

No Virginia,  
There Are No Data Elves In  
The Cloud

# Where Does Data Live?

## A Data Crisis?

## What Are The Options?

No Data Elves

## Available Storage Technologies

Whether in Hand, Traditional IT, or Cloud,

Data lives on:

Flash

HDD

Tape

Optical



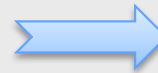
Physical Things Obey The Laws Of Physics

# Storage Technologies - Refresher

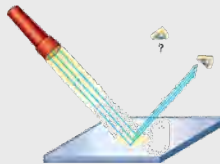
How do you store a bit?



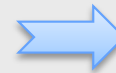
Magnetize something



Tape & HDD



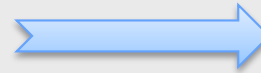
Change optical reflection



BluRay, DVD



Capture charge



Flash

# Storage Technologies - Refresher

How do you decrease \$/TB?

Increase # of bits



Constant cost



Lower \$/GB

“Areal Density”  
=  
Number of bits  
per sq inch

Increase areal density without increasing cost of media or device is key

Increase capacity



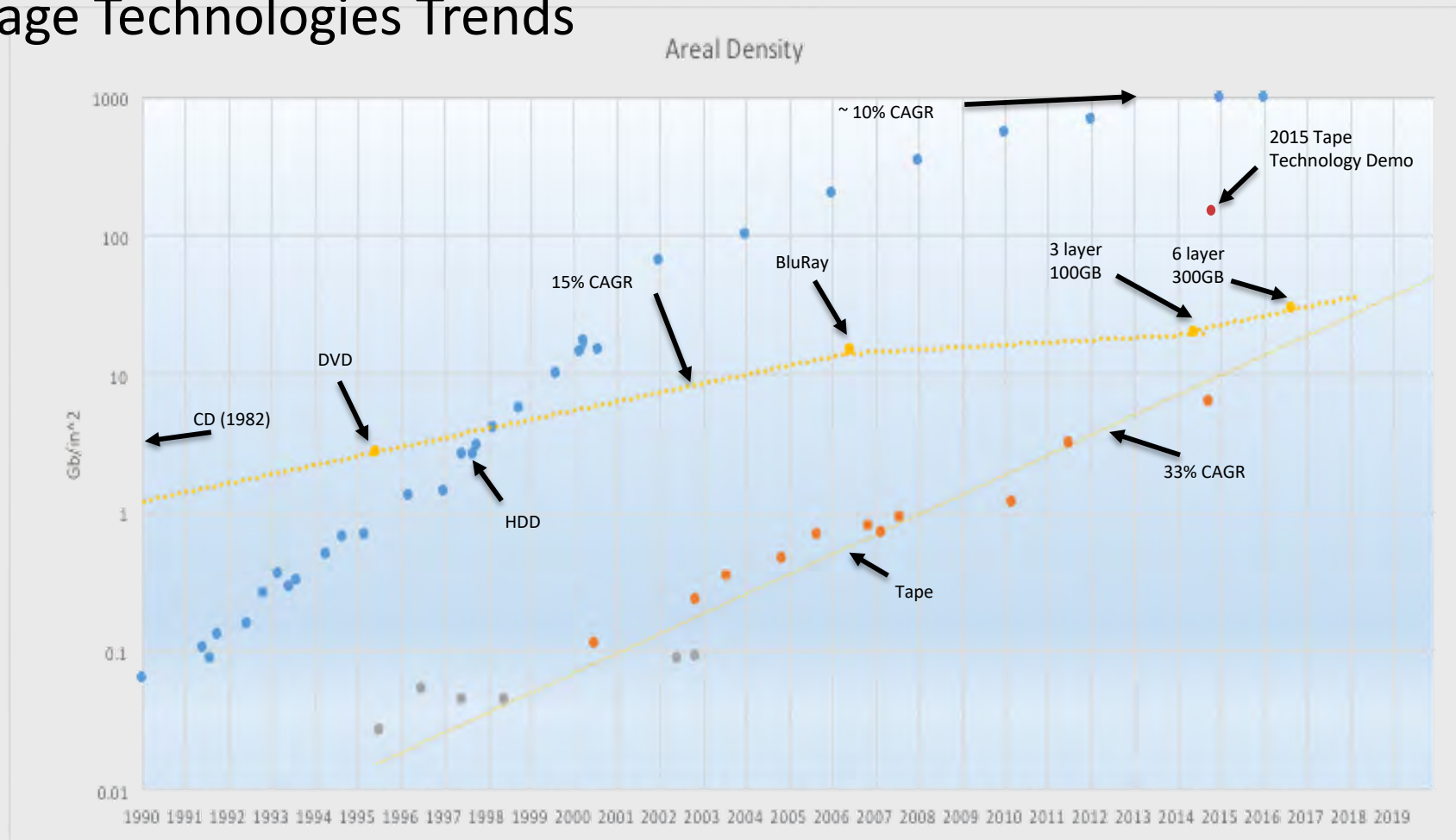
Higher cost



Lower \$/GB

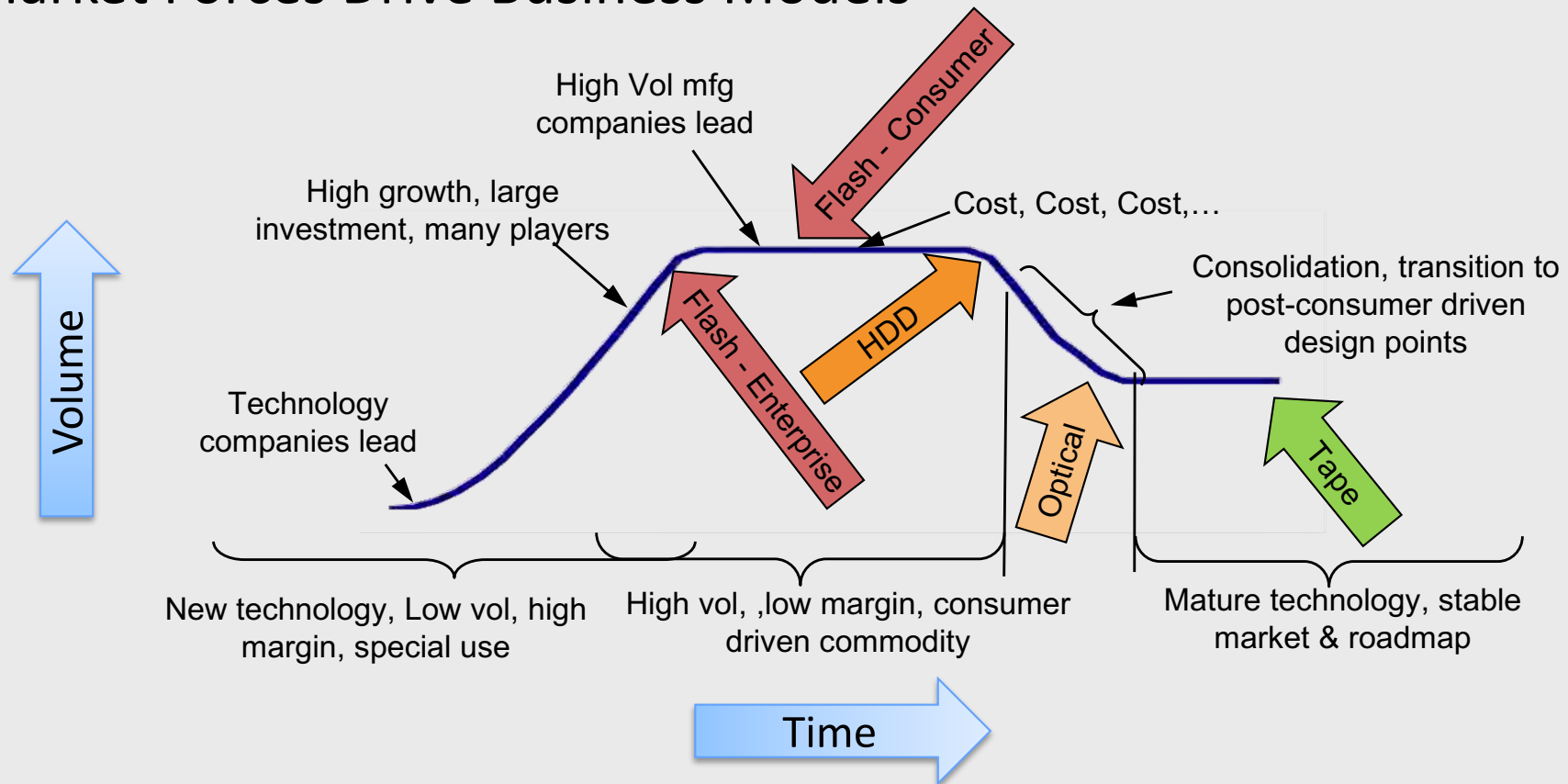
No Data Elves

# Storage Technologies Trends



No Data Elves

