



Fujifilm 2016 Conference

“Exploring the New World of Storage”



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DEEP STORAGE EXPERTS

Spectra's BlackPearl S3 Gateway To Tape



Eighth Rack	Quarter Rack	Half Rack	Full Rack	Multi-Rack
2U BlackPearl + T50e Tape Library	BlackPearl + T120 Tape Library	BlackPearl + T200 Tape Library	BlackPearl + T380 Tape Library	BlackPearl + T680 Tape Libraries
80TB Raw Disk Storage	160TB Raw Disk Storage	928TB Raw Disk Storage	1,696TB Raw Disk Storage	6.1PB+ Raw Disk Storage
300TB Uncompressed Tape Storage	720TB Uncompressed Tape Storage	1,200TB Uncompressed Tape Storage	2,280TB Uncompressed Tape Storage	4,020TB Uncompressed Tape Storage

BlackPearl™

ExaScale Edition TFinity™

System Configuration:

BlackPearl 4U Deep Storage Gateway

- 6.1PB Raw Capacity Cache

5 Frame TFinity Tape Library **5,590 LTO Slots**

- 13.9PB Uncompressed Capacity using LTO-6 tape technology
 - 33.5PB Uncompressed Capacity using LTO-7 tape technology
-
- ### **4,239 TS Enterprise Slots**
- 42.4PB Uncompressed Capacity using TS1150 tape technology

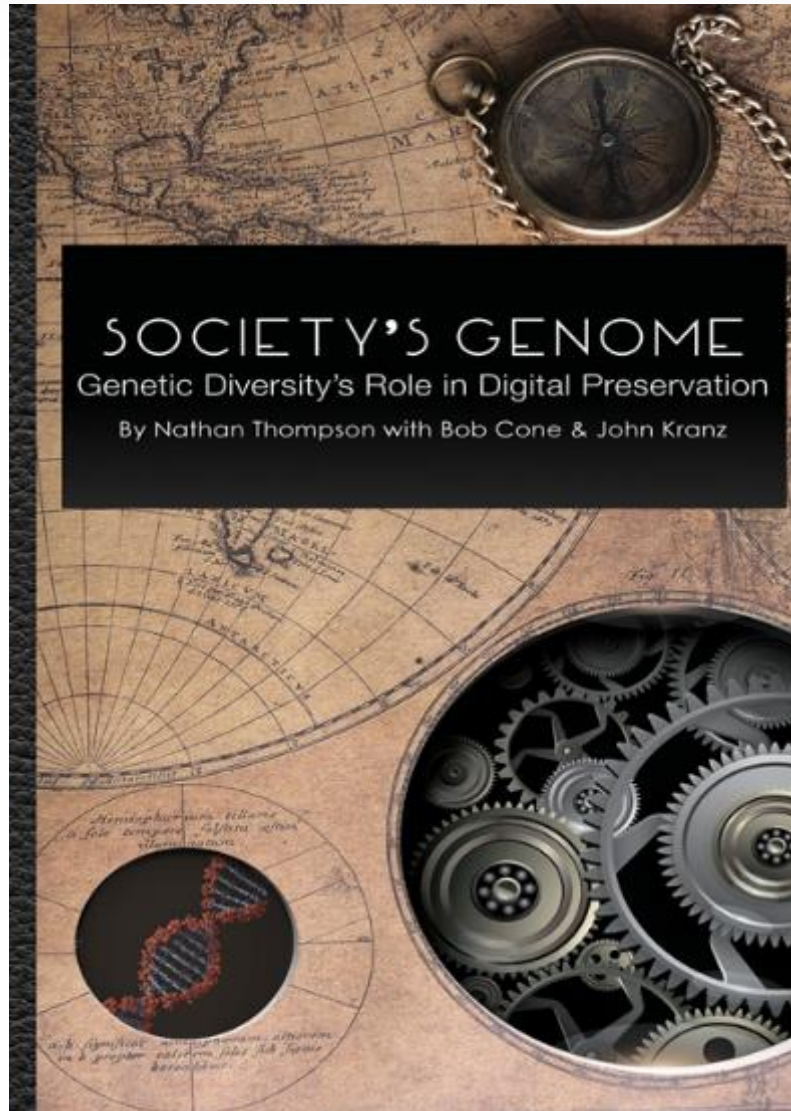


DEEP STORAGE EXPERTS

Exploring The New World Of Storage

- At the last Fujifilm event I spoke about two upcoming publications
 - Spectra's Storage Forecast which you can download from the Spectra Logic web site for free (<http://spectra.cc/lgh>)
 - The Book "Society's Genome"
- Both are now published
 - I will tell you a few of our findings
 - At the end of this event, I will give you a copy of the book—thanks to Fujifilm
- First the book

Society's Genome



All Plants and Animals Have Read-Only Data Storage

- It's DNA
- Allows them to survive
- Allows them to adapt
- Moves them forward and gradually change

The Digital Universe (All of the Information We Create & Store) is Society's DNA

- This is what allows our social structures to move forward
- Allows us to survive and adapt
- Constantly under attack
 - Hackers, rouge states, hardware failures, economic conditions, flood/fire, insider threats
- Loss would be catastrophic
- This is a very important responsibility for those of us to store & create data, manufacture equipment and media

Preservation of The Human Genome vs. Society's Genome

Human Genome

- Cellular reproduction (Mitosis)
- Genetic diversity built into DNA and species
- Geographic dispersal
- Telomeres
- RNA Transcription Error Correction (Aurora B kinase B ABK)

Society's Genome

- Multiple cost effective copies
- Genetic diversity across media types
Disk/Tape/Cloud/Flash
- Geographically separate copies
- Check-summing
- Digital error correction

