

Magnetic Recording Innovations for the Zettabyte Era

Fujifilm Global IT Executive Summit, 2022

Defining the Zettabyte Era

According to Wikipedia

Zettabyte Era refers to the total amount of all the digital data that exists in any form, from digital films to transponders that record highway usage to SMS text messages.

According to this definition, the Zettabyte Era began in 2012, when the amount of digital data in the world surpassed one zettabyte.

How Big is One Zettabyte?

Measured by Black Holes in Space



Messier 87 Galaxy Black Hole

EXTREMETECH

It Took Half a Ton of Hard Drives to Store the Black Hole Image Data

By Ryan Whitwam, April 11 2019



How Big is One Zettabyte?

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Messier 87 Galaxy Black Hole

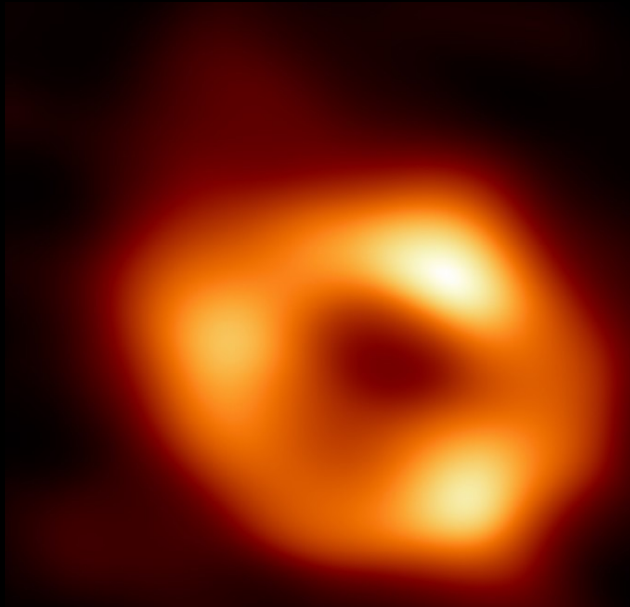
Each image is 5 Petabytes in size

200,000 images equals 1 Zettabyte

**Our galaxy has more than
100 million black holes**

How Big is One Zettabyte?

Measured by Black Holes in Space



1st Image of Our Milky Way Galaxy Black Hole

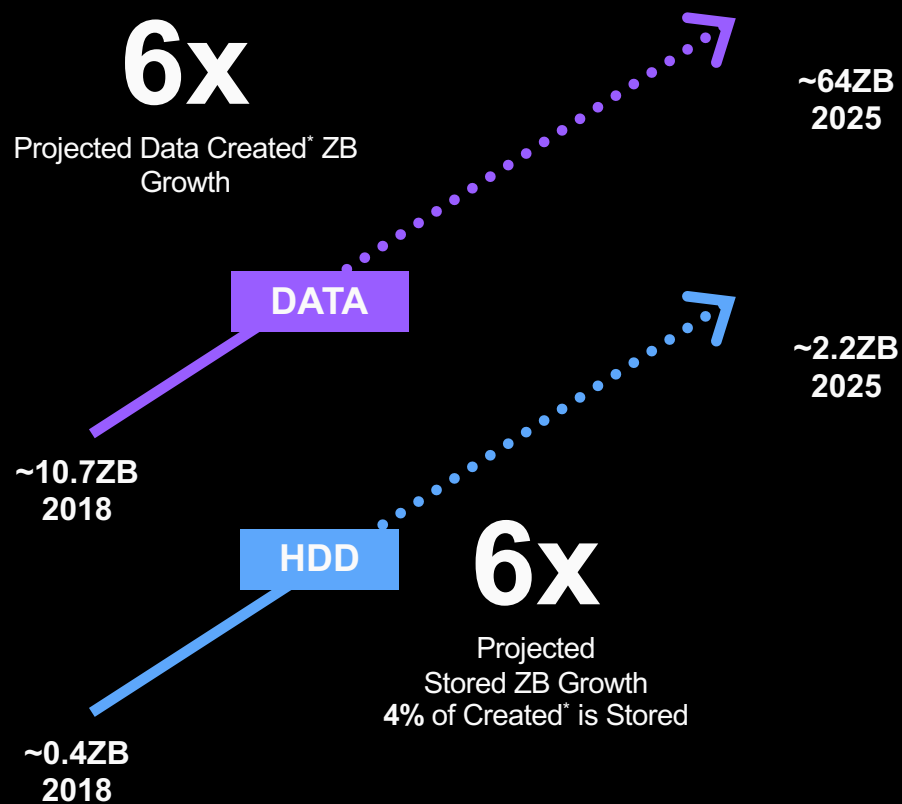
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Data Storage in the Zettabyte Era