# Engineers Solve Technical Problems but.... Market Forces Drive Business Models



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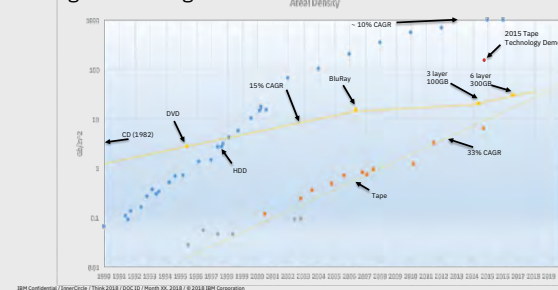
## Storage Technology Outlook

# Fundamental Technology Trends

## Consumer Market Trends

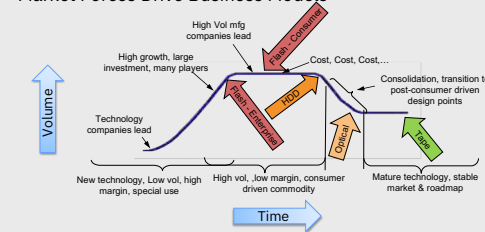
There Are No Data Elves

### Storage Technologies Trends



How Do You Store A Zettabyte?

Engineers Solve Technical Problems but....  
Market Forces Drive Business Models



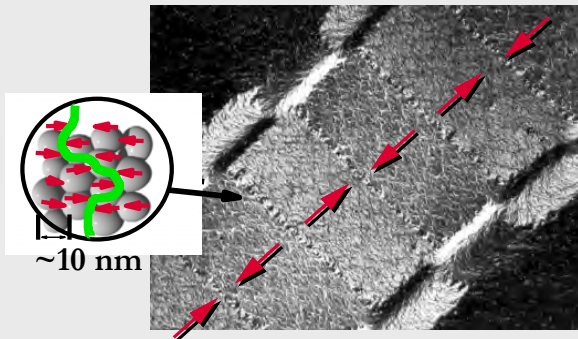
## Technology Outlook



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# HDD Challenges

## Technology Scaling Limits



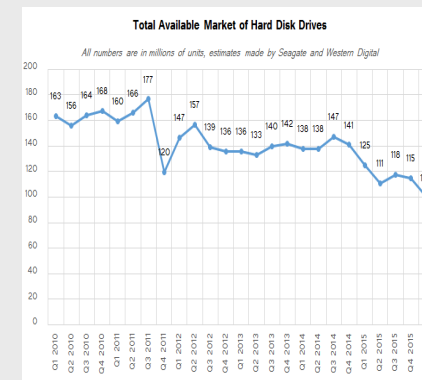
If grains become too small,  
magnetic state is unstable  
→ superparamagnetic effect



\$/TB Impacted By  
Increased Cost Of  
Brick



Declining Consumer Demand



Technologies to go beyond  
the superparamagnetic limit  
= \$\$

- HAMR
- MAMR
- BPM
- BPM+HAMR



High Perf / High Margin Market  
Taken Away By Flash

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# Optical Storage Challenges

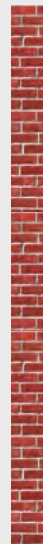
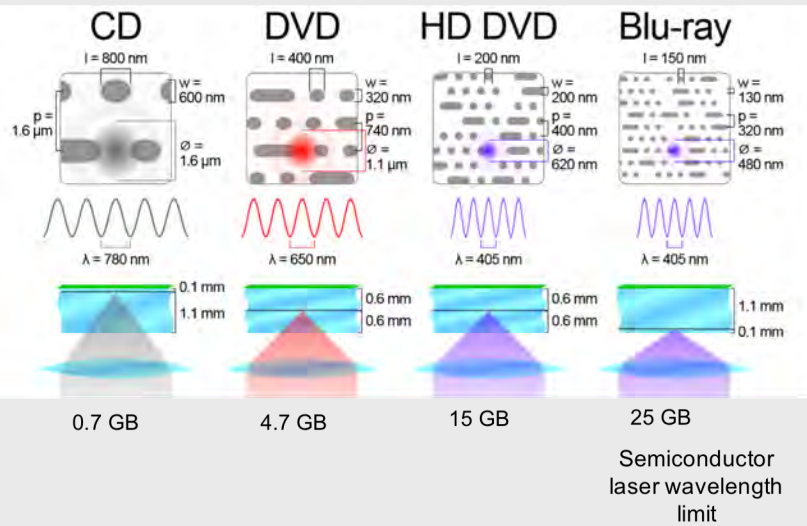
Technology Scaling Limits