Tiered Storage Example: Photography



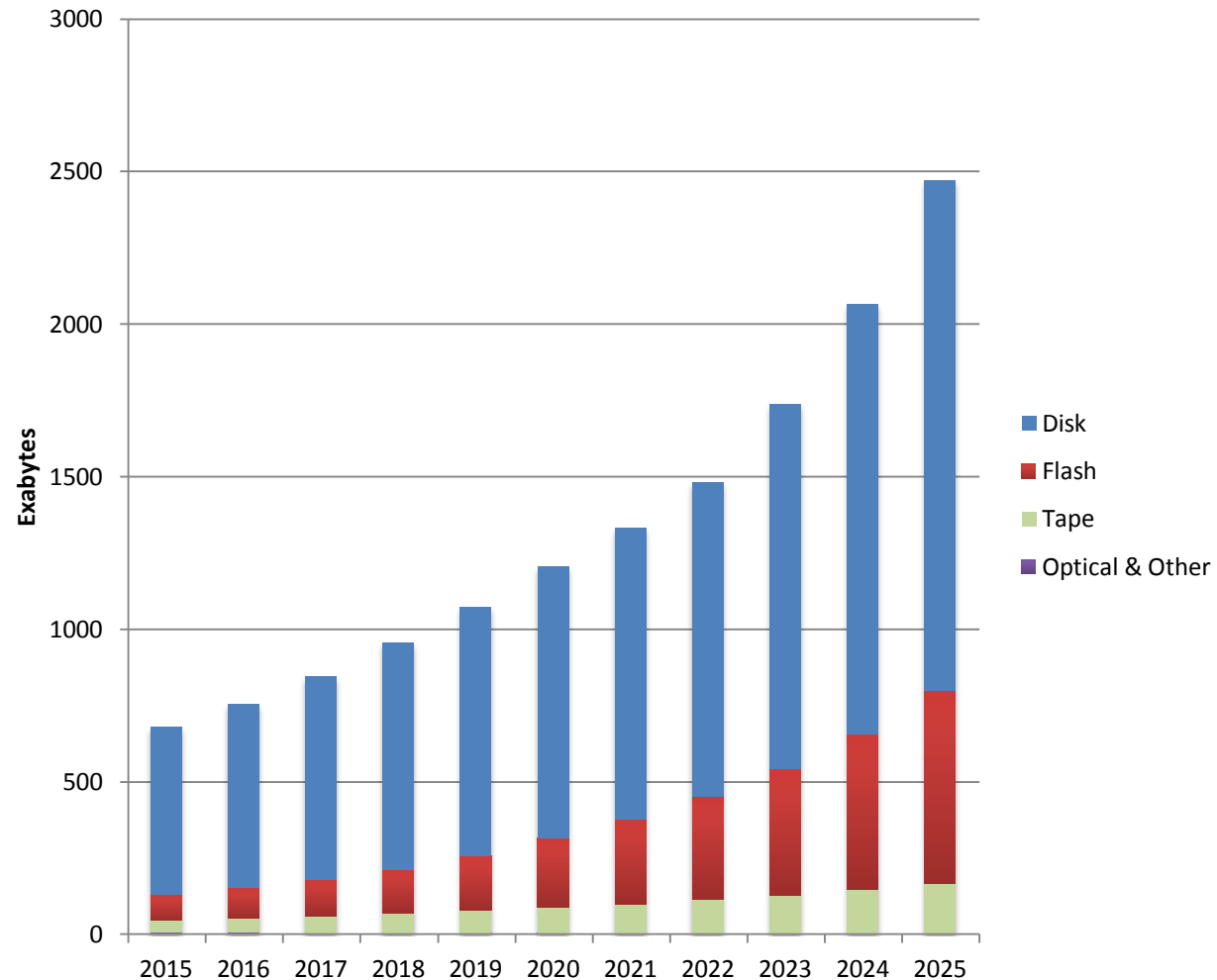


Spectra Logic's Storage Forecast

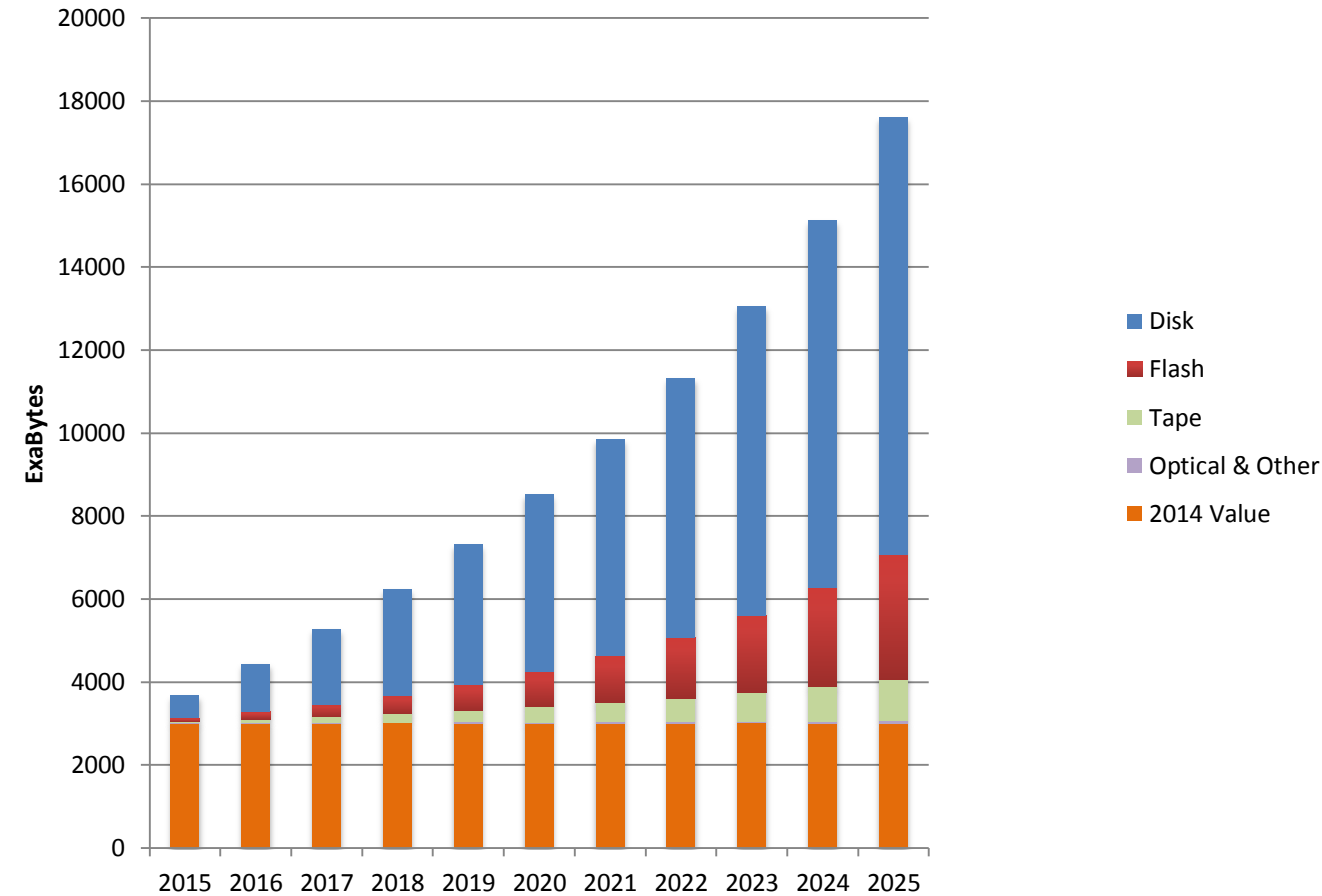