Creating the Data-Driven Economy



Data Generation is Growing Exponentially



And Only ~4% is Stored

Magnetic Recording Introduction

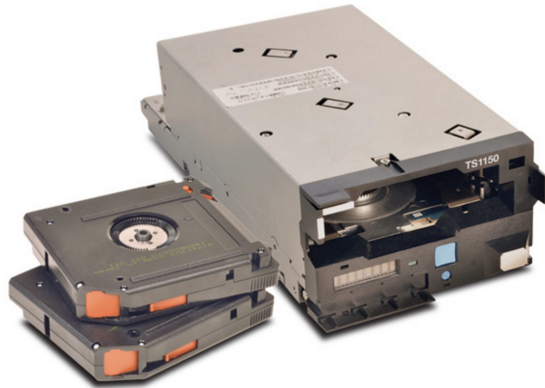
Tape and HDD Have Been Co-Existing in the Last 60 Years



Magnetic Recording Scaling

Tape and HDD Have Been on the Same CAGR Slope Over the Last 60 Years

2018 IBM TS1160 (Jaguar6)
Tape Drive
20TB tapes - 12Gb/in²



Tape 66-year
CAGR of 1.3x

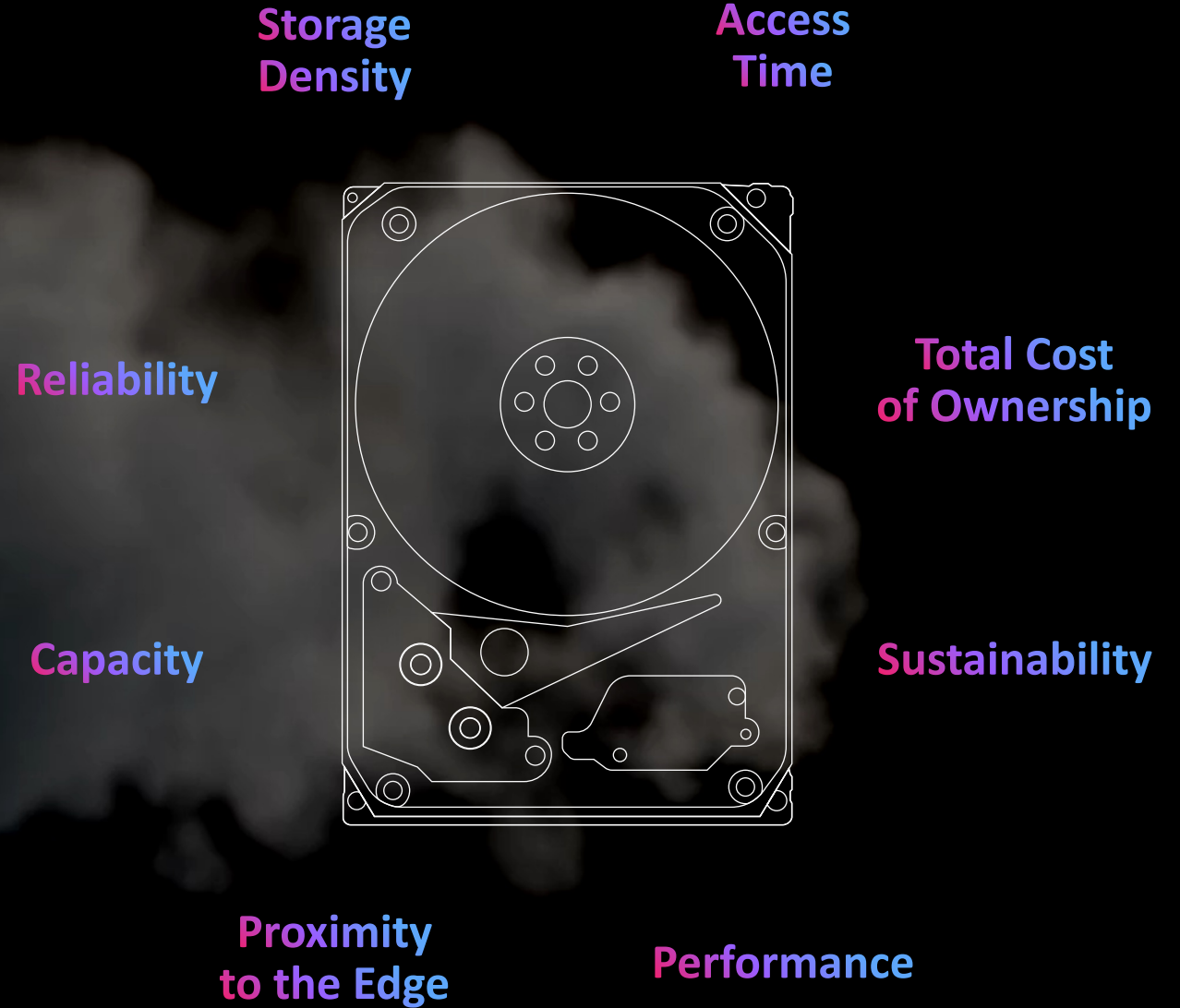
2022 Western Digital Ultrastar
Helium HDD
20TB capacity - 1.1Tb/in²