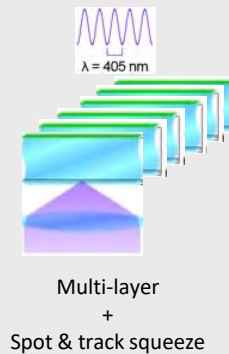
\$/TB not reduced with multi-layer



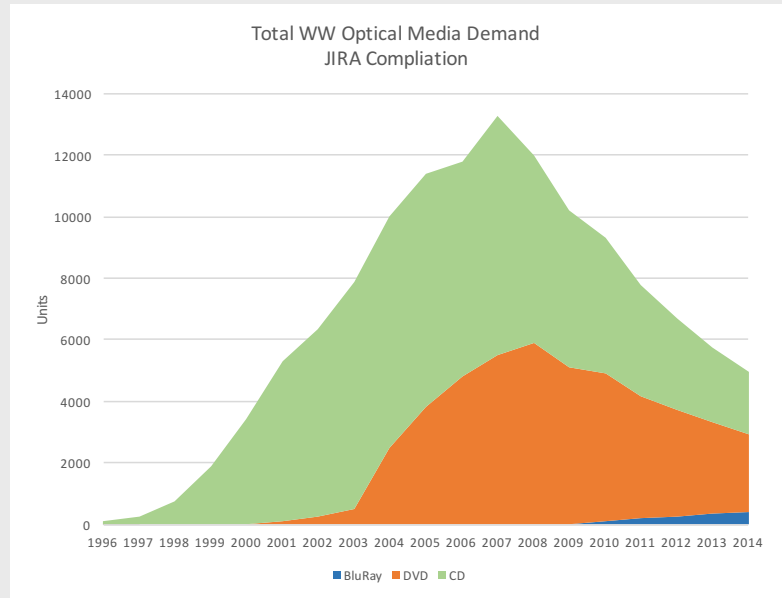
Declining Mfg Media Demand



ODA



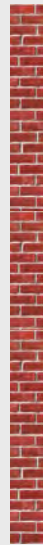
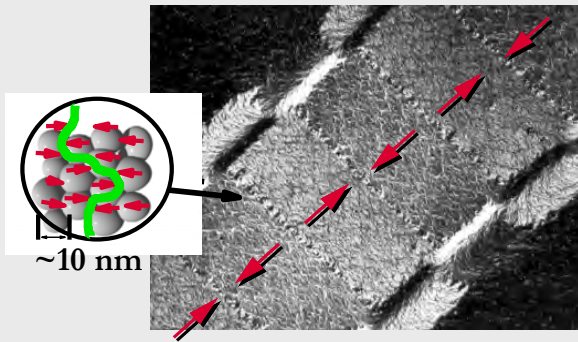
"Comparison CD DVD HDDVD BD" by Cmglee - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons - [http://commons.wikimedia.org/wiki/File:Comparison\\_CD\\_DVD\\_HDDVD\\_BD.svg#/media/File:Comparison\\_CD\\_DVD\\_HDDVD\\_BD.svg](http://commons.wikimedia.org/wiki/File:Comparison_CD_DVD_HDDVD_BD.svg#/media/File:Comparison_CD_DVD_HDDVD_BD.svg)



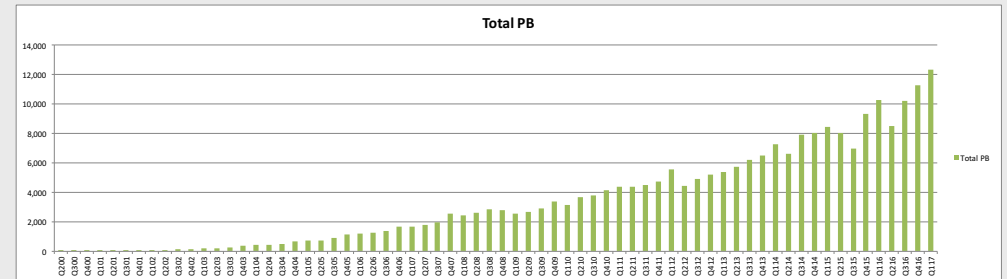
No Data Elves

# Tape Technology Outlook

**NO** Technology Scaling Limits



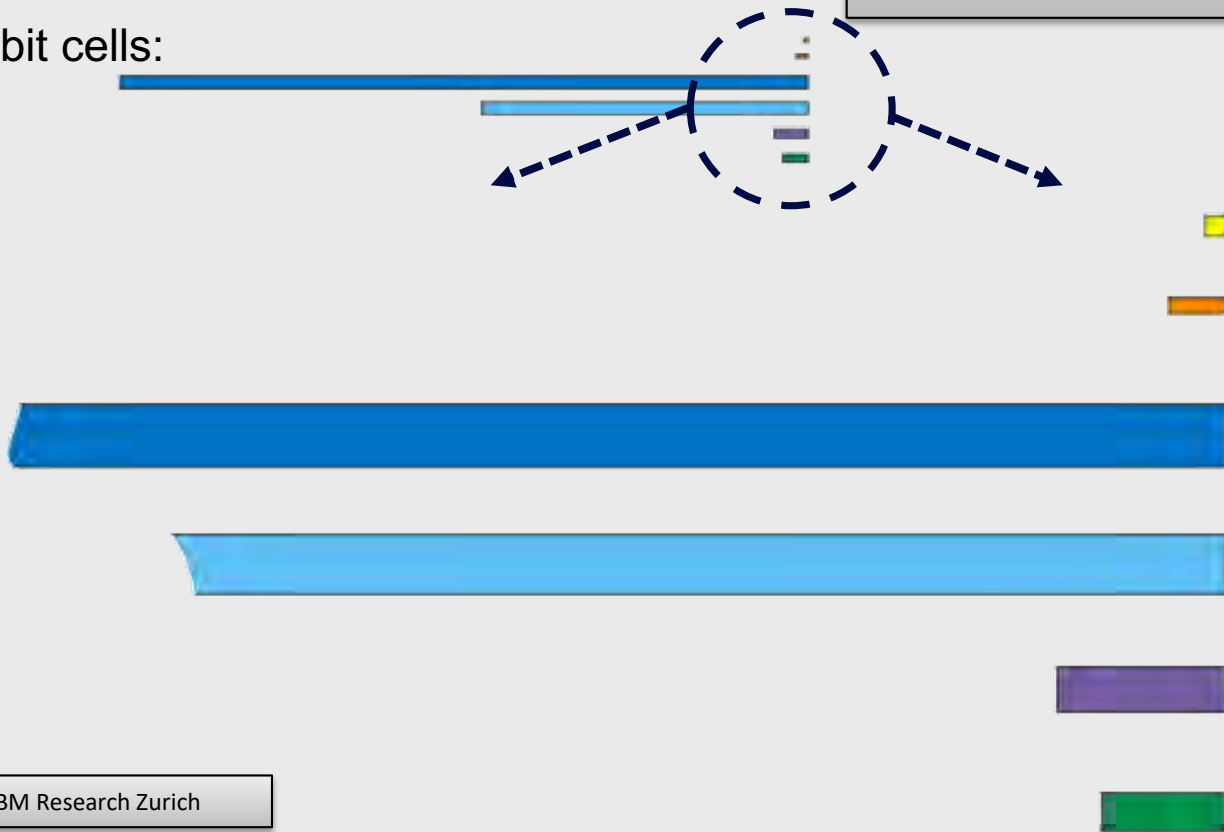
Increasing Consumer Demand



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# Tape Technology Outlook

Scaled bit cells:



Tape Technology Is Unique Among Storage Technologies As It ***Is Not*** Facing Fundamental Scaling Limitations



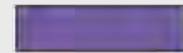
**NAND Flash (3 bits)** 2150 Gb/in<sup>2</sup>  
17.3 nm x 17.3 nm



