



# The Future of Tape!

Why you should use Tape even more!

## Tape Storage Solutions

**TAPE \$AVES: COST • ENERGY • DATA • COMPANY**

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<http://www.linkedin.com/pub/josef-weingand/2/788/300>

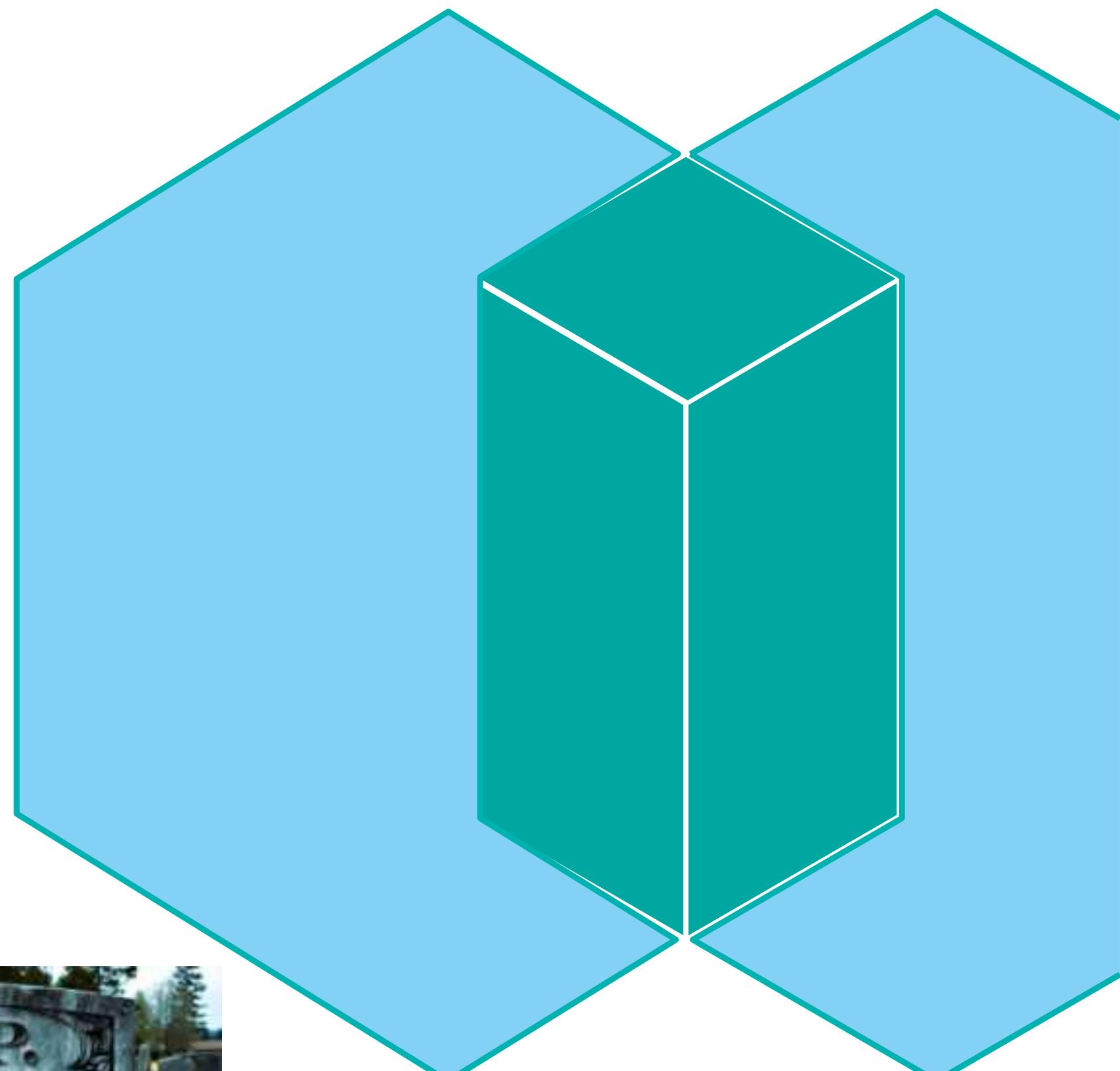
<http://www.facebook.com/josef.weingand>

<https://www.facebook.com/Sepp4Tape/>

<http://de.slideshare.net/JosefWeingand>

[https://www.xing.com/profile/Josef\\_Weingand](https://www.xing.com/profile/Josef_Weingand)

<https://www.xing.com/net/ibmdataprotection>



# Why Tape?

- Cost
- Performance (single stream, scalability)
- Security
- Capacity / Floor space
- Roadmap

# Usage of Tape?

- Backup / Restore
  - Last Line of Defense (Security)
  - In combination with Disk/Flash
    - for long-term, cold archive, etc. (Cost/Roadmap)
    - Protect disk backup – „Last Line of Defense“
  - Backup of huge data with high performance and many parallel streams
- Archive
  - „Content-Rich“ data
    - Big Data / Much Data
    - Science / engineering data
    - Video, movie, broadcast, surveillance, automotive
  - Cold and Cloud data
    - Unstructured Data / NAS (Never Access Storage)

**Microsoft Azure will use Tape!!!**

# Why Backup and why Tape for Backup

For many organizations, backup is either breaking or broken

**42% of small companies**

have experienced data loss. **32%** lost files forever.

## Companies Look to an Old Technology to Protect Against New Threats

Companies are once again storing data on tape, just in case

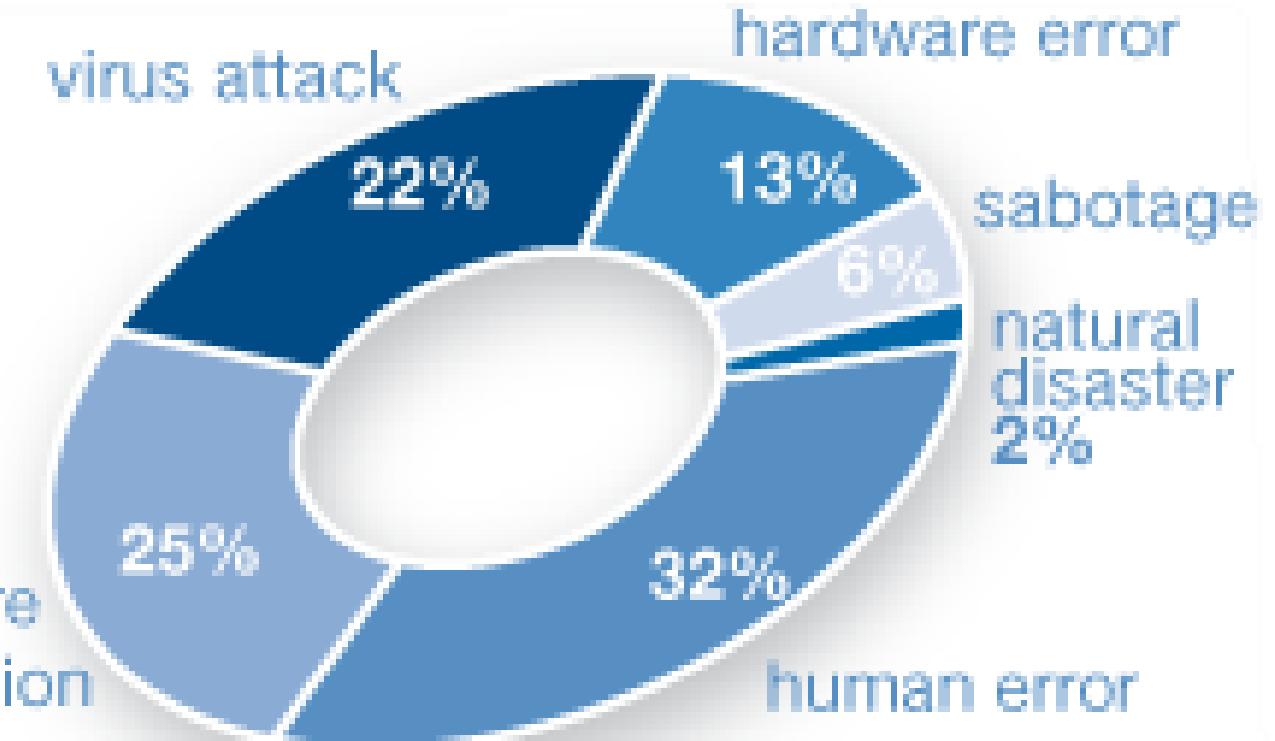
<https://www.wsj.com/articles/companies-look-to-an-old-technology-to-protect-against-new-threats-1505700180>

## Halten Sie Ihre Backup-Daten offline, um gegen Ransomware geschützt zu sein

<http://www.searchstorage.de/tipp/Halten-Sie-Ihre-Backup-Daten-offline-um-gegen-Ransomware-geschuetzt-zu-sein>

Bei den wenigen konkreten Ransomware-Angriffen, die publik werden, zeigt sich: nur kalte Datensicherung schützt vor den Folgen eines erfolgten Angriffs. Nur, wenn Daten so gesichert wurden, dass sie systembedingt vor der Verschlüsselung oder dem Löschen geschützt sind, ist die Wiederherstellung und damit die Verhinderung einer Lösegeldzahlung möglich.

[http://www.storage-insider.de/ein-backup-ist-kein-archiv-a-595016/?cmp=sm-fb-swyn&utm\\_source=facebook&utm\\_medium=sm&utm\\_campaign=fac ebook-swyn](http://www.storage-insider.de/ein-backup-ist-kein-archiv-a-595016/?cmp=sm-fb-swyn&utm_source=facebook&utm_medium=sm&utm_campaign=fac ebook-swyn)



Source of data: *The Cost of Data Loss* by David M Smith

ING-Bank: Serverausfall durch Probealarm

heise online 12.09.2016 10:55 Uhr – Lutz Labs

vorlesen



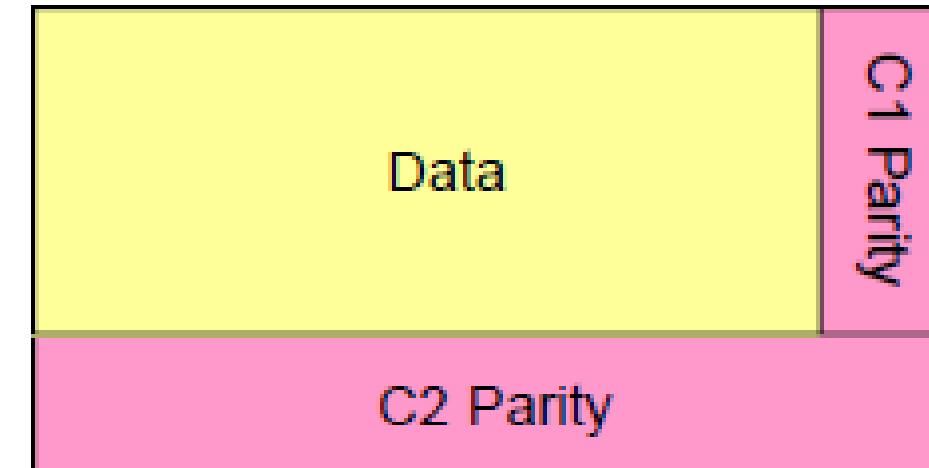
Ein Rechenzentrum der rumänischen Niederlassung der ING-Bank ist am Wochenende durch den Test der Feuerlöschanlage ausgefallen. Grund war wohl der laute Knall der Gaspatronen.

Das Schlimmste, was einer Bank heutzutage passieren kann, ist ein Serverausfall. Daher sind die Rechenzentren besonders geschützt. Ein Feuer wird etwa nicht per Wasser oder Schaum gelöscht, sondern meistens mit Stickstoff – so wird das Feuer ersticken, ohne die wertvolle Hardware zu beschädigen.

Der Test einer solchen Löschanlage aber führte in einem rumänischen Rechenzentrum der ING-Bank zu einem Ausfall diverser Festplatten. Nach [Angaben der Bank](#) waren Kartentransaktionen, Transaktionen am Geldautomaten und Internet-Banking betroffen sowie die Website [www.ing.ro](http://www.ing.ro) am Samstag zwischen 13 und 23 Uhr nicht verfügbar.

