

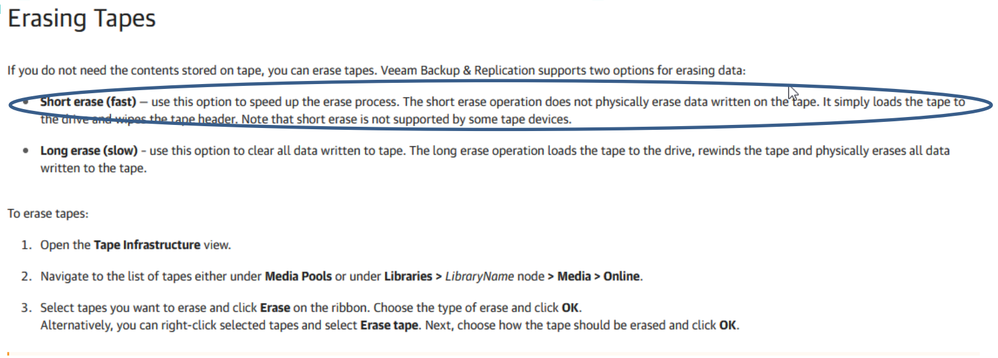
Use offline tape storage for outstanding protection

The Last Line of Defence!

Beispiel: Veeam & Angriff auf Tape

- Client mit Veeam und Tape Sicherung
- Hacker startet um 00:45 Uhr den Befehl „Erase“ Tape
- Admin entdeckt um ca. 09:00 Uhr
  - Backup wurde erfolgreich beendet
  - Ungewöhnliche Aktivitäten auf den Drives
- Analyse zeigte ungewöhnliche Aktivitäten
- Veeam Server wurde gestoppt – ca 10:30 Uhr
- „Nur“ 3 (unwichtige) Tapes wurden gelöscht

- Mittlerweile mehrere Fälle bekannt
  - Alle Tapes wurden gelöscht mit „Short erase“



Erasing Tapes

If you do not need the contents stored on tape, you can erase tapes. Veeam Backup & Replication supports two options for erasing data:

- **Short erase (fast)** – use this option to speed up the erase process. The short erase operation does not physically erase data written on the tape. It simply loads the tape to the drive and wipes the tape header. Note that short erase is not supported by some tape devices.
- **Long erase (slow)** – use this option to clear all data written to tape. The long erase operation loads the tape to the drive, rewinds the tape and physically erases all data written to the tape.

To erase tapes:

1. Open the **Tape Infrastructure** view.
2. Navigate to the list of tapes either under **Media Pools** or under **Libraries >** *LibraryName* node **> Media > Online**.
3. Select tapes you want to erase and click **Erase** on the ribbon. Choose the type of erase and click **OK**.
   Alternatively, you can right-click selected tapes and select **Erase tape**. Next, choose how the tape should be erased and click **OK**.

- Veeam - **Practical tips to prevent ransomware attacks on backup storage**
  - The ransomware threat is real and it’s much more than just a PC problem. Here at Veeam, we see customers and partners encounter ransomware in a number of situations including the data center. One important part of being resilient to ransomware is being able to recover from backups.

2. Have offline storage as part of the Availability strategy

One of the best defenses against propagation of ransomware encryption to the backup storage is to have offline storage. There are a number of offline (and semi-offline) storage options for Veeam, explained below:

Media	Characteristic
Tape	Completely offline when not being written or read from.

Tape / Air-Gap Stufen => Safeguarded Tape

1. Backup allgemein

2. Tape Backup in Tape Library

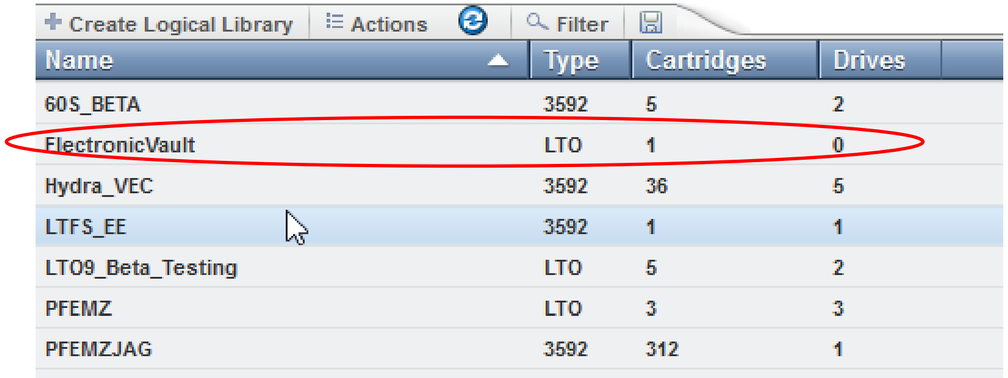
3. Auslagerung von Tapes (Copies/Duplicates) in „Safeguarded Tape“
   - LL ohne Drive (od mit Media Verfication Drive)
   - Checkout LibVol libname libvol Remove=bulk/no
     - Use cli/RestAPI/WebGUI to move cart to „Safeguraded Tape“

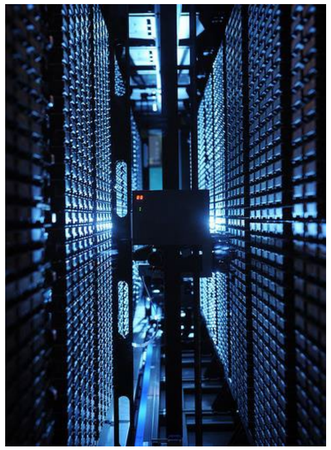
     Script (GitHub): safeguardedtape.py --sourceLogicalLibrary xxx --targetLogicalLibrary
     - Kein physikalisches Movement notwendig
     - Media Verfication möglich
     - **Cartridges sind vom Applikations-Server nicht mehr sichtbar/zugreifbar**
   - Tape Library mit Schlösser sichern

5. Schreibschutz auf den Kassetten in der Library

6. Library FC/SAN offline nehmen

7. Auslagerung der Tapes
   a) IO-Catridges Magazine
   b) in Vault
   - Encryption der Tapes





The Last Line of Defence!

Tips/Empfehlung

- Physikalisches Offline Backup !
- Spectrum Protect DB muss auf ein "Air-Gap" gesichert werden.

