



# IBM Storage Trends and Portfolio

Thomas Bish

Master Inventor  
Principal Architect – Client Engineering  
IBM Senior Technical Staff Member

[tbish@us.ibm.com](mailto:tbish@us.ibm.com)



# Meeting Agenda

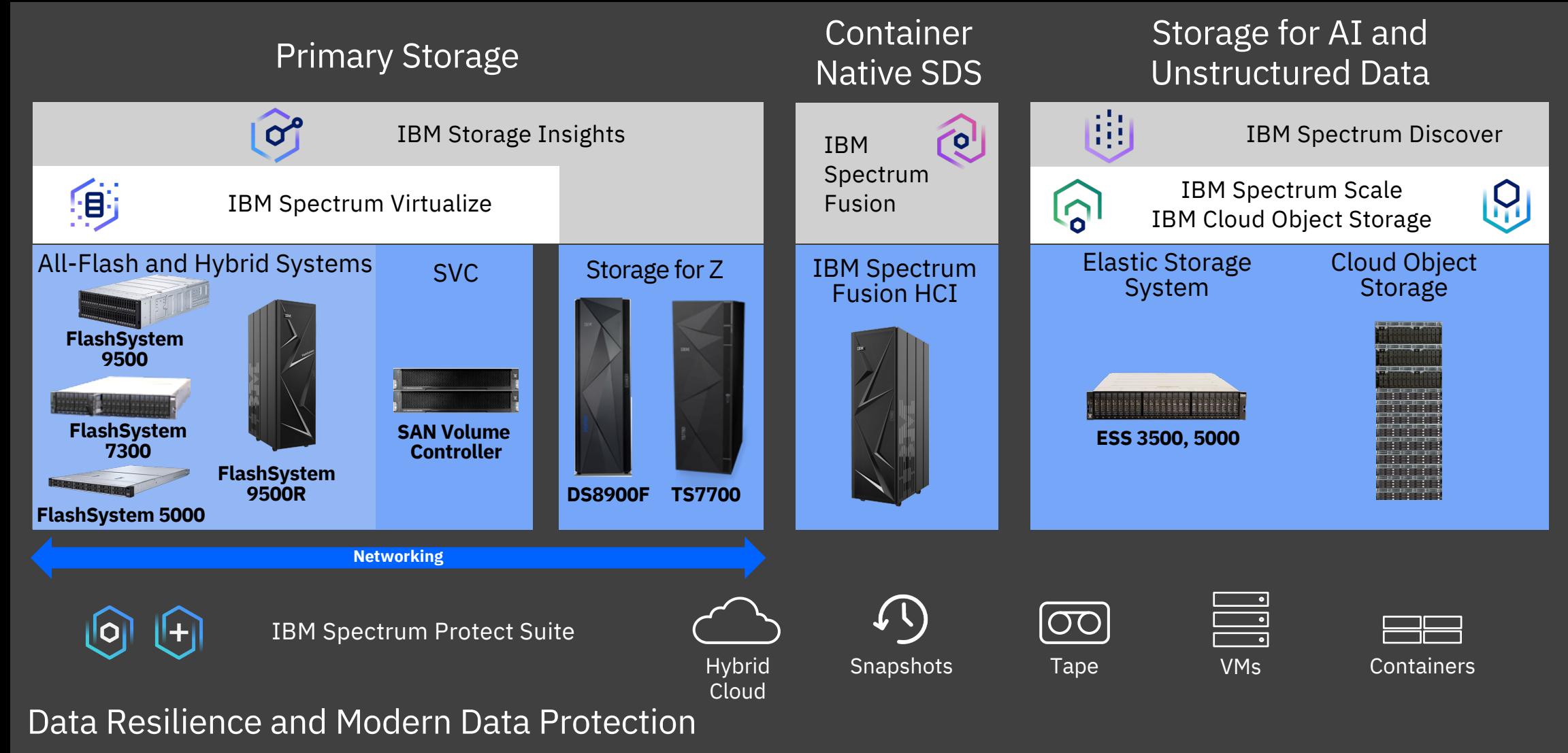
- **IBM Storage Overview**
  - Primary Storage with Flash
  - Container storage – Application modernization
  - Storage for AI and Big Data
  - Tape Drives and Libraries

## 5 Hot Storage Trends

1. Continued adoption of Flash, SCM and NVMe
2. Leverage Hybrid multicloud
3. Modernization:
  - Applications, automation and data protection
4. Incorporating AI everywhere
5. Security - Cyber Resiliency

# IBM Award-Winning Storage Portfolio

## Driving Hybrid Cloud and Container Deployments



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# IBM FlashSystem Family

Storage  
made simple  
for hybrid  
cloud

## Entry



FlashSystem 5000



FlashSystem 5200

## Midrange



FlashSystem 7300



**5200 through 9500 use IBM Differentiated Flash! The FlashCore Modules (FCM)!**

## High-End Enterprise



FlashSystem 9500  
and 9500R

SAN Volume  
Controller (SVC)  
SV3

## Hybrid Cloud



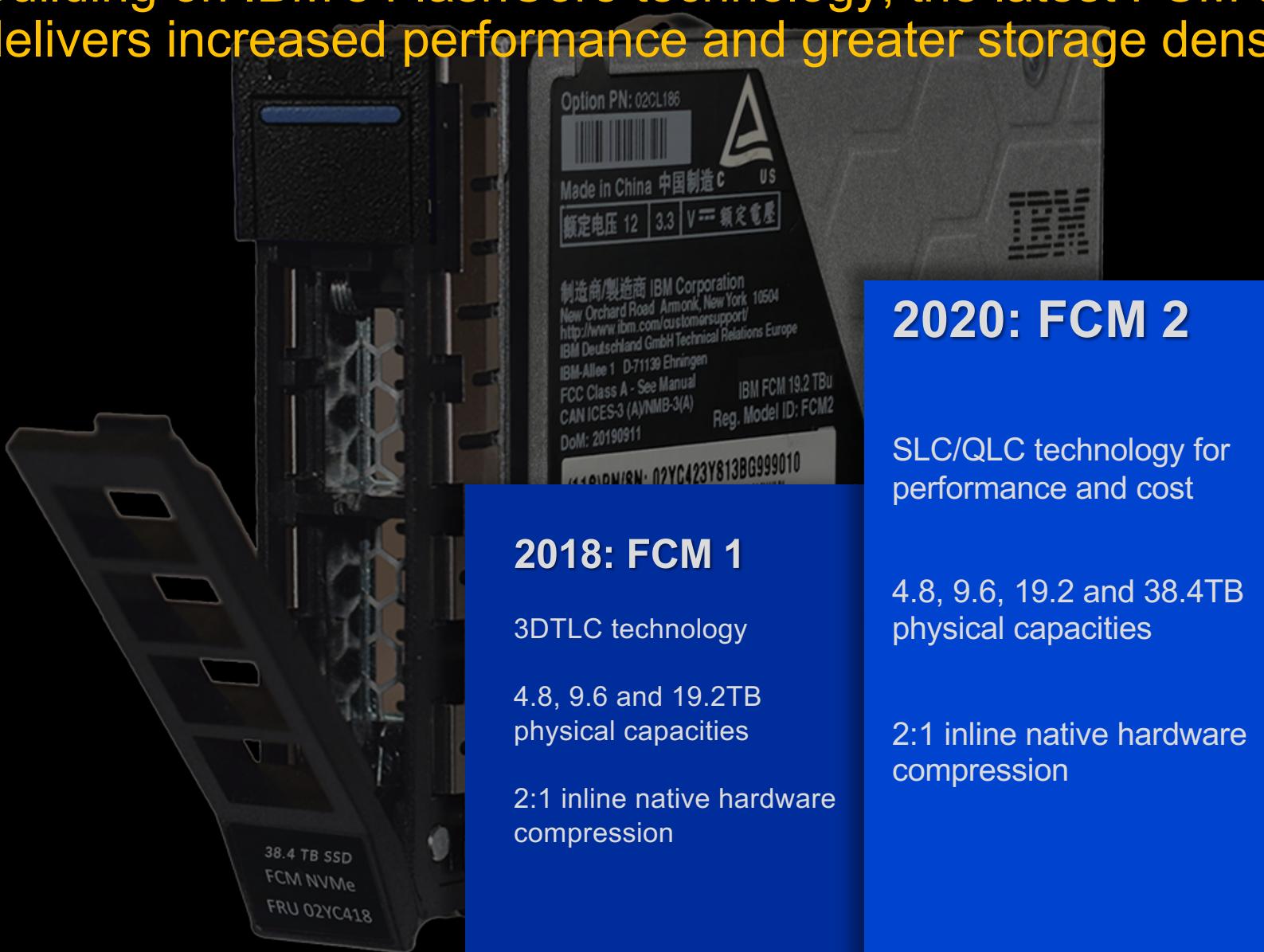
Spectrum Virtualize  
for Public Cloud  
(SV4PC)

IBM Spectrum Virtualize

**Consistent software capabilities**

# A new FlashCore Module 3

Building on IBM's FlashCore technology, the latest FCM 3 drive delivers increased performance and greater storage density



## 2018: FCM 1

3DTLC technology

4.8, 9.6 and 19.2TB physical capacities

2:1 inline native hardware compression

## 2020: FCM 2

SLC/QLC technology for performance and cost

4.8, 9.6, 19.2 and 38.4TB physical capacities

2:1 inline native hardware compression

## 2022: FCM 3

Same SLC/QLC technology

4.8, 9.6, 19.2 and 38.4TB physical capacities

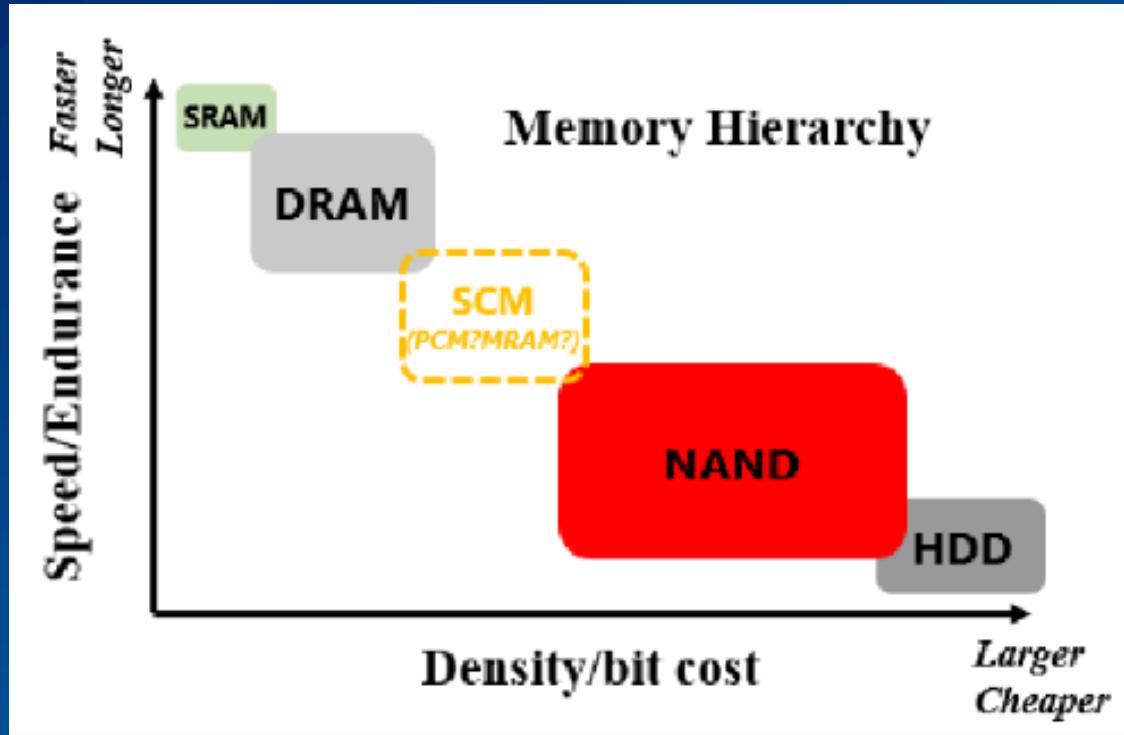
Expanded metadata management delivers up to 3:1 effective to usable ratio improvement with no performance penalty

*22, 29, 58, 115TB effective capacities*

*Significantly increased throughput*

***FlashSystem 5200, 7300 and 9500***

# IBM FlashSystem support for Storage Class Memory (SCM)



Storage Class Memory (SCM) is a term that is used to describe non-volatile memory devices that perform faster ( $\sim 10\mu\text{s}$ ) than traditional NAND SSDs ( $100\mu\text{s}$ ), but slower than DRAM ( $100\text{ns}$ ).