# Data Security / Protection with Tape

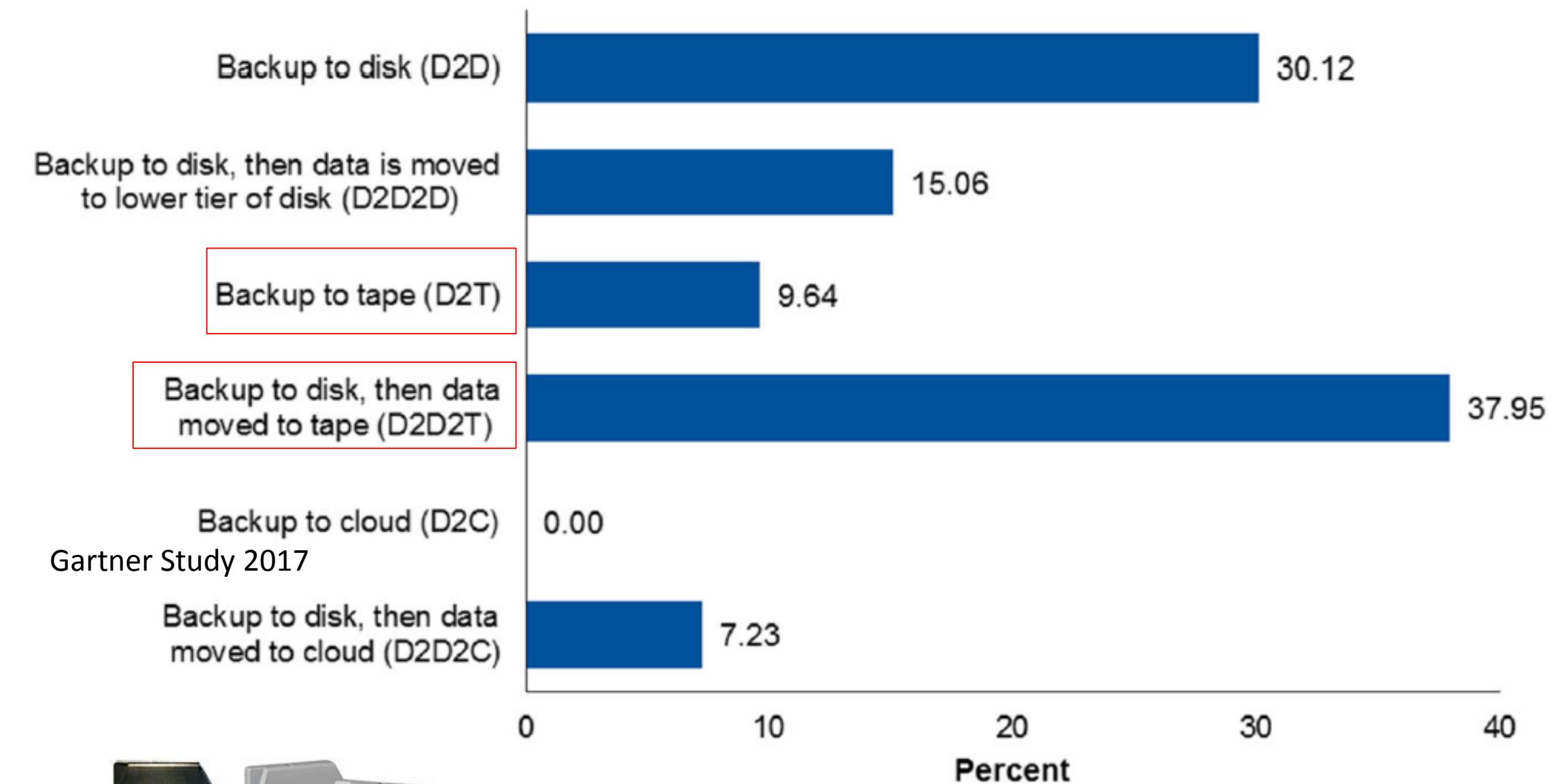
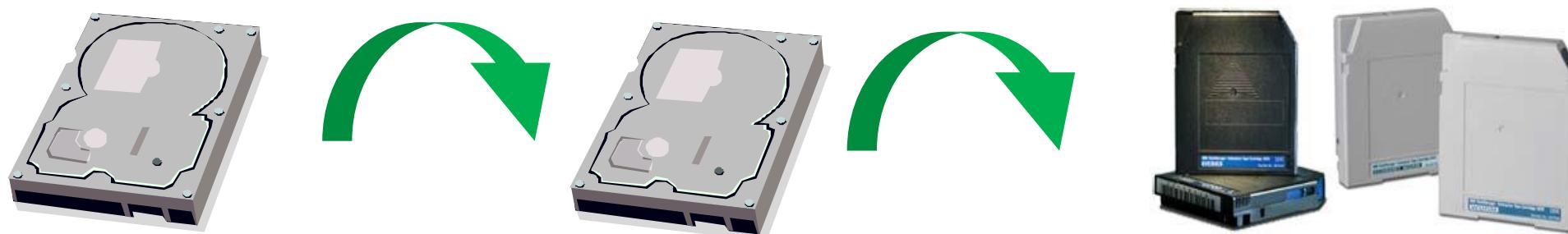
- Tape offers:
  - Read-After-Write Verification
  - 2 independent ECC (=Raid6)
    - IBM Jaguar Drives can recover a Media failure of about 11 mm
  - Lifetime Warranty for IBM Tape Media
    - Returns > 0,02% (10 000 Cartridges -> 2 broken)
  - **In addition Tape is a “offline” Media!**
    - No Virus, no software failure, no sabotage, no human Errors,... “Tape is last line of defense!”
- SAS HDDs Bit Error Rate  $10^{16}$ 
  - NL SAS  $10^{15}$ 
    - <http://www.enterprisestorageforum.com/storage-technology/sas-vs.-sata-1.html>
- With NL SAS you will get a Data loss after 110 TB!!!!
- Example: 50 TB/daily; 2,5 PB capacity
  - Raid5 with 8 TB (8+1) => 470 HDDs -> 0,12 TB per HDDs / daily ->
  - Failure=Data Loss after ~950 days = 2,5 years
  - With Tape: Data loss after 62 years!



Device	Hard Error Rate in bits	Equivalent in Bytes	Equivalent in PB's
SATA Consumer	$10E14$	$1.25E+13$	0.01
SATA/SAS Nearline Enterprise	$10E15$	$1.25E+14$	0.11
Enterprise SAS/FC	$10E16$	$1.25E+15$	1.11
LTO and some Enterprise SAS SSD's	$10E17$	$1.25E+16$	11.10
Enterprise Tape	$10E19$	$1.25E+18$	1110.22

# Gartner Study 2017

- The use of tape in backup remains far greater than what many perceive; with even higher usage in Europe, compared with North America
- Disk-to-tape remains the predominant methodology: **47.59 %** of the respondents use D2T or D2D2T
- **..., and Gartner expects this backup methodology to remain highly deployed through 2022.**



**“The most-frequent deployment with tape is D2D2T, and Gartner expects this backup methodology to remain highly deployed in the foreseeable future, as organizations try to obtain maximum life out of their installed tape technology.”**

# Tape Saves the Day

Ben Treynor, VP Engineering and Site Reliability Czar for Google Gmail, used the official Gmail blog to explain the situation and provided a powerful endorsement for off-line removable tape storage.

“I know what some of you are thinking: how could this happen if we have multiple copies of your data, in multiple data centers...well, in some rare instances software bugs can affect several copies of the data. That’s what happened here. Some copies of mail were deleted...To protect your information from these unusual bugs, we also back it up to tape. Since the tapes are offline, they’re protected from such software bugs”.

From Google blog at <http://gmailblog.blogspot.com/2011/02/gmailback-soon-for-everyone.html>



*Online disk data is exposed to corruption*

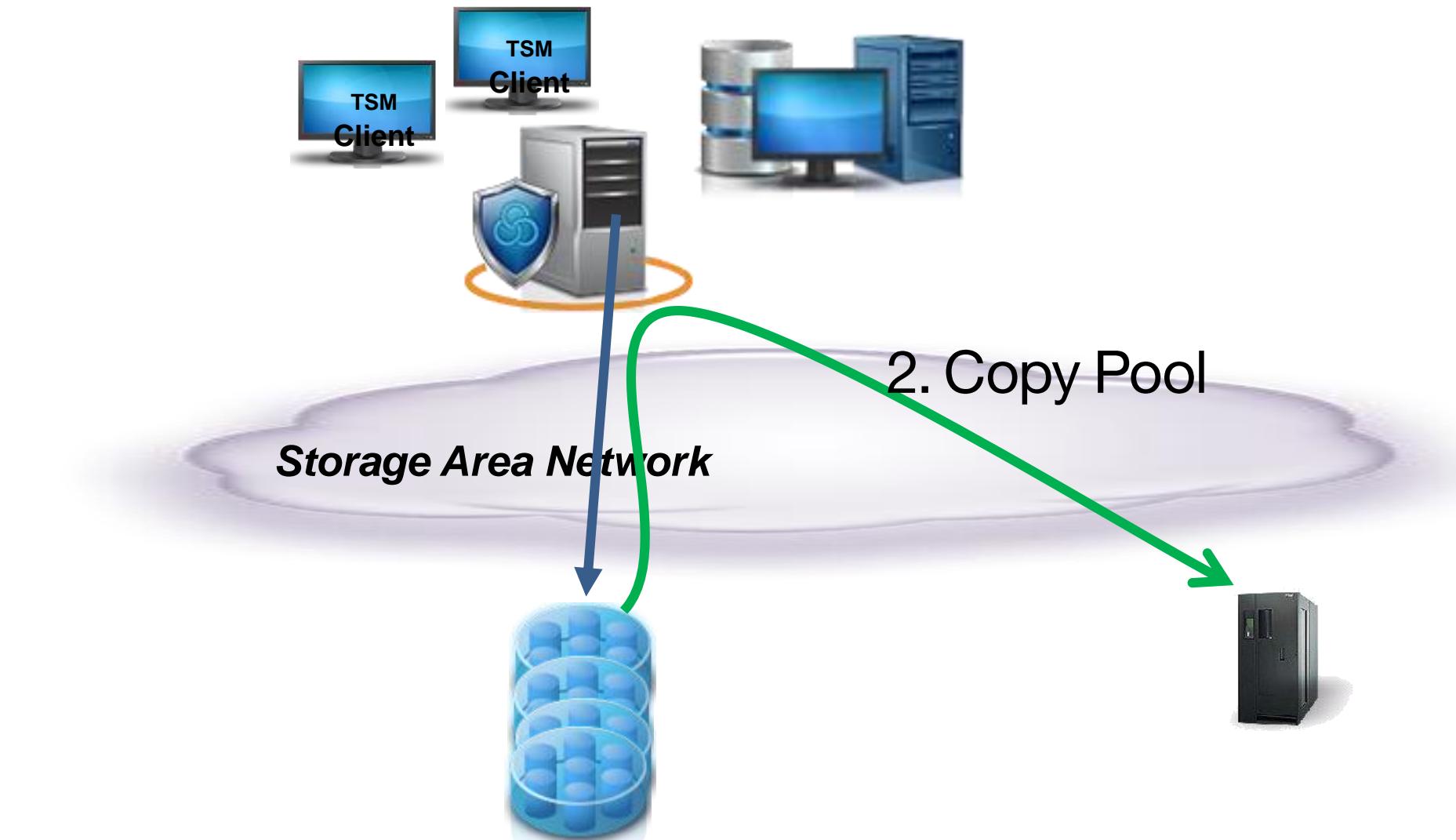
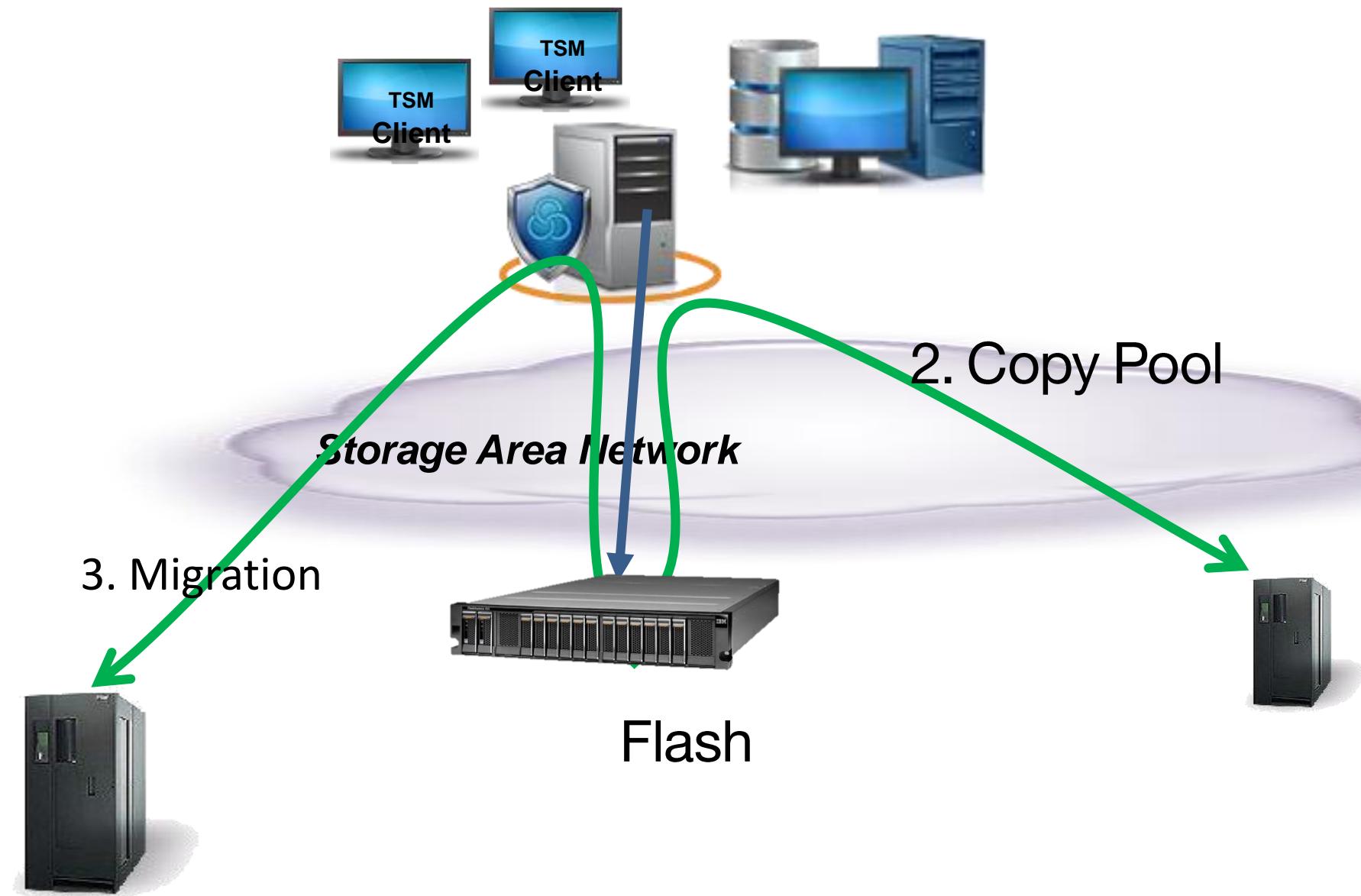