- Folgende Punkte sollten kurzfristig überprüft werden sollte:
  - a) Regelmäßige Sicherung der volhist und der Device Config auf ein "Air-Gap" Medium
  - b) Sicherung des disaster recovery manager (DRM) auf ein "Air-Gap" Medium
  - c) Sinnvolles Einsetzen von Colocation um ein schnelles Restore von Tape zu ermöglichen

- Backups monitoren
  - Besonders an Wochenende und besonders an langen Wochenenden (Weihnachten, Ostern, etc.)
  - Tape Mounts/h monitoren -> RestAPI

IBM Tape Produktfamlie

IBM Spectrum Protect / IBM Spectrum Archive

Media

LTO 7
•6 TB
• 300 MB/sec

LTO8
• 12 TB
• 360 MB/sec

LTO9
• 18 TB
• 400 MB/sec

TS1150
• 10 TB
• 350 MB/sec

TS1160
• 20 TB
• 400 MB/sec

TS1170
• 50 TB
• 400 MB/sec

Tape Drives

1 HH

48 HH
16 FH

14xLTO9

128

TS2900
• 9 Slots

TS4300
• 40 – 280 Slots
• bis zu 21 Drives

Diamondback
• 1584 Slots

TS4500
• 100 – 23 170 Slots

TSLM

Tape Libraries

Whats new!

November 2018
- TS1160: 20 TB / 400 MB/sec

Oktober 2019
- TS7770: Power9, Cloud-Tiering
- TS1160: Ethernet-Anschluss

März 2020
- TS7770: Rackmount-Option

August 2021
- TS7770: SSD Cache

September 2021
- **LTO9: 18 TB / 400 MB/sec**

Oktober 2022
- **Diamonbback: 14xLTO9, 1584 Slots**

August 2023
- **TS1170: 50 TB / 400 MB/sec**

Januar 2024
- **TS4300: 640 Slots, 48 Drives**

TS7700
• VTS für zOS

Tape Virtualization & D2D

EOS/EOD

- **TS3500** **->** EOD 31.12.2021 **EOS 31.12.2023**

- LTO4 -> EOS 31.12.2023
- LTO5 -> EOS 31.12.2024
- 3592-E06 (TS1130) -> EOS 31.12.2023!
- 3584-L/Dx3 (TS3500) -> EOD 31.12.2020 EOS 31.12.2023!
- TS3310 -> EOD 31.12.2020 EOS 31.12.2023

WFM

- **LTO7** **-> WFM 31.12.2023 für die TS4500**
  -> WFM 30.06.2024 für die TS4300

- SingelModeFC LTO Drives -> WFM 31.12.2023

Tape Drive History and Roadmap

LTO Generations	LTO-5	LTO-6	LTO-7	LTO-8	LTO-9	LTO10	LTO11
Capacity (Native)	1.5 TB	2.5 TB	6 TB	12.0 TB	18 TB	Up to 36 TB	Up to 72 TB
Other Format Capacities	800 GB (400 GB R/O)	1.5 TB (L5) (800 GB R/O)	2.5 TB (L6) (1.5 TB R/O)	9 TB (M8) 6 TB (L7)	12 TB (L8)		Up to 18 TB (L9)
Native Data Rate	140 MB/s	160 MB/s	300 MB/s	360 MB/s	Up to 400 MB/s	Up to 500 MB/s FC-32Gb for FH, FC-16Gb for HH; 12Gb SAS	Up to 1000 MB/s

2008 2010 2011 2013 2014 2015 2017 2017 2018 2021 2023 LTO10+6-12 months

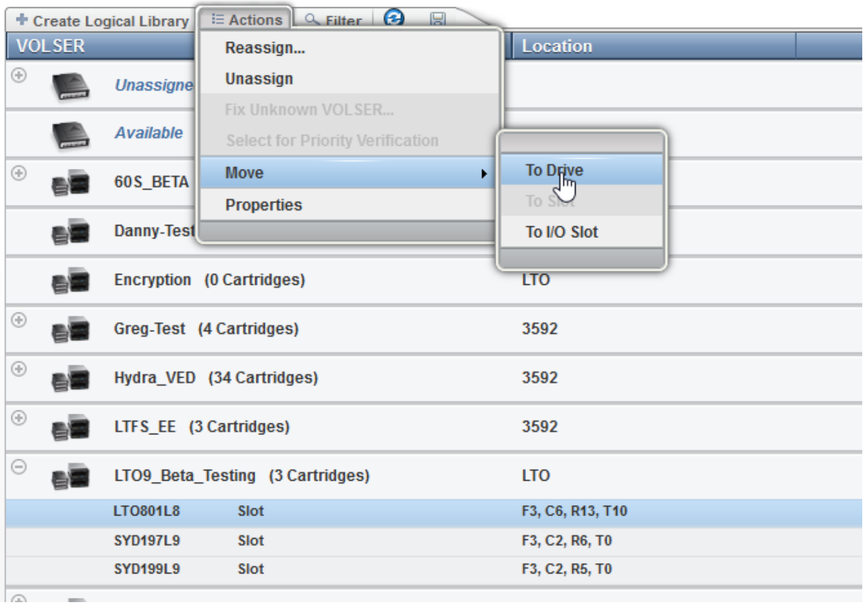
	TS1130	TS1140	TS1150	TS1155	TS1160	TS1170	TS1180
New Format Capacity (Native)	1 TB (JB) 640 GB (JA)	4 TB (JC) 1.6 TB (JB)	10 TB (JD) 7 TB (JC)	15 TB (JD)	20TB (JE) 15 TB (JD) 7 TB (JC)	Up to 50 TB (JF)	Up to 120-80 TB (JG) Up to 50 TB (JF)
Other Format Capacities (Native)	700 GB (JB) 500 GB (JA) 300 GB (JA)	1 TB (JB) 700 GB (JB) (All JA R/O)	4 TB (JC)	7 TB (JC) 4 TB read only (JC)	10 TB (JD) 7 TB (JC) 4 TB (JC)		JE / JF
Native Data Rate	160 MB/s	250 MB/s	360 MB/s	360 MB/s	400 MB/s FC-16	400 MB/s FC-16	Up to 1000 MB/s FC-32, 25 GibE

LTO-9

- LTO 9 Full High Drive – für TS4500
  - 18TB nativ Kapazität
    - 12TB, LTO8 Media read/write
  - 8Gb Fibre Channel und 12Gb SAS
    - Bis zu 400MB/s
- Integration in TS4500 & TS4300
  - FC und SAS Anschluss
  - Bis zu 417PB (uncompressed)
- Verfügbar seit 10. Sept. 2021
- LTO 9 Half-High und TS4300 seit Dezember 2021

LTO-9

- LTO-9 Media Optimization
  - Performed on the first Initialization/load of an LTO-9 media
  - Performed only 1 time at the first load/intialization*
  - Most effective when performed in the final install ecosystem
  - Min=18 min, Avg=18-40 min, Max=1 hours
  - Do not use pre-initialized Media
- With SP use “Label libvol”
- Or use the WebGUI
- Or use TS4500 CLI: moveToDrive <VOLSER> <-f# -c# -r#> / moveFromDrive <-f# -c# -r#>



Media Optimization for IBM tape libraries

- With ITDT-SE 9.6.1 a new scripting parameter librarymediaoptimization was introduced.
- Syntax: *librarymediaoptimization [-start number] [-slots numberofslots] [-drives numberofdrives] [-drivelist identifiers]*
  - Parameters:
    - -start number:

      number should specify the first storage element address which should be used for the media optimization.