<http://spectra.cc/lgh>

A Supply Side View of The Digital Universe

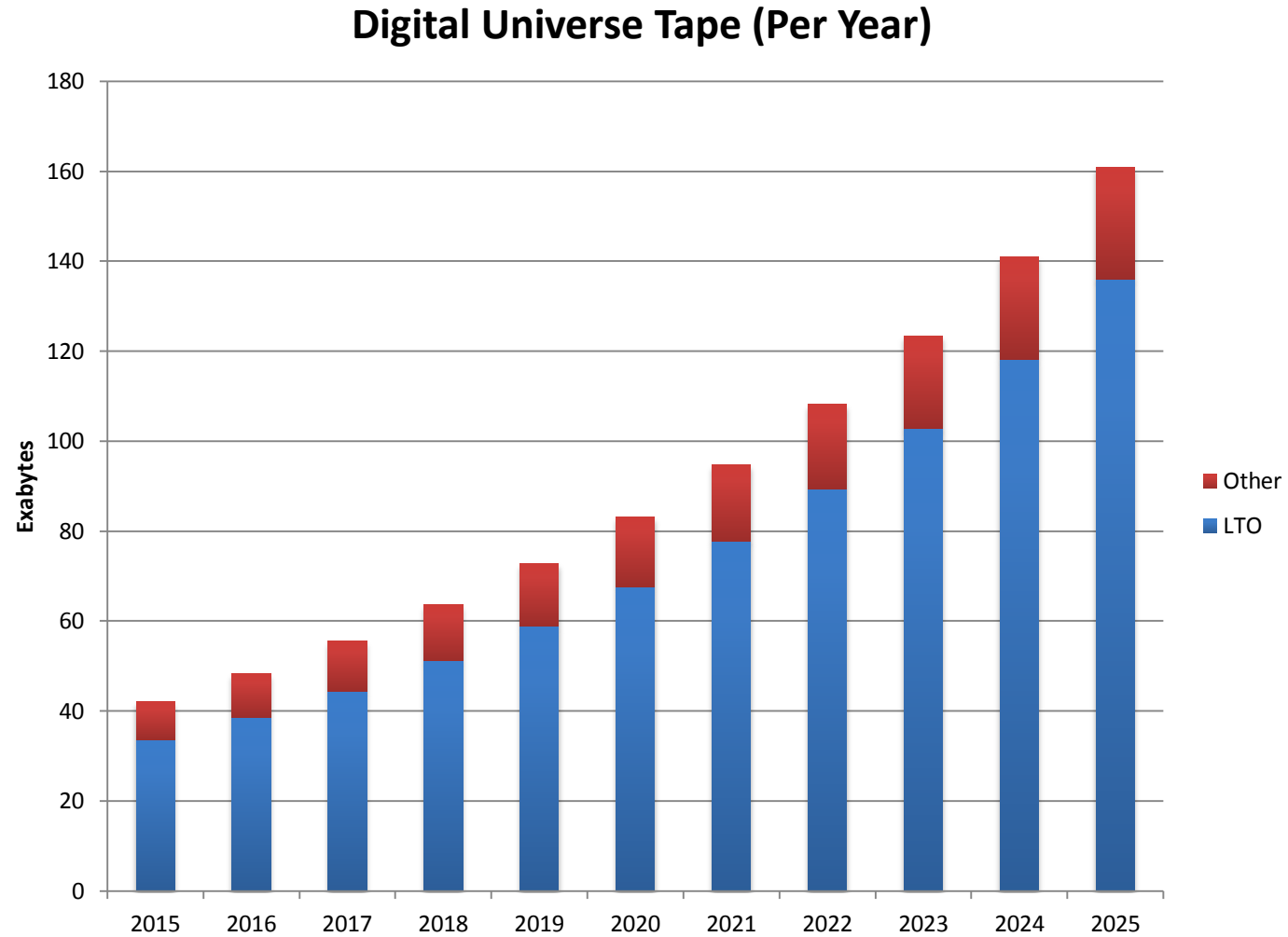
Stored Digital Universe (Per Year)