*Use offline tape storage for outstanding protection*

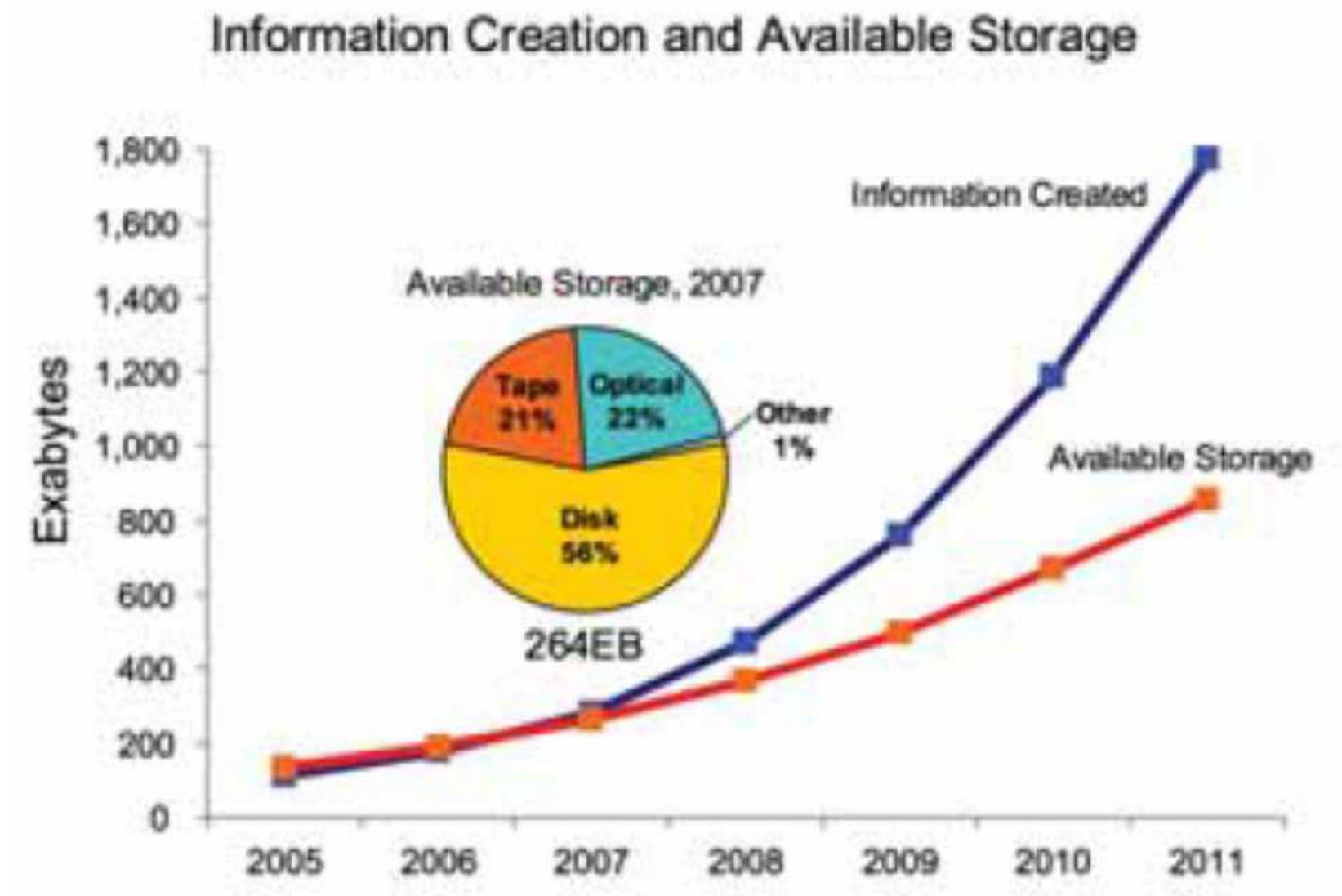
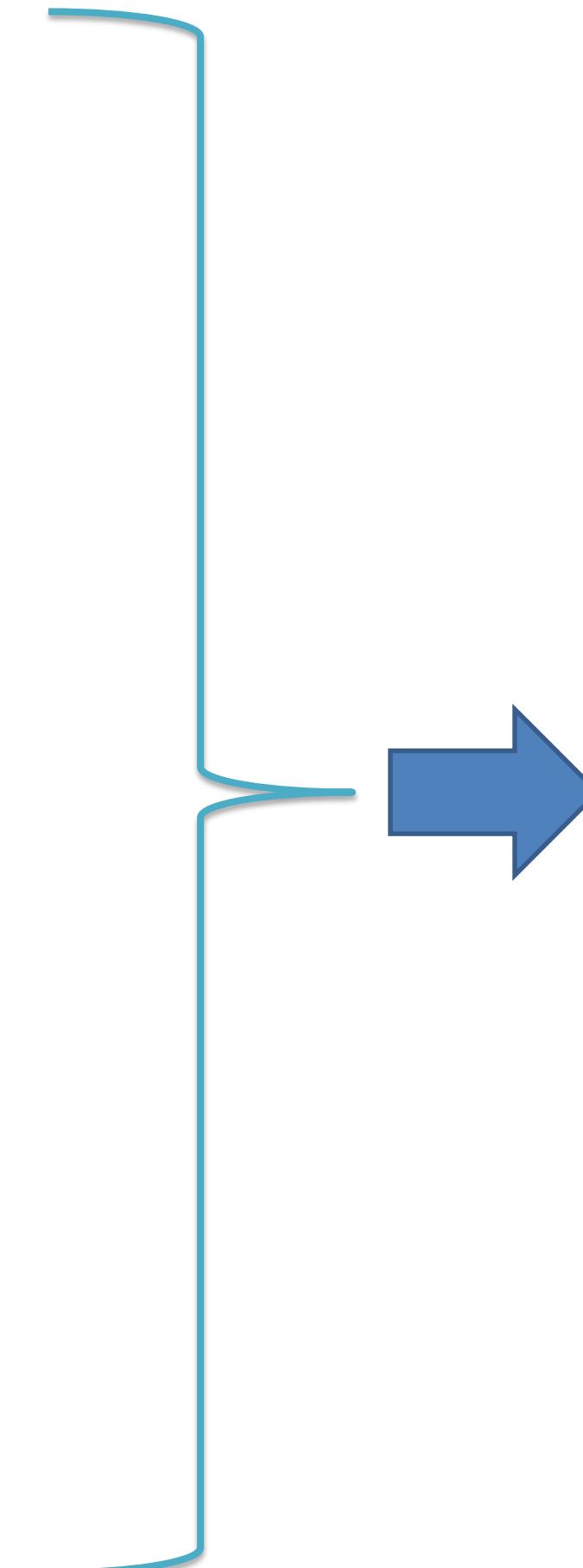
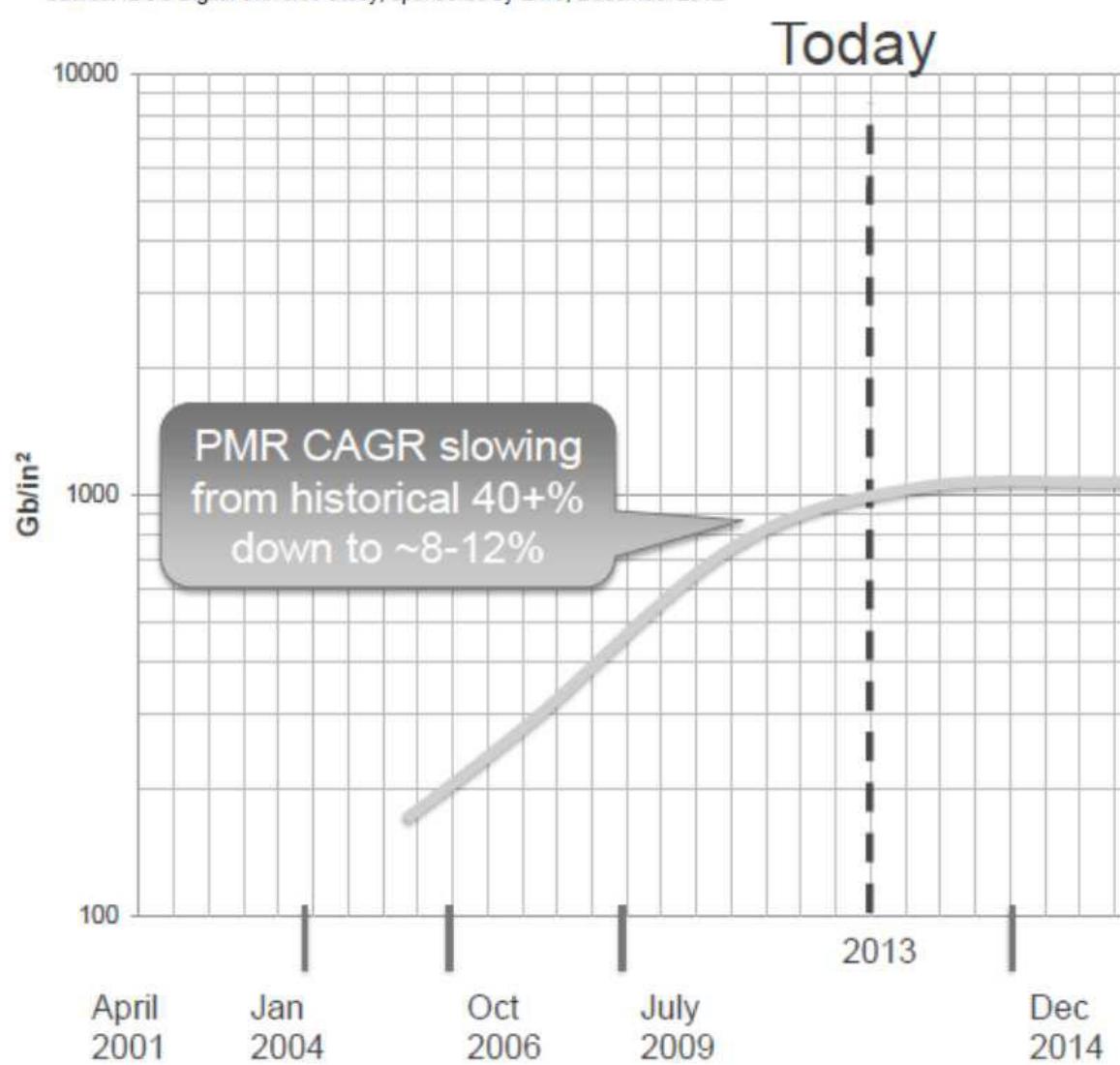
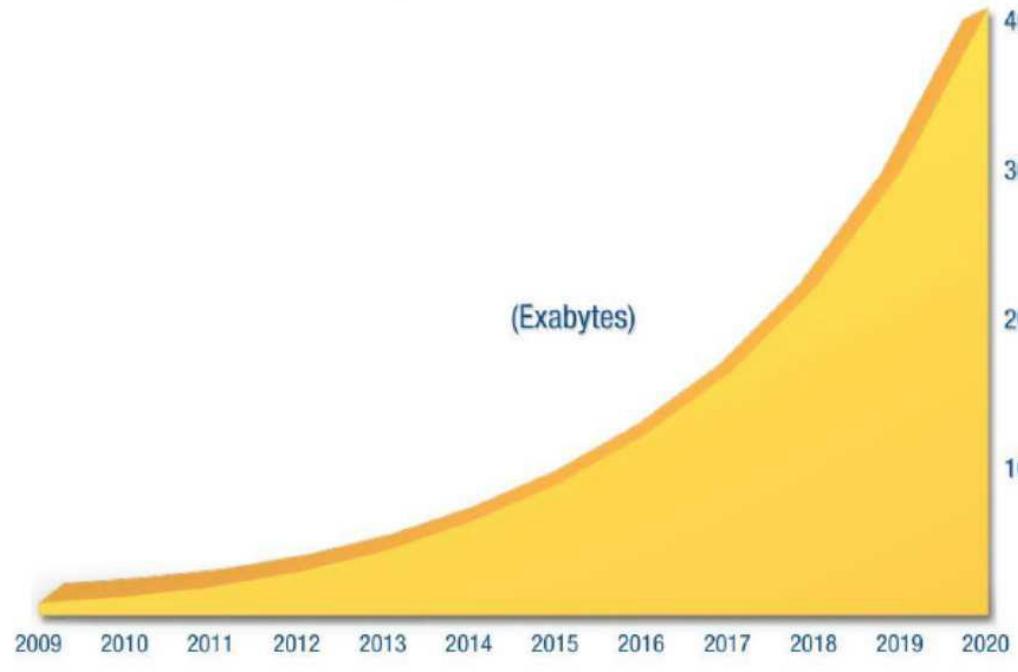
## The Last Line of Defense!