**HDD** 1000 Gb/in<sup>2</sup>  
47 nm x 13 nm

**LTO8 Tape** ~8.6 Gb/in<sup>2</sup>  
1560 nm x 48.4 nm

**Jag5A Tape** ~9.6 Gb/in<sup>2</sup>  
1347 nm x 50 nm



**BaFe Demo** 123 Gb/in<sup>2</sup>  
140 nm x 37 nm

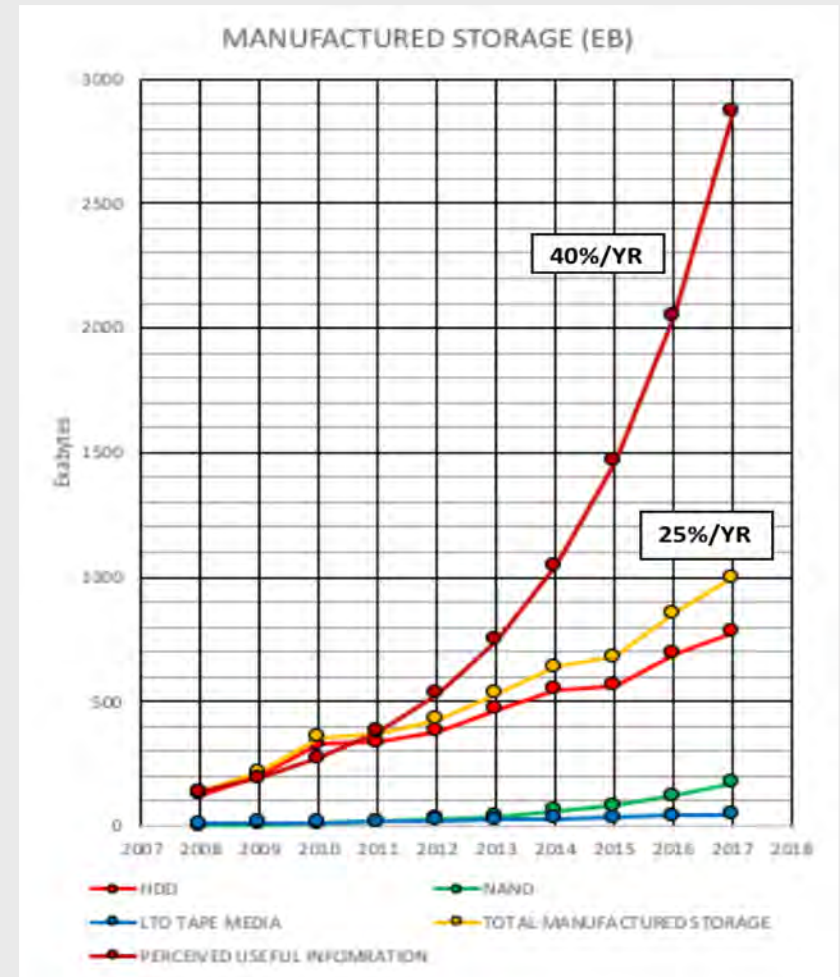
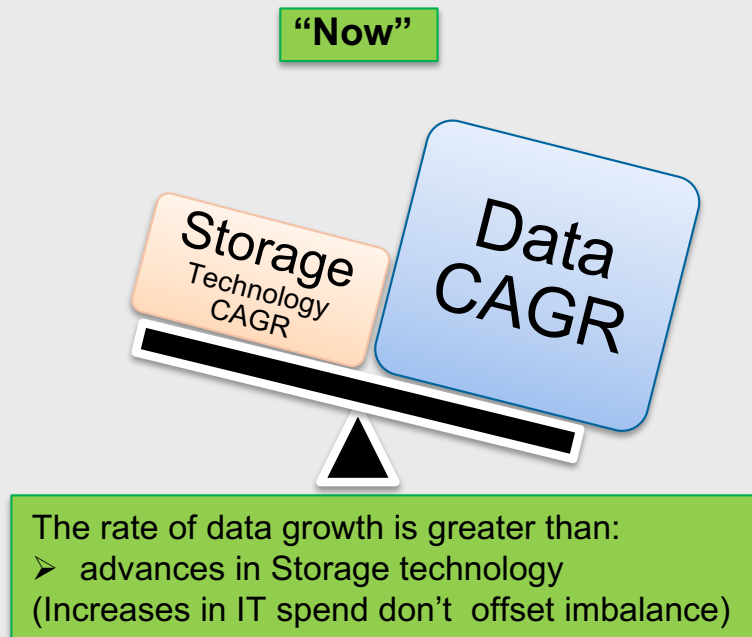


**Sputtered Demo** 201 Gb/in<sup>2</sup>  
103 nm x 31 nm

Mark Lantz – IBM Research Zurich

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## A Fundamental Imbalance



Storage Component Technologies Trends and Future Projections  
Sept 2018 | by [Gary M. Decad](#), [Robert E. Fontana Jr.](#)

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## A Zettabyte Apocalypse !?

Surrounded by blood-thirsty, half-alive, subhuman wretches demanding that you store, preserve and protect all of their data – however banal – you suddenly realize that you are confronting the

**Z-pocalypse!!!**

(Zettabyte Apocalypse)

At that moment, Storage Pro, you realize that your “relevance” is obvious.

Jon Toigo @ DrunkenData.com

Ed Childers 2018 Fujifilm Media Conference

## Data Shortage !?





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## What Are The Options?

- 1) Hope for a storage technology breakthrough
- 2) Pour concrete, spend more \$ on HDD
- 3) Delete Data
- 4) Increase Storage Efficiency