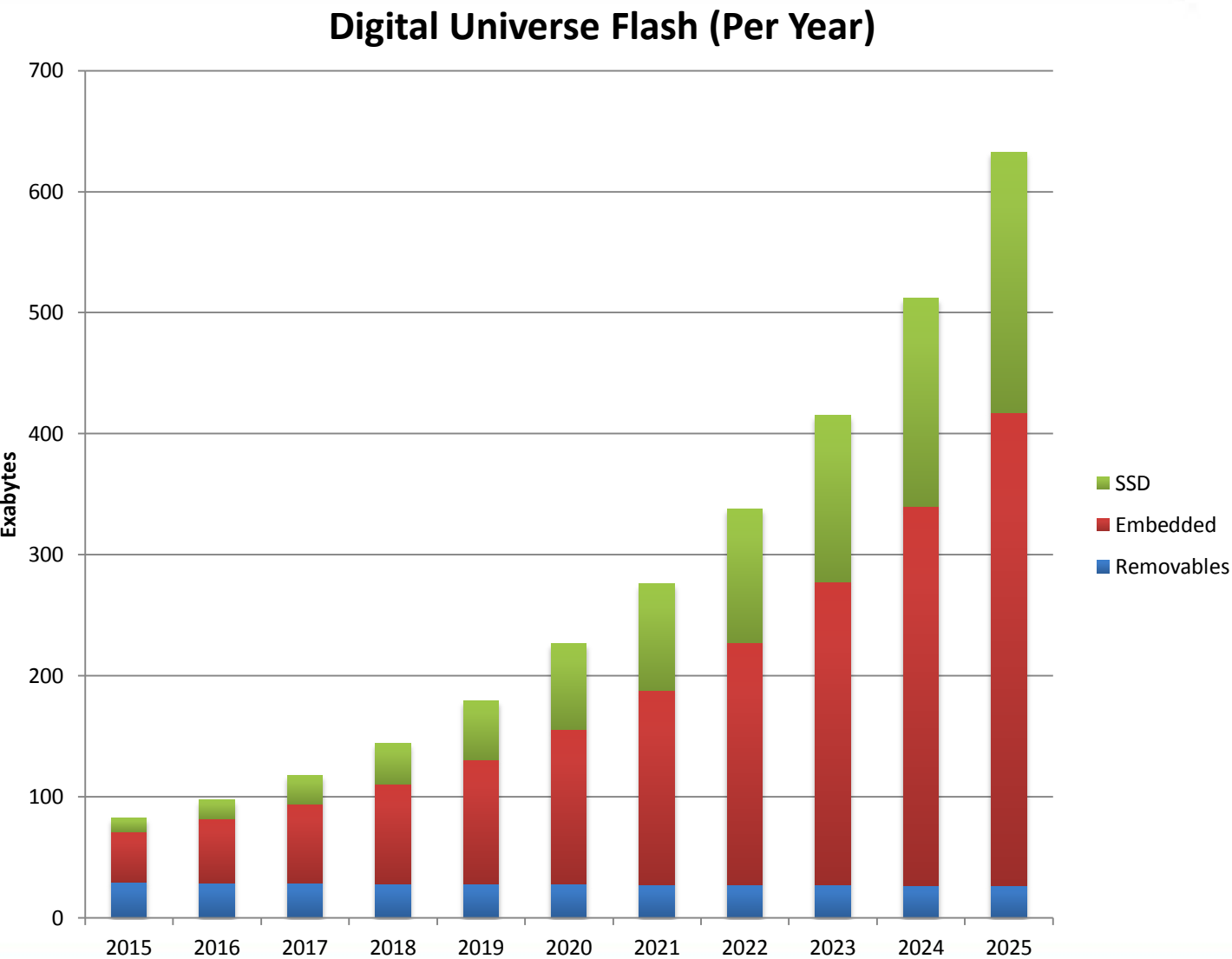
Total Stored Digital Universe



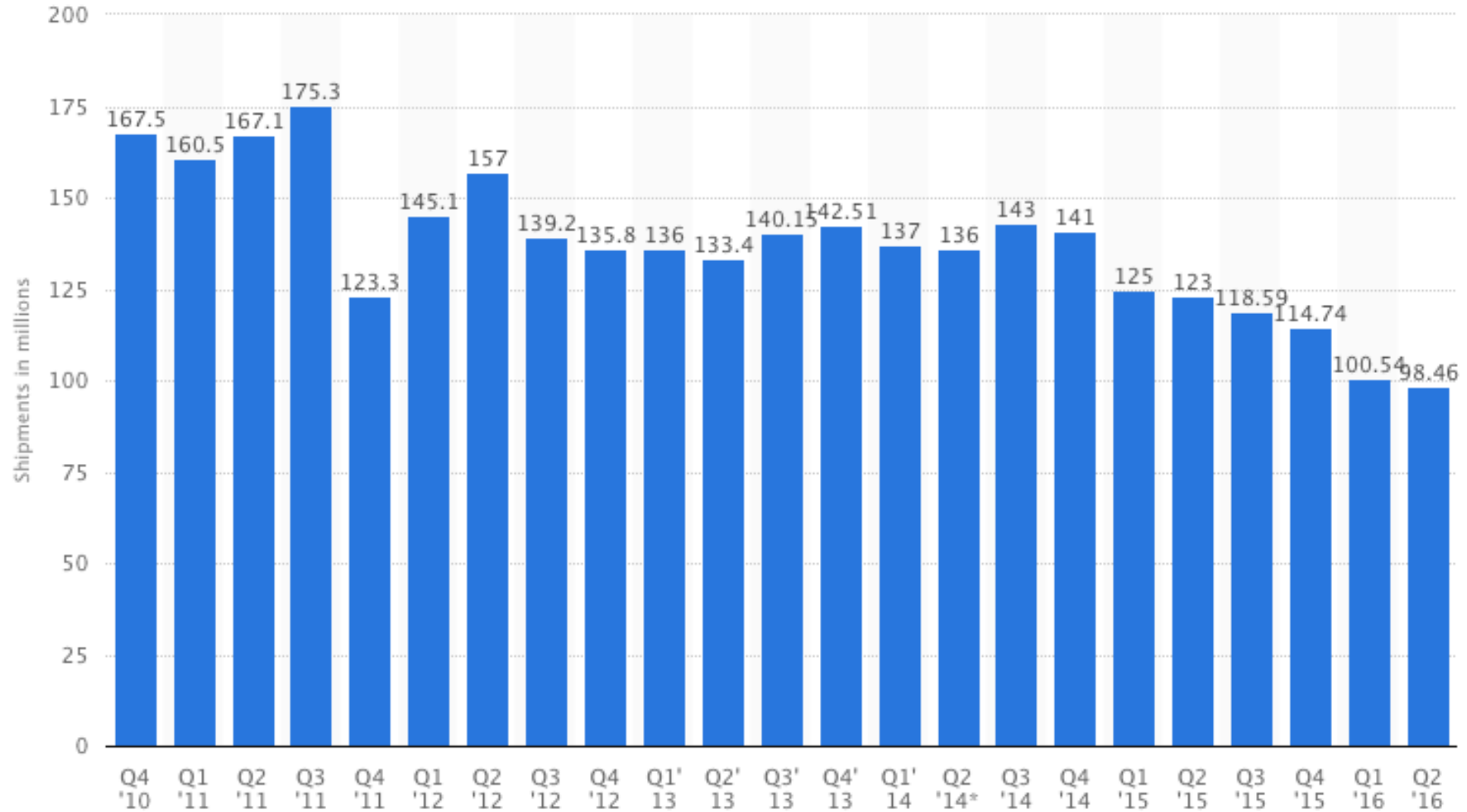
Tape Is Growing



Flash and Solid State Are Doing Great



Disk Volumes Are Accelerating Rate of Decline



But Two “Megatrends” Have Changed: Disk Roadmap Page 1

- The volume is falling out of the business due to flash becoming more efficient the consumer/low-capacity and high-performance disk storage segments. In the next three years disk unit volumes will fall further to 40 million or less units per quarter. This is reducing the industrial base, and driving up cost.
 - In my opinion, Toshiba is dependent consumer segment of the disk drive business and therefore likely to exit the disk drive business to focus on flash (incidentally with WD)
- Due to the super-parametric limit, conventional methods for increasing have been exhausted, leaving only one-time fixes such as Helium and Shingled
- The two significant disk drive provider (WD and Seagate) are focusing more growth markets—flash and are reducing capacity or “de-investing” in rotating media