# Backup Storage Trends

- D2D&Copy2T
  - Usage of Container Pool
- D2F2T



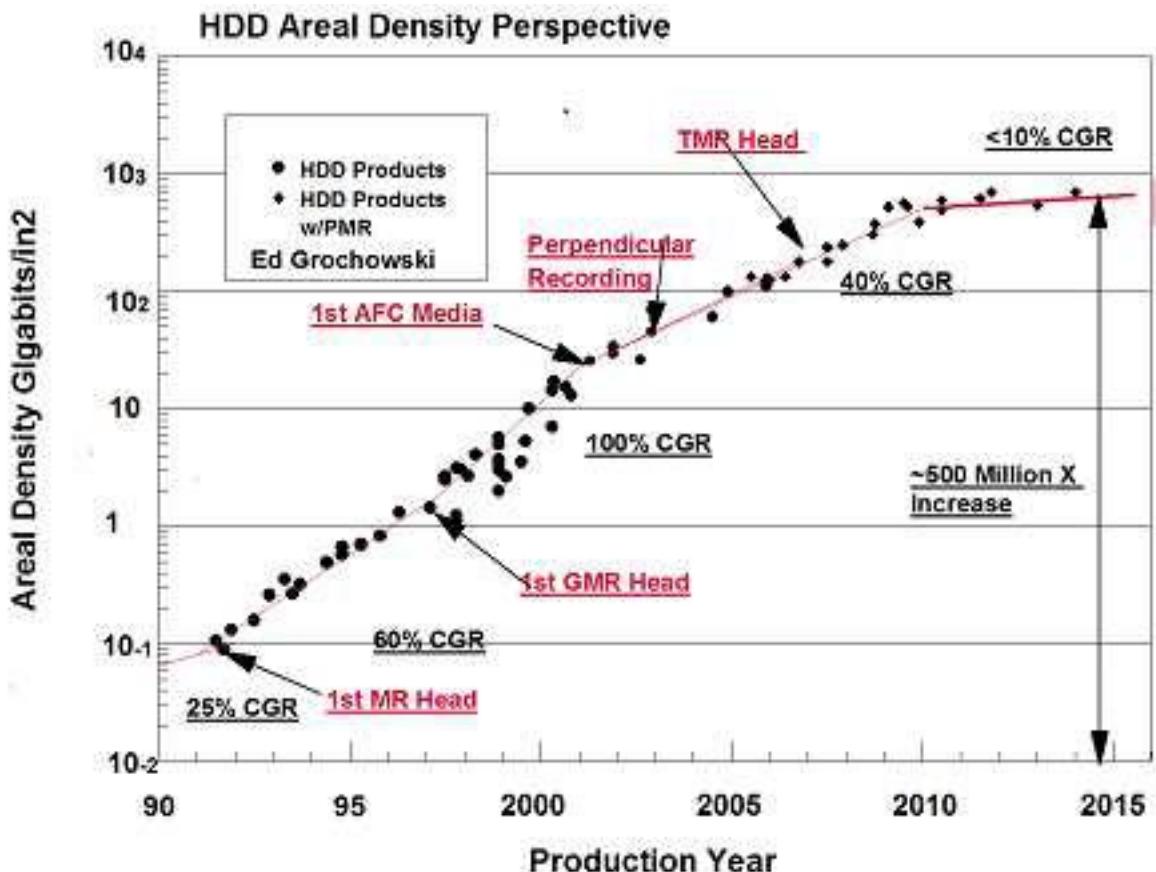
# The data deluge



- 80% of all files created are inactive
- no access in at least 3 months!
- => NAS: Never Access Storage

# HDD ?!?

- HDD has reached the limit of (known) materials to produce larger write fields:
  - Areal density/capacity scaling achieved by shrinking the same basic technology to write smaller and smaller bits on disk
- Technologies to go beyond the superparamagnetic limit:**
  - Two dimensional magnetic recording (TDMR)
  - Heat Assisted Magnetic Recording (HAMR)
  - Microwave Assisted Magnetic Recording (MAMR)
  - Bit Patterned Media (BPM)
- Recent Capacity Scaling of HDD: Volumetric Density
  - Slow down in areal density scaling partially compensated by adding more disks: conventional technology has reached space limit (~5 platters)
  - Helium filled drive less turbulence thinner disks higher capacity
    - WD 6TB (2013) 6 platters
    - HGST 10TB Drive (2015) 7 platters w/ shingled magnetic recording
  - Doesn't scale: No space for more heads and platters!**



Magnetic Media “Trilemma”:

Small particles ( $V$ )

$$SNR \propto V$$

Writability

$$H_0 \propto K_u$$

Thermal Stability

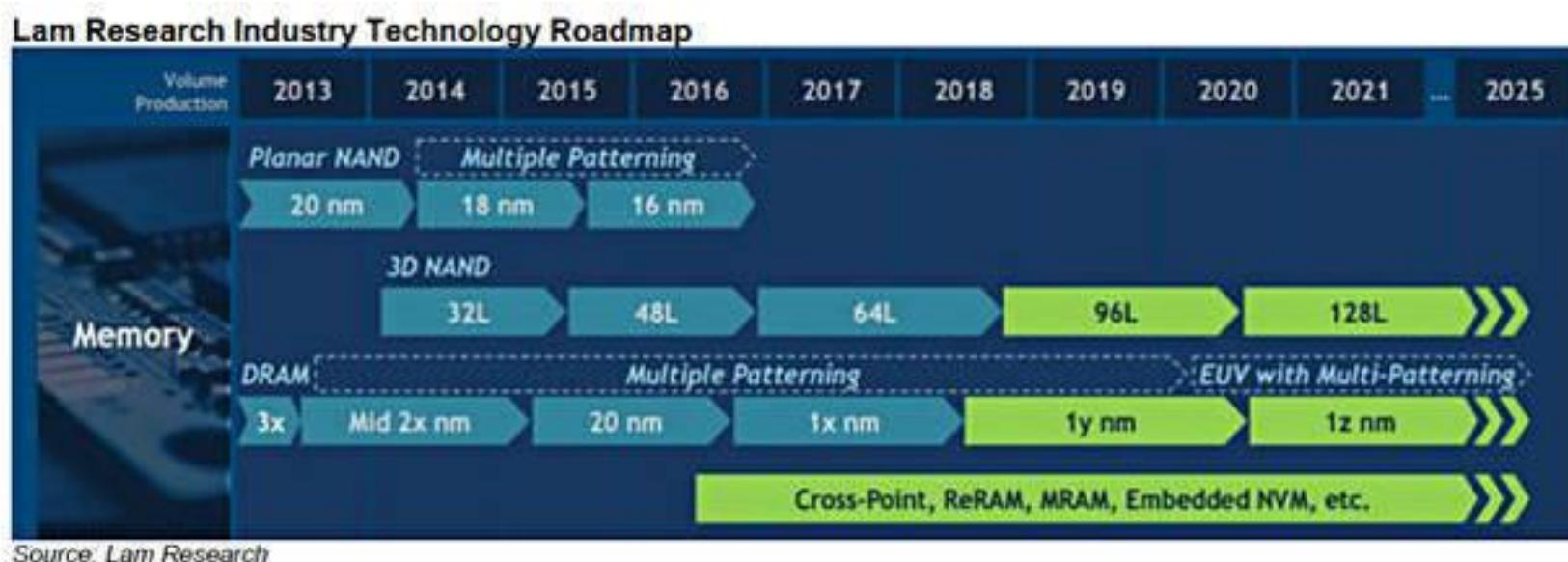
$$E_B \propto K_u \cdot V$$

$H_0 < Head\ Field$

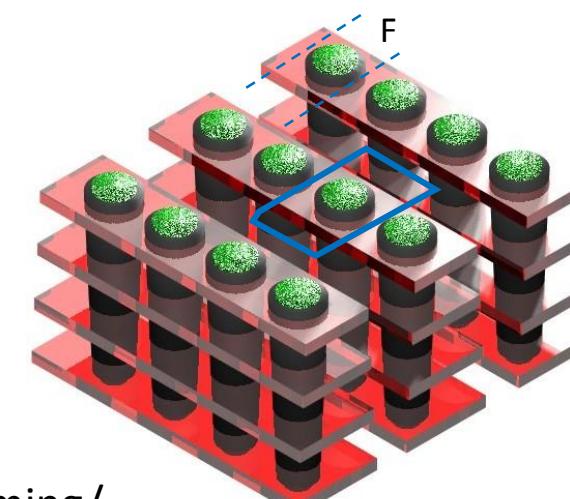


# NAND Area Density

- NAND has three strategies for increasing bits per unit area in a silicon chip
1. Lithographic scaling of the bit cell (x, y) dimensions by reducing F\*
    - - 20nm to 16nm → 1.56X more density
    - - 16nm to 13nm → 1.51X more density
  2. Increasing the number of bits per cell
    - - 1 bit per cell to MLC (2 bits per cell) → 2.00x increase
    - - MLC to TLC (3 bits per cell) → 1.50x increase
  3. 3D stacking (larger bit cell but multiple layers of cells)
    - Example: 16 nm goes to 48 nm and cell design goes from  $4F^2$  to  $6F^2$  so cell area increases 13.5x But by using 27 layers the effective density on the surface of the wafer increases by 2.00x (27/13.5)