No Data Elves

## What Are The Options?

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No Data Elves

# Storage Technologies Looking Forward

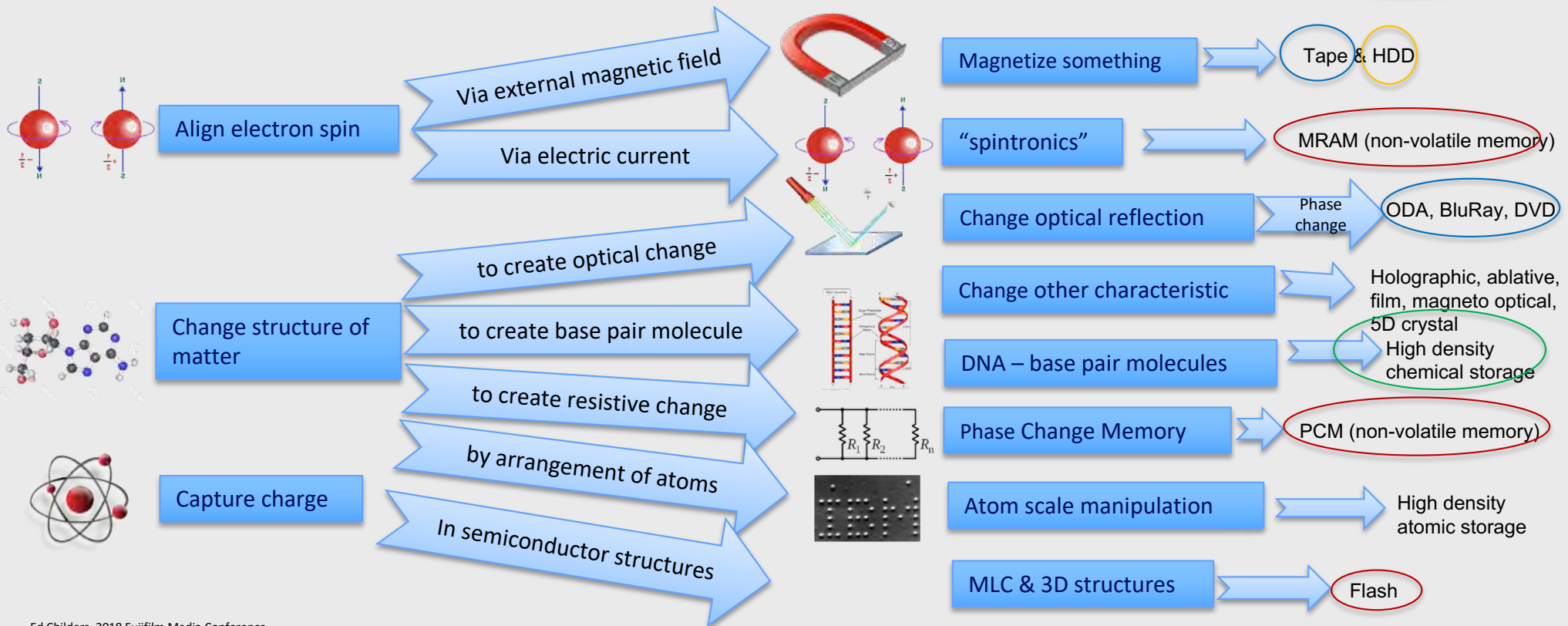
## How do you store a bit? (looking forward)

Low Latency/high perf

Capacity/active

Low cost, archive

Cold/Deep archive



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## Potential Disruptors

### Flash

- Growing at HDD expense
- \$/TB reductions limited going forward

### Macromolecule Base Pair / DNA

- Incredible densities possible - EB/in<sup>3</sup>
- Extreme long life + low power
- Challenges
  - Data Reliability
  - Very Low Reader and Writer speed

### 5D Crystal

- Mult-state optical WORM
- Potential for permanent records, high density
- Challenges
  - Femtosecond lasers, R/W speed

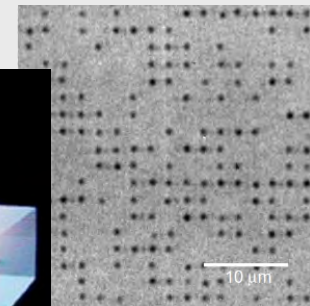
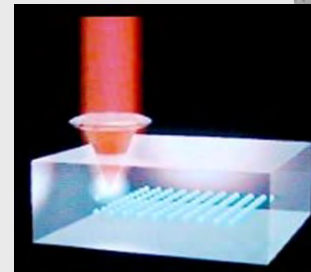
Nothing Near Term Will Impact Total Data CAGR



encoded GIF



recalled GIF



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## What Are The Options?

### 1) Hope for a storage technology breakthrough

- Nothing coming near term

### 2) Pour concrete, spend more \$ on HDD

### 3) Delete Data

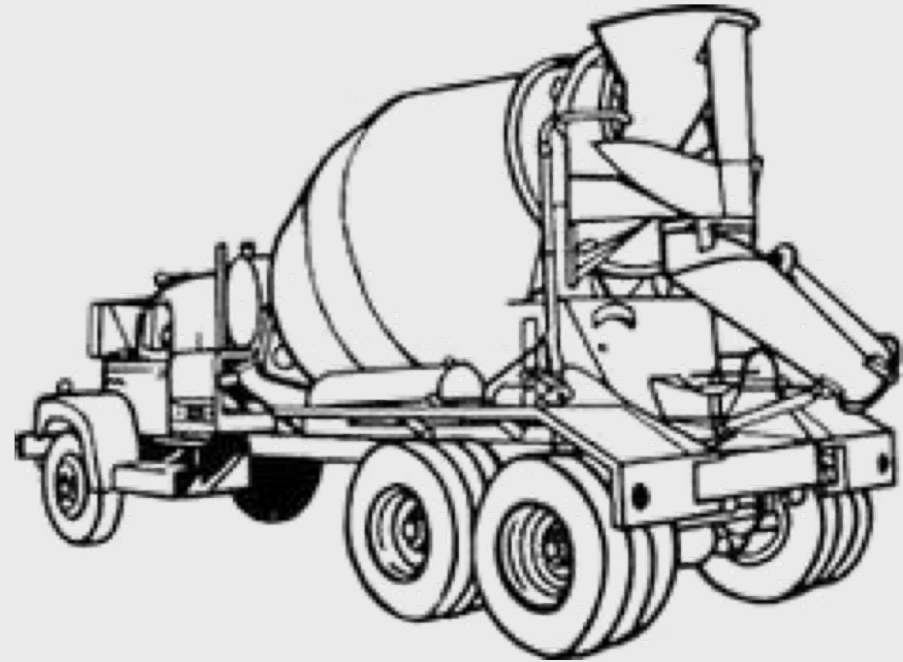
### 4) Increase Storage Efficiency



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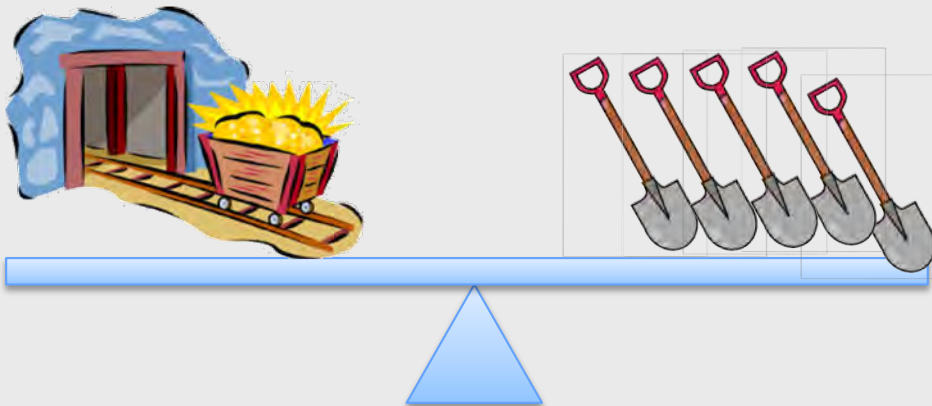


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Is The Value Derived From Data  
Growing at the same rate as Data ?