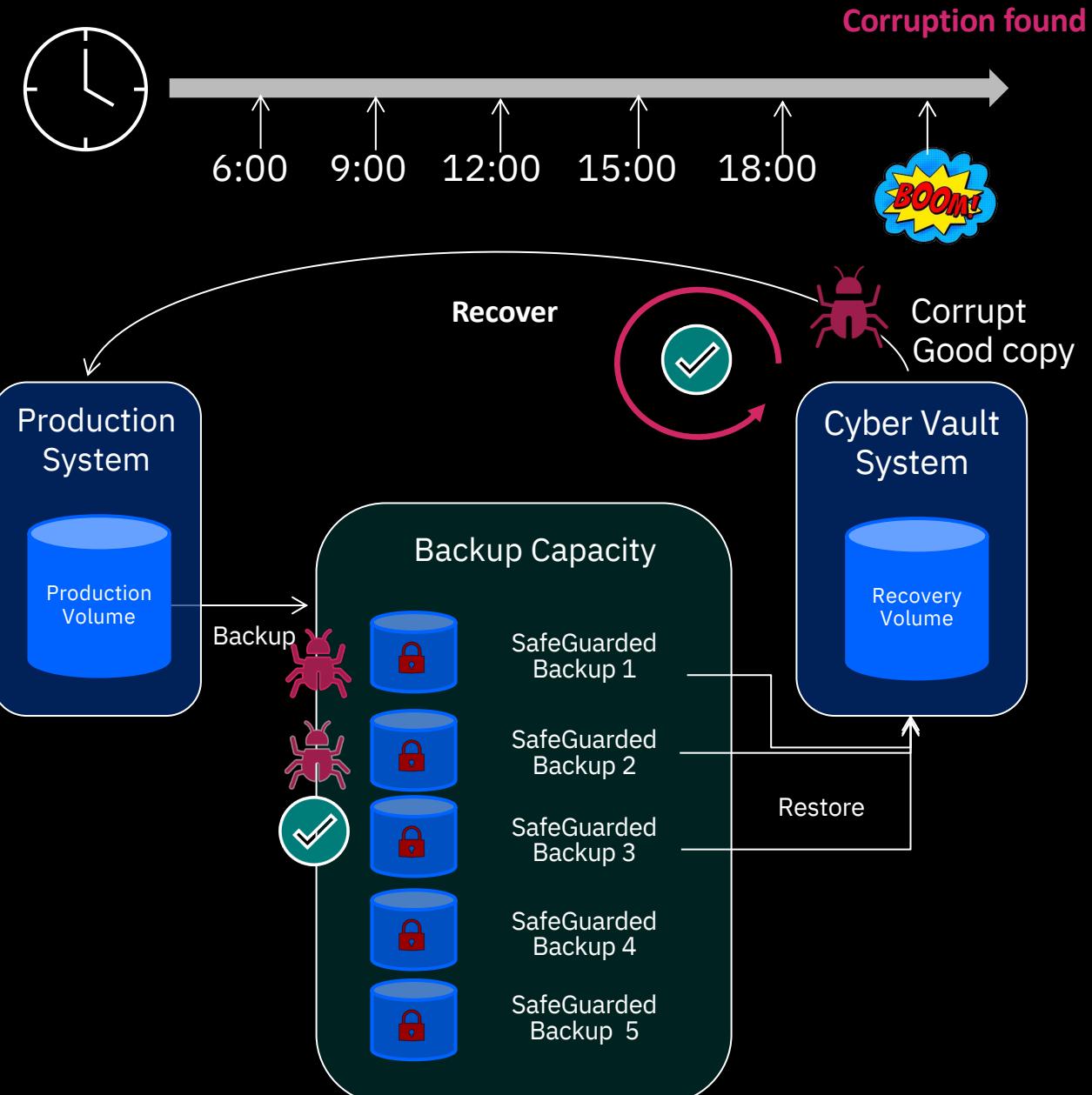
IBM FlashSystem supports SCM drives that are built on two different technologies:

- 3D XPoint technology from Intel, developed by Intel and Micron (Intel Optane drives)
  - Capacities 0.35 TB and 0.75 TB
- zNAND technology from Samsung (Samsung zSSD)
  - Capacities 0.80 TB and 1.80 TB

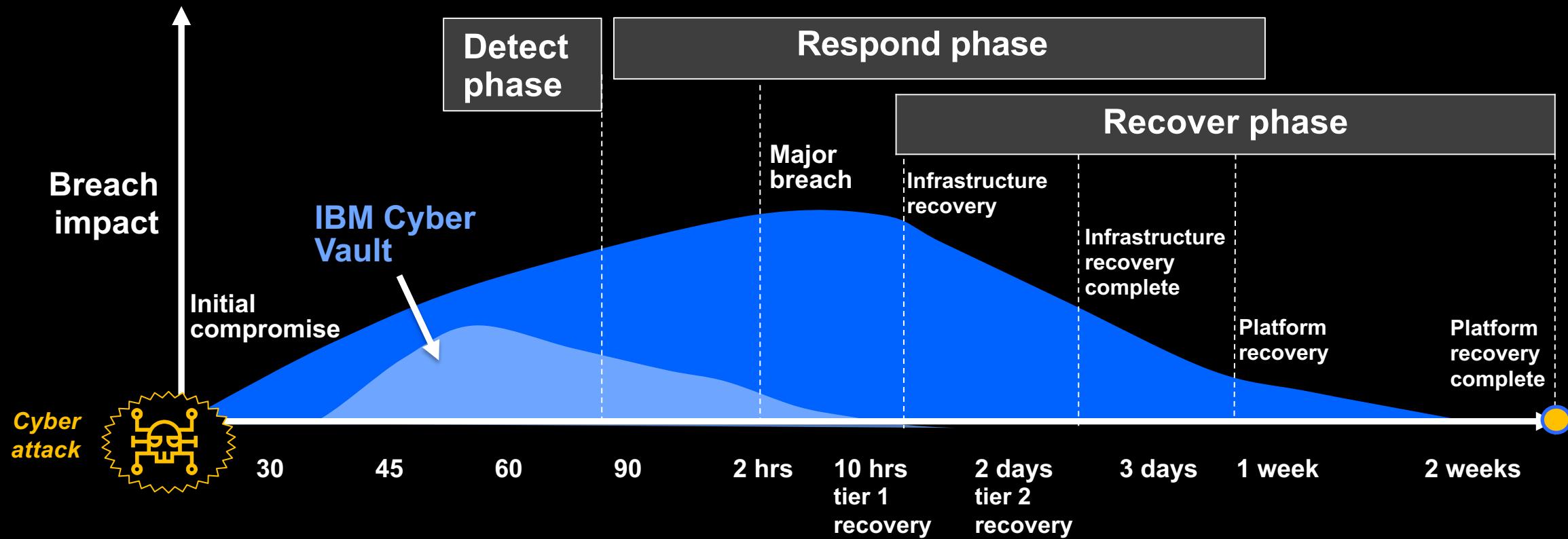
Up to 12 SCM drives supported with IBM Spectrum Virtualize 8.4.0 level

# IBM Storage Virtualize provides Safeguarded Copy

- **Logical Corruption Protection** to prevent sensitive point in time copies of data from being modified or deleted due to errors, destruction or ransomware
- Up to **15864 objects** to provide **immutable Safeguarded copies** of production data stored in Safeguarded backup capacity known as a Child Pool
  - Not directly accessible to any server or application
- Data is accessible *only* after a Safeguarded copy is **recovered to a separate recovery volume**.
- **Proactive monitoring** for signs of attack
  - Identify Safeguarded Volume to recover based on time index of identified attack
- Recovery volumes are used for:
  - Data validation
  - Forensic analysis
  - Restoration of production data



# Speed recovery to significantly reduce the impact of breaches



Due to the Cyber Vault environment and the use of SafeGuarded Copy technology, data is continuously checked and corruption is found and can be corrected fast. Leading to a shorter impact time

(Remark: timeline is an example, however based on real client experience)

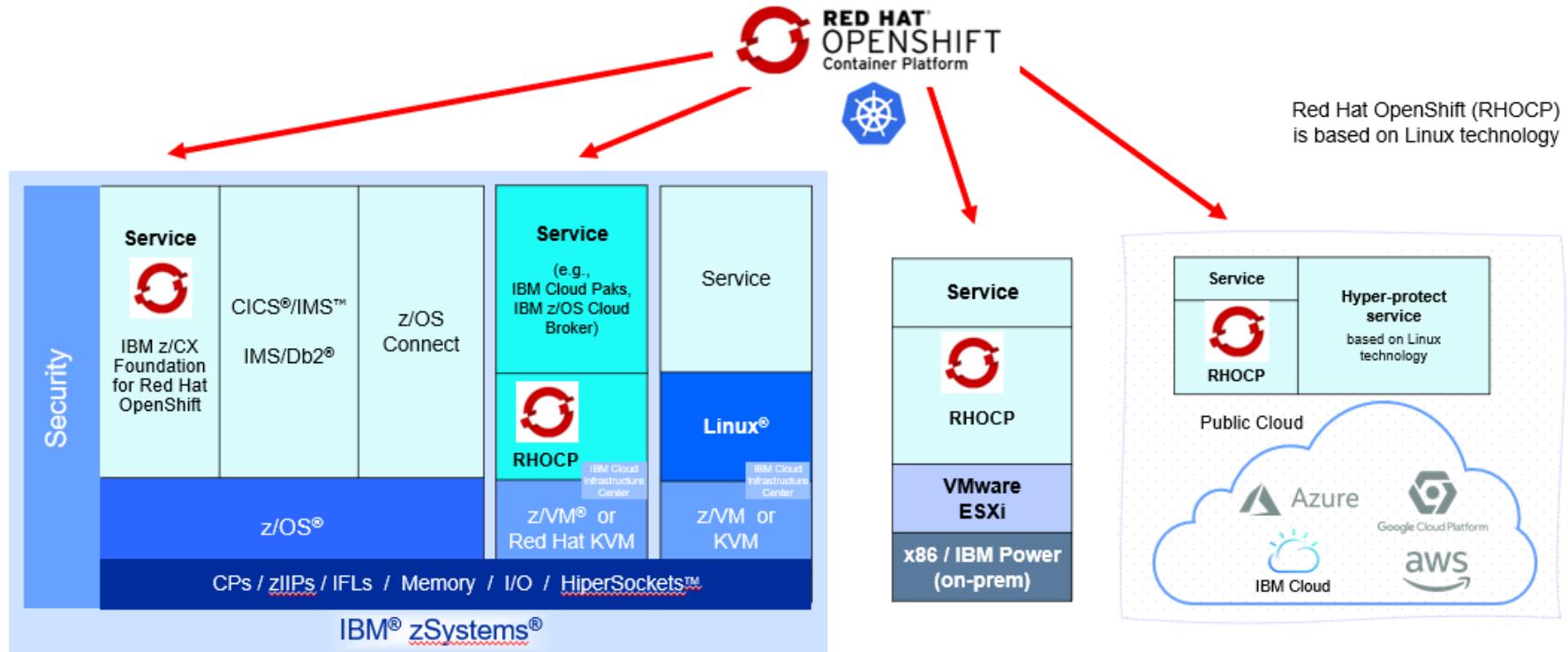
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# The vision of hybrid cloud with Red Hat OpenShift

Hybrid workloads and multiple Red Hat OpenShift clusters can run in parallel on a physical IBM zSystems server.

Adapt enterprise DevOps with consistent, cloud native development, and CI/CD tooling.



# IBM zSystems platform capabilities

## Efficient & effective management

- Designed to conserve energy and achieve sustainability goals
- Scale up horizontally, vertically or both
- Fewer IT components require less maintenance

## *Scalability and agility*

## Unmatched reliability and resiliency

- Tamper-proof firmware provides multitenant workload isolation (EAL5+)
- Concurrent hardware repair, replace, and upgrade
- 99.99999% platform uptime and reliability

## *Business continuity*

## Industry leading security

- etcd encryption (including k8s secrets)
- Traffic encryption for routes with FIPS 140-2 level 4
- On-chip cryptography
- Secure Execution to protect from insider threat

## *Confidential computing*

## Industry leading performance

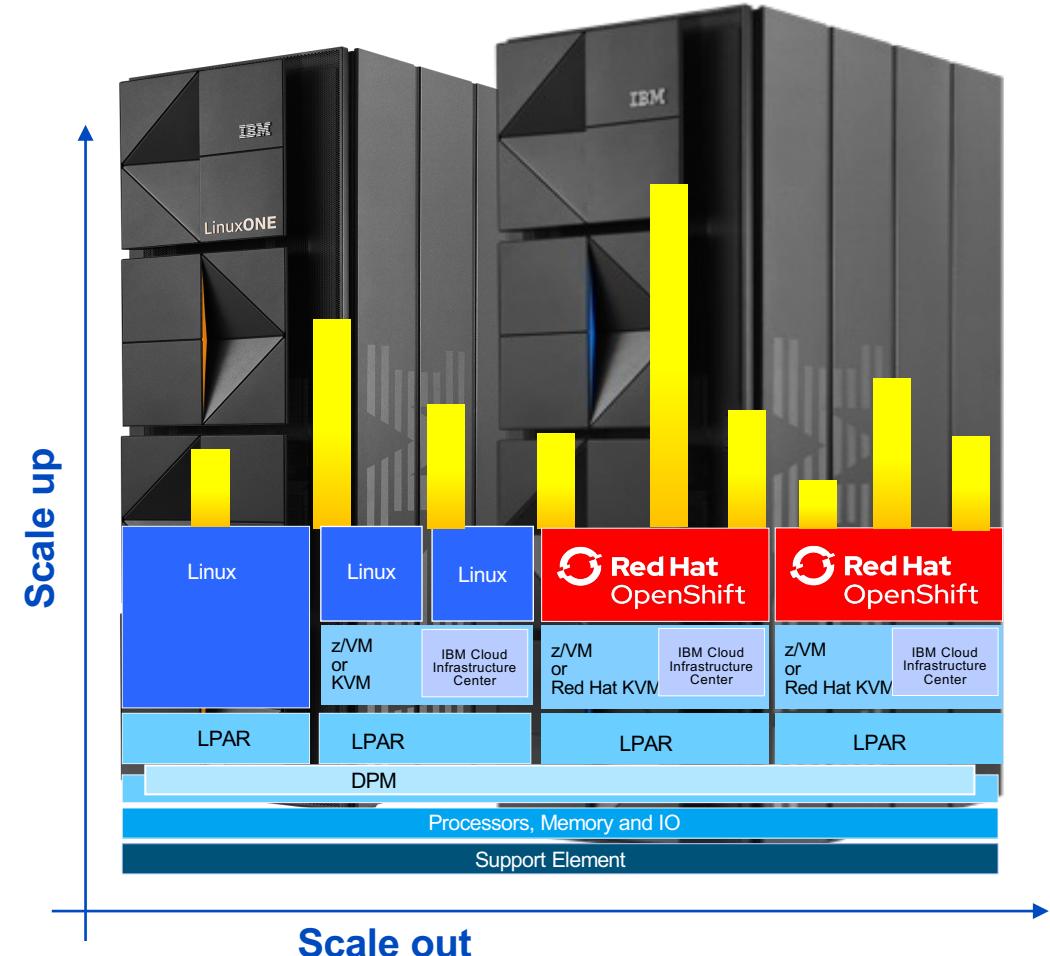
- Up-to 25 billion encrypted transactions per day
- Up-to 4.2x more throughput through colocation
- Fast internal connections

## *Low latency*

# Cost optimization of containerized workload

- High workload density / server capacity
- Fewer IT components require less maintenance
- High resource utilization helps on less software license costs
- Unique arrangements for administration, security, backup and DR
- Transparent exploitation of on-chip accelerated AI, compression, and encryption