Disk 63-year
CAGR of 1.3x

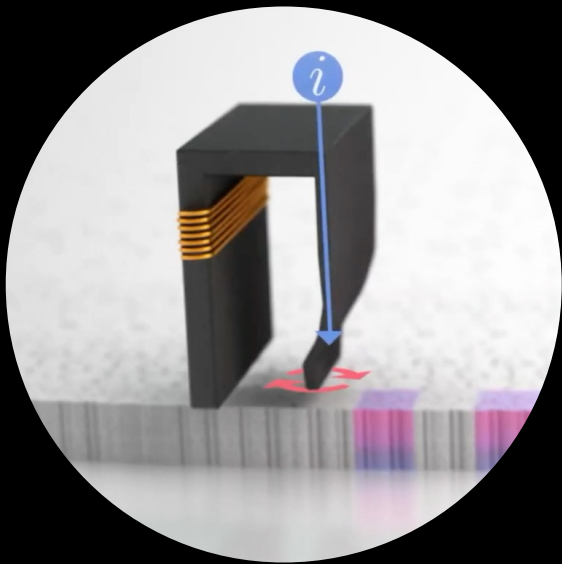
Innovating

To Meet the Cloud Challenge



ePMR

Our Foundational, Multi-Generational Energy-Assisted Magnetic Recording Technology



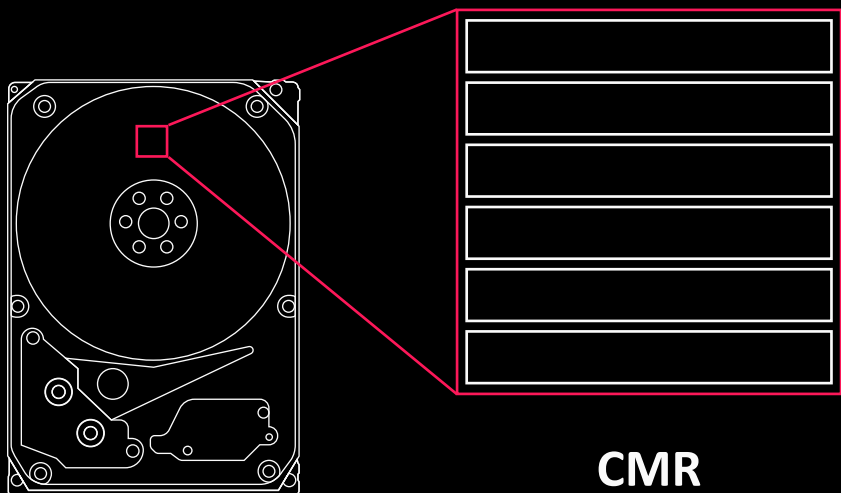
ePMR

- Introduced with 18TB CMR and 20TB SMR HDDs in 2020
- CMR capacity points from 18TB - 22TB

ePMR 2

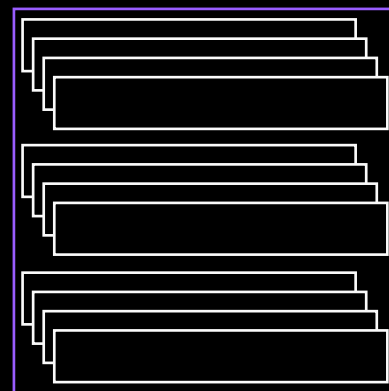
- Second generation with advanced write head structures
- CMR capacity points from 24TB - 30TB+