[http://www.theregister.co.uk/2016/11/21/ssd\\_ships\\_up\\_46\\_per\\_cent\\_and\\_128layer\\_3d\\_flash\\_coming/](http://www.theregister.co.uk/2016/11/21/ssd_ships_up_46_per_cent_and_128layer_3d_flash_coming/)



## 3D Design Example

- Basic Cell  $2F \times 3F$  ( $F$  is minimum feature)
- 12 cells per layer
- 4 layers
- 2 bits or 3 bits per cell

# IBM Research Rüschlikon: Tapetechnologie Demonstration August 2017

**Areal recording density :**  
**201 Gb/in<sup>2</sup>**

**20x TS1155 areal density**

**→ 330 TB cartridge capacity**

**This demonstration shows that tape technology has the potential for significant capacity increase for years to come!**

HDD Technology:

- No room to continue adding platters
- HDD capacity will be driven by areal density scaling (10-20% /a)



**Cost advantage of tape will continue to grow!**

# IBM's Tale of the Tape

More than 60 years of tape innovation



	2006	2010	2014	2015	2017
Aerial Density (bits per sq inch)	6.67 Billion	29.5 Billion	85.9 Billion	123 Billion	201 Billion
Cartridge Capacity (Terabytes)	8	35	154	220	330
# of Books Stored	8 Million	35 Million	154 Million	220 Million	330 Million
Track Width	1.5 µm	0.45 µm	0.177 µm	0.140 µm	103 nm
Linear Density (bits per inch)	400'000	518'000	600'000	680'000	818'000
Tape Material	Barium Ferrite	Barium Ferrite	Barium Ferrite	Barium Ferrite	Sputtered Media
Tape Thickness (micrometers)	6.1	5.9	4.3	4.3	4.7
Tape Length (meters)	890	917	1255	1255	1098

#5thtaperecord

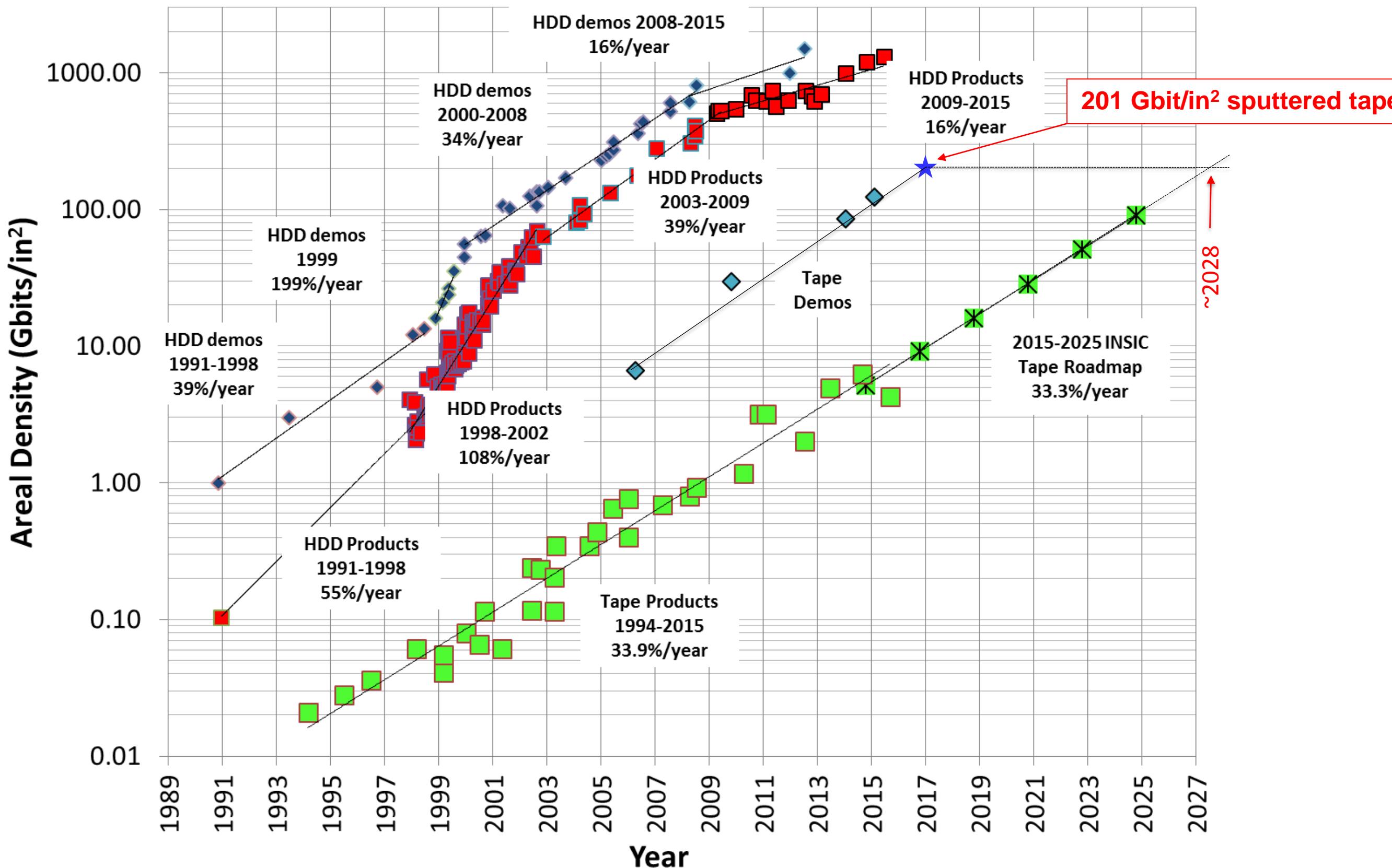
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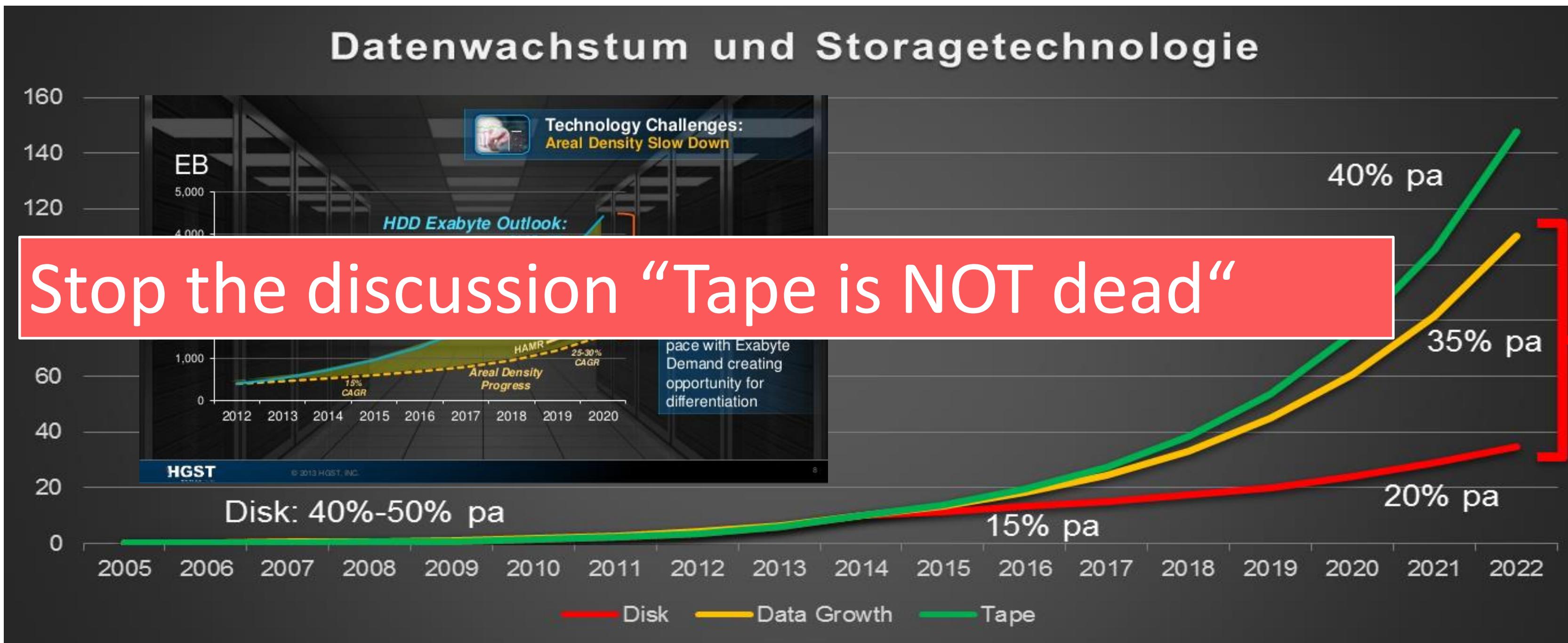
# Areal Density Scaling

2015: IBM-FujiFilm demonstration of 123 Gb/in<sup>2</sup> on BaFe tape

2017: IBM-Sony demonstration of 201 Gb/in<sup>2</sup> on Sputtered Tape



# Data Growth and the GAP with HDD Technology



Until 2014 disk capacity growth outperform data growth.

**Now Data Growth is much higher than disk capacity growth.**

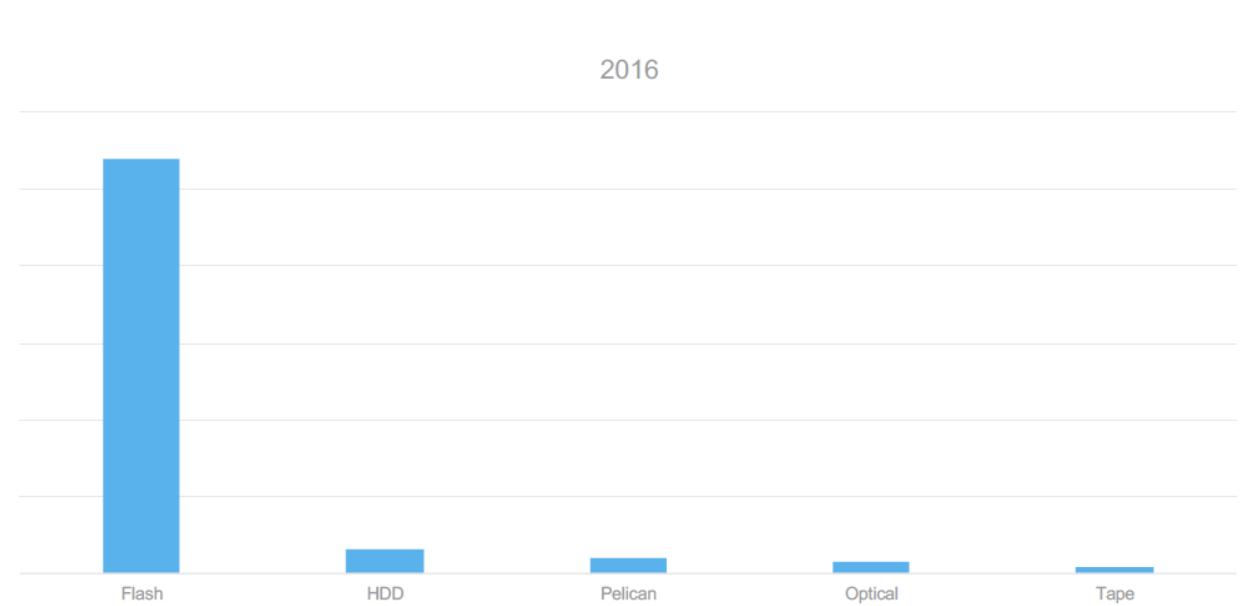
**Close the GAP with TAPE**

# Microsoft Azure will use Tape

## ■ Why Microsoft Azure will use Tape:

- The cheapest most economical way to store cold data, continued improvement with 30%+ CAGR and easiest roadmap.
- Cheaper-Separating the media from the reader/writer
  - Both Tape and Optical pull the media out of the reader/writer.
  - 1 expensive part, and service any amount of media.
- Tape libraries can be more flexible in drive / media ratio
- New tape drives can store more data on older media
- Tape libraries have less environmental constraints