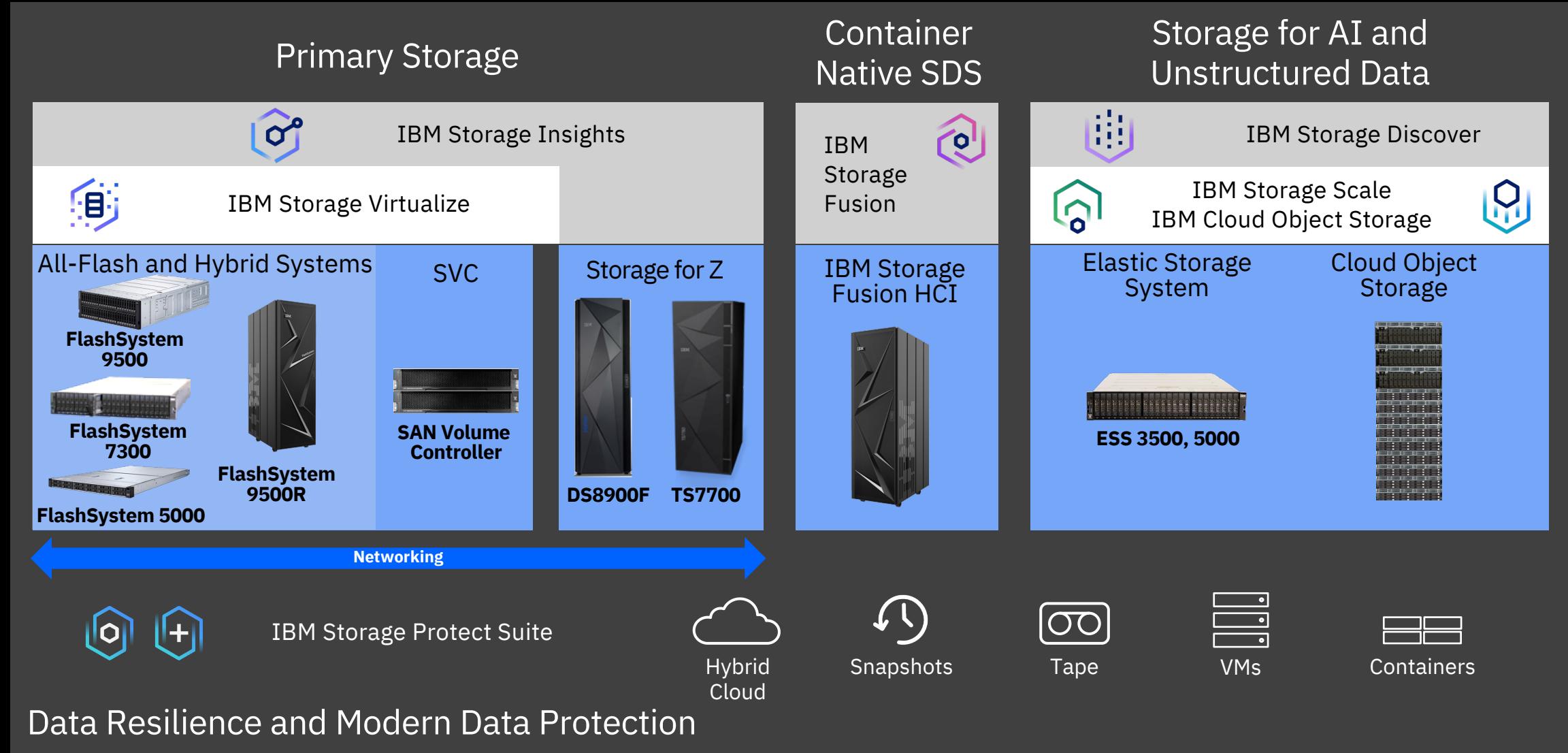
Accessing your database while running an OLTP workload on Red Hat OpenShift Container Platform, requires up to **3.6x fewer cores** running your workload when co-located on IBM z16 versus running the workload on compared x86 platform connecting remotely to the IBM z16.\*



\* This is an IBM internal study designed to replicate banking OLTP workload usage in the marketplace deployed on Red Hat OpenShift Container Platform (OCP) 4.9 on IBM z16 using z/VM versus on compared x86 platform using KVM accessing the same PostgreSQL 12 database running in a z16 LPAR. IBM z16 configuration: The PostgreSQL database ran in a LPAR with 12 dedicated IFLs, 128 GB memory, 1TB IBM FlashSystem 900 storage, RHEL 7.7 (SMT mode). The Compute nodes ran on z/VM 7.2 in a LPAR with 8 dedicated IFLs, 188 GB memory, DASD storage, and OSA connection to the PostgreSQL LPAR. The OCP Proxy server ran in an LPAR with 1 IFL, 4 GB memory and RHEL 8.5. x86 configuration: The Compute nodes ran on KVM on RHEL 8.5 on 32 Cascade Lake Intel® Xeon® Gold CPU @ 2.30GHz with Hyperthreading turned on, 192 GB memory, RAID5 local SSD storage, and 10GbE Ethernet connection to the PostgreSQL LPAR. Both systems are delivering equal throughput. Results may vary.

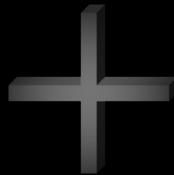
# IBM Award-Winning Storage Portfolio

## Driving Hybrid Cloud and Container Deployments



# IBM Storage Fusion

Unlocking the Full Potential of Red Hat OpenShift



- Application portability**
- Security, resiliency, and backup**
- Integration with existing storage**
- Enterprise hardened**
- Infrastructure elasticity, agility**
- Data discovery and sharing**



# IBM Storage Fusion

**Container data services** that are *simple to use, consistent everywhere, strategic*

- **Protect application data**

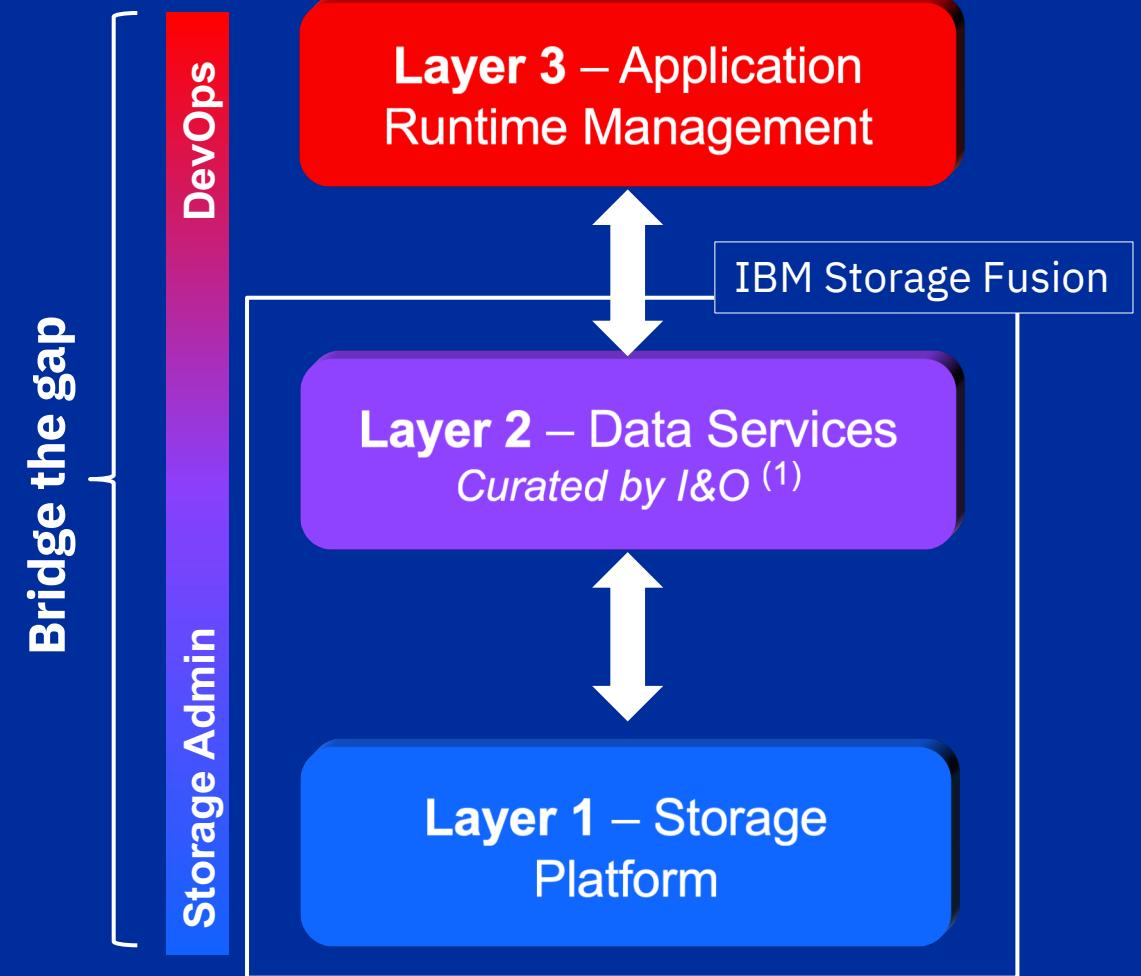
*Configure application backup policies; recover applications to any point in time*

- **Ensure application availability**

*Configure cross-zone data replication; manage availability with policies to RPO / RTO objectives*

- **Access any data, anywhere**

*Manage access to data with policies; connect applications to any data source, anywhere*



# IBM Storage Fusion with two deployment options: *OpenShift Appliance* or *Stand-alone software*



## IBM Storage Fusion HCI *Storage Fusion data services platform*



Bare-metal Red Hat  
OpenShift cluster-in-a-box

## IBM Storage Fusion *Stand-alone software*



X86 Bare Metal

zSystem

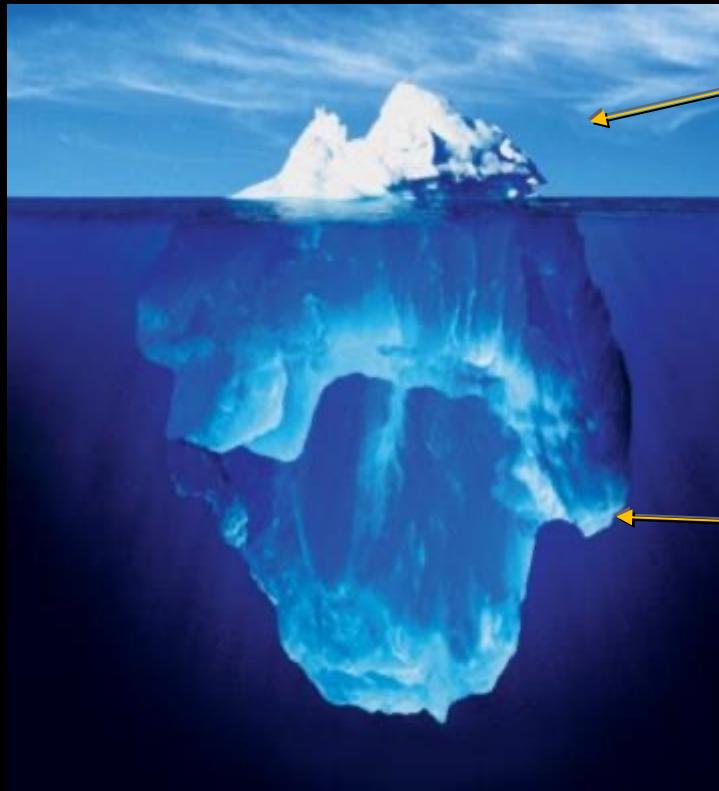


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# The Problem with Big Data

## Your Data



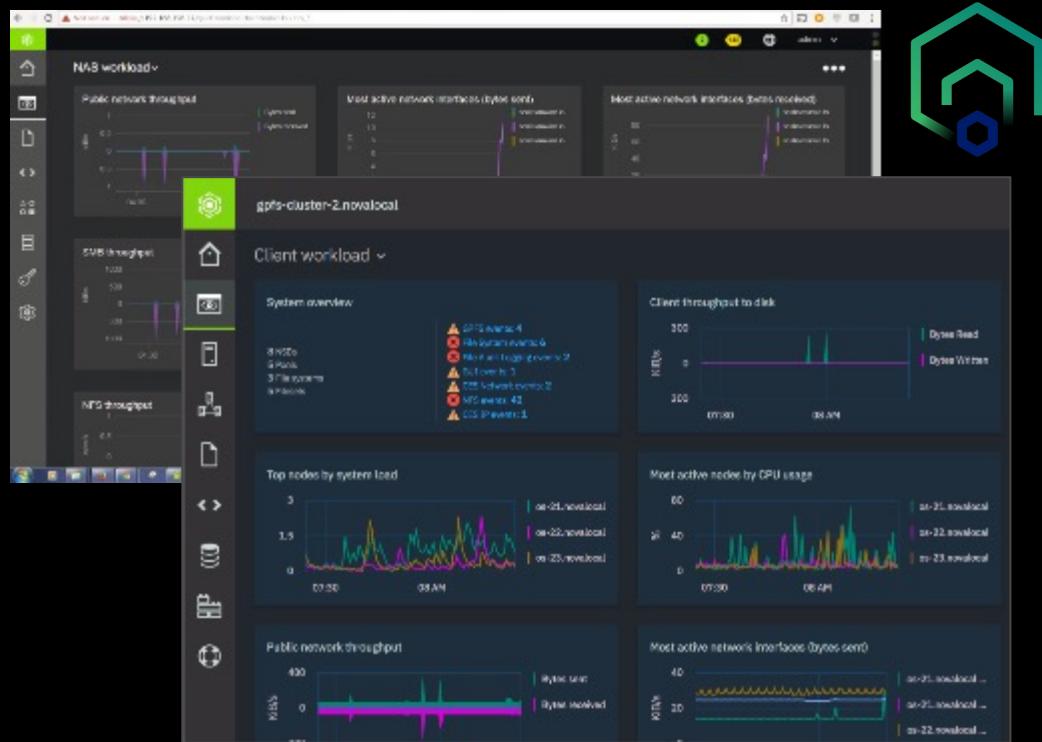
- High Speed Random Access
- Minimal response time required
- Frequent access
- I/O intensive



- Rarely, if ever accessed
- Minimal response time required

# IBM Storage Scale

Drive innovation and create flexibility with global data services and high-performance global data access



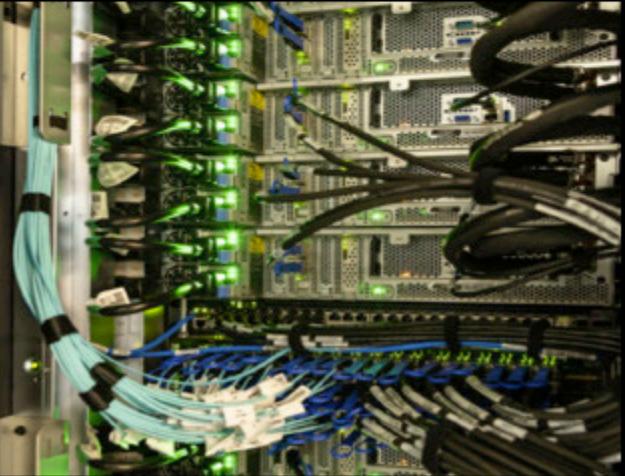
- Parallel high-performance for faster results
- Access data anywhere for agility
- Simplicity at scale for growing requirements
- Enterprise data services to protect and secure your data
- Data efficiency to lower cost
- Container native storage to bring high performance global data for modern workloads
- Transparently simplify HDFS access and optimize big data workloads with global data access and enterprise data services