      default: first storage element address
    - -slots numberofslots:

      numberofslots specifies the number of cartridges which should be used for the media optimization.

      default: number of storage elements
    - -drives numberofdrives:

      numberofdrives specifies the maximum number of drives used for the optimization.

      default: all drives are used
    - -drivelist identifier(s):

      identifiers is a comma separated list containing the drive element address or the drive serial number

      default: all drives are used

IBM LTO G8, G7 and G6 FH and HH Comparison

Function	IBM TS1170	IBM LTO9 FH	IBM LTO9 HH	IBM TS1160	IBM TS1155	IBM LTO 8 FH	IBM LTO 8 HH	IBM LTO 7 FH	IBM LTO 7 HH	IBM LTO 6 FH	T10000 D
Capacity (Native)	50 TB	18 TB	18 TB	20 TB	15 TB	12 TB	12 TB	6.0 TB	6.0 TB	2.5 TB	8 TB
Compressed Capacity		45 TB	45 TB	60 TB	45 TB	30 TB	30 TB	15.0 TB	15.0 TB	6.25 TB	
Data rate	400 MB/sec	400 MB/sec	300 MB/sec	400 MB/sec	360 Mb/sec	360 MB/s	300 MB/s	300 MB/s	300MB/s	160 MB/s	252 MB/sec
Compression data Rate (2.5:1)		750 MB/sec (SAS) 1000 MB/sec (FC)	720 MB/sec (SAS) 700 MB/sec (FC)	900 MB/sec	750 MB/sec	750 MB/s	750 MB/s	750 MB/s	750 MB/s	400 MB/s	
Max Sustained transfer rate	1600 MB/sec	750 MB/sec (SAS) 1000 MB/sec (FC)	720 MB/sec (SAS) 700 MB/sec (FC)	1200 MB/sec	800 MB/sec	500 MB/s (SAS) 700 MB/s (FC)	500 MB/s (SAS) 700 MB/s (FC)	500 MB/s (SAS) 700 MB/s (FC)	500 MB/s (SAS) 700 MB/s (FC)	500 MB/s (SAS) 700 MB/s (FC)	
Host Interfaces	FC-16Gb SAS	FC 8 Gb SW/LW SAS	FC 8 Gb SW/LW SAS	FC-16Gb SAS Ethernet	FC-8Gb Both dual ports	FC-8Gb SW/LW dual ports	SAS-6Gb FC-8Gb dual ports	FC-8Gb Both dual ports	SAS-6Gb FC-8Gb dual ports	SAS-6Gb FC-8Gb dual ports	FC-16 Gb
Speed Matching		177-400 MB/sec	177-284 MB/sec	122 – 400 MB/s	110 - 360 MB/s	110 - 360 MB/s	100-300MB/s	100-300 MB/s	100-300MB/s	40-160 MB/s	120/250 MB/s
Buffer	2 GB	1 GB	1 GB	2 GB	2 GB	1 GB	1 GB	1 GB	1 GB	1 GB	2 GB
Media to Load / Unload	12 sec / 31 sec	17 sec / 30-165 sec	16 sec / 56-186 sec	12 sec / 31 sec	12 sec / 22 sec	15 sec / 24 sec	15 sec / 24 sec	15 sec / 20 sec	15 s / 20 s	12 s / 17 s	13 s / 23 s
Rewind speed		12 m/sec		18 m/s	12,4 m/s	10 m/s	9 m/s	10 m/s	9 m/s	10 m/s	10-13 m/s
Locate speed		12 m/sec		18 m/s	12,4 m/s	10 m/s	9 m/s	10 m/s	9 m/s	10 m/s	10-13 m/s
Average file access	45 sec	45 sec	65 sec	45 sec	45 sec	59 s	60 s	56 s	60 s	62 s	50 sec
Media length		1035 m	1035 m	1163 m	1075m	960m	960m	960m	960m	846m	
Tracks	18 944	9 856	9 856	8 704	7 680						
BER		10^19	10^19	10^20	10^19	10^19		10^18			

IBM TS1170 Tape Drive

- Größte Kapazität und höchste Performance
- 50 TB native Kapazität – JF-Kassette (only)
  - Bis zu 150 TB pro Kassette bei 3:1 Kompression
  - Bis zu 50 PB pro TS4500 Frame

- 400 MB/sec Durchsatz
  - Bis zu 900 MB/sec bei 3:1 Kompression

- Encryption, WORM, LTFS
- 16 Gibt Dual-ported FC, 12 Gbit SAS
- Upgrademöglichkeiten von TS1160

- Verfügbar seit 25. August 2023

2.5X

Greater Capacity

55 PB/m²

TS4300 Tape Library

Modular Tape Library

Bis zu 11,5 PB nativ Kapazität (LTO9)