Relative Costs of Different Platforms



## How Do You Store A Zettabyte? Microsoft And IBM Know...

Aaron Ogus – Microsoft Azure Storage,  
Development Manager Storage Architect

Ed Childers – STSM, Manager Tape Development



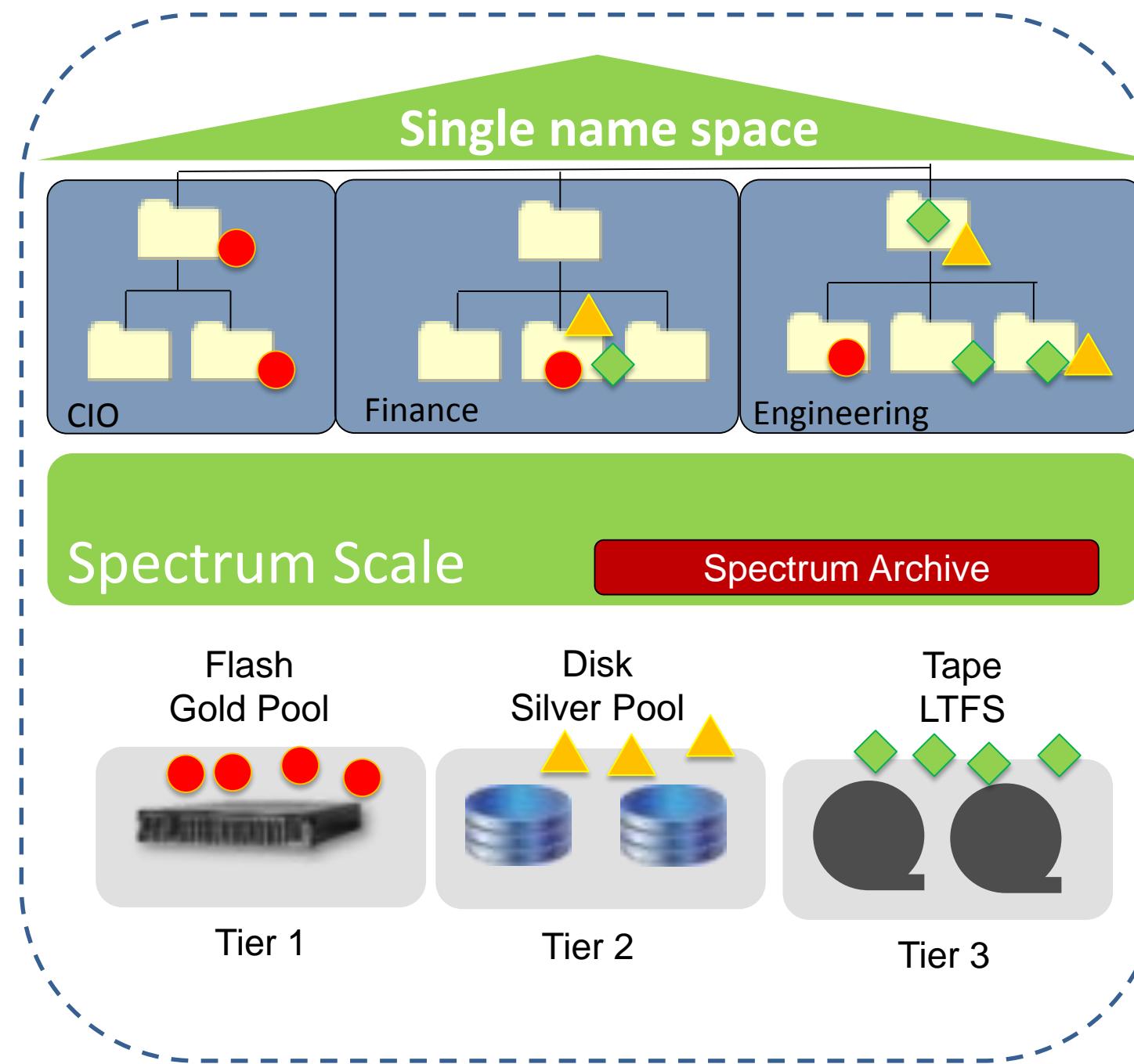
Current and Future Service Cost Estimates under model using retail pricing

Flash	2015	2020
Cost / GB	3.45	0.71
Cost / ZB	\$3.4 Trillion	\$714 Billion
Cost / ZB / year	\$1.15 Trillion	\$238 Billion

HDD	2015	2020
Cost / GB	0.125	0.05
Cost / ZB	\$125 Billion	\$50 Billion
Cost / ZB / year	\$41 Billion	\$17 Billion

Tape	2015	2020
Cost / GB	0.06	0.013
Cost / ZB	\$55 Billion	\$13 Billion
Cost / ZB / year	\$8 Billion	\$1.9 Billion

# IBM Spectrum Archive: Tape Tier



## Spectrum Scale plus Spectrum Archive - Changing the economics of storage with low cost file system based storage

Seamlessly incorporates tape storage to keep data online at much lower costs

Data still listed in directories

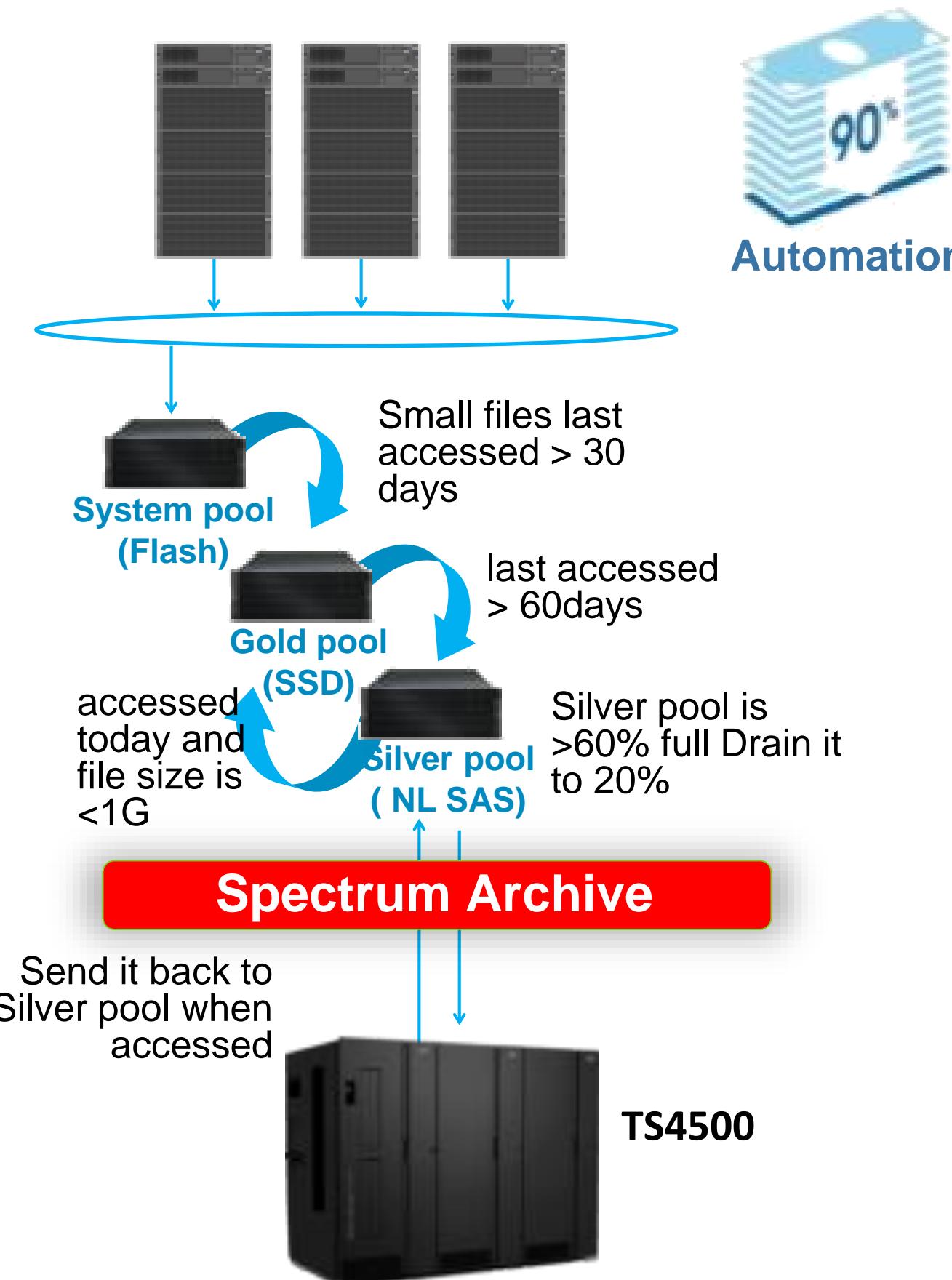
Once data is accessed it is moved to disk

Other than longer access times, users have no idea data is stored on tape

## Featuring the award winning Linear Tape File System (LTFS) technology

Up to 15TB in single tape cartridge now, 330 TB tape cartridge in future  
(Research Demo in 2015)

# IBM Spectrum Archive: Policy-based Cost Optimization



- **Powerful policy engine**

- Example: File Heat measures how often the file is accessed.
- As the file gets “cold” move it automatically to a lower cost storage pool
- Information Lifecycle Management
- Fast metadata ‘scanning’ and data movement
- Automated data migration to based on threshold

- **Users not affected by data migration**

- Single namespace
- Persistent view of the data

- **Tape as the external pool of Spectrum Scale**

# IBM tape storage for hyperscale computing

The more things change, the more they stay the same...



IBM Statement of Direction for TS1150 –  
Ethernet interface and 15 TB tape  
cartridge

## How to store a zettabyte on a budget

- Aaron Ogus, Microsoft Azure
- Global IT Executive Summit - October, 2015
- <https://tapepower.fujifilmrmd.com/LA2015/video/id/presentation.5>



## How Google Backs up the Internet

- Raymond Blum, Google Site Reliability
- NYC Tech Talk Series - October, 2013
- <https://www.youtube.com/watch?v=eNliOm9NtCM>

### Lessons Learned Backing Up Google

- Ensuring durability and integrity of user data is job one  
A lapse in availability can be ridden out, but data loss can be hard to recover from, if even possible
- Redundancy does not bring recoverability  
Corruption and deletes can replicate quite nicely
- Distributed processing imposes data consolidation  
You need to collect shards into one cohesive world view at some point
- The backup process has to scale with data volume
- If you haven't restored, you haven't backed up
- The Payoff: A case study

# Whats new!

Oktober 2015

- LTO 7 Tape Drive: 6 TB / 300 MB/sec
- TS4500 18 Frame Support
- TS4500 Media Verification

Dezember 2015

- Spectrum Archive (LTFS EE): Multiple Library Support
- Spectrum Archive (LTFS LL): Free of charge