# Nothing else like it. Not even close.



## Summit & Sierra by the numbers

2 of Top 10 most powerful supercomputers,  
built for AI

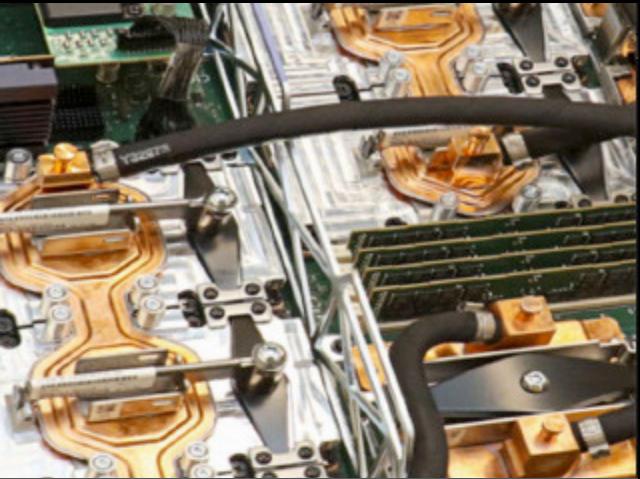


Together, more than  
**44,000 NVIDIA GPUs**

**400 PB**  
of IBM Storage

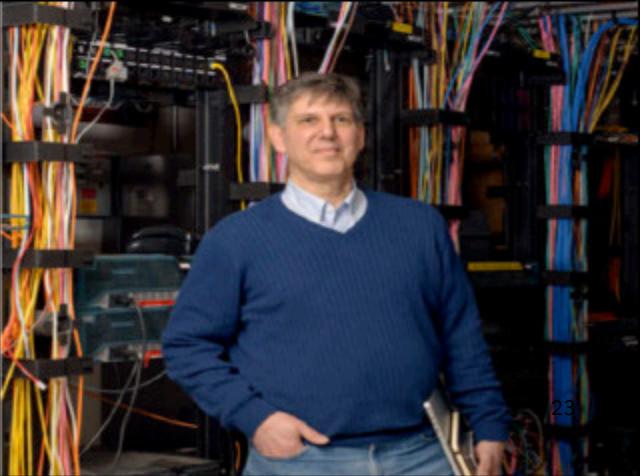


**2.5 TB/sec**  
single stream IOR



**2.6 Million**  
32K file creates/sec

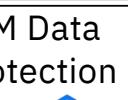
**50K creates/sec**  
per shared directory



**Single Node 16 GB/sec**  
sequential read/write

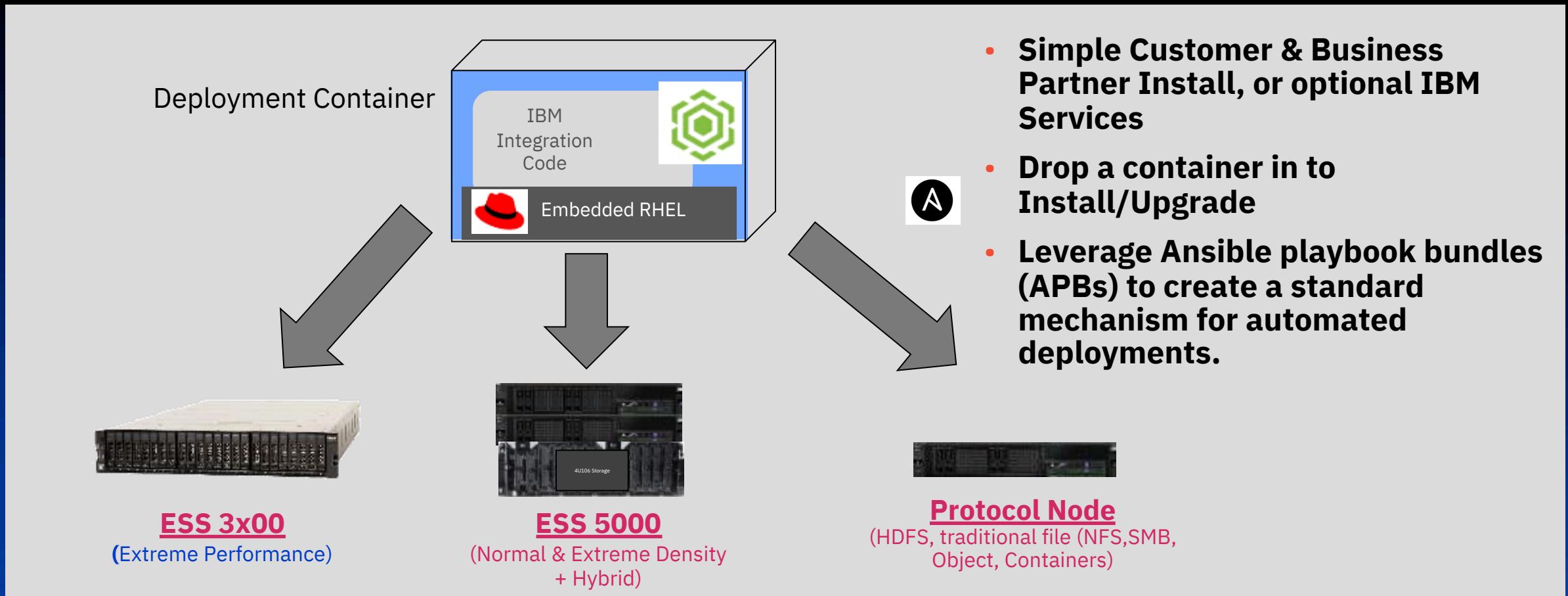
**1 TB/sec**  
1MB sequential  
read/write

# Lower infrastructure costs by data consolidation with a hybrid cloud information architecture

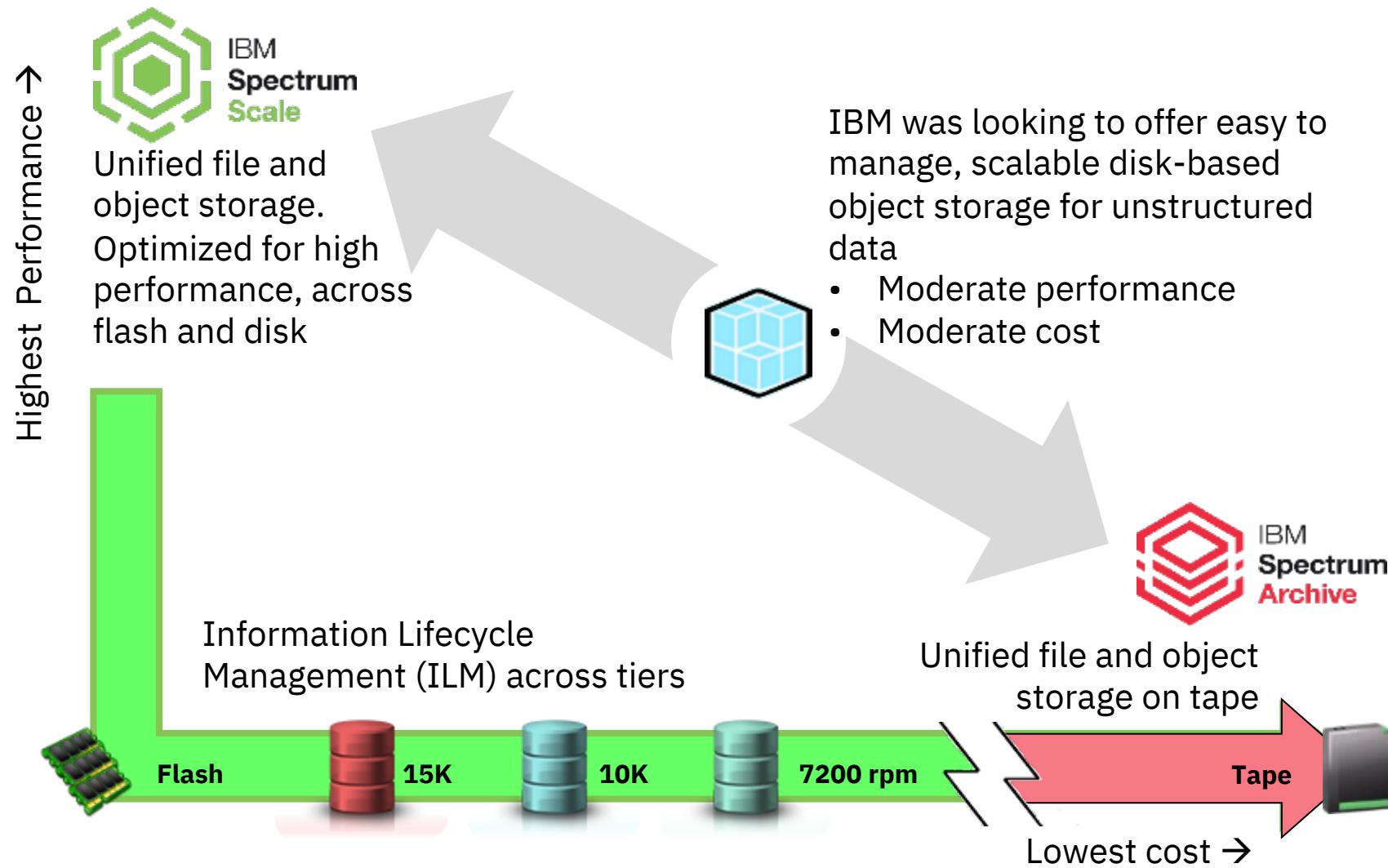
Use Cases	AI / ML	Edge Collaboration	Kubernetes Applications	HPC	Video/Digital Workloads	Cloud Services	ADAS or IoT Workloads	Big Data Analytics	Research	Backup and Archive
Solutions	IBM Cloud Paks  	 IBM Archive  	    	    						
Data Catalog and Data Orchestration			 IBM Spectrum Discover 							
Global Data Services	Security		Data Protection		Global Data Access		Data Optimization			
Hybrid Cloud Information Architecture			NFS	SMB	POSIX	HDFS	Object	Kubernetes		
			 IBM Spectrum Scale and ESS IBM Cloud Object Storage							

# The New Simplified Elastic Storage Server (ESS)

- Easy to Install & Upgrade
- Fast re-configuration
- Embedded Red Hat with Containerized deployment



## Storage Positioning – Filling a Gap



## How is Object Storage Different?



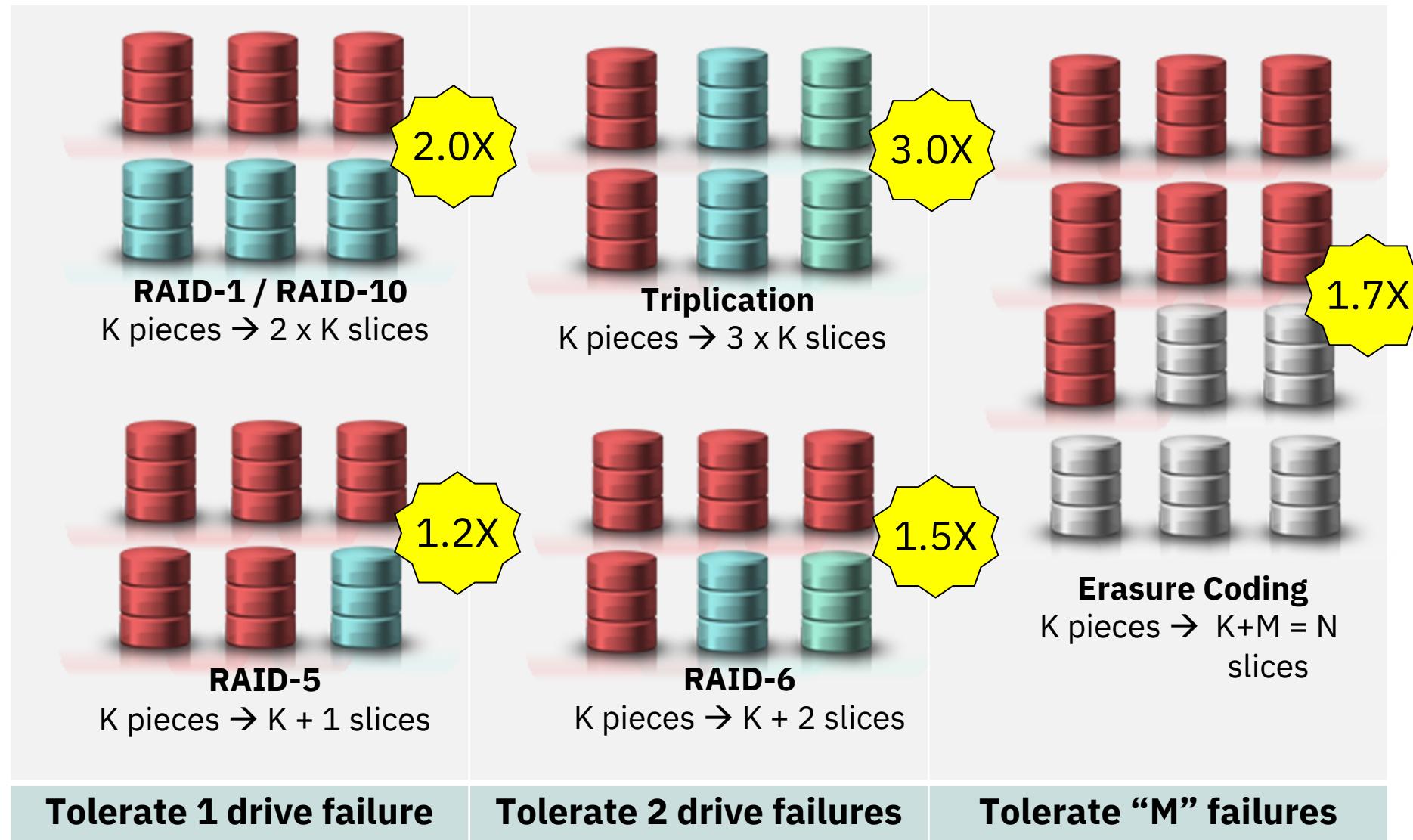
### Block and File Storage

- Decide where to put it
  - For block, which array/volume/LUN
  - For file, which filer/subdirectory
- Remember where it is to get it back
- Don't let anyone else move it
- Read/Write records, append data
- Limits on LUN size, number of files