But Two Megatrends Have Changed: Disk Roadmap Page 2

- Heat Assisted Magnetic Recording (HAMR) which has “been just around the corner” since 2007, is still not working.
 - HAMR is not and never will be commercially viable—there are just too many physics problems
 - There are no other commercially viable technologies for recording density including patterned media
- I’m now convinced that magnetic disk will top out at 14-18TB per 3.5” drive in 2019 or 2020.
- Combined disk drive and flash companies will need to invest in higher density flash such as 3D and Phase-Change. Costs per capacity drive will probably level out around \$300 around 2019
 - The only alternative is to go out of form-factor (taller) which doesn’t significantly improve cost

But Two Megatrends Have Changed: Tape Roadmap

- Tape is in a position to more rapidly deliver declining cost per bit over the next 10 years
 - Tape has plenty of potential for capacity improvement to reach at least four or five more doublings of current capacity, entirely due to surface area and Tunneling Magnetoresistive (TMR) heads
 - Fujifilm and IBM have demonstrated BaFe media has been proven to reach 220TB or more / cartridge
 - IBM and HP have partnered on the same head design at LTO-7 and beyond which gives them 98% market share (at LTO-7 and beyond) with plans to double every two years
 - This gives users confidence in a roadmap that can span for at least four more generations of drives
 - Nearly all of the large cloud companies see a significant role for tape

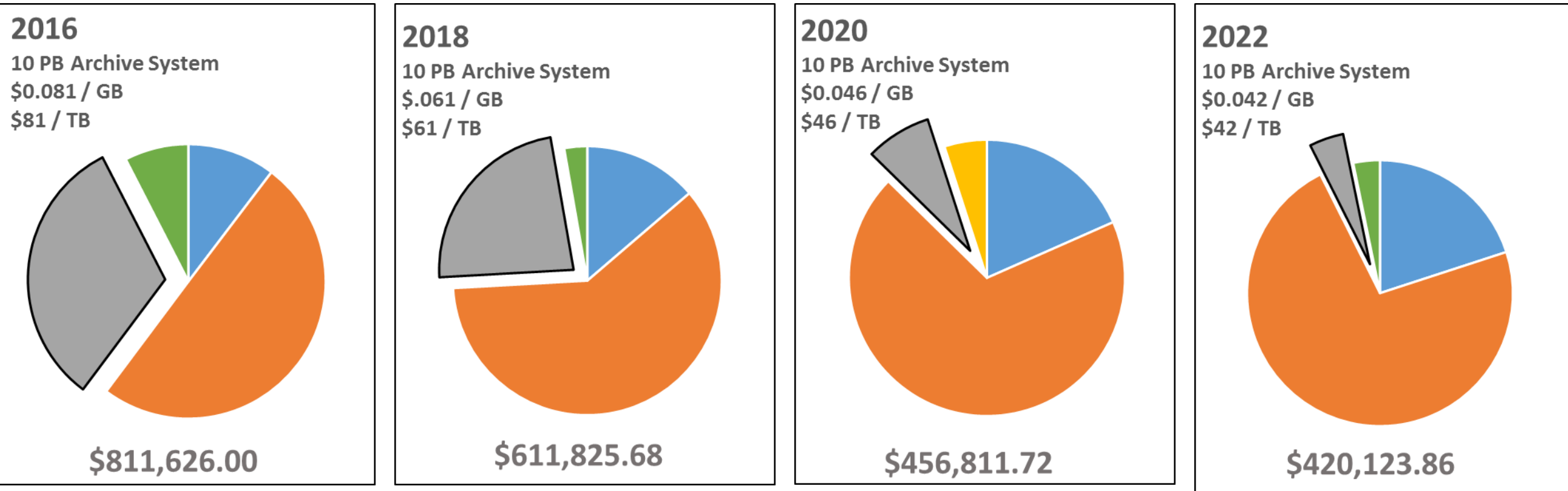
If the Tape Industry Plays the Long Game, It Can Achieve Growth

- The past growth of disk capacity has adversely impacted the tape market. But growth in disk capacity has nearly ended.
- If tape drives and media can succeed at the next two generations (TS1165, T10000F, LTO-9) it will maintain a near permanent cost advantage over disk.
- Flash, while great for many applications will always cost 25x that of tape
- Growth requires continued cooperation amongst the drive and media manufacturers!
 - The media manufacturers (Fujifilm and Sony) can't profitably sell LTO tapes below \$40 (and reinvest)

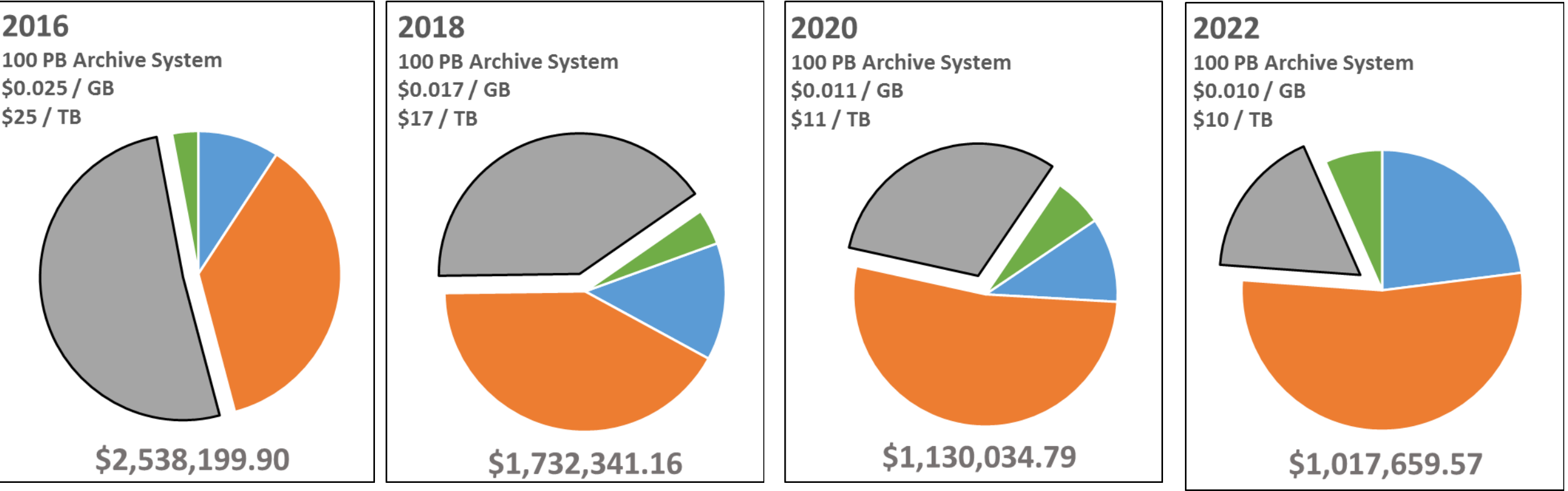
Here Is The Economic Opportunity For Tape