April 2016

- ProtectTier: New Hardware DD6

Mai 2016

- TS4500 HA Support
- TS4500 Mainframe Support
- TS7760 Neue VTS-Hardware

Mai 2017

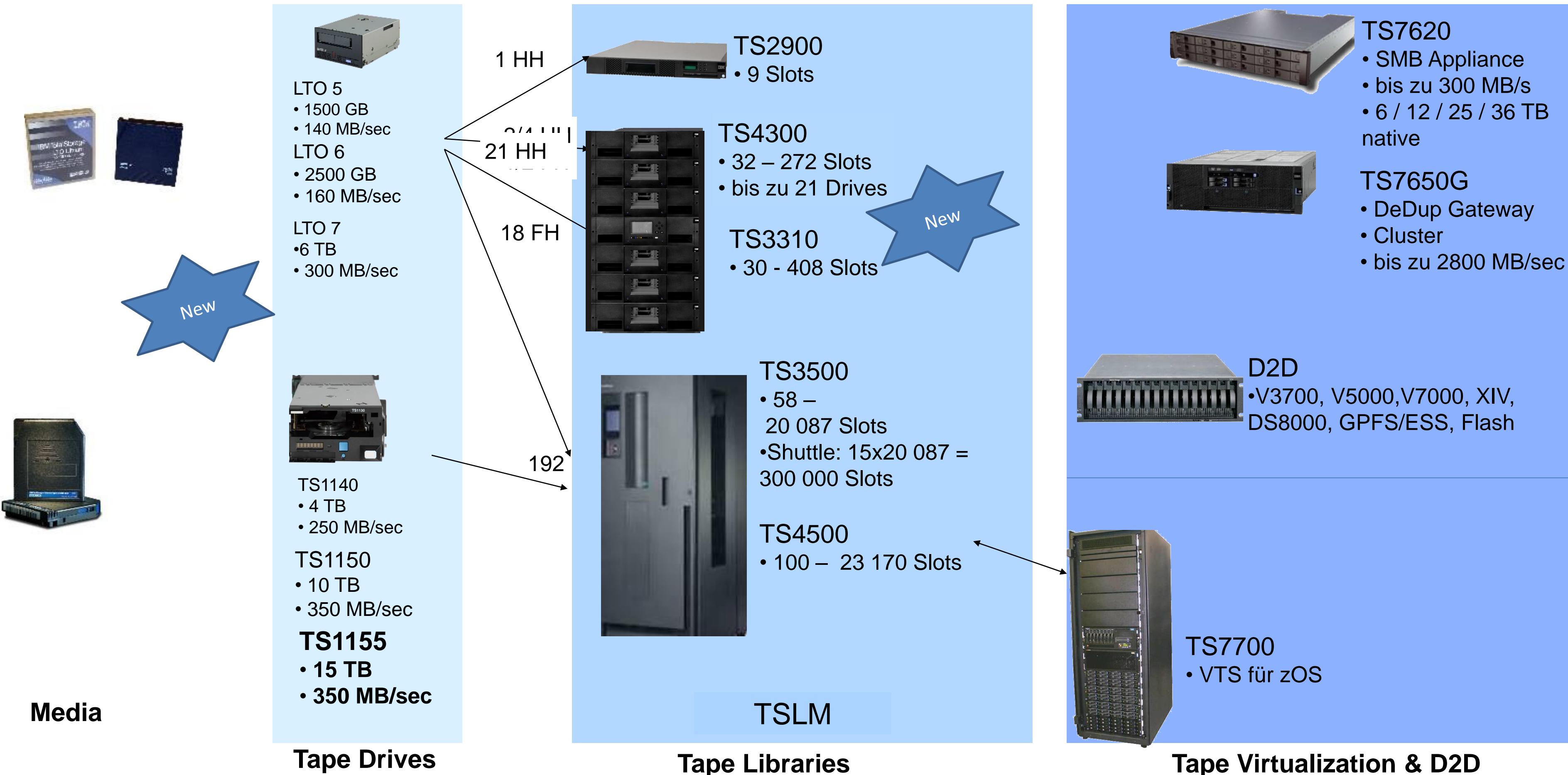
- TS1155 Tape Drive: 15 TB / 360 MB/sec

Juli 2017

- TS4300 Tape Library: 272 Slots / 21 LTO Drives

# IBM DP&R Storage / Produkte

## IBM Spectrum Protect / IBM Spectrum Archive



Media

Tape Drives

Tape Libraries

Tape Virtualization & D2D

# Tape Drive History and Roadmap



LTO Generations	LTO-5	LTO-6	LTO-7	LTO-8	LTO-9
New Format Capacity (Native)			6 TB (L7)	12.0 TB	Up to 25 TB (L9)
Other Format Capacities (Native)	800 GB (L4) (400 GB L3 R/O)	1.5 TB (L5) (800 GB L4 R/O)	2.5 TB (L6) (1.5 TB L5 R/O)	6 TB (L7)	Up to 12 TB (L8) (6 TB L7 R/O)
Native Data Rate	140 MB/s	160 MB/s	300 MB/s	Up to 360 MB/s	Up to 708 MB/s

2010

2013

2015

2017

2008

2011

2014

2017



TS1100 Generations	TS1130	TS1140	TS1150	TS1155	TS1160	TS1165	TS1170
New Format Capacity (Native)			10 TB (JD) 7 TB (JC)	15 TB (JD)	18-20TB (JE) 15-17 TB (JD) 10-12 TB (JC)	~30 TB (JE) 15-17 TB (JD) 10-12 TB (JC)	30-40 TB (JE)
Other Format Capacities (Native)	1 TB (JB) 640 GB (JA)	4 TB (JC) 1.6 TB (JB)		7 TB (JC) 4 TB read only (JC)	10 TB (JD) 7 TB (JC) 4 TB (JC)	TBD	18-20 TB (JE) 15-17 TB (JD) 10-12 TB (JC)
Native Data Rate	160 MB/s	250 MB/s	360 MB/s	360 MB/s	Up to 500 MB/s	Up to 500 MB/s	Up to 1000 MB/s

Any statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

# Tape Drive – TS1155

- High Capacity
  - JD – 15TB
- Compatible with TS1100 models
  - JD TS1150 backwards read support (J5D Read only)
  - TS1160 backwards read TS1155 JD format (J5A Read Only)
- Capacity will be achieved through a new head design and format on media
- Will be offered with Fibre Channel or Ethernet based RoCE external interface
- TS1150 to TS1155, TS1155 to TS1160 MESs supported
- Supported in TS4500



# New TMR Head

- Current Tape Drive Technology Based on GMR.
  - LTO7, T10000D, TS1150, T10000E
  - (HDD's stopped using GMR in 2004). GMR has reached its density limits.
- TMR provides a 4x improvement in signal sensitivity. Less susceptible to noise and media discrepancies.
- TMR Heads run cooler than GMR.
  - Benefits media and data integrity.
- IBM TS1155 and LTO 8 will be based on TMR
- Tape has 13 yrs of TMR development to leverage
- TMR Requires Major Manufacturing Re-Engineering
  - Investment
  - Head characteristics are substantially different than GMR
- IBM has had to pioneer new tech to make it work.
- What about others?

# TS4300 Tape Library Overview

## Modular library

Up to **1.6 PB** native capacity (LTO 7 cartridges storage)

- 1 base unit + 6 expansion units

**32 to 272** LTO storage slots

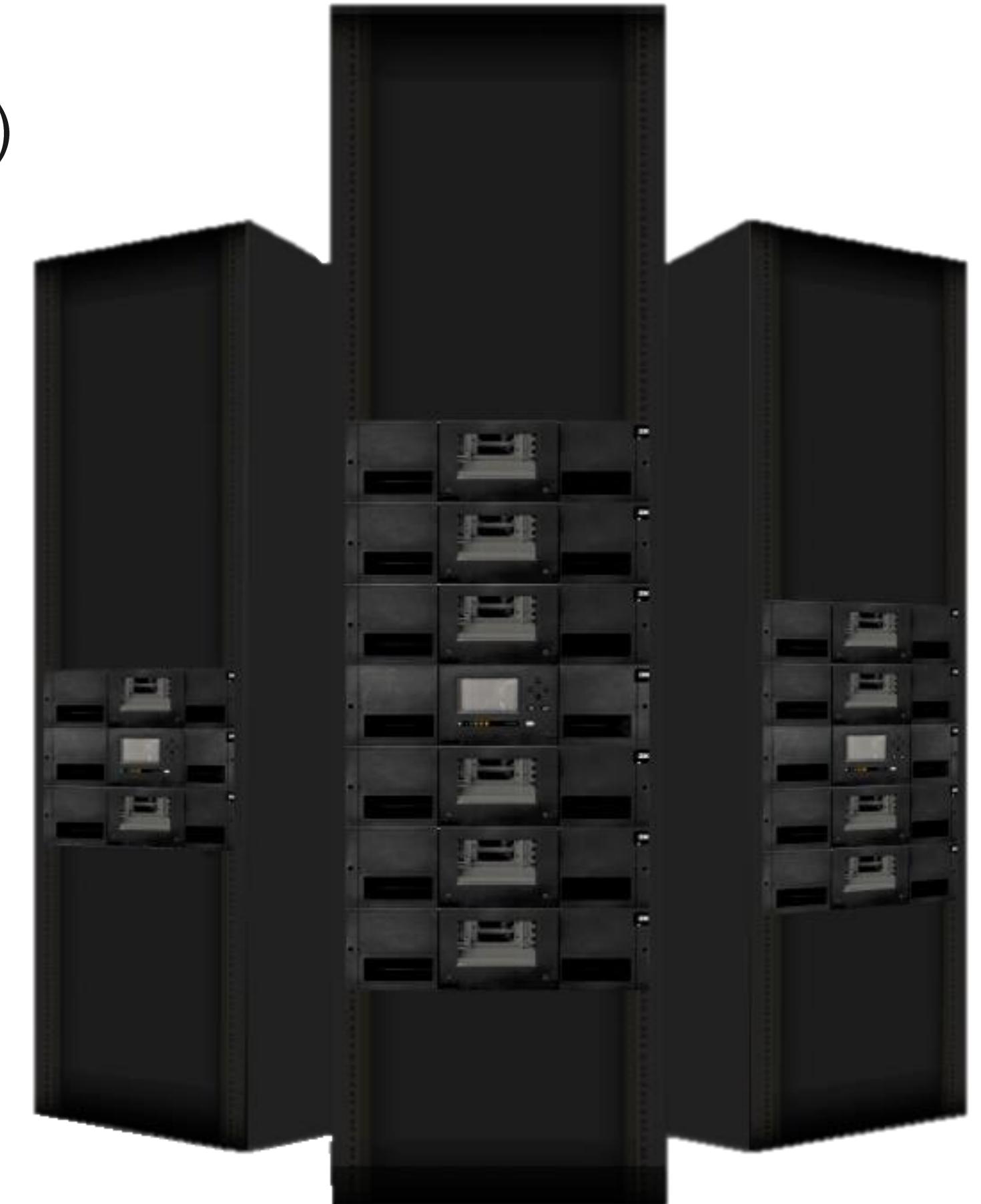
5 I/O slot per module

Up to 21 LTO 7 & 6 hot-swappable tape drives

- Combination of HH & FH drives

Two drive interfaces:

- 8 Gbps dual-port Fibre Channel (LTO 7 and 6 )
- 6 Gbps dual-port SAS (LTO 7 and 6 )
- Up to 360 MB/sec native performance



# TS4300 Tape Library Overview

## Features

### Management GUI

- Operator Panel
- Web Interface



### Advanced Reporting

- Diagnostic and trend analysis
- Drive resource utilization
- Media integrity report, Error report logging

### Diagnostics

- Library health monitoring
- Auto-recovery, Error-recovery

### Media Partitioning

- Supporting Spectrum Archive LE & EE

### Library Sharing

- Prevents unwanted access to slots/drives among different use cases
- Up to 21 logical libraries (up to number of drives installed)
- Numbering is bottoms up for all drives

- 100 % CRU
- Optional features
  - Rack mount
  - Path Failover (Data and Control)\*
  - First Power Supply (for E3A)
  - Redundant power supply

\*Planned availability - 4Q17

# TS4300 Scaling

## Base Module - L3A

192 TB native capacity (35 slots) using LTO-7 drives

3 HH LTO Ultrium 7 or 6 tape drives or 1 FH LTO Ultrium 7 or 6 FH tape drive and 1 HH LTO Ultrium 7 or 6 tape drive

5 slot cartridge I/O station (36 TB native capacity)

Optional redundant power supply

Desktop or Rack Mount

Rack Mount optional for 3U Base Module

Rack mount required from 6U to 21U configurations

No more than 3 expansions can be set either on top or bottom of base module



## Expansion unit - E3A

240 TB native capacity (40 storage slots)

3 HH LTO Ultrium 7 or 6 tape drives or 1 FH LTO Ultrium 7 or 6 FH tape drive and 1 HH LTO Ultrium 7 or 6 tape drive

Option of zero or 5 cartridge I/O slots

Optional power supply\*



Combined configuration (model L3B + 6 E3A) supports

1.6 PB native capacity (272 storage slots)

Up to 21 HH LTO Ultrium 7 & 6 tape drives

5 to 35 cartridge I/O slots

# Min / Max Configurations



Configuration	Capacity		
<b>Minimum</b> 1 Module Library Base Library	Cartridges	32	
	HH Tape Drives	3	
	FH Tape Drives	1	
	HH / FH Tape Drive Mix	1 / 1	
<b>Maximum</b> 7 Module Library Base Library 6 Expansion Modules	Cartridges	272	
	HH Tape Drives	21	
	FH Tape Drives	7	
	HH / FH Tape Drive Mixture Range	19 / 1 to 7 / 7	

