5,000 Years of Storage

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General Observations about the 2016 CES

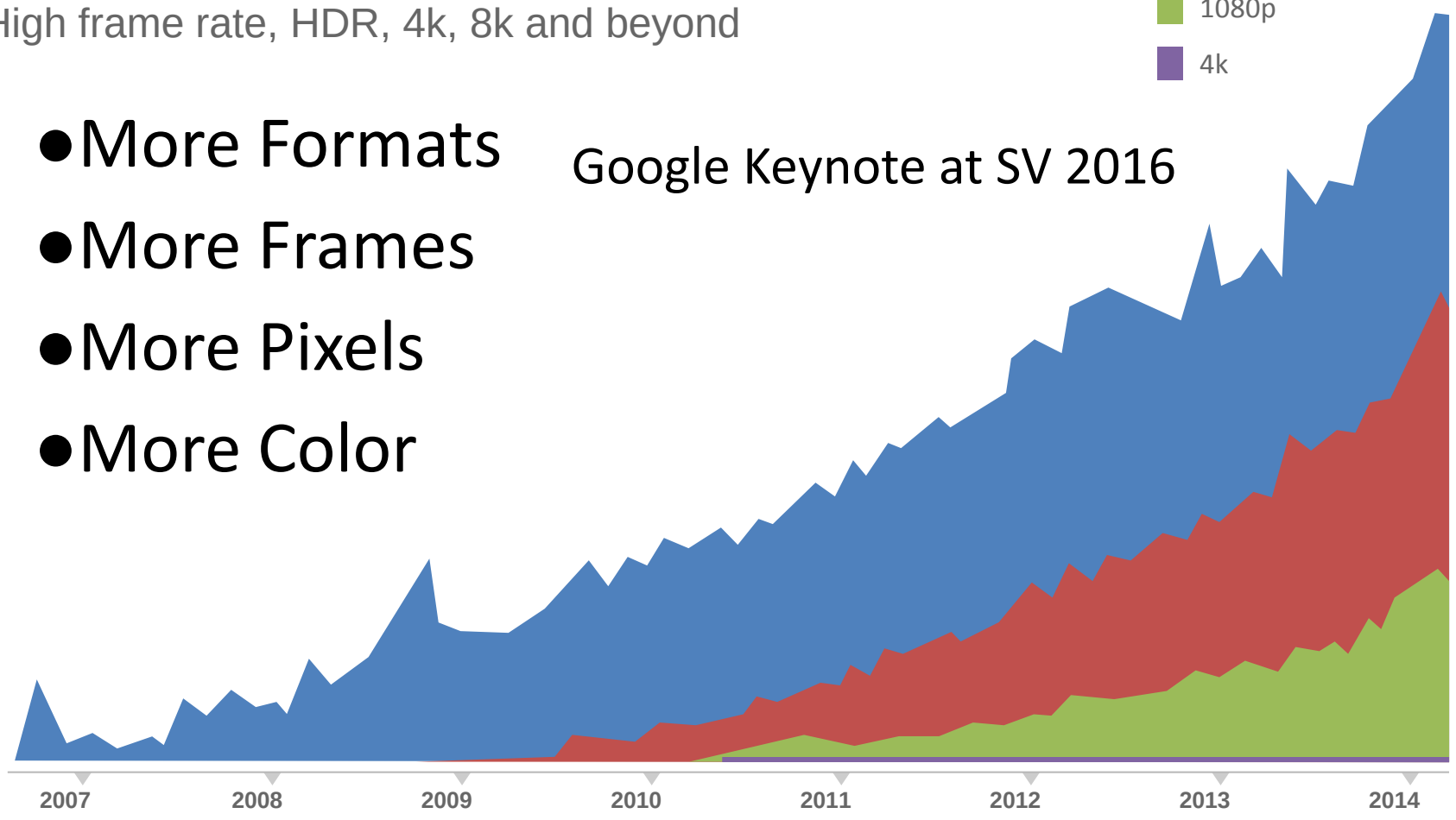
- Even fewer raw storage showings on the show floor—mostly in hotel suites
- Big themes are wearables, IoT, drones and VR
- Sands exhibit space was full of new companies with interesting and odd products and services
- Storage Visions theme was: Storage for the Next 5,000 Years (it was at the Luxor…)