1 Base Unit + bis zu 15 Expansion Module

40 bis zu 640 LTO Slots

5 I/O Slots pro Modul

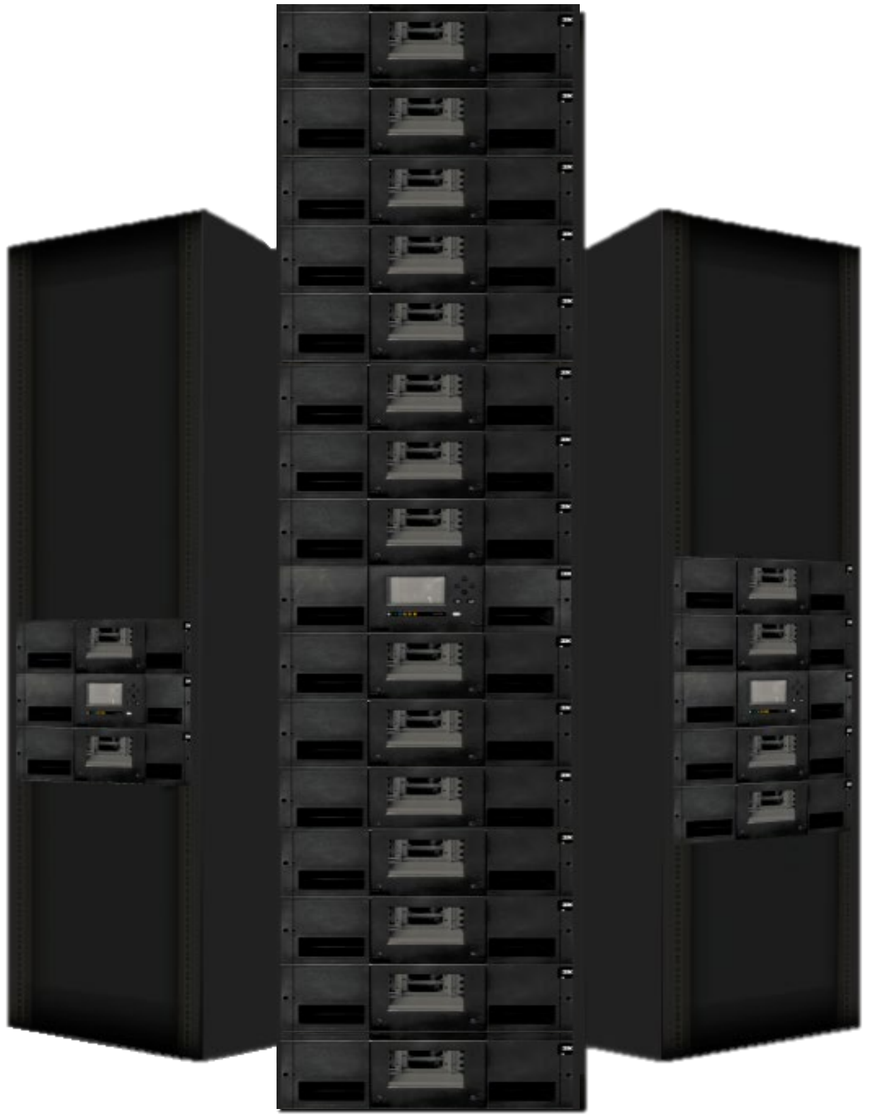
Bis zu 48 LTO Tape Drives

pro Modul 3 HH LTO Drives od 1 FH Drive

LTO ~~6, 7~~, 8 oder 9 Tape Drives

Dual-ported 8 Gbit FC

Dual-ported 6 Gbit SAS



TS4300 Skalierung

Base Module - L3A

- 720 TB nativ Kapazität (LTO9)
- 3 HH LTO Ultrium 9, 8, 7 oder 6 Tape Drives
- oder 1 FH LTO Ultrium 9, 8, 7 or 6 FH Tape Drives und 1 HH LTO Ultrium 9, 8, 7 or 6 Tape Drives
- 5 I/O Slots
- Optional redundant power supply
- Desktop oder Rack Mount
  - Rack Mount optional für 3U Base Module
  - Rack Mount required für 6U to 21U Konfigurationen
- Nur „neue“ (ab 23.01.2024) L3A können bis zu 15 Expansion supporten

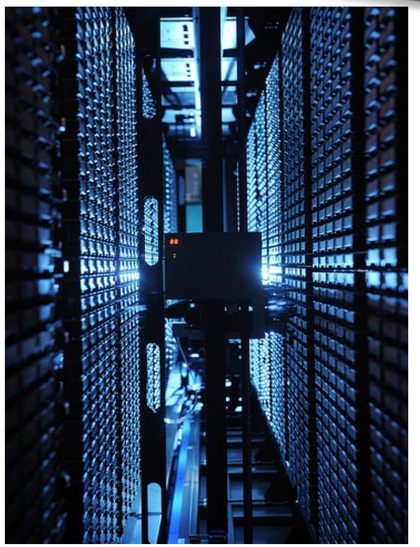
Expansion Unit - E3A

- 720 TB nativ Kapazität (LTO9)
- 3 HH LTO Ultrium 9, 8, 7 oder 6 Tape Drives
- oder 1 FH LTO Ultrium 9, 8, 7 or 6 FH Tape Drives und 1 HH LTO Ultrium 9, 8, 7 or 6 Tape Drives
- Option: 5 I/O Slots
- Optional: Power Supply

IBM TS4500 (3584) Tape Library

- **Enterprise Tape Library – Weiterentwicklung der TS3500 – Generation 4**
- **Modulares skalierbares Design**
  - Von 100 bis 23 170 Kassetten, 1 – 18 Frames
  - Easy Expantion (add Frame <1h)
- **Hochverfügbarkeits / Enterprise Features**
  - Dual Gripper (Standard), Redundante Power Versorgung (Standard),
  - Redundanten Library Kontroller und Kontrollpfade
  - **Dual Accessor – HA (optional) – Neu seit Mai 2016**
- **Beste Performance**
  - Schnellste Robotik+unique Gripper-Design; Drives verteilt (nicht centralized)
  - Floating HomeCell und Cartridge Caching
- **Laufwerke**
  - LTO 5-9 und TS11x0: Dual Ported 8/16 Gbit FC, SAS und Ethernet
- **Higher Density mit neuen HD-Frames mit bis zu 16 Tape Drives**
  - Bis zu 774 Slots und bis zu 12 Tape Drives im 1. Frame
  - Bis zu 970 Slots und bis zu 16 Drives in den Erweiterungs-Frames
- **Ease-of-Use**
  - Moderne GUI und schneller Controller mit mehr Speicher
- **Neues, verbessertes „Integrated Management“**
- **„Automatic Media Verfication“**
- **LTFS Library Edition, Encryption, Safeguarded Tape**