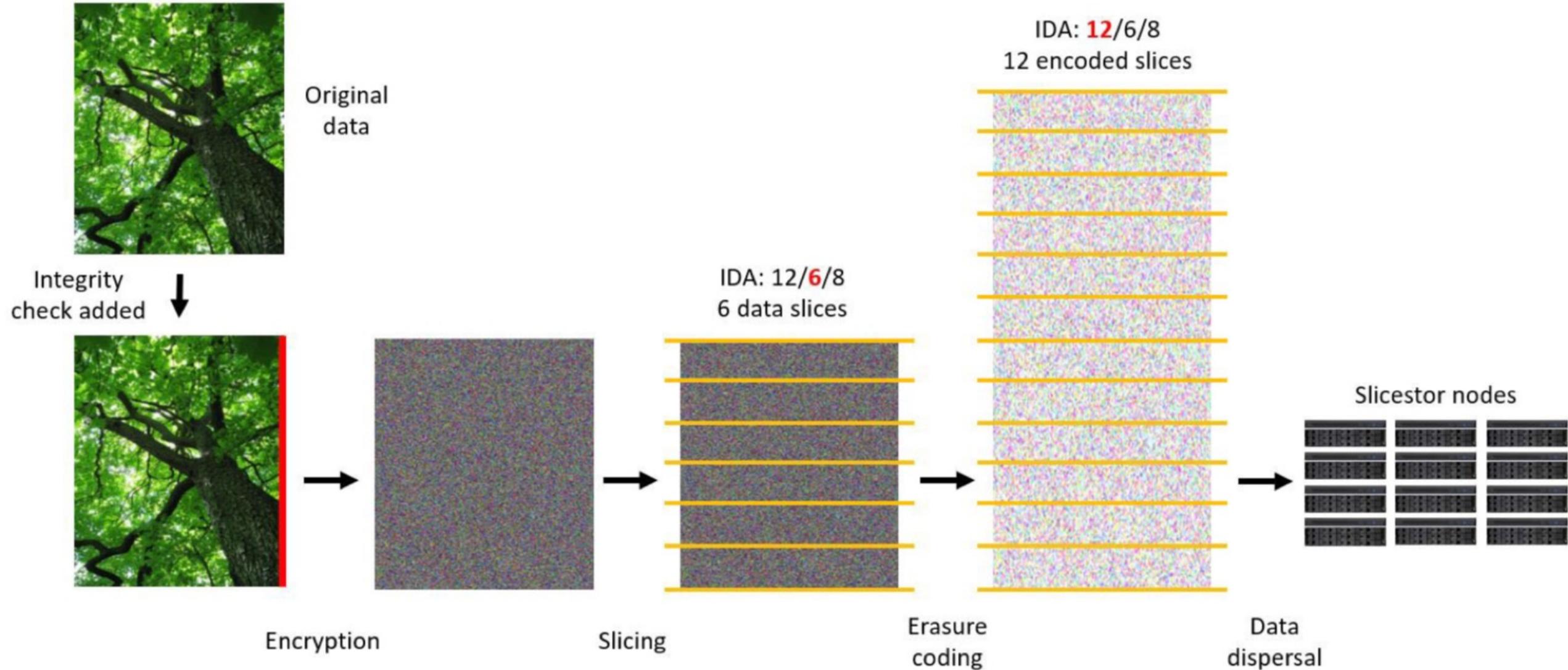
### Object Storage

- Provide data over to the Object storage
  - Get “claim stub” reference locator
- Use or share “claim stub” to access data HTTP, Openstack Swift, S3
- Get/Put/Delete object in its entirety
- Effectively “unlimited” scalability

## Data Protection Schemes

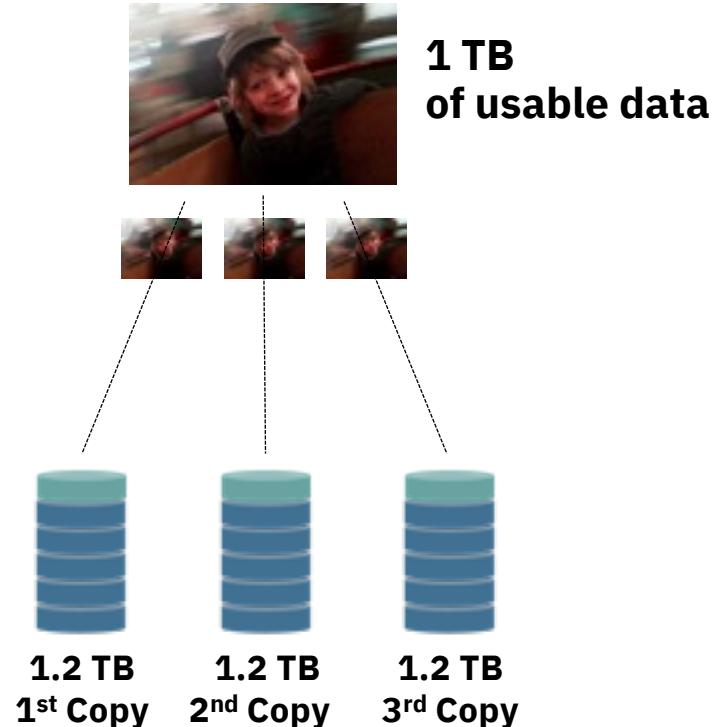


# Security is built-in with patented SecureSlice™



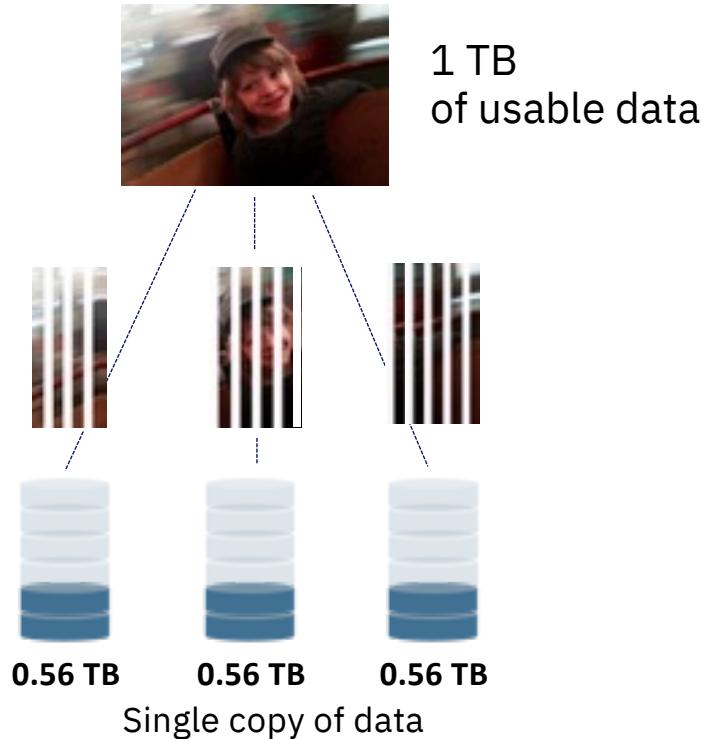
# Erasure coding brings efficiency for data protection

## Traditional Storage



**3.6 TB**  
of raw storage

## IBM Cloud Object Storage



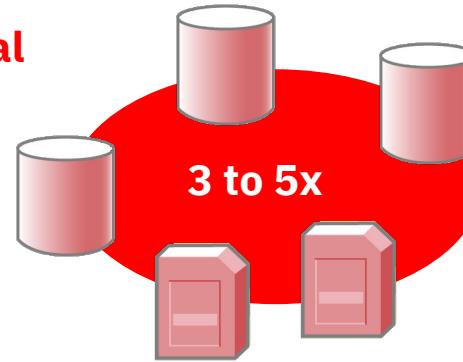
**1.8 TB**  
of raw storage

255% TCO savings based on IDC customer report

## Data Growth at Petabyte (PB) Scale

### Traditional Approach

PB of data



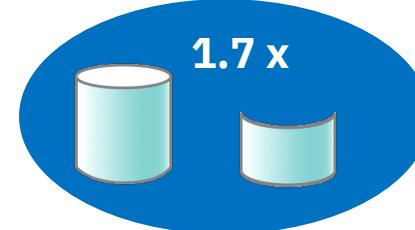
### Data Protection

RAID, Mirrors,  
Replication, Tape



### Infrastructure

Proprietary, specialized  
hardware, multiple systems

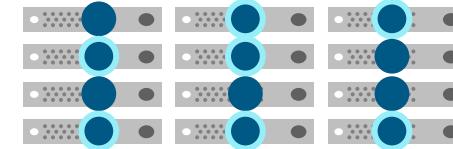


### IBM Cloud Object Storage Approach

### Data Protection

High Availability & Disaster Recovery  
Geo-Distribution & Erasure Coding

60% Less  
Hardware &  
Rack space



### Infrastructure

Software Defined,  
Commodity Hardware,  
Single System

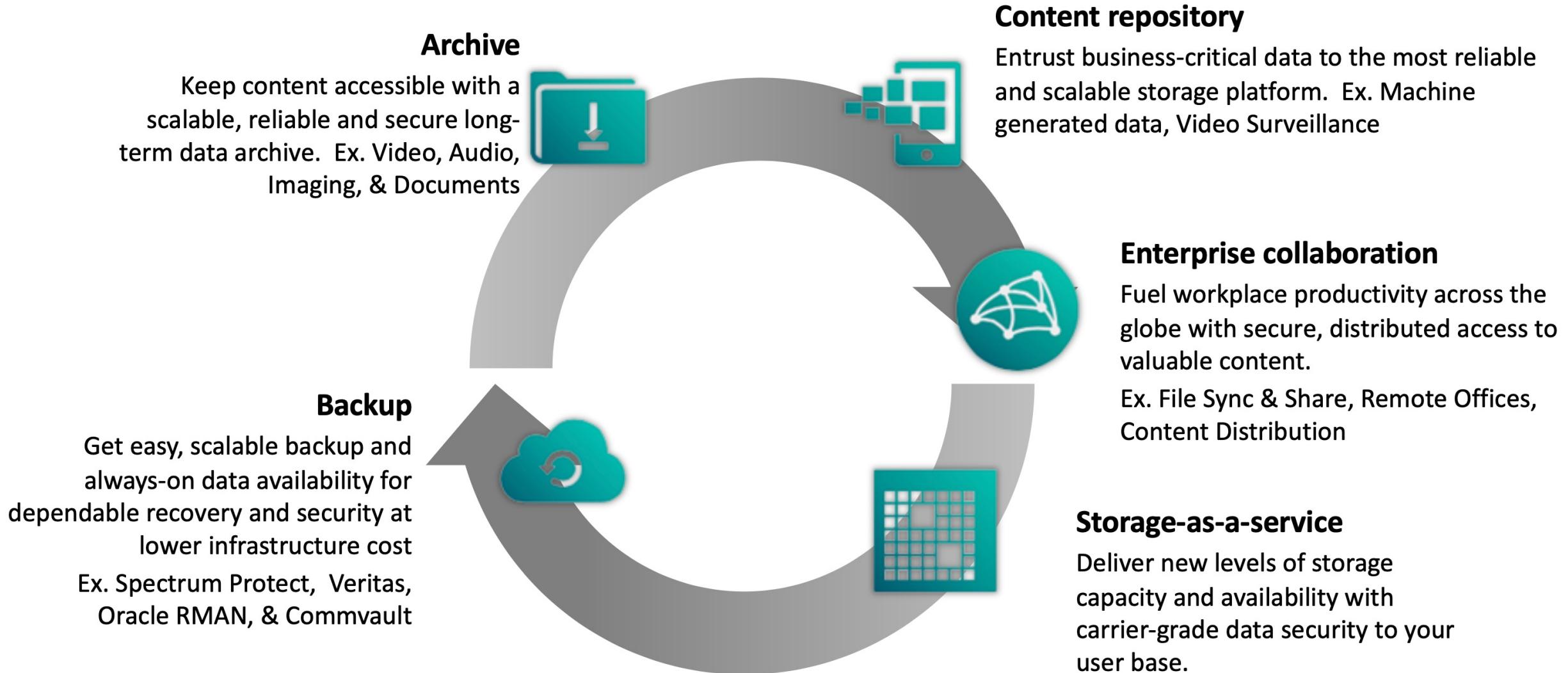
70%  
Lower  
TCO



### Operations

Less than 1 FTE per 6 PB  
Single system, Secure  
Self-healing

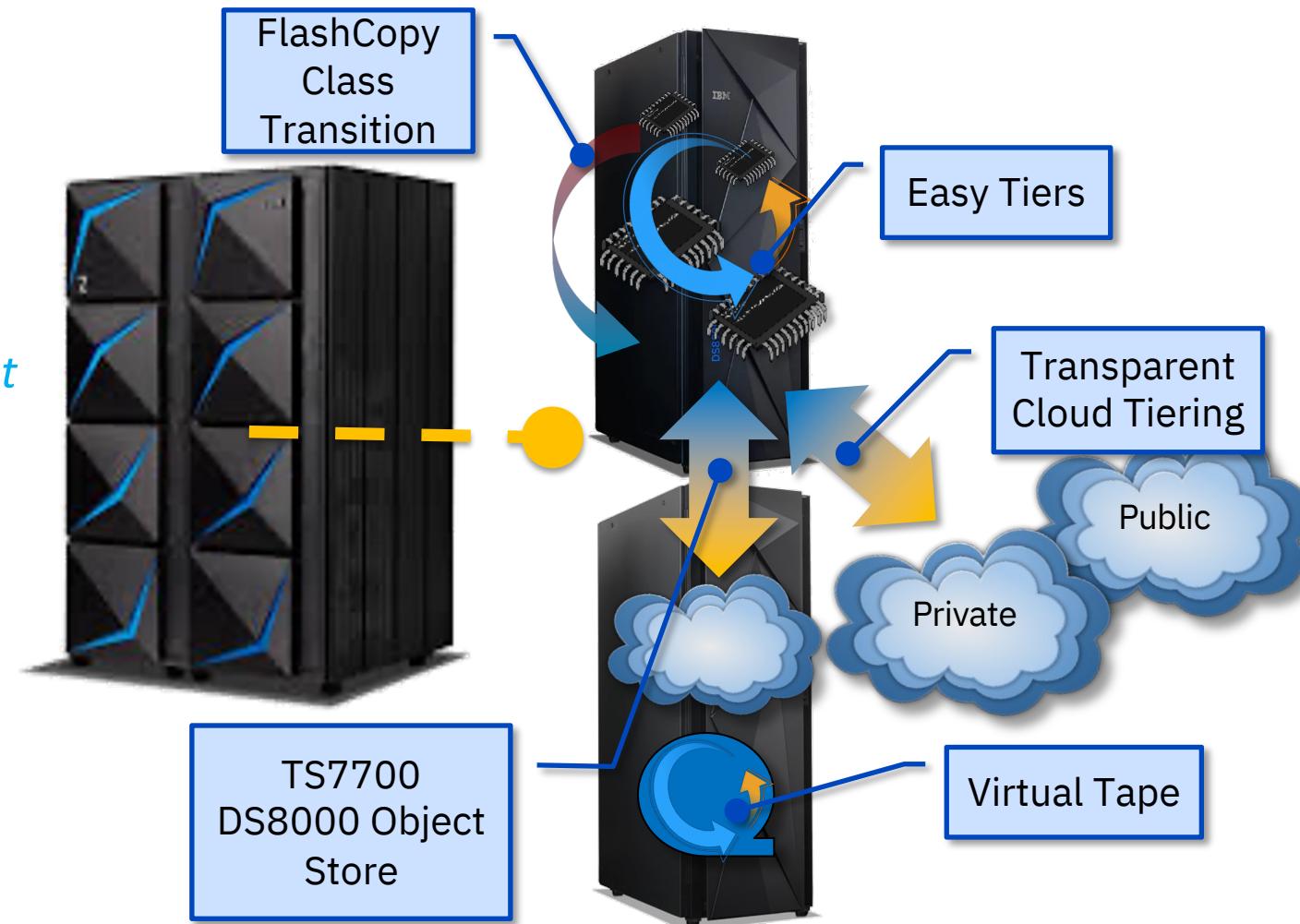
# Use Cases for Object Storage



# *Evolution of Data Management*

DFSMShsm's strategy is to *minimize physical data movement through Z* by leveraging leading edge storage-based solutions and become a *thin, automated, policy-based data manager that provides cyber resiliency and lifecycle management*