- Without HAMR, disk prices will level out at \$300 for capacity 3.5” disk drives, for 16TB, or about 2 cents per Gigabyte (raw) in 2019 and will increase with inflation from there
- Assuming constant media price and the industry stays true to a two year improvement cycle
 - LTO-7 is about 1.6c per Gigabyte now and will reach ~1c in 2017
 - LTO-8 will .8c per Gigabyte in 2018
 - LTO-9 tape will be .4c per Gigabyte in 2020
 - LTO-10 in ~2022 will be .2c per Gigabyte

10 PB Archive System (no compression)
5 PB Nearline Copy + 5 PB Ejected Copy of Data
Systems Configured with 12 LTO Drives
7x24 Support adds 6%-9% to total US Price, annually



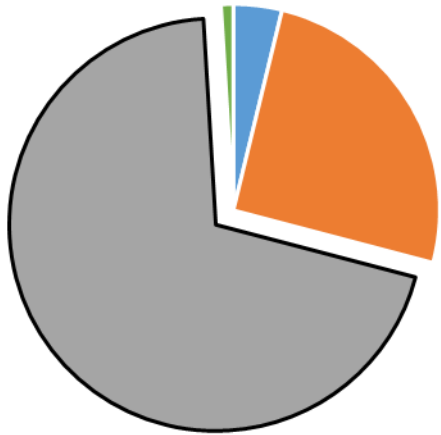
100 PB Archive System (no compression)
50 PB Nearline Copy + 50 PB Ejected Copy of Data
Systems Configured with 48 LTO Tape Drives
7x24 Support adds 6%-9% to total US Price, annually



1000 PB / 1 Exabyte System (no compression)
500 PB Nearline Copy + 500 PB Ejected Copy of Data
Systems Configured with 144 LTO Tape Drives
7x24 Support adds 6%-9% to total US Price, annually

2016

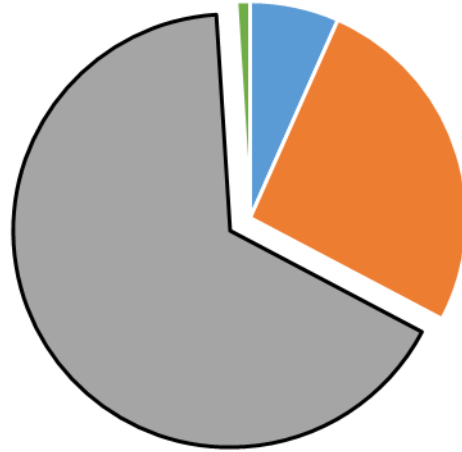
1 EB Archive System
\$0.018 / GB
\$18 / TB



\$18,486,451.06

2018

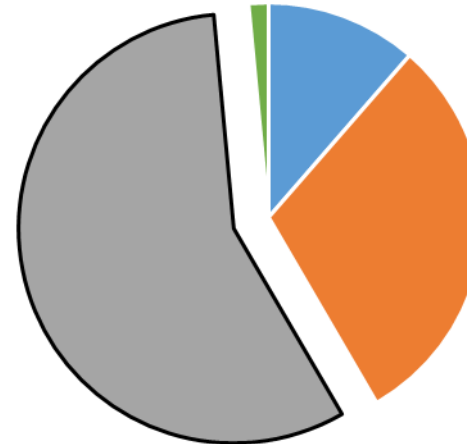
1 EB Archive System
\$0.011 / GB
\$11 / TB



\$10,593,261.38

2020

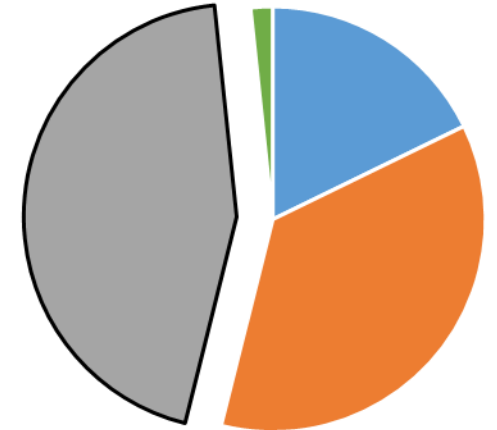
1 EB Archive System
\$0.006 / GB
\$6 / TB