New Video Formats are Data Hogs

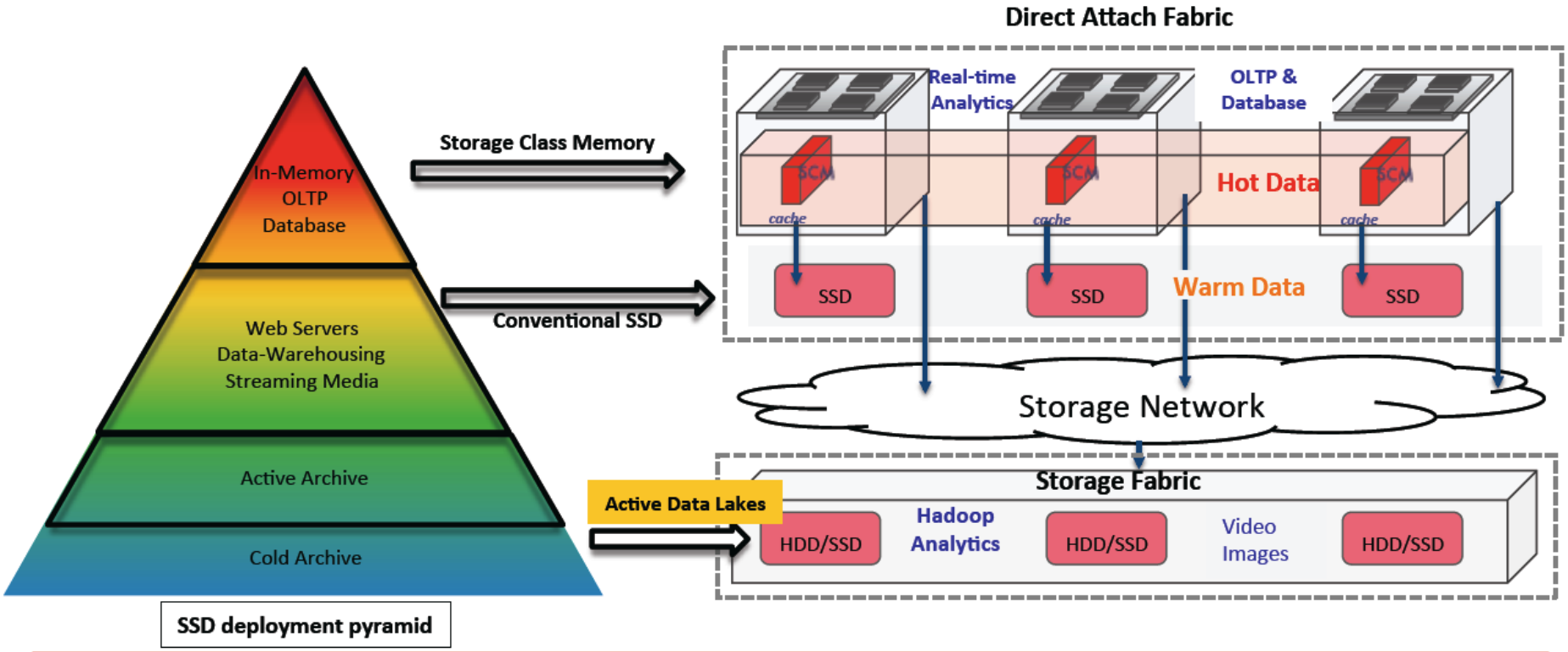
High frame rate, HDR, 4k, 8k and beyond

- More Formats
- More Frames
- More Pixels
- More Color

Google Keynote at SV 2016



New Storage Hierarchy
(SanDisk at SV 2016)