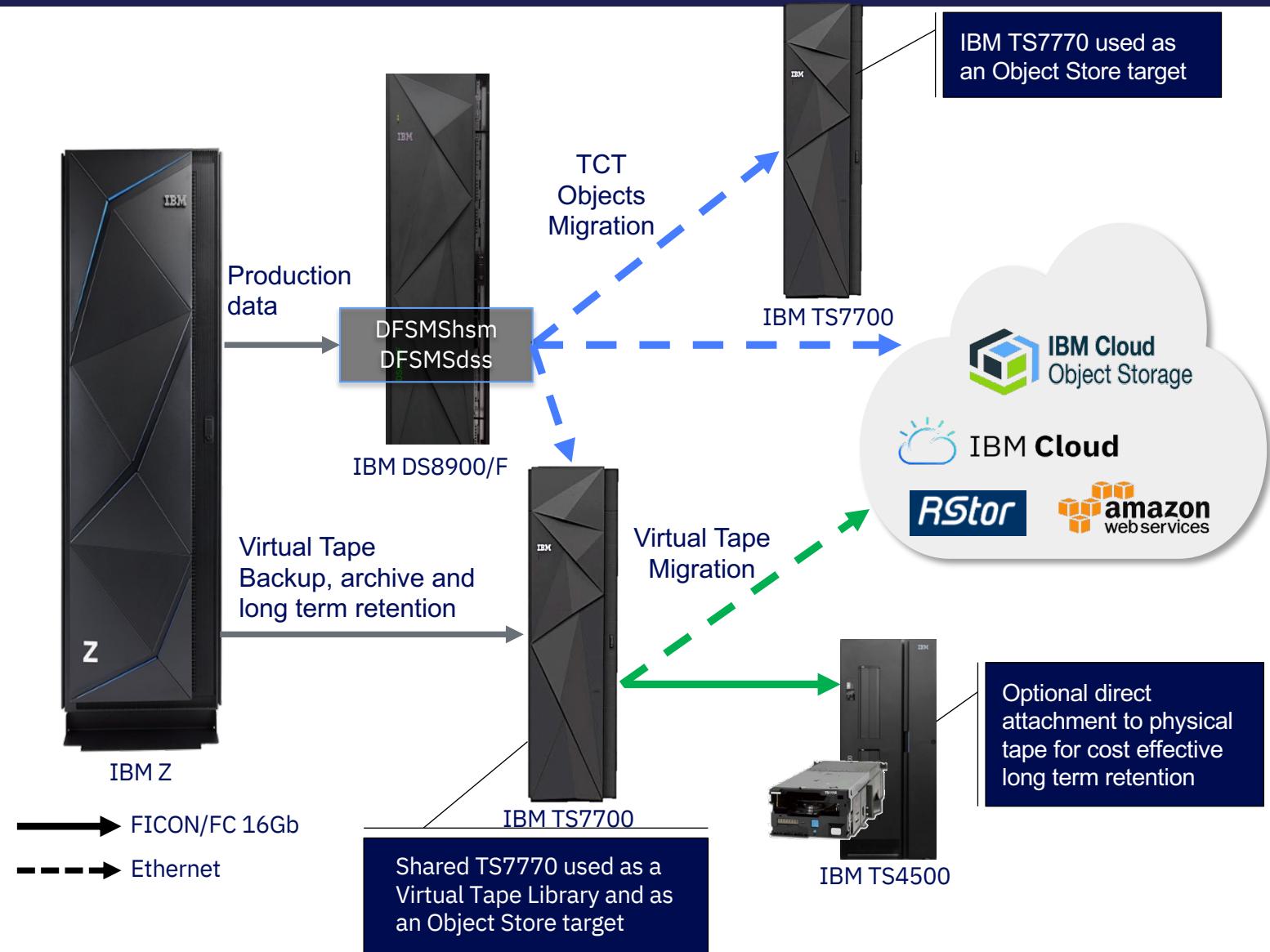
***Transparent Cloud Tiering completes the evolution of DFSMShsm life cycle management to automatic, policy-based, serverless data movement through your entire storage hierarchy!***



# Transparent integration to hybrid cloud use case for IBM Z

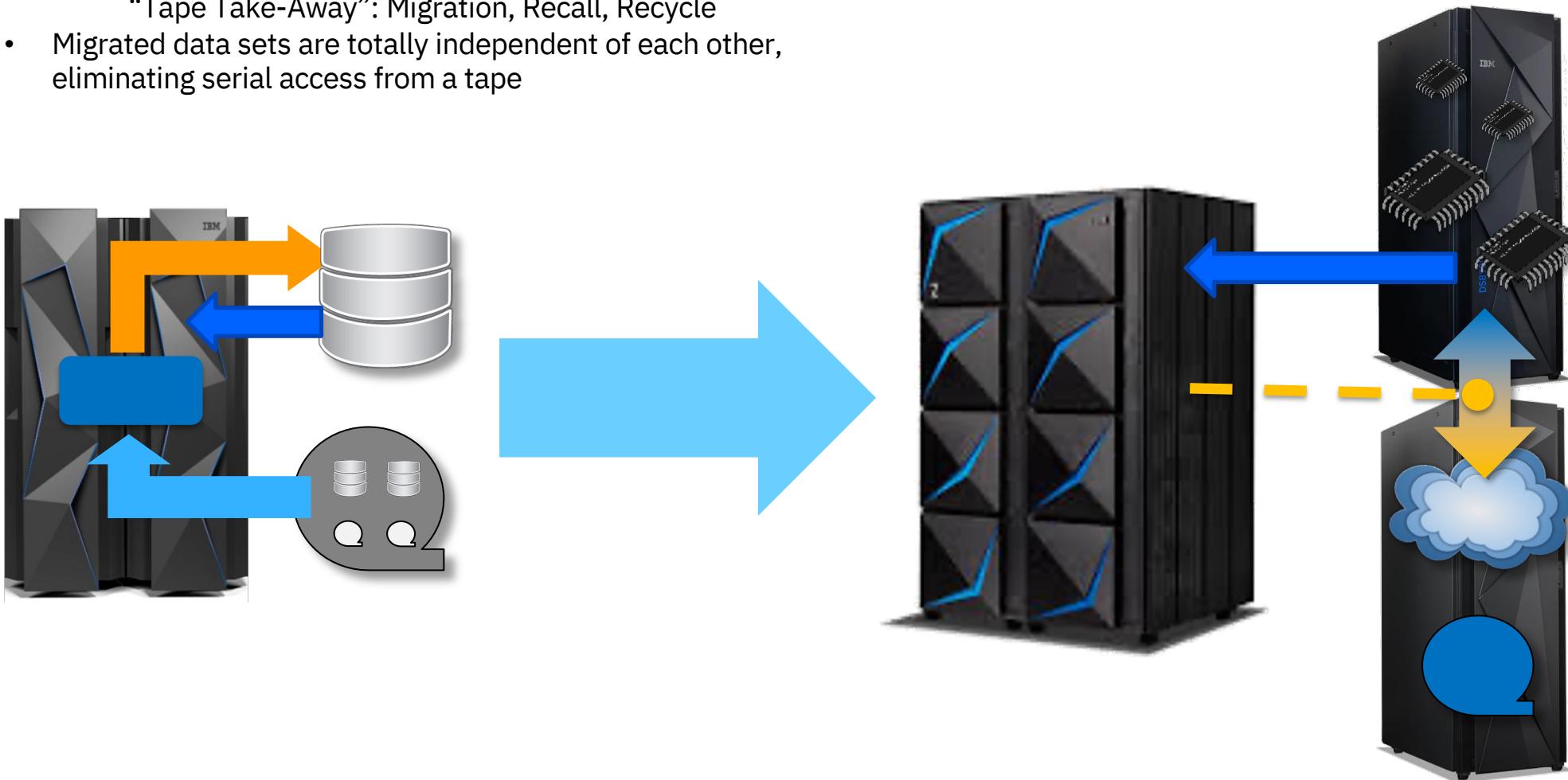


- DS8900 Transparent Cloud Tiering (TCT) enables hybrid cloud as an additional storage tier for data archiving, long term retention and data protection
- Efficiently moves data directly to the proper medium reducing costs while keeping the information available
- Provides up to 50% savings in mainframe CPU utilization when using TCT with DS8900/F to migrate large datasets
- TS7700 can offload virtual tape volumes to on-prem or off-prem object storage or physical tape

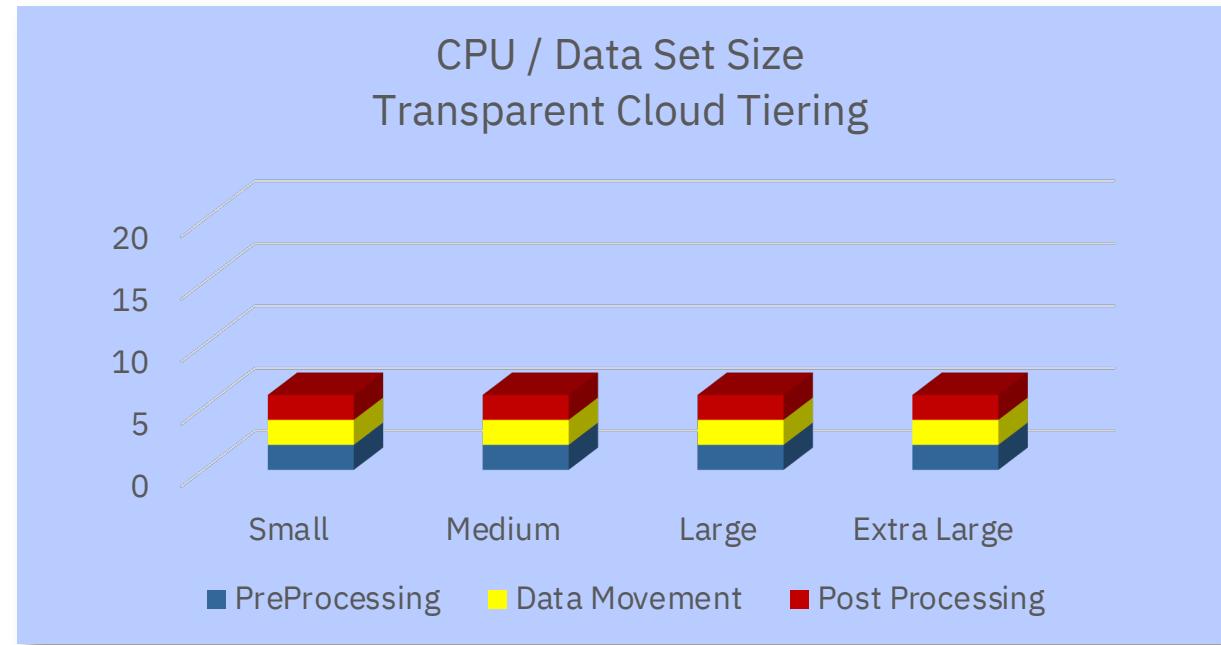
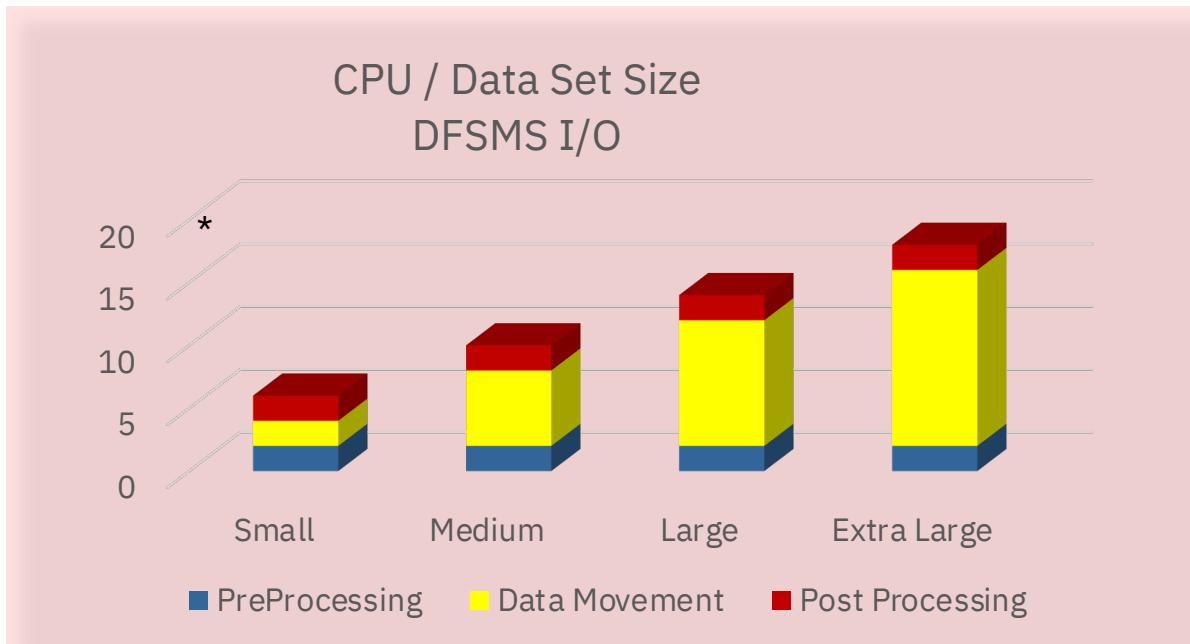