https://youtu.be/IRGz-tNBeXM



https://youtu.be/IRGz-tNBeXM

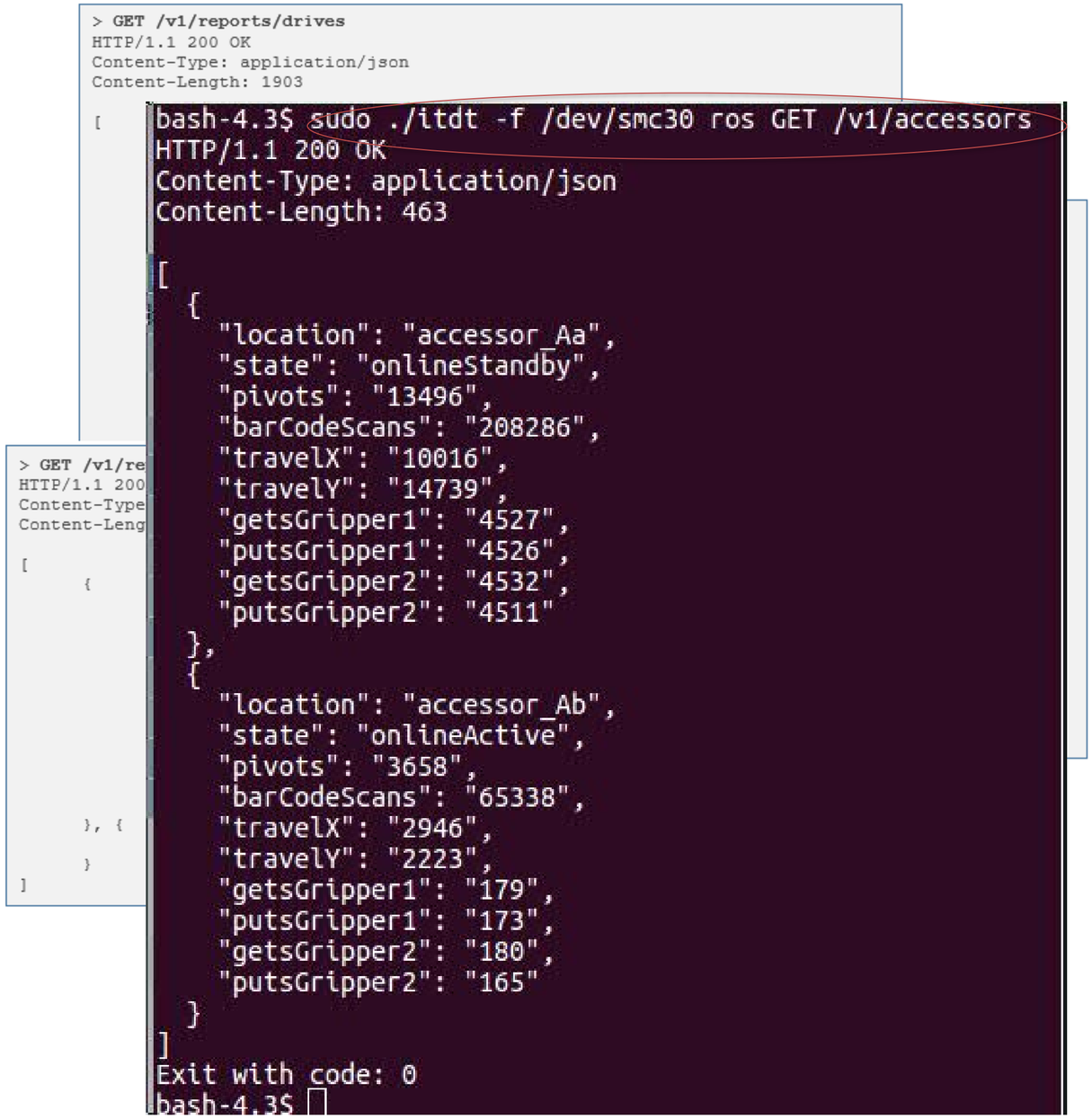
TS4500 REST API

JSON resources include accessors, cartridges, drives, node cards, events, tasks, and hourly reports for drive and library health, performance, utilization, and environmentals.

New monitoring option - designed to provide detailed and actionable states for all resources in the library.

Innovative REST over SCSI (RoS) approach supported via ITDT v9.4

REST over Ethernet available since Nov. 2024



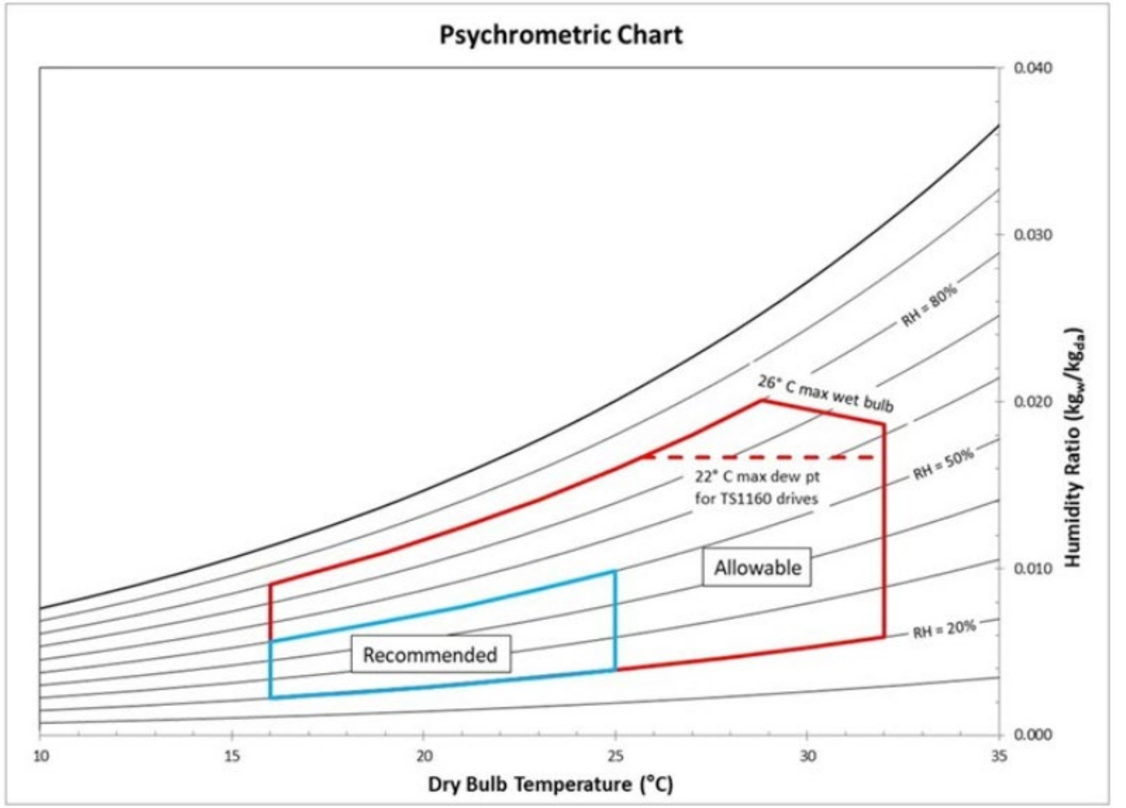
Tape - **Environmental specifications**

- https://www.ibm.com/docs/en/ts4500-tape-library/1.8.4?topic=planning-environmental-specifications

Table 1. Equipment environment specifications for the tape library

Product operation (equipment is powered on)								
Dry-bulb temperature			Humidity range, non-condensing			Maximum wet-bulb temperature[5]	Maximum dew point temperature[6]	Maximum elevation
Allowable[2]	Recommended 3	Maximum rate of change	Allowable	Recommended	Maximum rate of change			
16 to 32°C (60 to 90°F)	16 to 25°C (60 to 77°F)	5°C/hour (9°F/hour)	20% to 80% RH	20% to 50% RH	5% RH/hour[4] with no condensation	26°C (79°F)	22°C (72°F)	3050 m (10,000 fee

Figure 1. Psychrometric chart showing recommended and allowable operating environments for the tap



Energieeffizienzgesetz:

https://netzpolitik.org/2022/energieeffizienzgesetz-wie-rechenzentren-klimaneutral-werden-sollen/

„…Bis 2027 sollen Rechenzentren in Deutschland klimaneutral werden...