SMR & UltraSMR



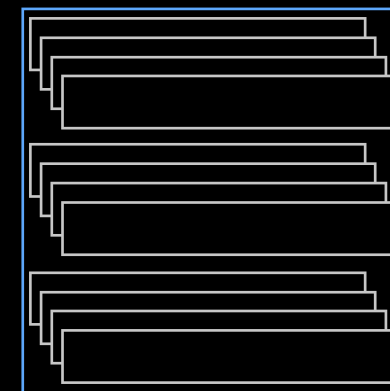
CMR

Data in Discrete Tracks



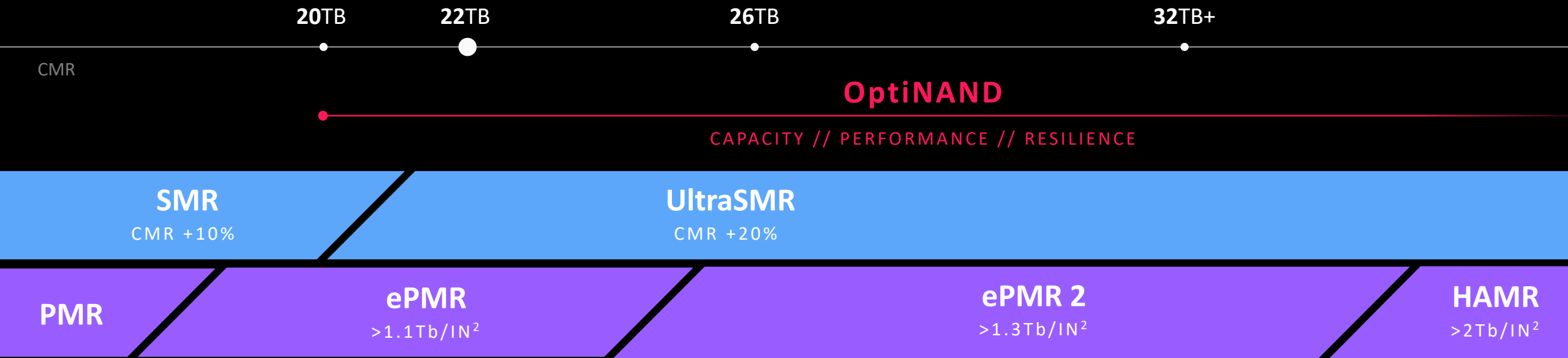
SMR

Data in Zones of
Overlapped Tracks



UltraSMR

Large Block Encoding,
Advanced Error Correction



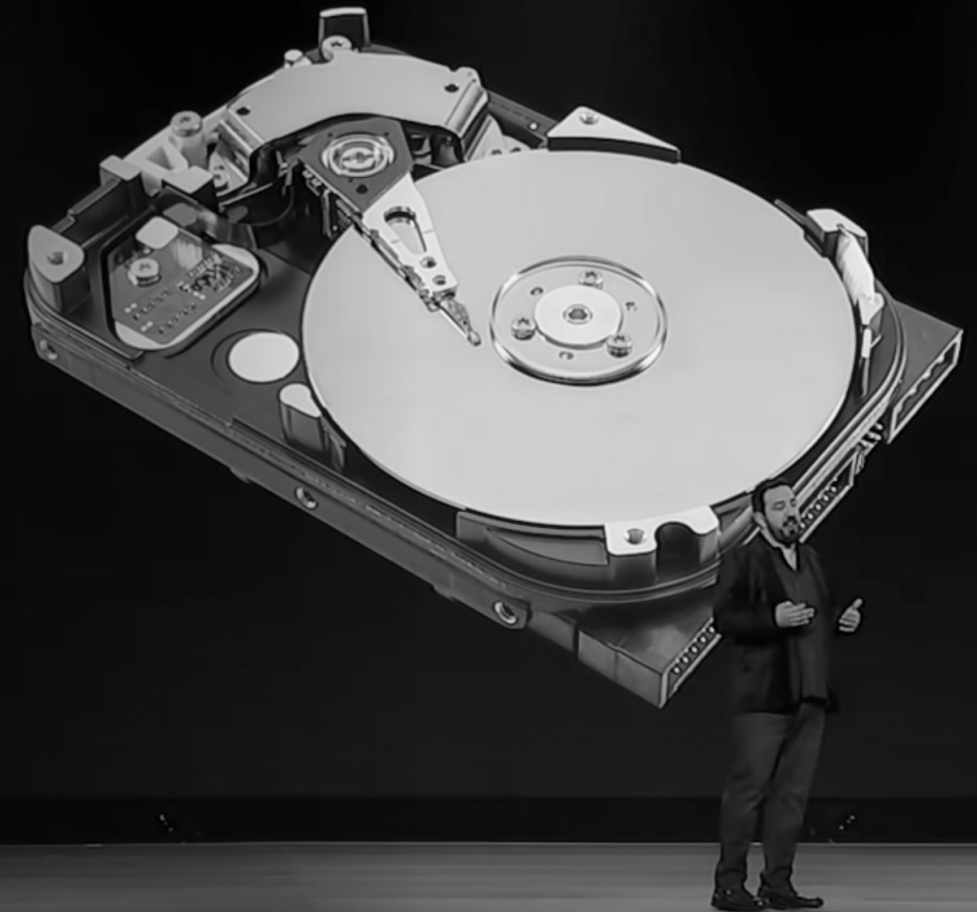
Predictable Capacity Increase

Built on Multiple Recording and Drive Technology Innovations

“While SSDs have replaced hard drives in a number of places, in the cloud, hard drives are still the king of big data.”