LaCie Chrome by Neil Poulton

- USB 3.1 Gen 2 (10 Gb/s)—up to 940 MB/s
- Pair of M.2 SATA SSDs in a RAID 0 Configuration
- USB-C connector
- Magnetized cable management
- Chrome Finish

USB-C
(Seagate Exhibit at CES)

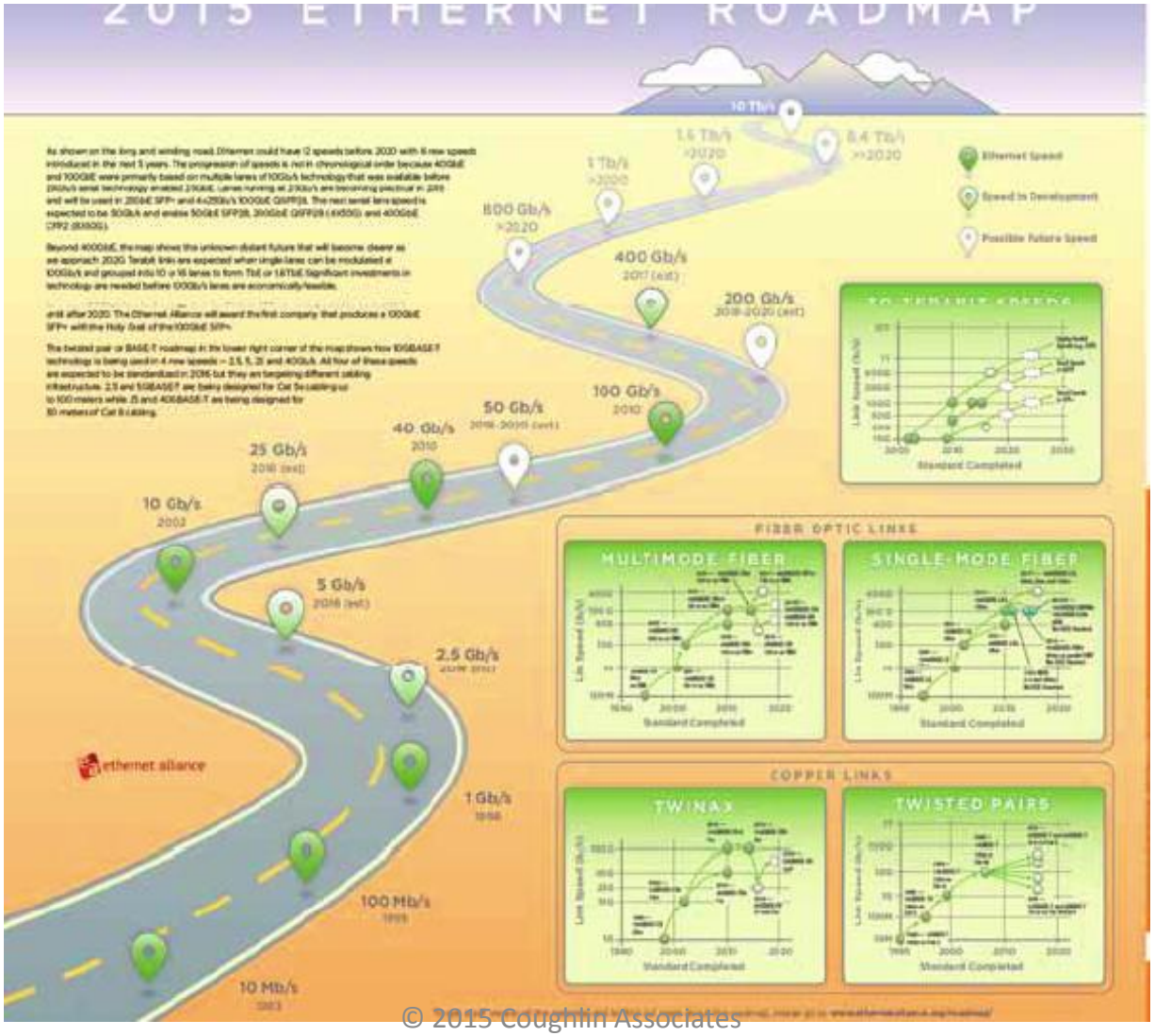
USB 3.0

USB-C

- USB-C connector. An interface that is a lot like the Apple Lightning cable. There is no wrong way to insert it. Both sides of thecable are identical too.
- • USB 3.1 Gen 1 = 5Gb/s = USB 3.0 (LaCie Porsche Design)
- • USB 3.1 Gen 2 = 10Gb/s (LaCie Chromé)
- • Gen 1 and Gen 2 have USB-C connector
- ▪ Unique Power Delivery feature for laptop charging (LaCie Porsche Design only)