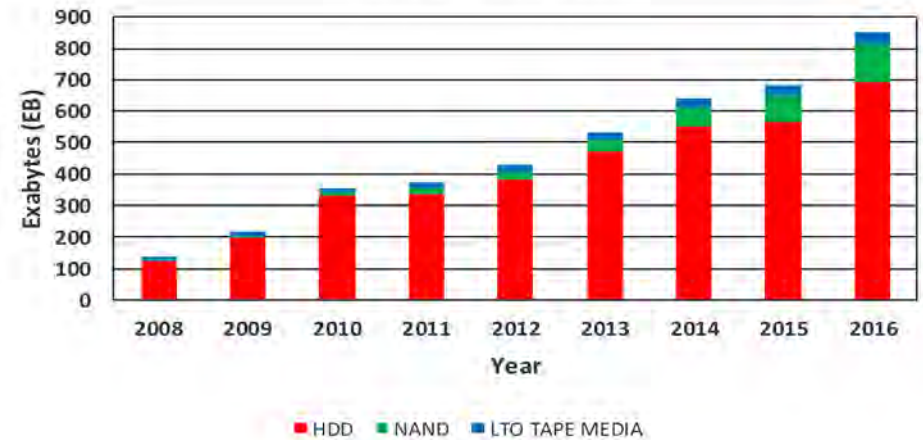
### Mining

Buy shovels until the cost of  
extracting gold ~ value of gold

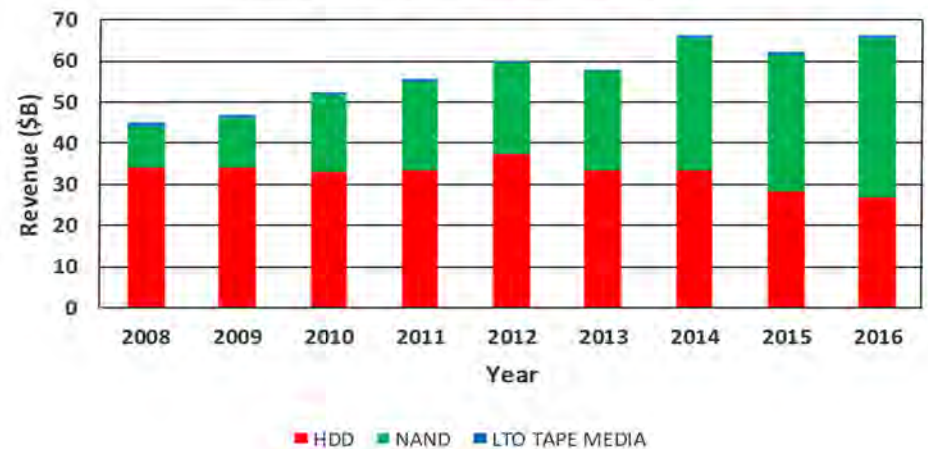


Ed Childers 2018 Fujifilm Media Conference

Manufactured EB



Storage Component Revenue (\$B)



A Look at Cloud Storage Component Technologies Trends and Future Projections

July 2017 | by [Gary M. Decad](#), [Robert E. Fontana Jr.](#)

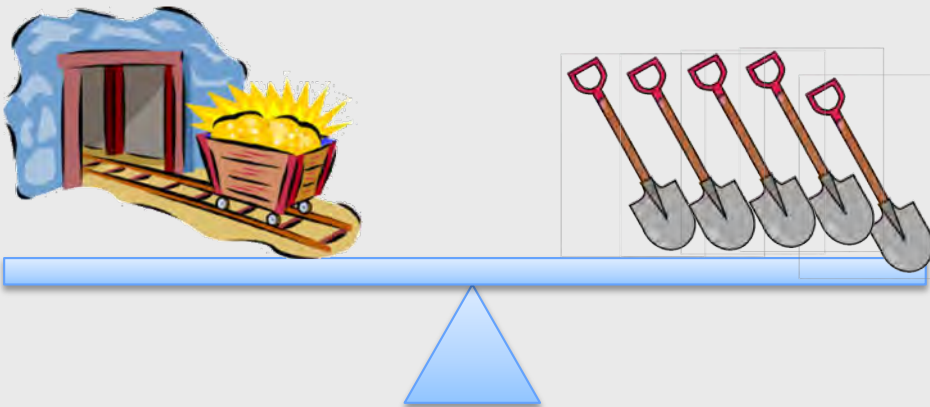
<http://www.ibmssystemsmag.com/mainframe/storage/Support/cloud-trends-projections/>

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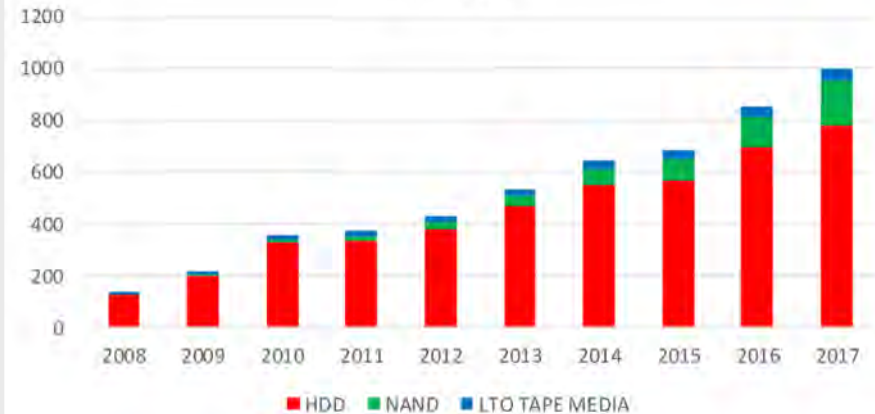
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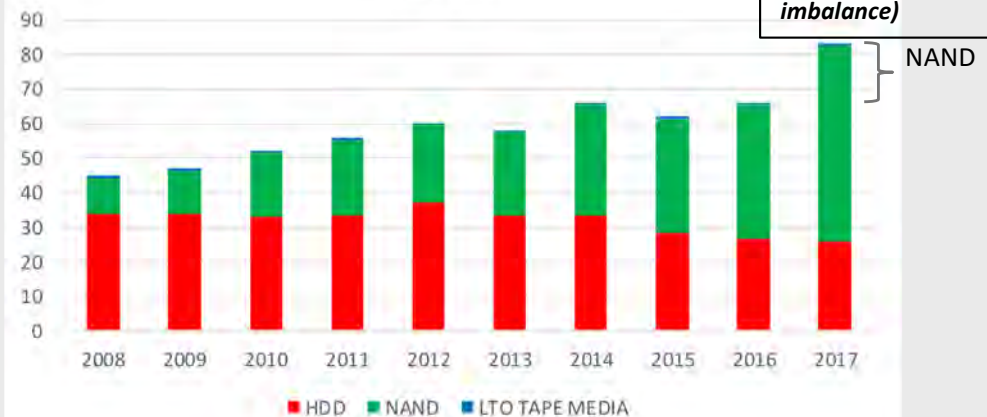