\$6,166,878.78

2022

1 EB Archive System
\$0.004 / GB
\$4 / TB

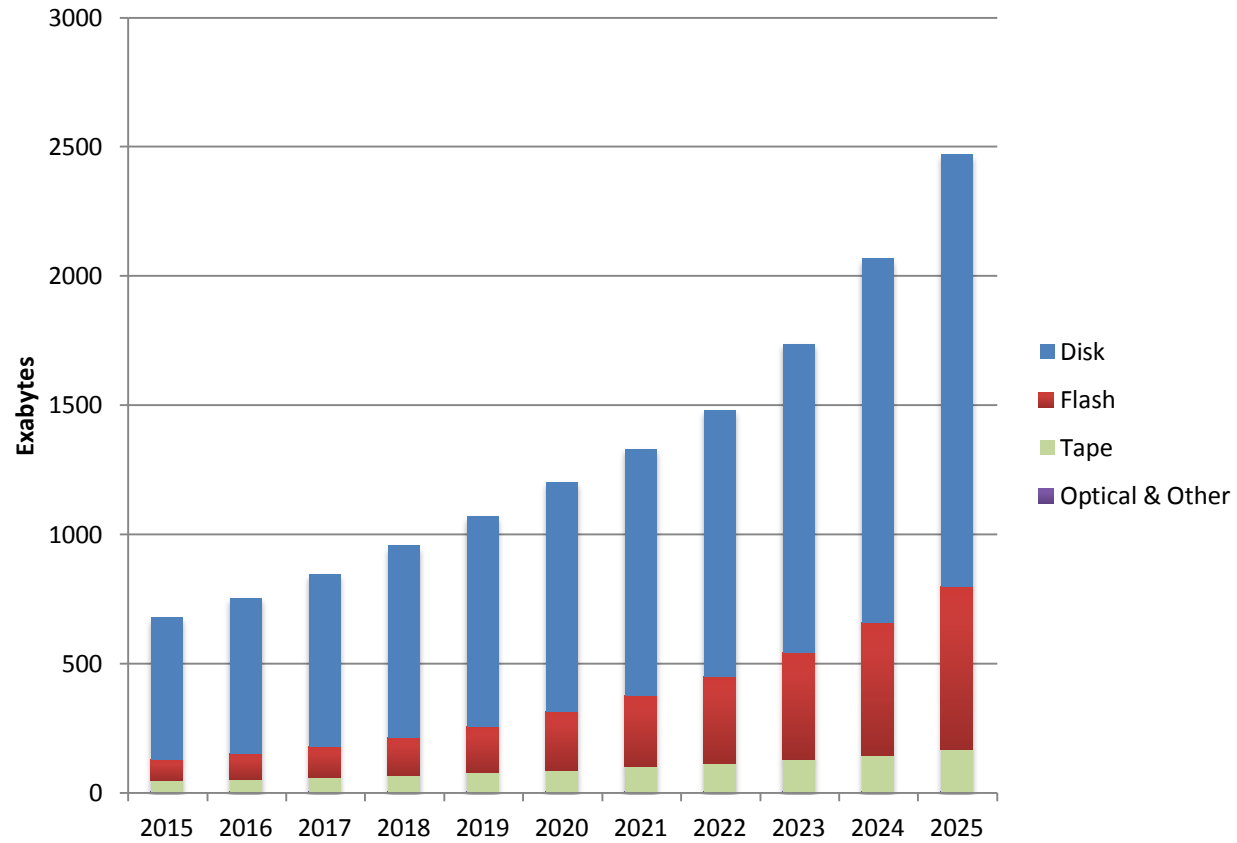


\$3,948,218.07

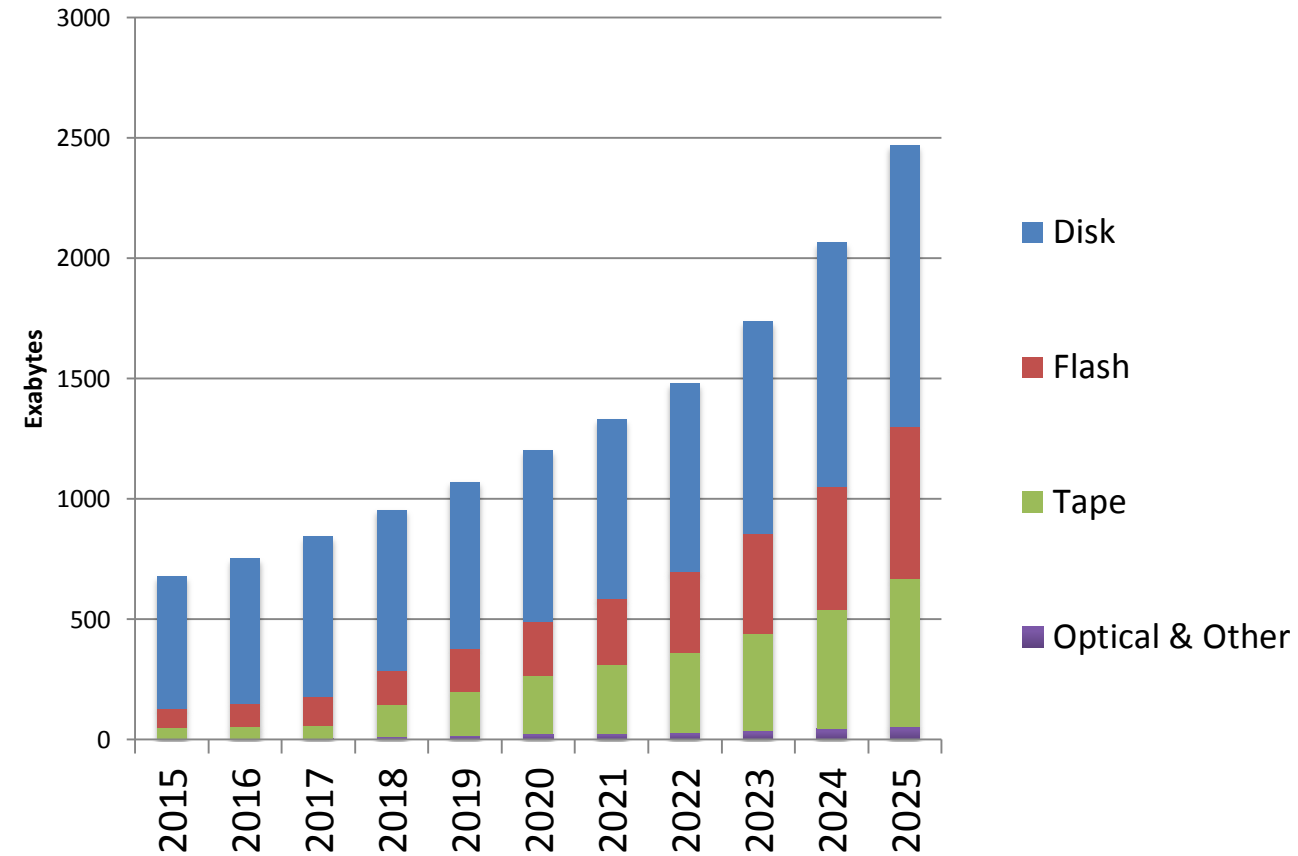
■ BlackPearl Hardware ■ Tape Library, Slots, Drives ■ Media ■ BlackPearl Licensing ■ Professional Services

What Does This Bring?