# IBM TS4500 (3584) Tape Library

- **Higher Density**
  - New HD-Frames with up to 16 Tape Drives
  - Up to 3.3X the slot density of TS3500
  - Up to 774 Slots and up to 12 Tape Drives on the first Frame
  - Up to 1054 and up to 16 Drives in all other Frames
- **Up to 18 Frames in one Library String =**
  - 23 170 Slots = 3,4 EB with LTO7
  - 17 550 Slots = 43,8 EB with TS1150
- Ease-of-Use
  - New GUI
- New, faster Controller with more Memory
- More standard features including:
  - Advanced Library Management System (ALMS), Dynamic partitioning, Transparency Capacity on Demand, Virtual I/O (VIO), Cartridge cache, Two I/O Stations
- New features:
  - **Media Verification**
- System console capabilities e.g. broadband call home (formerly TSSC)



8

<https://youtu.be/IRGz-tNBeXM>

# TS4500 G4 Control System – Improved Ease-of-Use

## GUI Example: At-a-Glance and Actionable Status

- TS4500 notifications – SNMP, Email, and Syslog options
- TS4500 security improvements:
  - LDAP (Lightweight Directory Access Protocol)/Kerberos client now integrated – no longer require a separate Storage Authentication Service
  - SSL/TLS (Secure Sockets Layer/Transport Layer Security) performance improved
  - Password and Session Policy now supported



**Notifications**

- Library Information
- SNMP Notifications
- SNMP Destinations
- Email Notifications
- Email Recipients**
- Syslogs Notifications

**Email Recipients**

Create Recipient Actions Filter

Recipient

Anacg4b > Settings > Notifications

**Syslog Notifications**

Create Recipient Actions Filter

Server Error Warning Info

9.11.27.123 ✓ ✓

Library Information

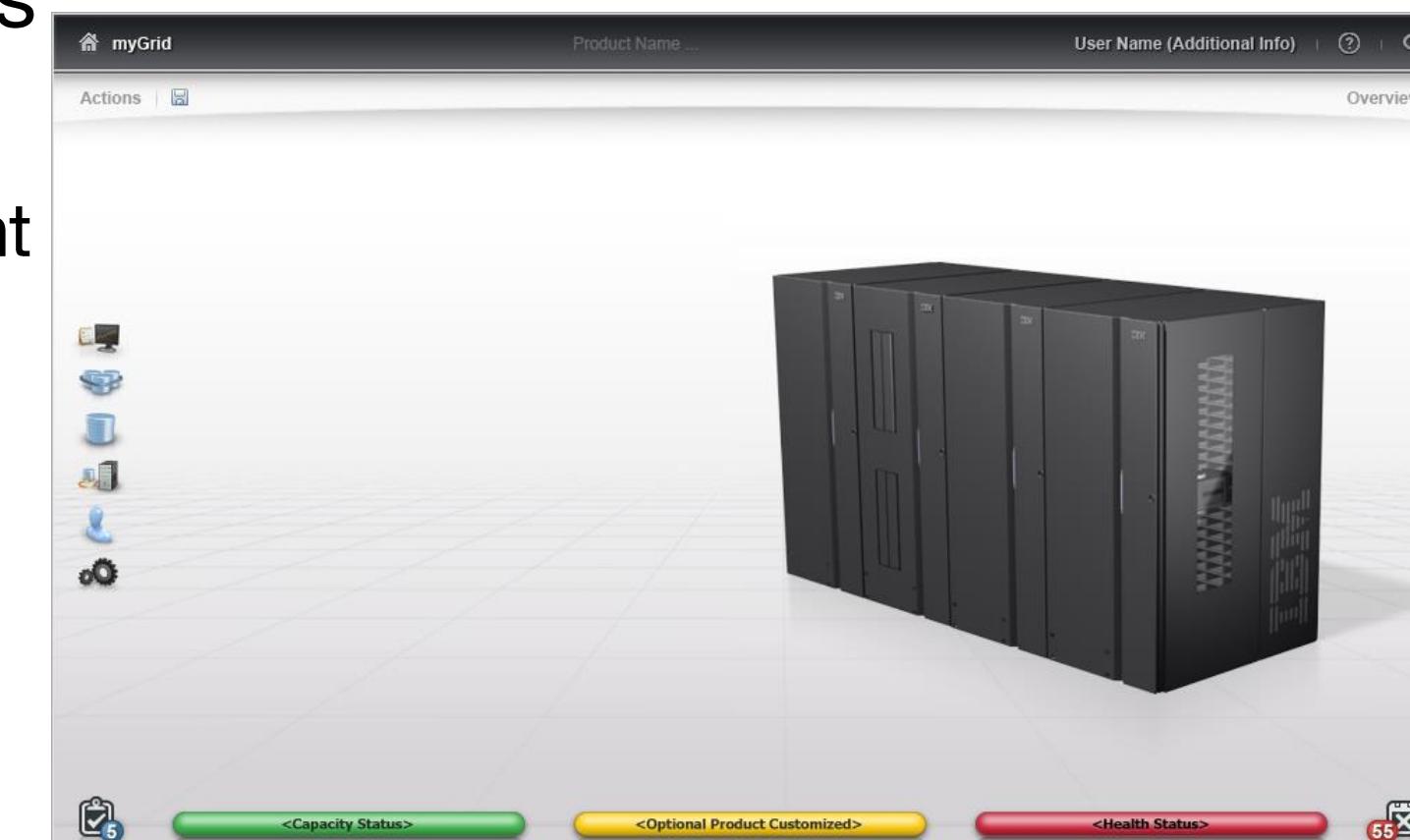
SNMP Notifications

SNMP Destinations

Email Notifications

Email Recipients

Syslogs Notifications



**Security** **Authentication**

Actions

Remote authentication

Preparation Create Group Assign a User

HTTPS

Encryption Key Servers

Encryption Internal Label

**Preparation**

The following steps must be performed on your remote before you enable remote authentication on this library.

Gather the following information before starting:

- Access to create users and groups on your remote authentication server.
- A primary LDAP repository URI.
- (Optional) A secondary LDAP repository URI.
- (Optional) An LDAP TLS certificate.
- If you are using Kerberos: the realm, KDC, domain name, and service principal names.

**Security**

Automatic logout: 0 minutes

Password lock: 5 attempts

Automatic IMC (local GUI) login at power on: Disabled

Minimum number of characters: 8

Minimum number of upper case characters: 1

Minimum number of lower case characters: 1

Minimum number of numeric characters: 1

Minimum number of special characters: 0

Cannot contain the User ID: Enabled

Maximum identical, consecutive characters: 2

Maximum password age: 90 days

Minimum password age: 1 day

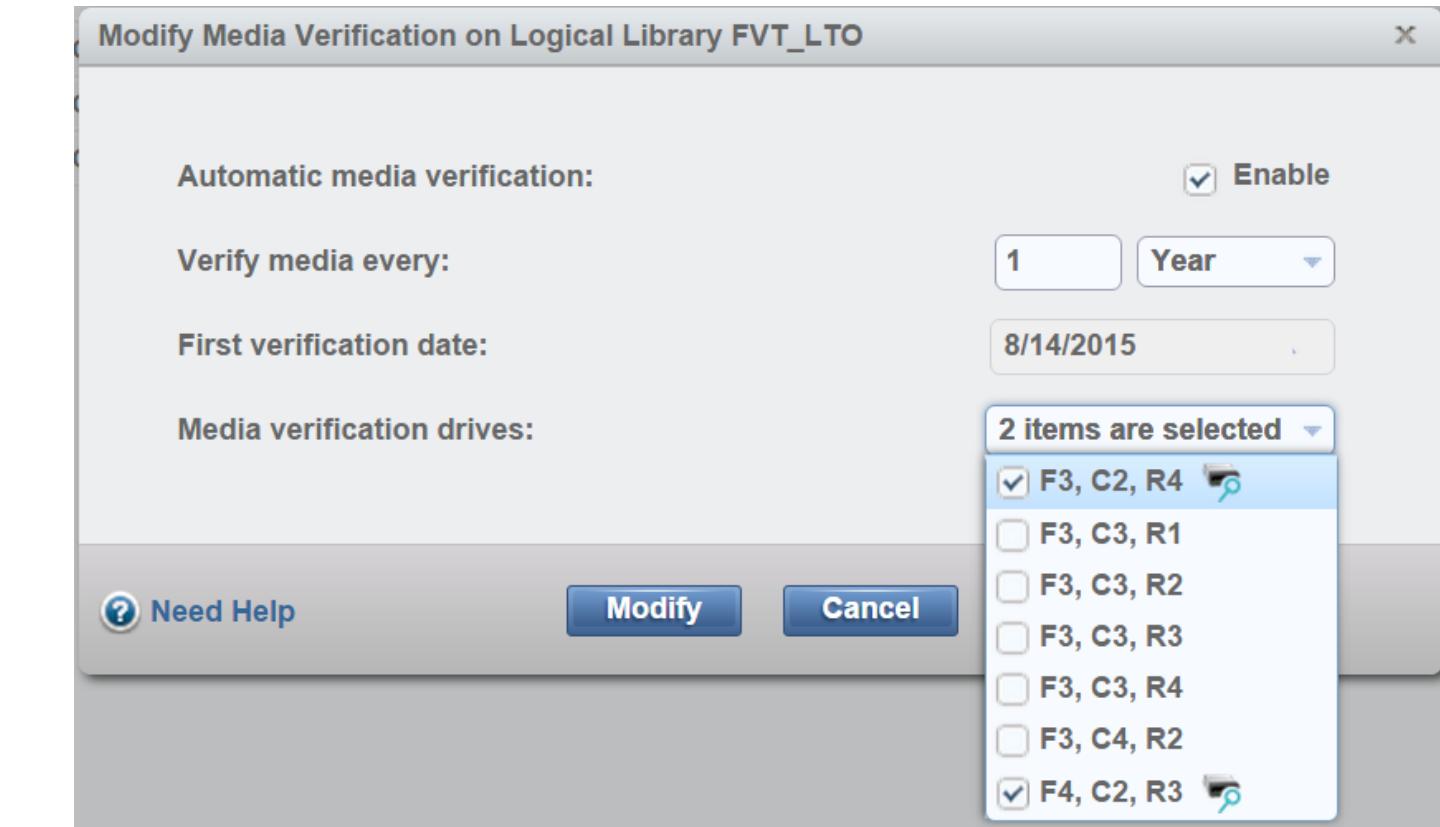
Number of unique passwords before reusing: 8

Modify

# TS4500 Automatic Media Verification

Pro-actively verify the ability to read data stored on tape from any open systems application

- Simple policy designates policy period, start date, and media verification drives for the logical library
- Results are viewable in the Cartridges and Events pages of the TS4500 GUI
- Notification of failure sent via SNMP, email, or syslog
- Works with any open systems application\*
- Free of charge!



The screenshot shows a table of cartridges in the 'Cartridges by Logical Library' section. The columns are VOLSER, State, Location, Last verification, and Verification results. All cartridges listed have passed their last verification.

VOLSER	State	Location	Last verification	Verification results
IMN427L5	Slot	F4,C6,R3,T0	8/14/15, 2:56 PM	Passed
IM1392L6	Slot	F4,C8,R8,T0	8/14/15, 2:59 PM	Passed
IM1376L6	Slot	F3,C1,R12,T2	8/14/15, 3:00 PM	Passed
IM1374L6	Slot	F2,C6,R7,T0	8/14/15, 3:02 PM	Passed
IM1375L6	Slot	F2,C10,R28,T0	8/14/15, 3:05 PM	Passed
IM1373L6	Slot	F2,C4,R8,T0	8/14/15, 3:07 PM	Passed
IM1349L6	Slot	F4,C8,R4,T0	8/14/15, 3:09 PM	Passed

\*Not supported with application-managed encryption (decryption required)

# The future of Tape begins now

TAPE \$AVES: COST • ENERGY • DATA • COMPANY

- The era of big data is creating demand for cost effective storage solutions
- IBM Research Rüschlikon/Zürich has proven the future of Tape with 220 TB Capacity.
- Tape remains the most cost-efficient and greenest technology for archival storage and active archive applications
- Tape has a sustainable roadmap for at least another decade
  - 123 Gbit/in<sup>2</sup> areal density demo shows feasibility of multiple future tape generations
  - Potential exists for the continued scaling of tape beyond 123 Gbit/in<sup>2</sup>
- The cost advantage of tape over HDD and optical disk will continue to grow
- Tape is safe & secure; ideal for Backup
- „Tape is the last Line of Defense!“



# Questions?



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# Thank You!



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