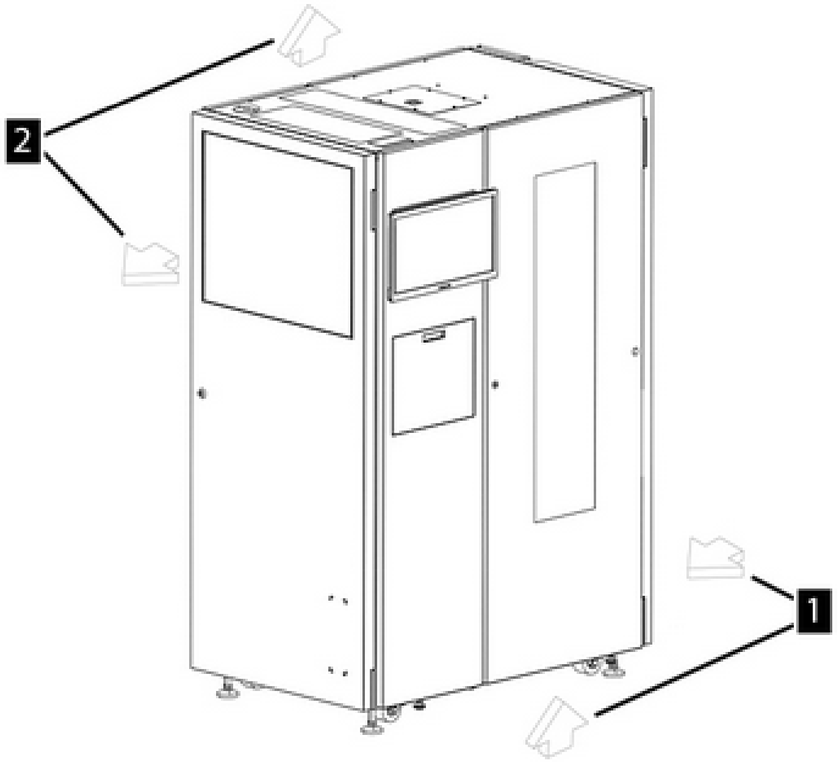
Ab 2028 dürfen Betreiber*innen **Rechenzentren** nicht mehr auf weniger als **27 Grad herunterkühlen**. Für Neubauten gilt das sogar schon ab 2024“

Air Flow

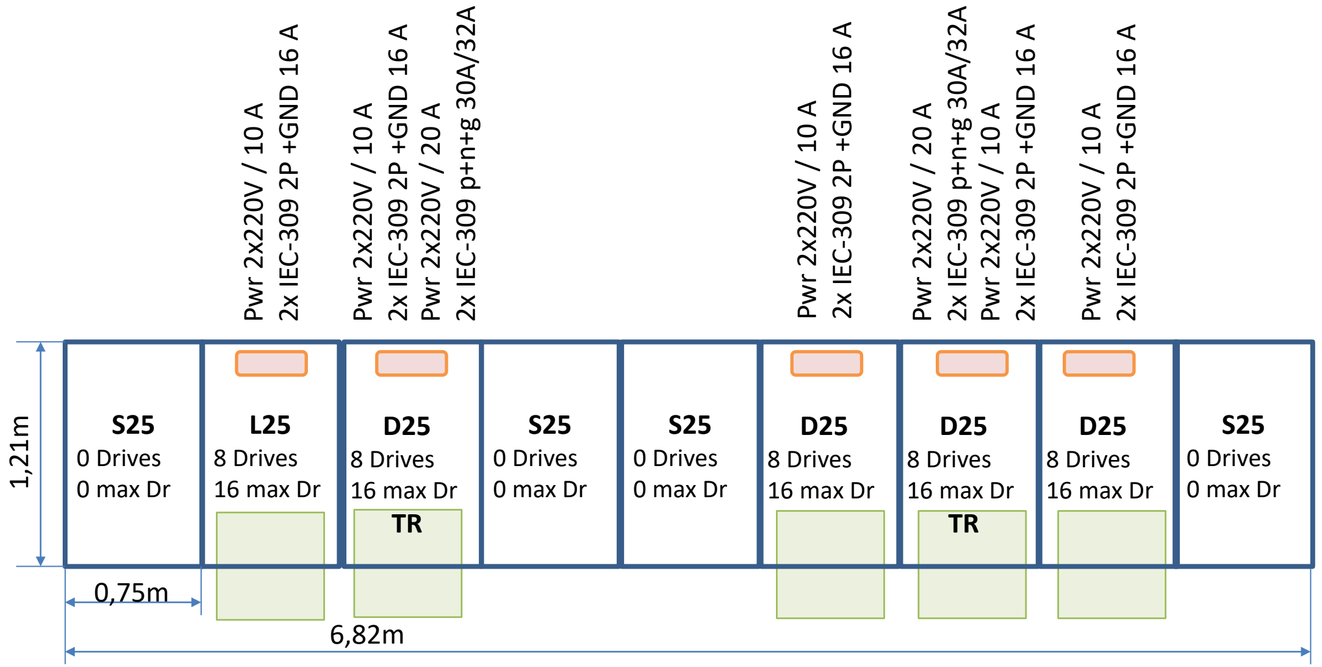
- Lüftungsplatten vor/unter den L-/D-Frames

Air Flow - Front Isometric

Air Flow - Rear Isometric view



Beispiel -



Bodenplattenausschnitt

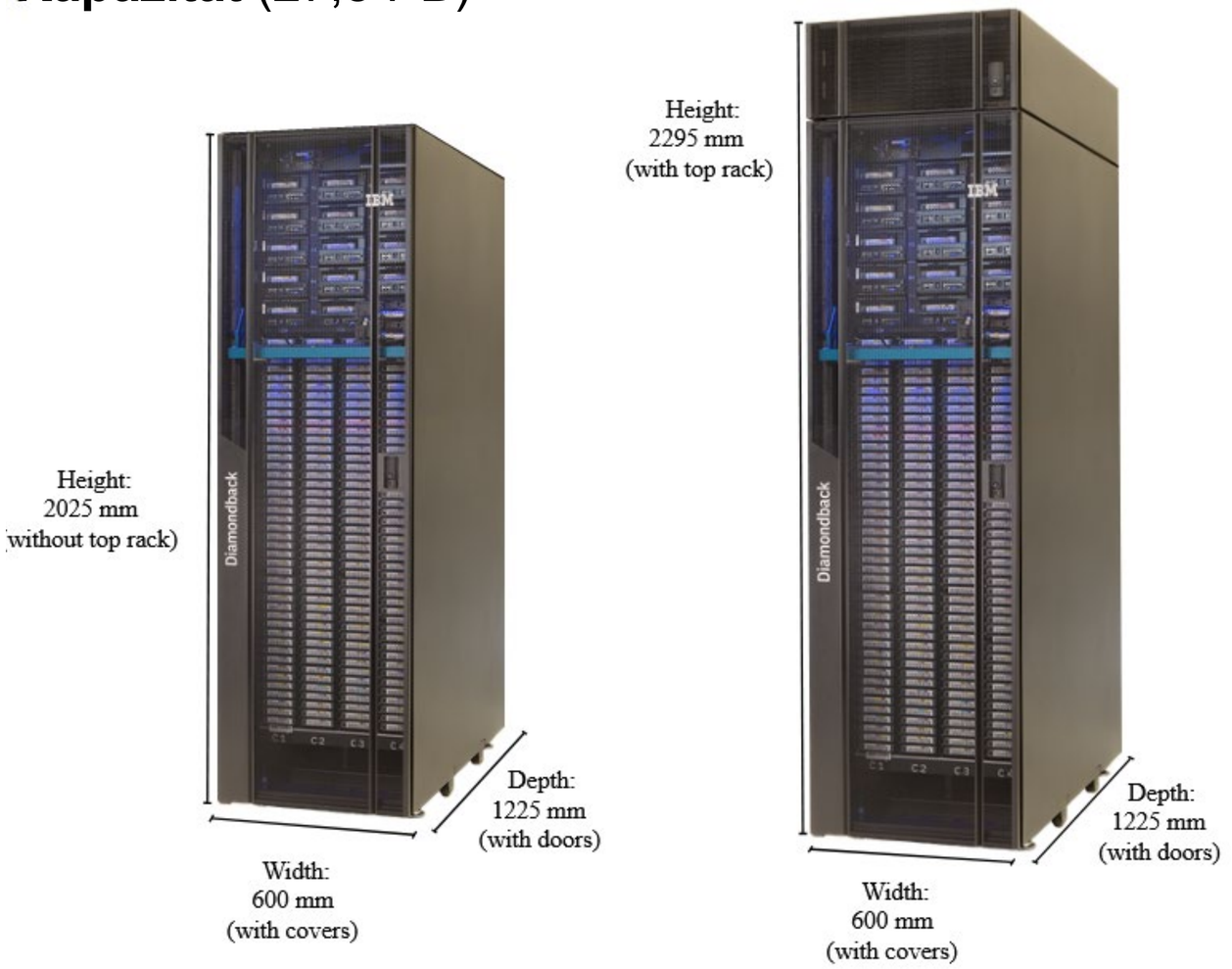
Bodenplatten mit Luftaustritt (Lüftung)