Stored Digital Universe (Per Year)



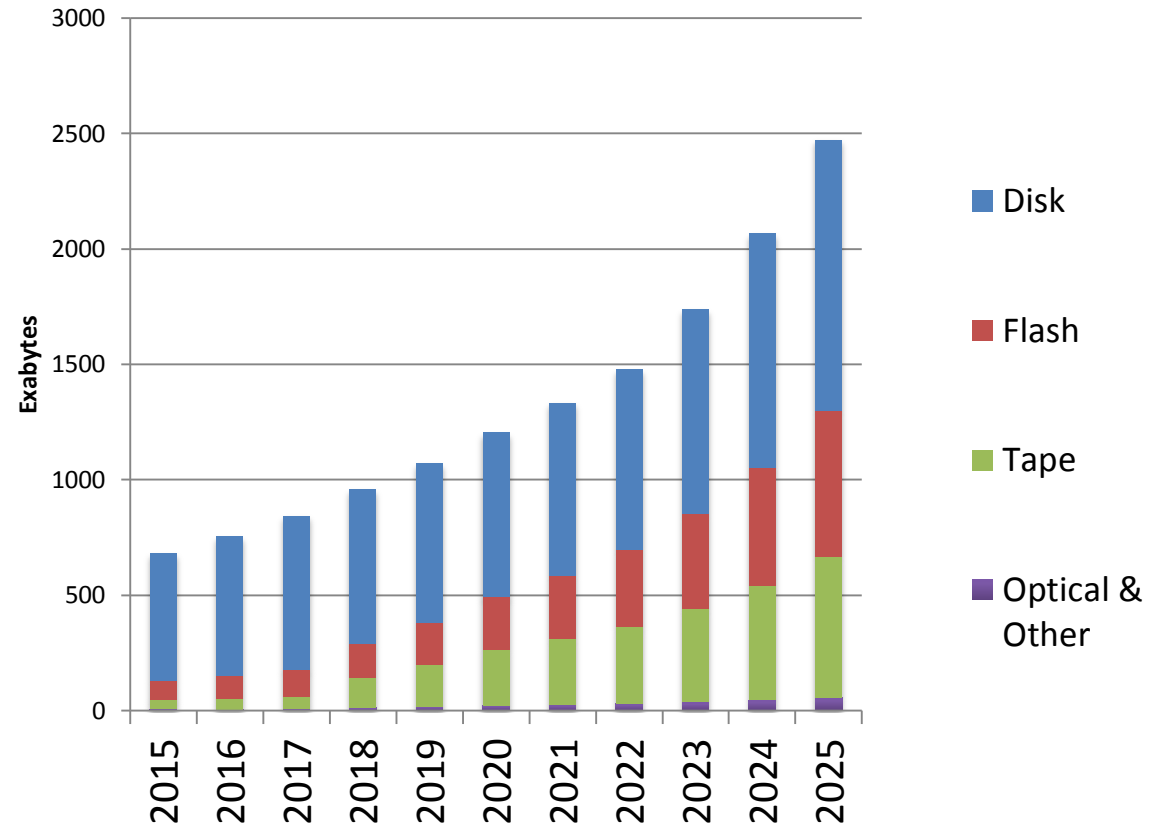
Radical Re-Forecast: Stored Digital Universe (Per Year)



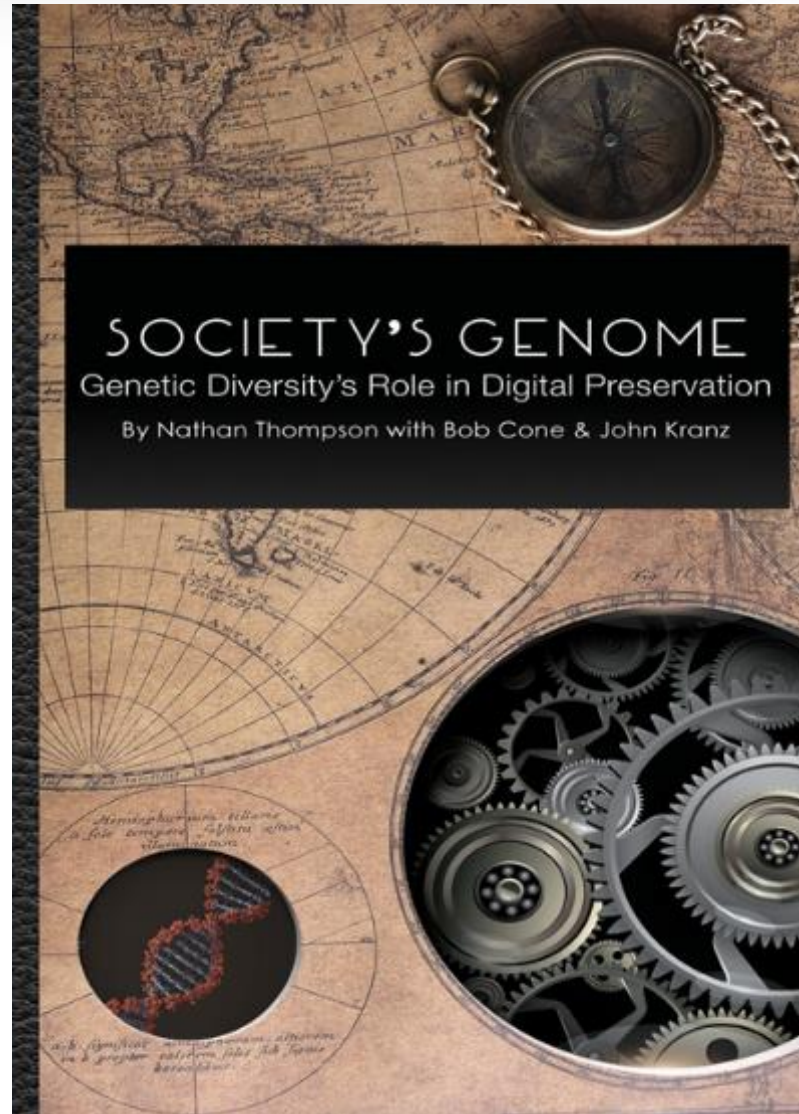
Result Will Be A Growing Tape & Storage Industry

- Demand growth faster than tape media growth
- Tape is a significant part of long-term storage delivering cost savings, genetic diversity & geographic dispersal
- Much of long-term storage in cloud is on tape
- Lower carbon footprint due to reduction of spinning disks drives

Stored Digital Universe (Per Year)



Questions?





**Spectra Storage Forecast White Paper
will be published in October 2016**

<http://spectra.cc/lgh>

“Society’s Genome”

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