## Consider Recall...

- Data only read into Z once, when application reads in data
- Migration and Recall are totally independent
  - Recalls are not held due to tape in use by other functions  
“Tape Take-Away”: Migration, Recall, Recycle
- Migrated data sets are totally independent of each other, eliminating serial access from a tape

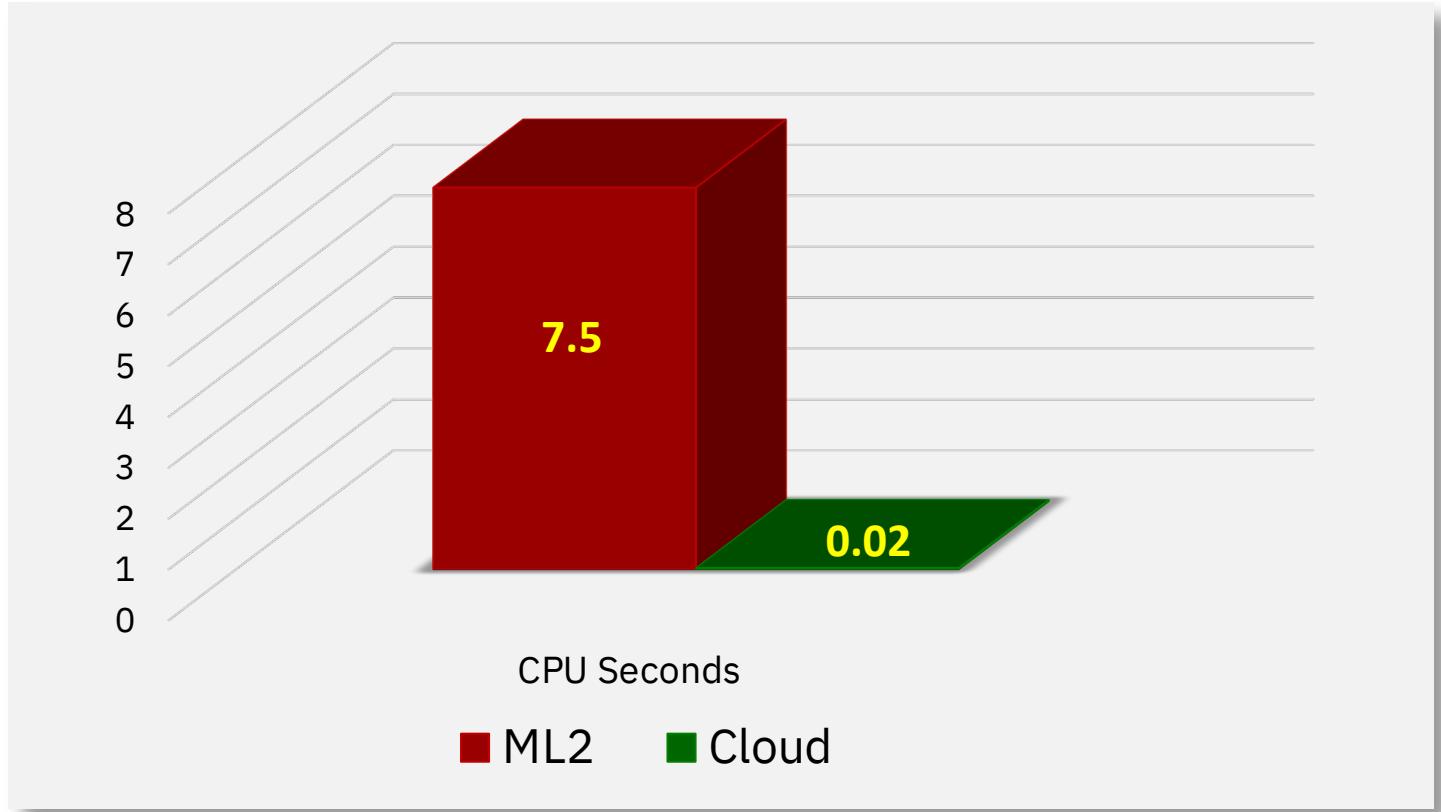


# Just How Much CPU Savings?



# Just how much CPU for Migration?

*CPU consumed to migrate a  
5 GB data set*



\* Disclaimer: Based on projections and/or measurements completed in a controlled z15 environment.  
Results will vary by customer based on individual workload, configuration and software levels.

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- **Tape Drives and Libraries**

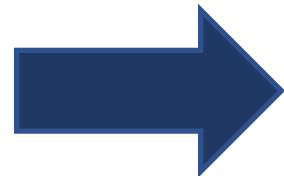
# Is Tape storage still relevant?

## Myth



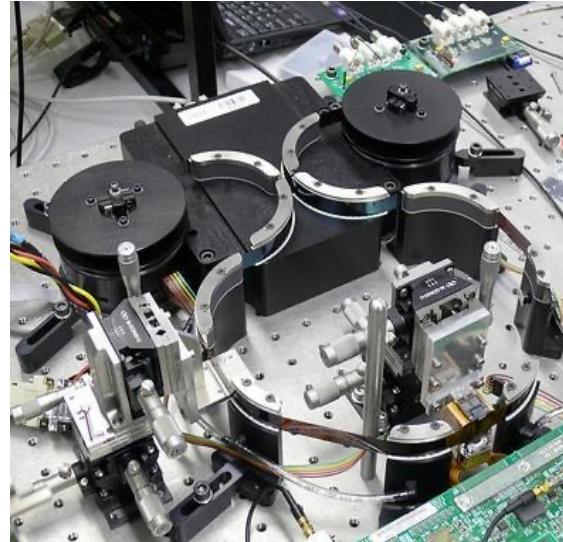
Tape is often viewed as an old-fashioned, outdated technology of the past

In reality



Tape is:

## Fact



- The lowest cost form of data storage....period
  - Cheaper than disk, cheaper than cloud
- Highly reliable – more reliable than disk!
- Removable – I can move data offsite
- Green – a tape cartridge consumes no power
- Scalable to handle extreme data growth
- Fast – offering high throughput
- Unparalleled longevity

# Tape is the world's most economical, secure, and eco-friendly means of storing large amounts of data

- **4X TCO advantage**

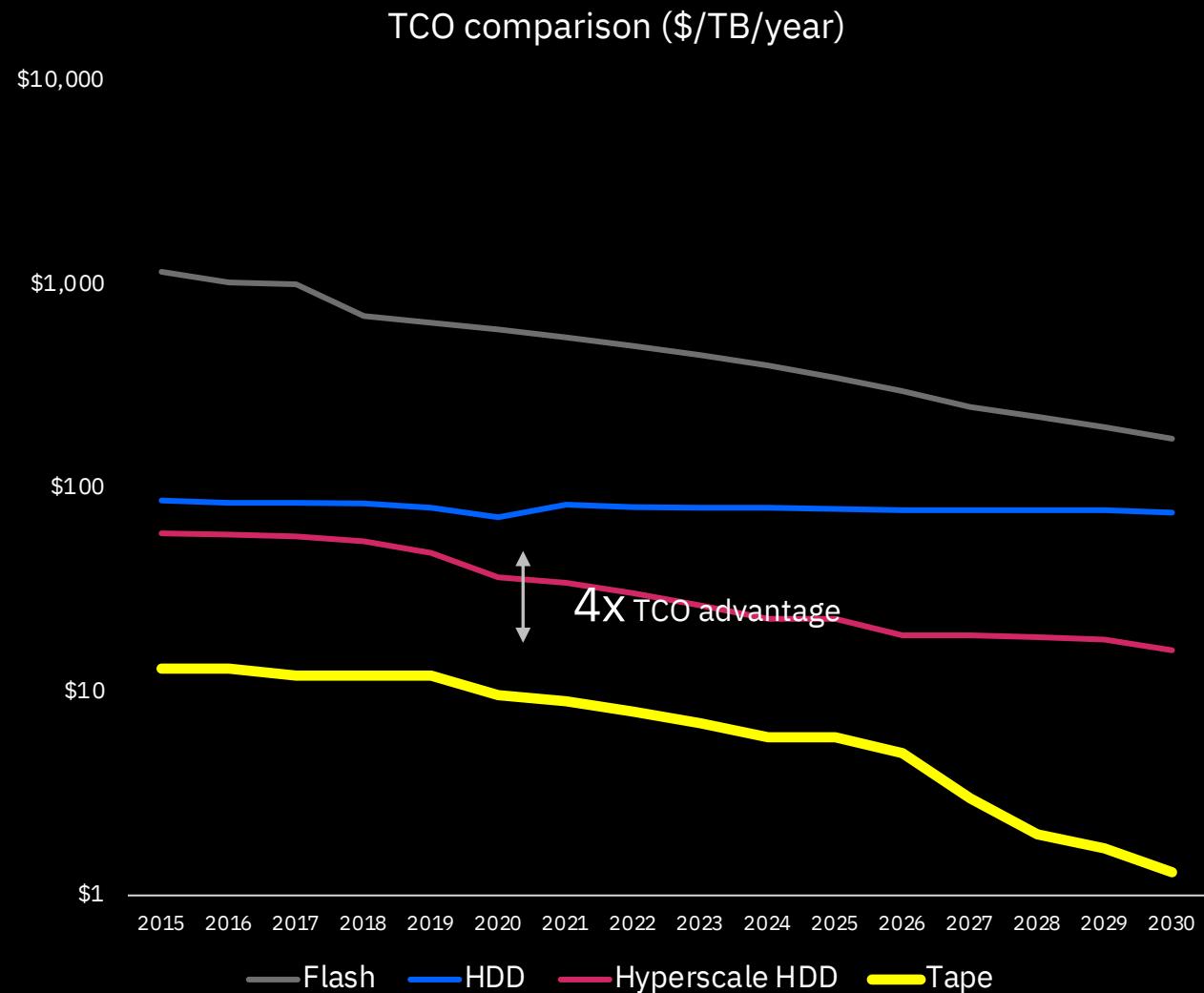
- Consistent – always been lowest cost choice against other storage options
  - Enduring – Fuji and IBM demonstrated single tape capacity to hold 580TB (compared to 18-20TB today)

- **Cyber-Resilient and Secure**

- Physical air gap and encryption for data protection

- **Eco-friendly**

- 90X reduction in CO<sub>2</sub> emissions compared to HDD
  - Zero energy use for data at rest



# Active Archive TCO

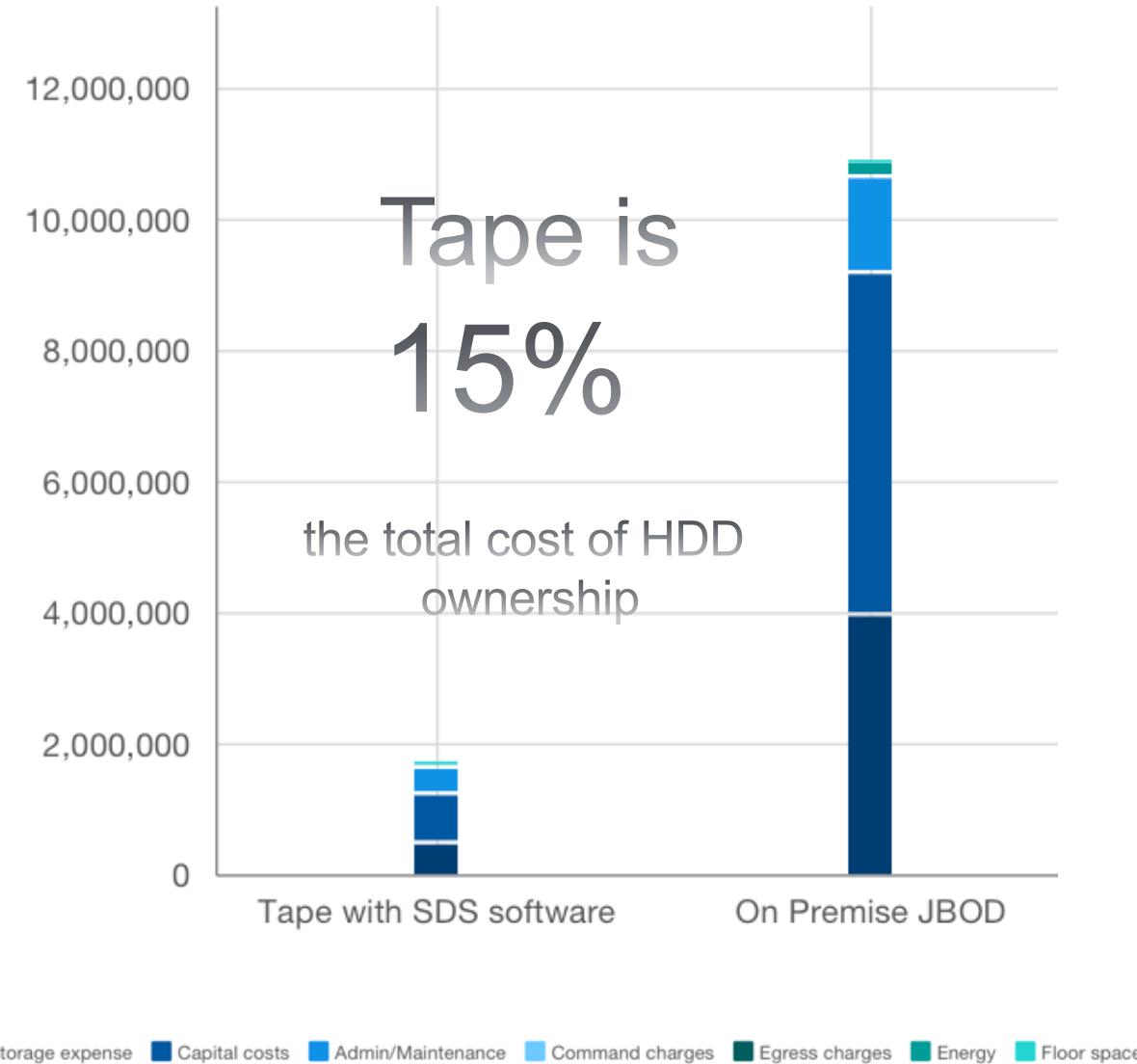
Tape lowers CAPEX, OPEX, Administrative overhead and Energy Consumption