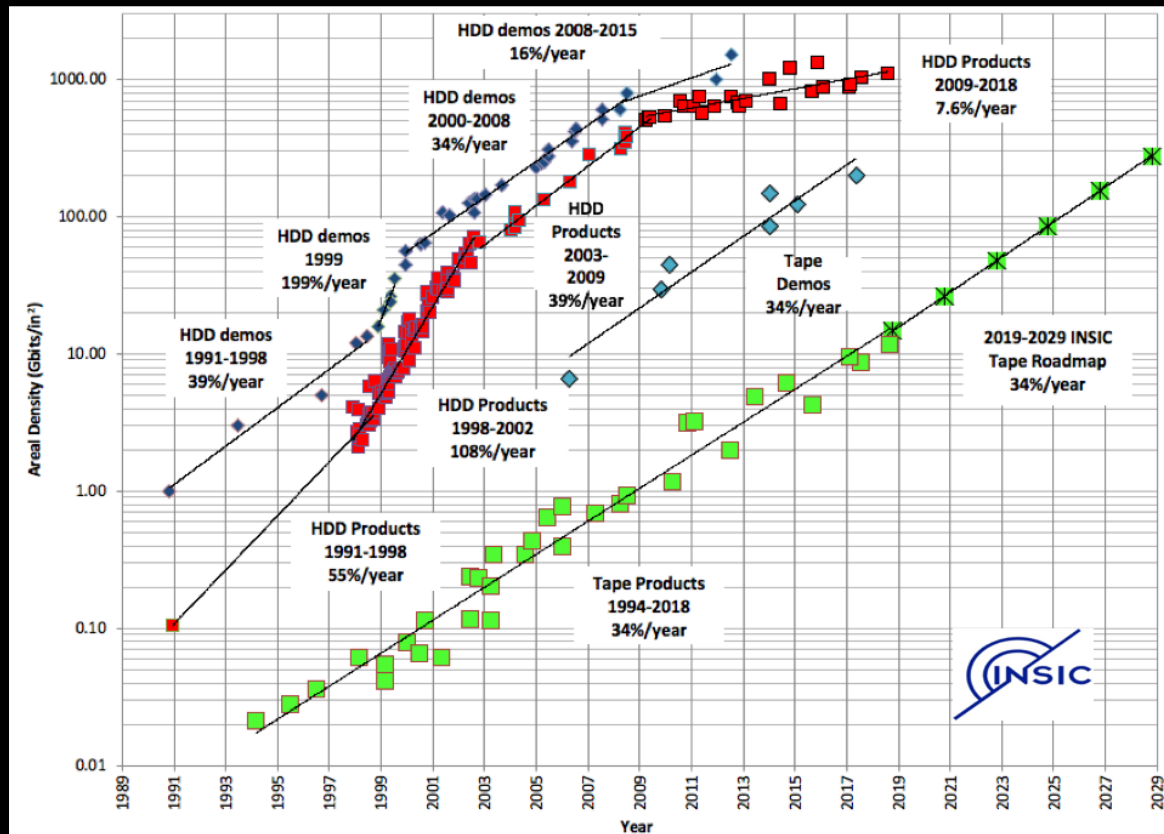
Peter DeSantis

AWS re:Invent 2021 Keynote



Magnetic Tape for the Zettabyte Era

Unleashing the ADC Potential

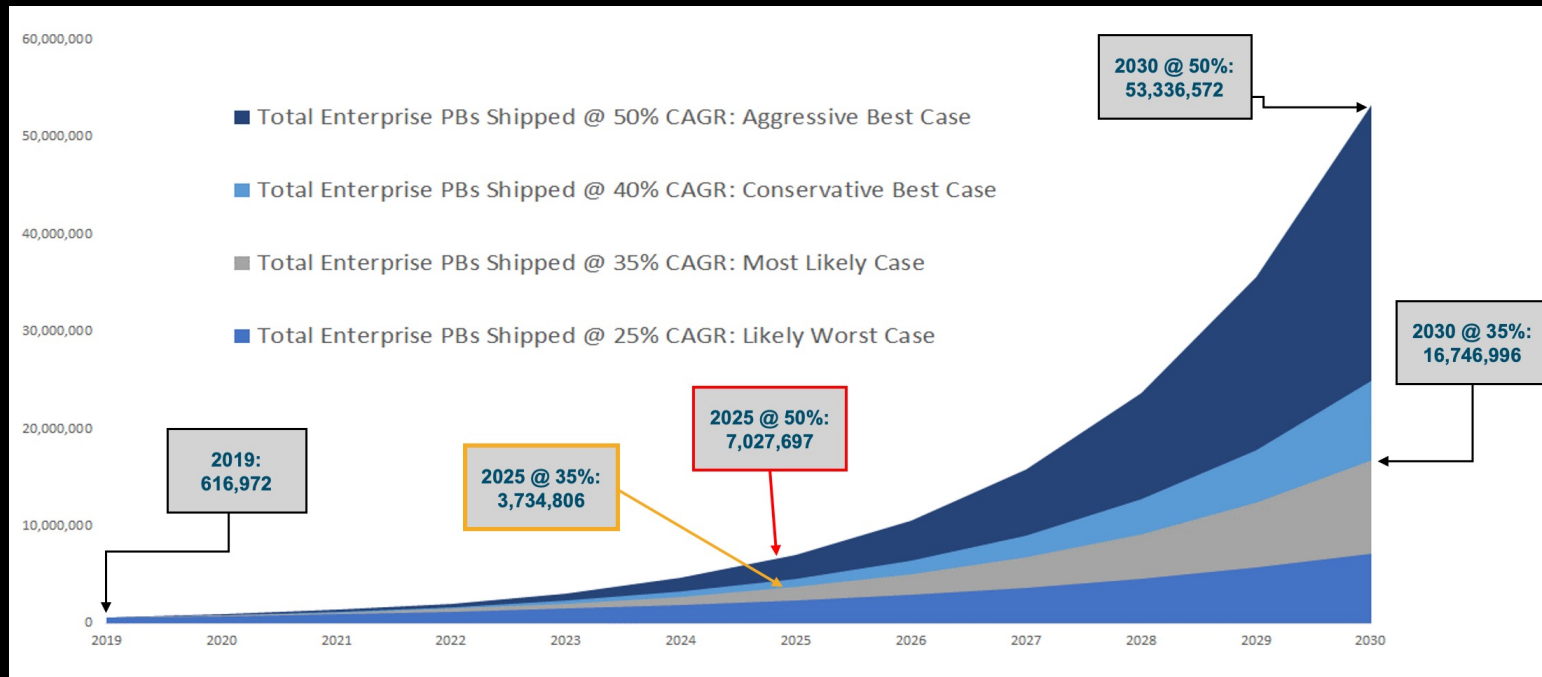


Source: Information Storage Industry Consortium Areal Density Chart