- https://www.ibm.com/docs/en/ts4500-tape-library/1.8.4?topic=specifications-frame-models-l25-d25
- https://www.ibm.com/docs/en/ts4500-tape-library/1.8.4?topic=planning-clearance-specifications-library


Announcement
25. April 2023
General Availability
28. April 2023

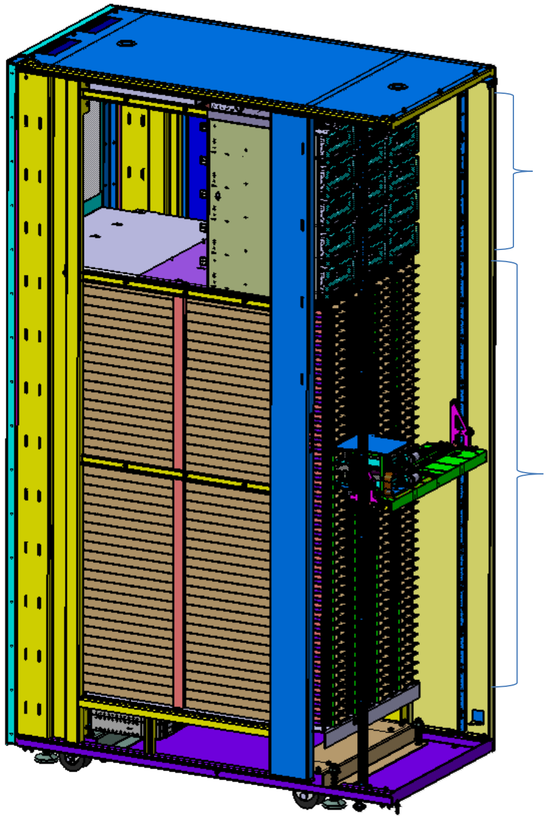
IBM Diamondback

- **Ultra Density –** bis zu 1548 LTO9 Slots ~ **70 PB Kapazität** (27,8 PB)
  - Pre-Loaded Option
  - 800 Slots od. FullCapacity
- Bis zu 14 LTO9 Drives ~20 TB/h Durchsatz
  - SAS od FC/SAN
- 19” Rack
- TS4500 Funktionen
  - CPF/DPF
  - Partitioning & Safeguarded Tape
  - Encryption / WORM
  - REST API
  - LDAP
  - Spectrum Archive (LTFS)
- Wartungskonzept
  - 1/3/5 Jahre Warranty
  - Expert Care: Basic / Premium



Diamondback

- Design: reduzierte Komplexität
  - Verringert Kosten
  - Erhöht Verfügbarkeit
- Design Merkmale:
  - Keine Expansion Frames
    - Verringert Frame & Robotics Maintenance
    - Vereinfacht interne Library Kommunikation und Elektronik
  - Keine Slots an der Tür
  - Kein „Pivot“ am Gripper
    - Verringert Robotics Maintenance
  - Kein Panel
  - Kein I/O Station an der Tür
  - Keine Dual Robotics
  - Verringerte Firmware Komplexität
    - Große Synergie mit TS4500

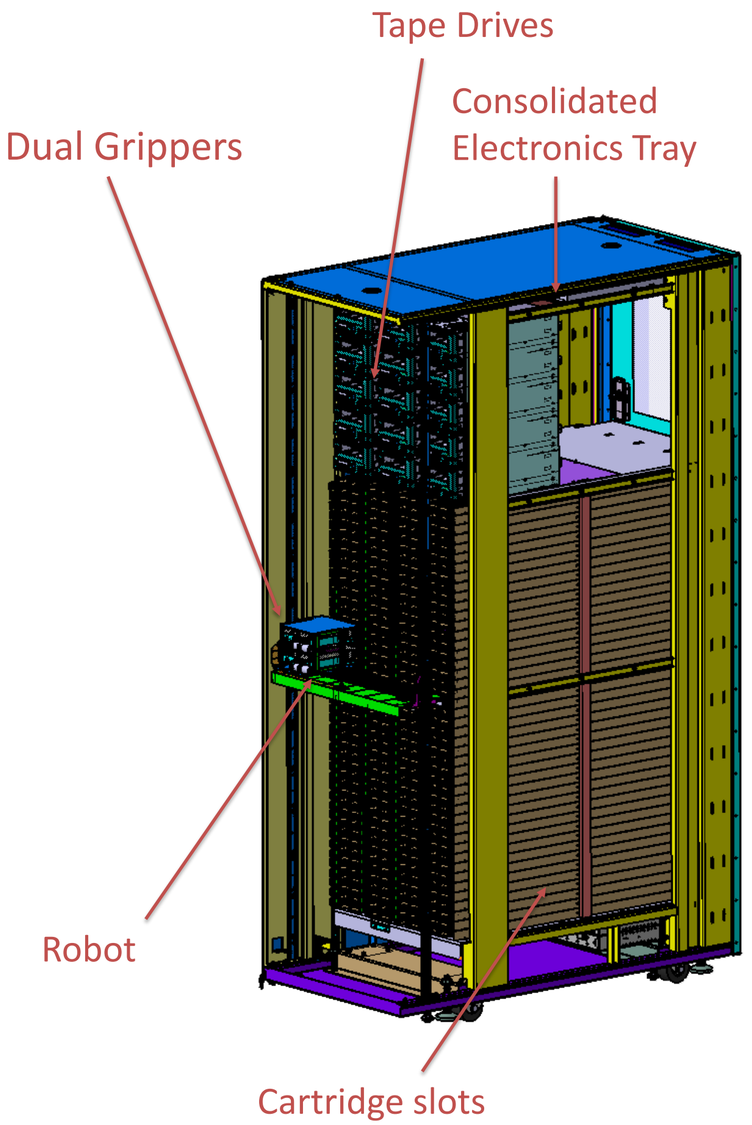


14 LTO drive slots
1 Cartridge Service Magazine
3 Columns, 5 Rows

1584 LTO cartridge slots

9 Tiers for LTO

4 Columns
44 Rows for LTO



Cartridge Service Magazine

- Magazine für bis zu 10 LTO Cartridges
- Nutzt ein Tape Drive Slot
- LED Beleuchtung im Drive Schacht
- Geeignet zum Austauschen von Cleaning und Daten Cartridges
- Import/Export Operations…
  …gesichert durch verschließbar Tür an der Rückwand
  …im laufenden Betrieb möglich
  …kein Eingriff im Cartridges/Storage Slots nötig