Ed Childers 2018 Fujifilm Media Conference

EB Shipped



Revenue



A Look at Cloud Storage Component Technologies Trends and Future Projections

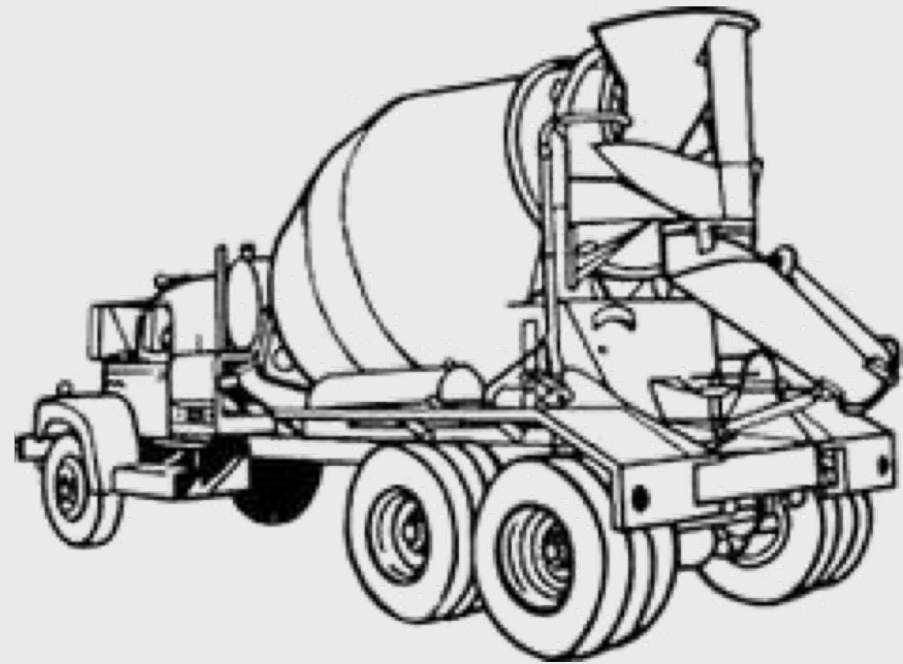
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<http://www.ibmssystemsmag.com/mainframe/storage/Support/cloud-trends-projections/>

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## What Are The Options?

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- 2) **Pour concrete, spend more \$ on HDD**
  - An answer *IF* the value of data is growing
- 3) Delete Data
- 4) Increase Storage Efficiency



No Data Elves

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## The Bits Have No Value

Data is a:

# Currency

representing underlying

# Assets

(currencies can suffer from inflation)



2x Data  $\neq$  2x Asset Value

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## The Bits Have No Value

Data can be distilled only to:

Enlighten

or

Entertain

(are they the same thing?)



2x Data  $\neq$  2x Enlightenment

No Data Elves

Representing an Asset or  
Distilled to Enlightenment

Data Enables a

# Competitive Advantage

(how much is that worth?)



More Data = More Competitive

(it's just not a linear relationship)

No Data Elves

## What Are The Options?

- 1) Hope for a storage technology breakthrough
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  - An answer if the value of data is growing
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  - **Maybe, You go first.**
- 4) Increase Storage Efficiency



No Data Elves

## What Are The Options?

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- 2) Pour concrete, spend more \$ on HDD
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  - Maybe, You go first
- 4) Increase Storage Efficiency**
  - a) Pay someone else to deal with it – ie. Cloud
  - b) Integrate Flash, HDD, Tape & Manage Data Placement





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## Cloud Vendors @ Hyperscale Can:

Pour concrete, spend more \$ on storage

- Flash, HDD, & Tape
- How much more efficient can hyperscale storage be than large on-prem IT?

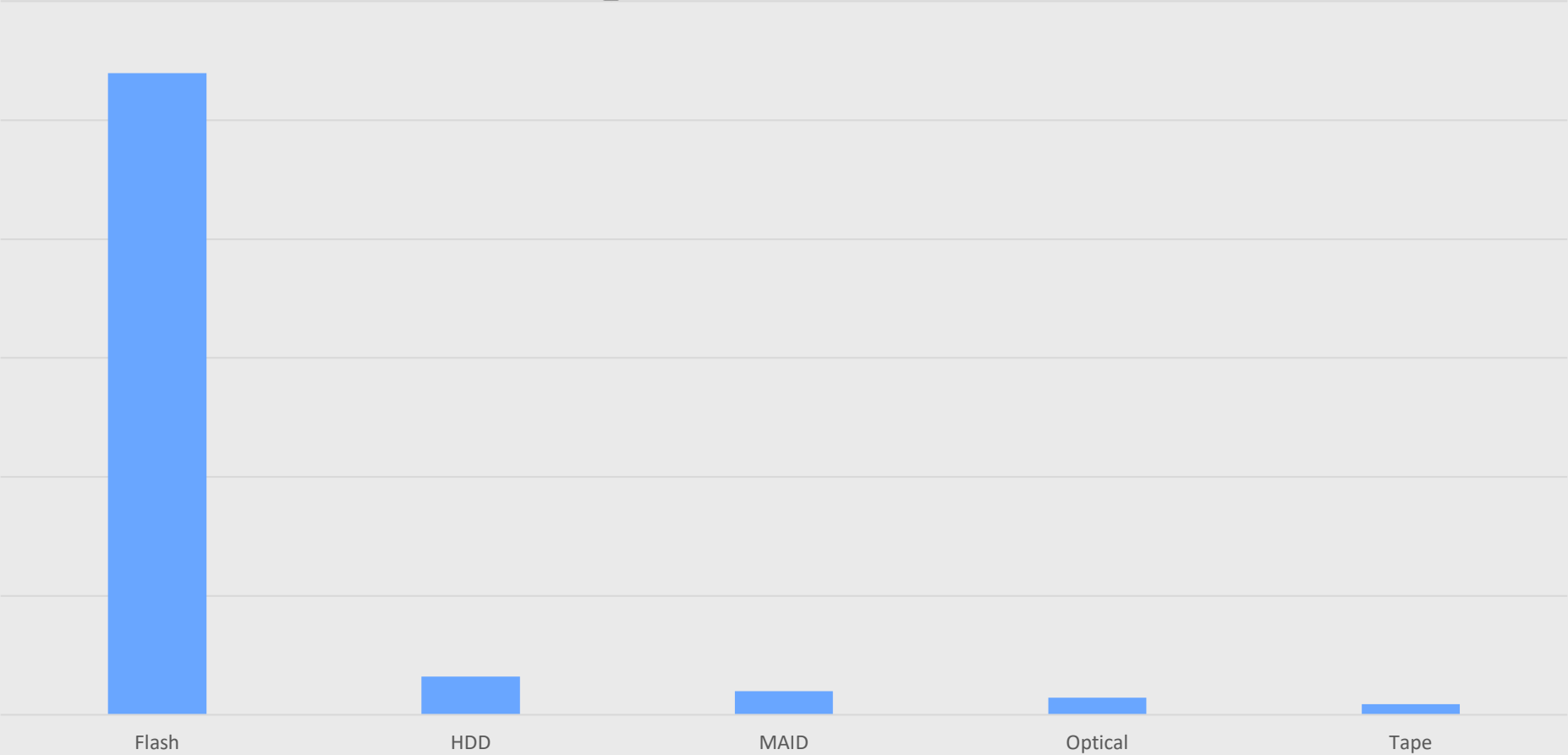
Invest in managing data placement

- Storage Technology data placement by policy
  - aka – SLA vs cost choices



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# Relative Total Cost of Storage At Scale