- 100x ADC lower than HDD
- >20x ADC lower than Tape Technology Demo

Scaling Up from Data Lakes to Data Oceans

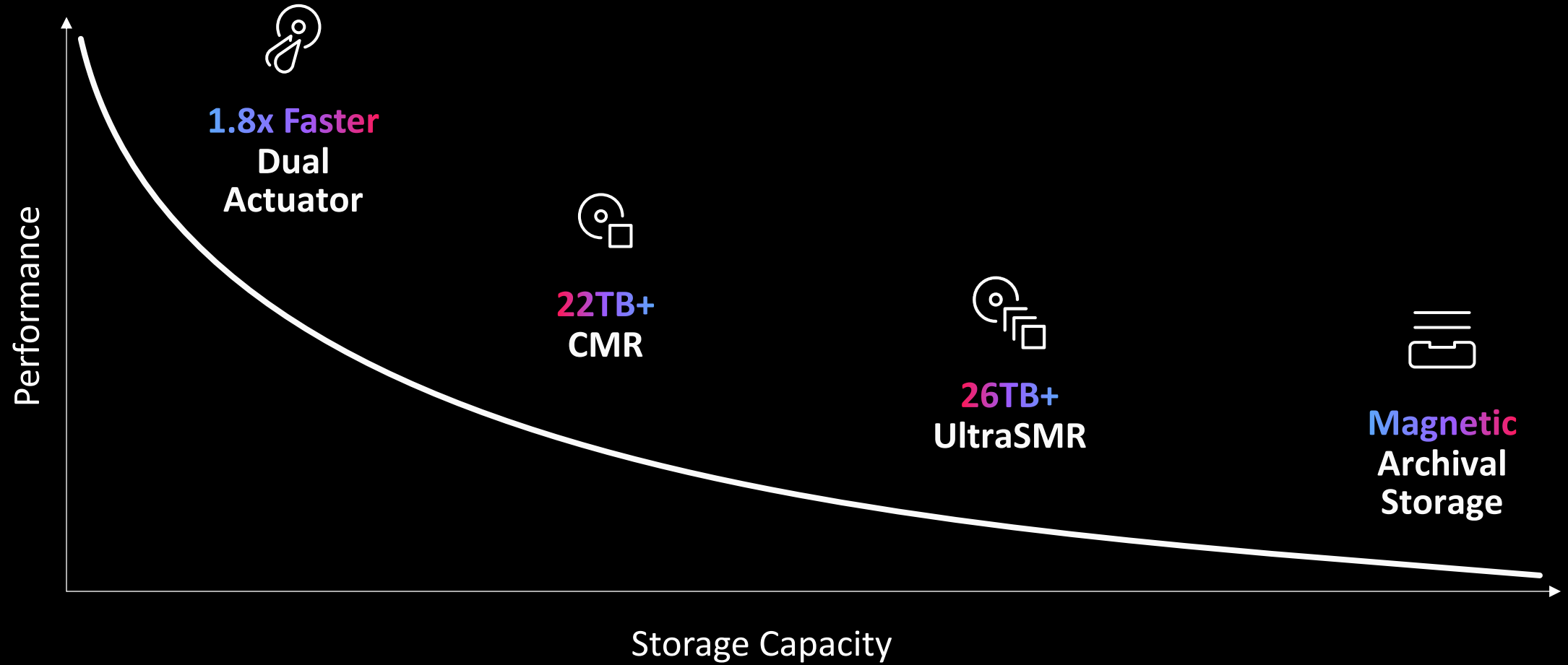
Experts Estimate Supply of Data Storage Won't Keep Up with Demand!



Source: Gartner

Society is Finding Value in “Cold Data”

New breeds of storage technologies must be created in response to the emerging need for immense available capacity at minimal cost in enterprise data centers



Innovation Across Data Tiers



Western Digital[®]

Create What's Next