Specifications Compare

Feature	TS4500	Diamondback	TS4300
Base Frames	1	1	1
Expansion Frames	Up to 17	Not Applicable	Up to 15
Tape Drives	Up to 128	Up to 14	Up to 48
Data Rate per hour	Up to 184.3 TB	Up to 20.2 TB	Up to 51,8 TB
Supported Tape Drives	TS1140, TS1150, TS1155, TS1160 LTO-5, LTO-6, LTO-7, LTO-8, LTO-9	LTO-9	LTO-6, LTO-7, LTO-8, LTO-9
Supported Media	All drive supported Media		
Storage Slot Configuration	Up to 23,170	Up to 1548*	640
Native Capacity	Up to 417 PB	Up to 27.8 PB*	11,5 PB
I/O Stations	2 min, 8 Max	1	1 min, 16 Max
I/O Slots	Up to 144	10**	Up to 80
High Availability Robots	2	1	1
Service and Support	IBM Service Support	Self-service CRU or IBM Service Support	Self-service CRU or IBM Service Support
Distributed Systems Attach	AIX®, MS Windows®, Linux®, Unix®		

*TS1160 Industry use cases at 3:1
**LTO Compression 2.5:1

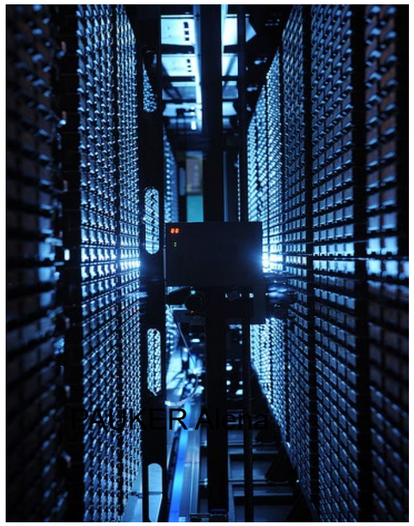
*Active storage slots are determined by recommended reserve slots for system operations
**Intended for diagnostic, failure and expired cartridge I/O only

Veranstaltungen

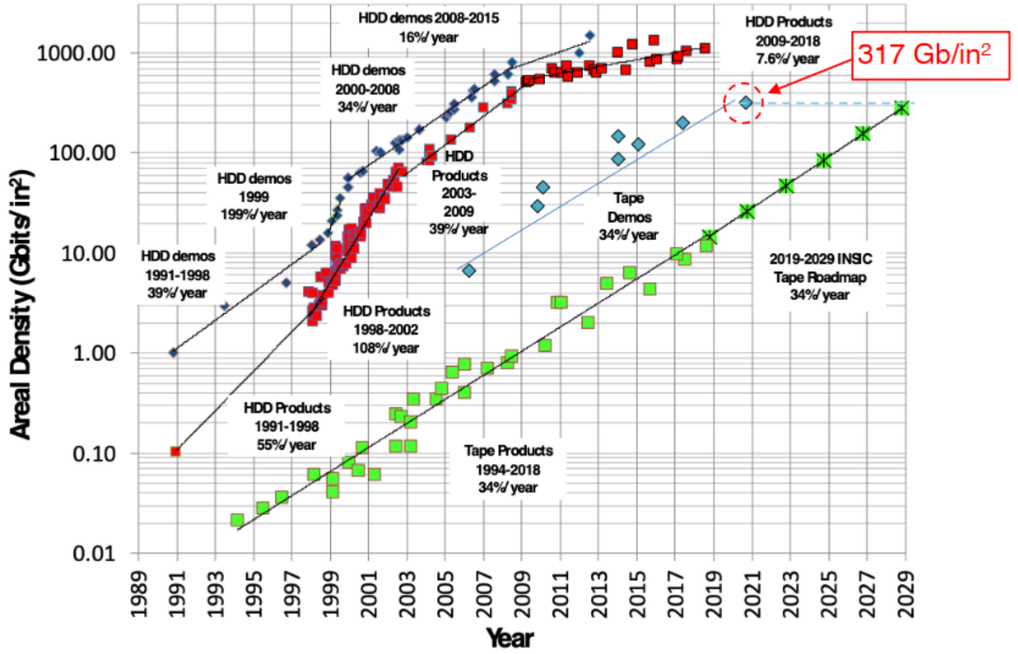
- GSE Arbeitskreis Storage – 6.- 8. Mai 2024 – Karlsruhe bei Atruvia
- Future of Tape (FoT) Workshop – IBM Rüschlikon – 28./29. Mai 2024
  - Einladung „auf Request“ – Mail an: weingand@de.ibm.com
- **17th GSE ISP Symposium September 25, 2024 - September 27, 2024**
  - https://www.gse.org/events/17th-gse-isp-symposium-2024/

Tape

- Exponentielles Datenwachstum, aber nur noch geringe Steigerungsraten bei HDD
  - < 10% CGR
- Tape: Kapazitätswachstum 30-40% pro Jahr
  - **Heute 50 TB … in 10 Jahren über 500 TB**
- Sehr lange Lebensdauer von über 30 Jahren
- Zuverlässigkeit
  - Bit-Error-Rate wesentlich besser als HDD
  - Tape ist offline => Tape Air-Gap
- Tape ist sehr schnell
  - 1,4 TB/h –mit 20 Drives bis zu ~700 TB/d
- Energieeffizient und schützt das Klima
  - Kein Energie notwendig nachdem die Daten geschrieben wurden
- Hohe Speicherdichte, spart Stellfläche - 20 PB/m²
- Nur 1/5 der TCO von Disk – wird sich bis auf 38x in 2030 verbessern



317 Gb/in2 demonstrates the sustainability of the INSIC Tape Roadmap
34% CAGR in Areal Density for the next decade



The main net advantage of tape is low cost !

Online disk data is exposed to corruption

Use offline tape storage for outstanding protection

Tape is the Last Line of Defense!

Thank You!

May The Tape Be With You

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