No Data Elves

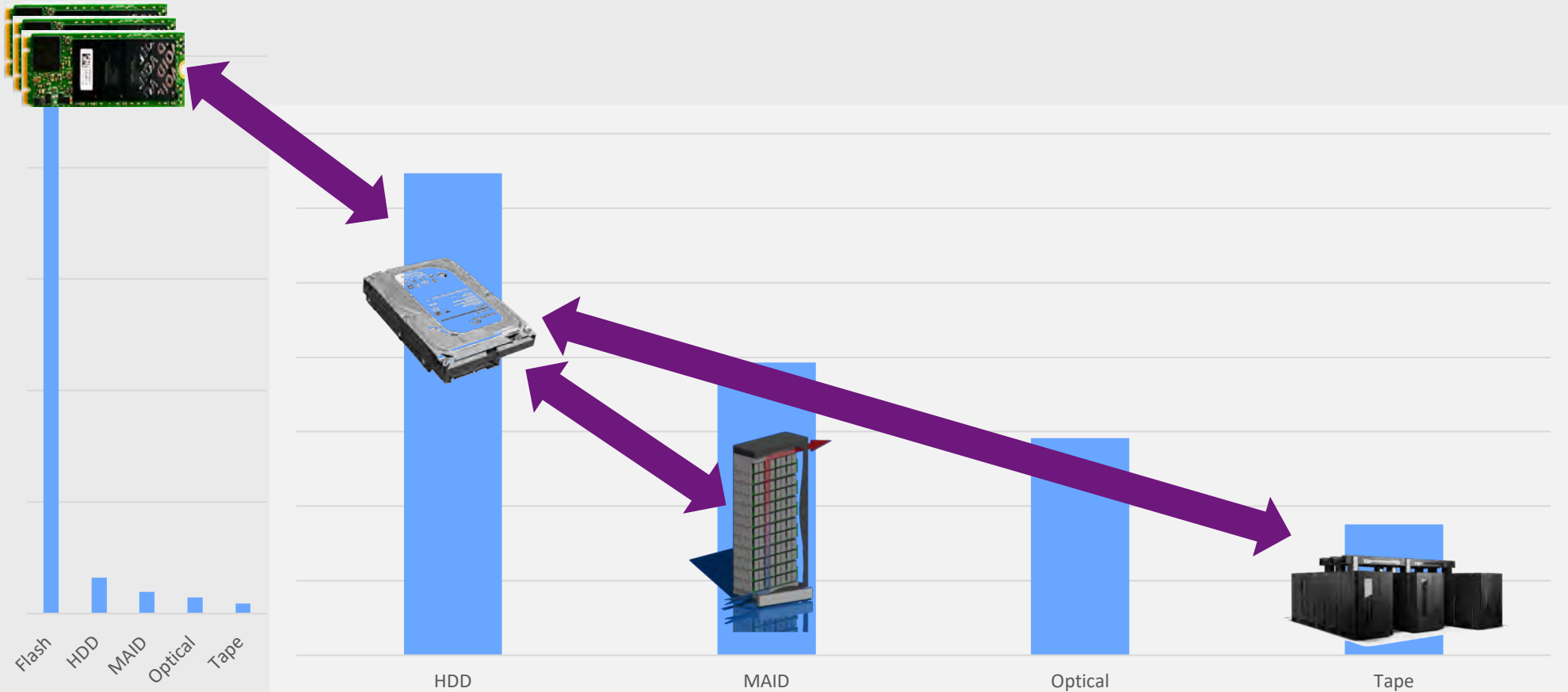
## Relative Total Cost of Storage At Scale





No Data Elves

## Moving Data Between Tiers Can Provide Huge Savings



No Data Elves

## What Are The Options?

### 1) Hope for a storage technology breakthrough

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- An answer if the value of data is growing

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- Maybe, You go first

### 4) **Increase Storage Efficiency**

- a) Integrate Flash, HDD, Tape & Manage Data Placement
- b) Pay someone else to do it – ie. Cloud



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## Get Efficient

### “Future Proof” Your Storage Strategy

- Use of Flash, HDD, & Tape together is essential to scale storage
  - Pay Someone To Do It For You (ie. Cloud)
  - Do It Yourself
    - Spectrum Scale + Spectrum Archive for Flash, HDD, & Tape
    - Open Object via SWIFTHLM+LTFS DM

Either way, data is on Flash, HDD, & Tape

- It’s just who you pay to manage it & how - capex vs opex

So,

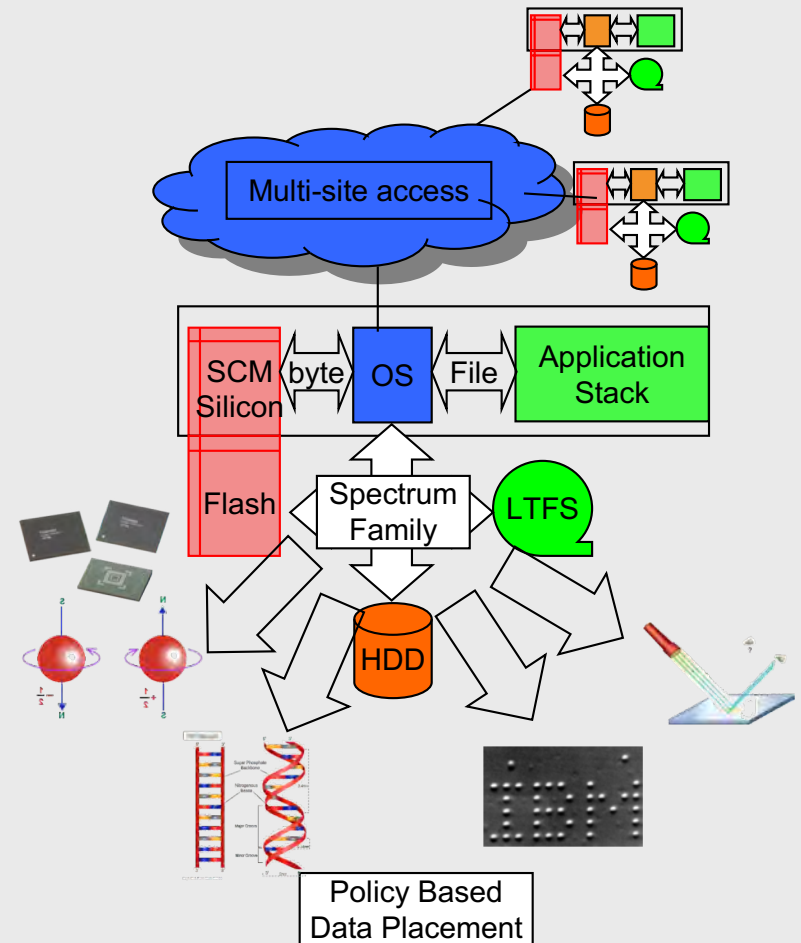
Take advantage of differentiated SLA vs cost

- Cloud or on prem – same thing

Be ready for the Re-emergence of the Data Lifecycle Mgmt

- though very cold storage could become the place data goes to die

## Technology Agnostic Storage



# Thank you

Ed Childers

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STSM, Manager Storage Development

—

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