## Assumptions:

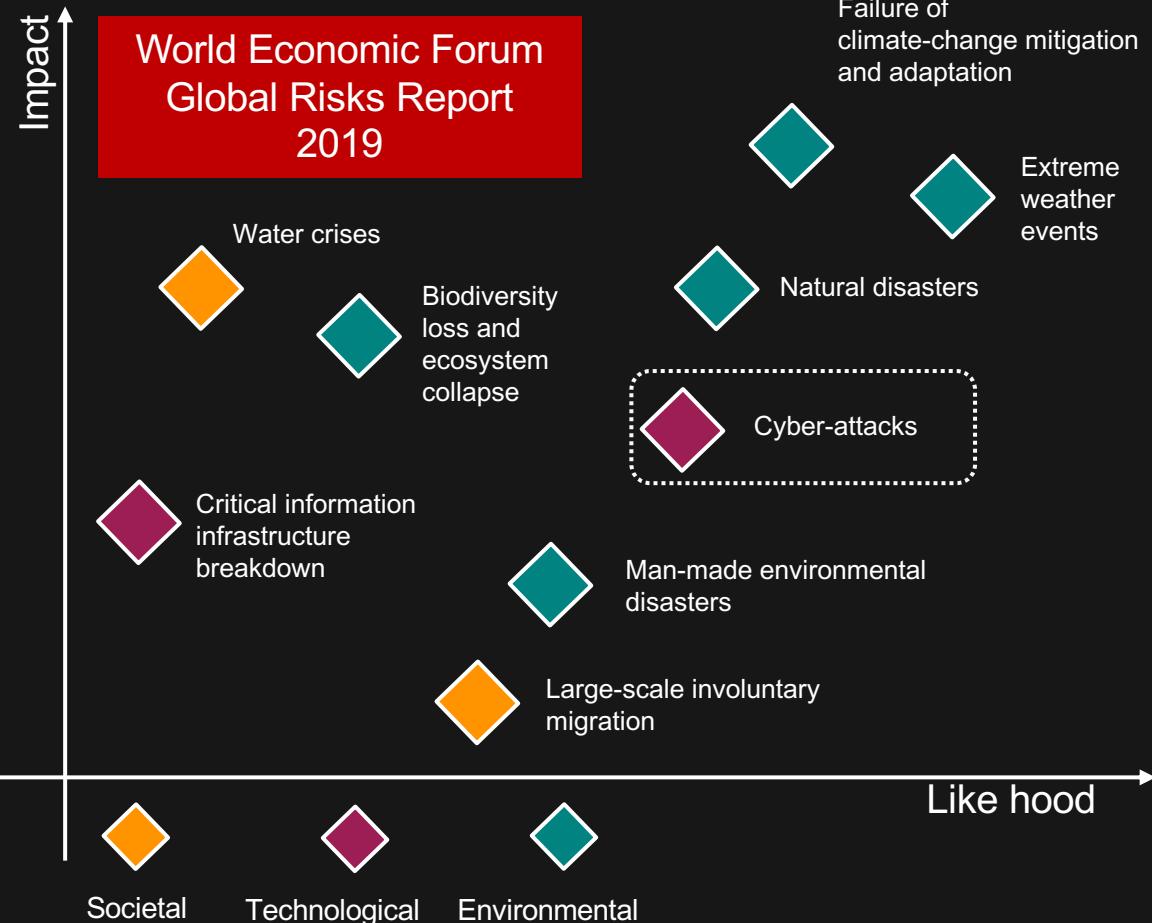
- 12 PetaBytes of data
- 15% Data CAGR
- 10-year retention
- 11-nines of calculated data durability
- Storage Compares:
  - Tape with SDS
  - Premises Object with HDD

## Total Solution Cost

USD



# Cyber-attacks are a major global risk



## DS8900F Safeguarded Copy



Up to 500 immutable point in time copies of production data with dual control security to quickly recover from data integrity issues

## Tape Air Gap protection



“Offline by design” tape cartridges only accessible when mounted to provide the most secure line of data protection

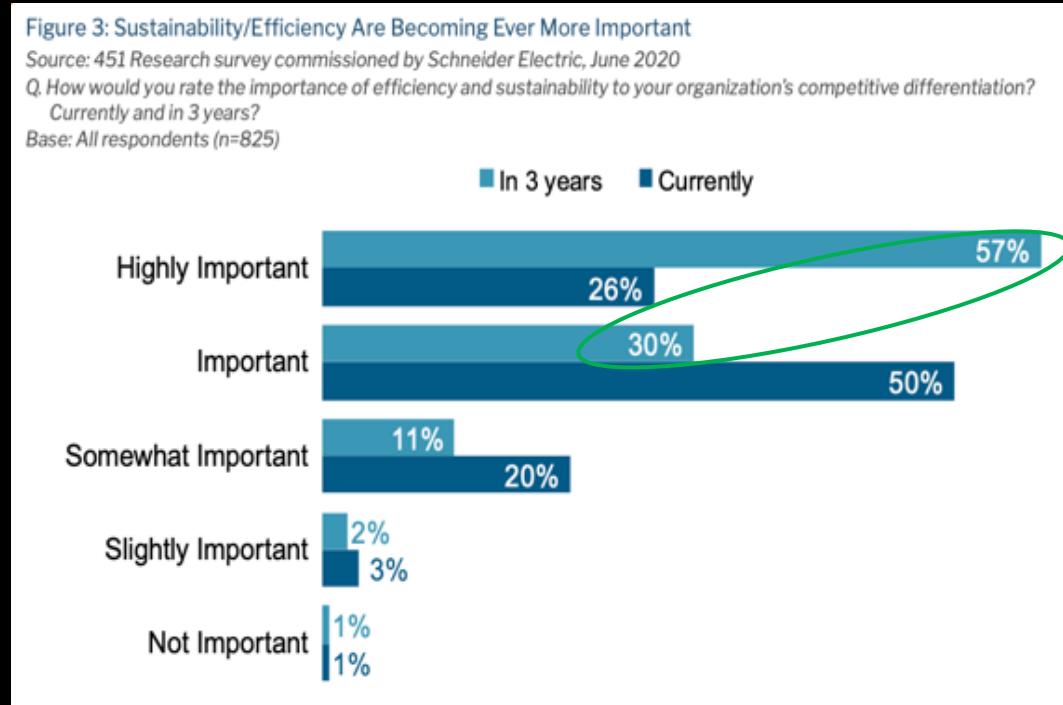
“IBM has a comprehensive portfolio of cyber resiliency solutions designed to help organizations reduce the risk of business disruption and financial losses due to user errors, malicious destruction or ransomware attacks.”

—Phil Goodwin, Research Director, IDC

# Environmental Consciousness

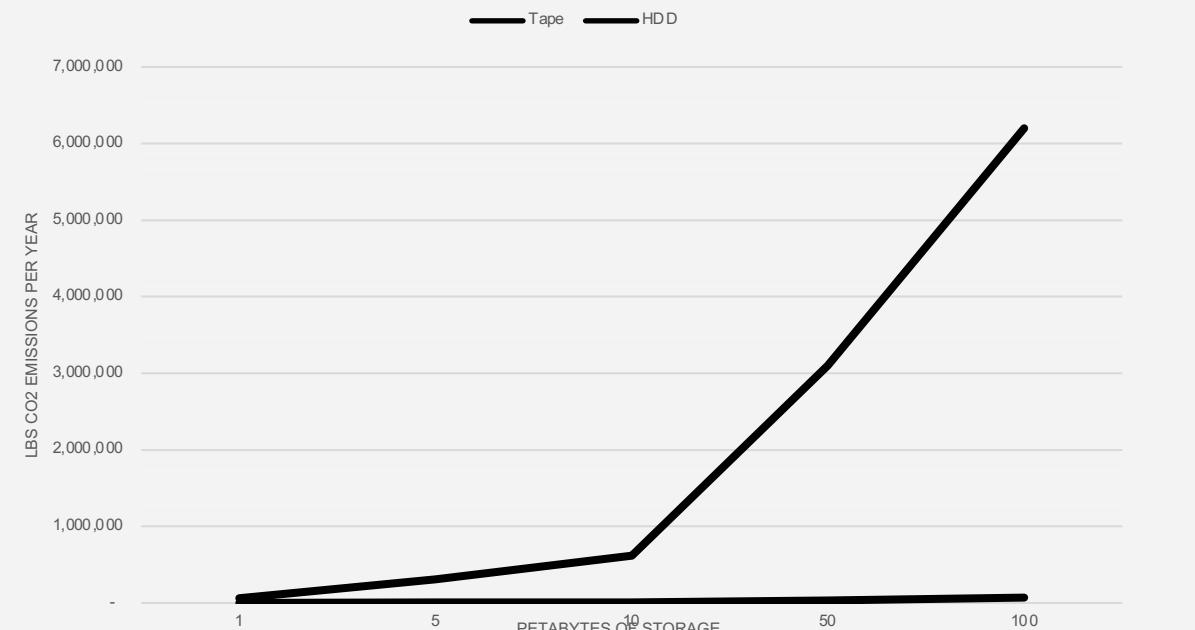
87%

Rate sustainability as important or very important



90X

Reduction in CO<sub>2</sub> emissions when comparing Tape to HDD



# IBM Tape Product Lineup

## Tape Drives

**LTO® : Linear Tape Open®**



## **Enterprise Tape:**

IBM TS1100  
“Jaguar”



## Characteristics

The LTO family was first introduced in 2000  
We are now on the 9<sup>th</sup> Generation or LTO-9  
Compatible drives are available from third party vendors  
Distributed Systems only, cannot be used z/OS or TPF  
Lower in cost as compared to Enterprise tape

New Type M media offers 9 TB on LTO-7 cartridges

IBM’s Enterprise family of tape was introduced in 2003  
We are now on the 6<sup>th</sup> Generation or TS1160  
IBM exclusive drive  
Overall superior to LTO in capacity, performance and reliability  
• Both drives and cartridges are higher priced than LTO  
Used for both Open Systems and mainframe

Allows “upformating” of media, new drives produce higher capacity with older generation media

## Product Specifications

Newest Product: LTO-9  
Introduced: 2017  
Capacity: 15 TB / 45 TB (compressed)  
Performance: 360 MB/s (Native)

Newest Product: TS1160  
Introduced: 2018  
Capacity: 20 TB / 60 TB (compressed)  
Performance: 400 MB/s (Native)

# IBM LTO Tape Portfolio

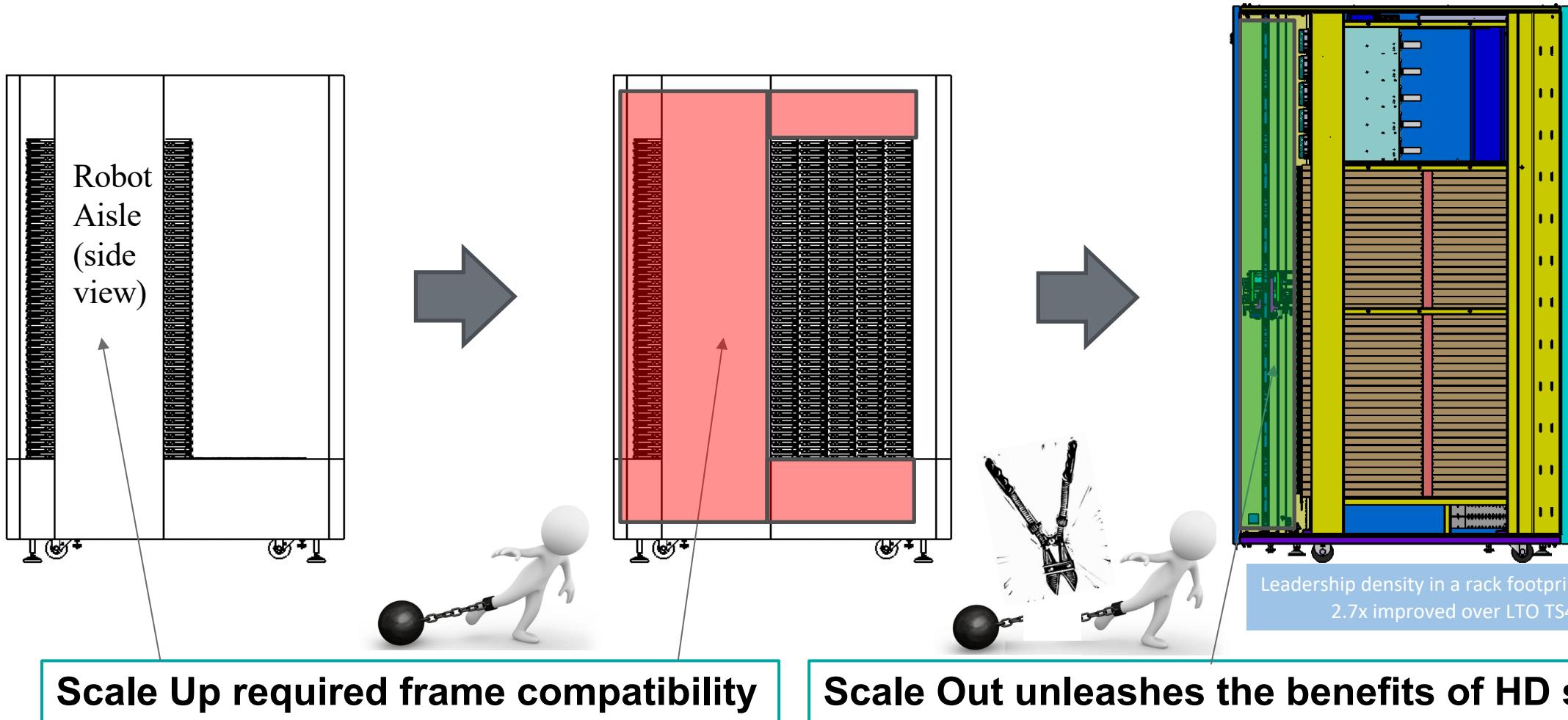


	LTO 9	TS2900	TS4300	TS4500
<b>Max capacity</b>	<b>15 TB*</b>	<b>108 TB*</b>	<b>3.36 PB*</b>	<b>278 PB*</b>
<b>Max # drives</b>	<b>1</b>	<b>1</b>	<b>21</b>	<b>128</b>
<b>Max # cartridges</b>	<b>1</b>	<b>9</b>	<b>280</b>	<b>23,170</b>

\*All capacities are based on LTO 9 native format

# An evolution in Storage Technology

IBM Original Density -> High Density (HD) -> Ultra-High Density (UHD)

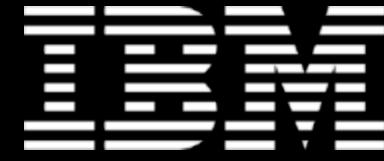


# IBM Diamondback - Overview



- Single Frame design – No expansion frames
- Up to 14 LTO-9 Tape drives
- Up to 1548 Tape cartridges
  - 27.8 PB uncompressed capacity\*
- *1 cartridge service magazine with 10 I/O slots*
- Single robot, high availability grippers
- Pre-loaded media option
- Self-service design
- GKLM library managed Encryption
- Open systems attachment including AIX®, Linux, MS Windows®

\*Actual capacity will vary depending on swap availability and number of operational cartridges



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