Ethernet Roadmap

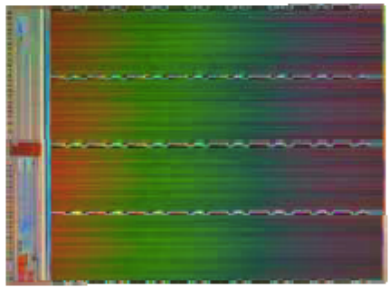
(Scott Kipp, Ethernet Alliance, SV 2016)

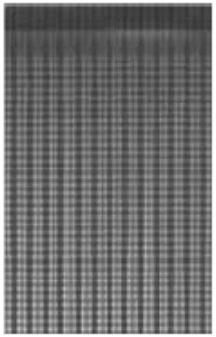


3D NAND

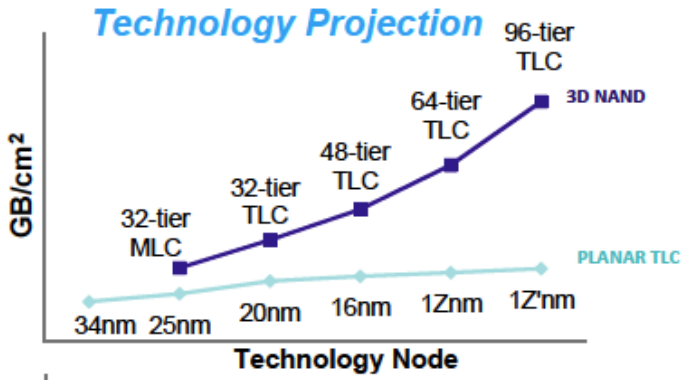
(Rob Peglar, Micron SV 2016 Keynote)

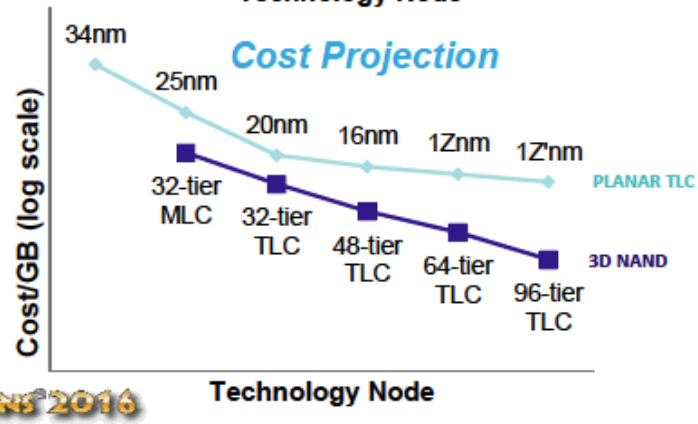
3D NAND Comparison with Planar NAND Scaling





- Planar NAND scaling
  - Planar can be scaled below 16nm, but performance and cost are not competitive with 3D NAND
- 3D NAND scaling
  - 3D NAND cost improvement over planar expands with subsequent nodes
  - 3D NAND cell architecture enables significant performance improvement relative to planar technology





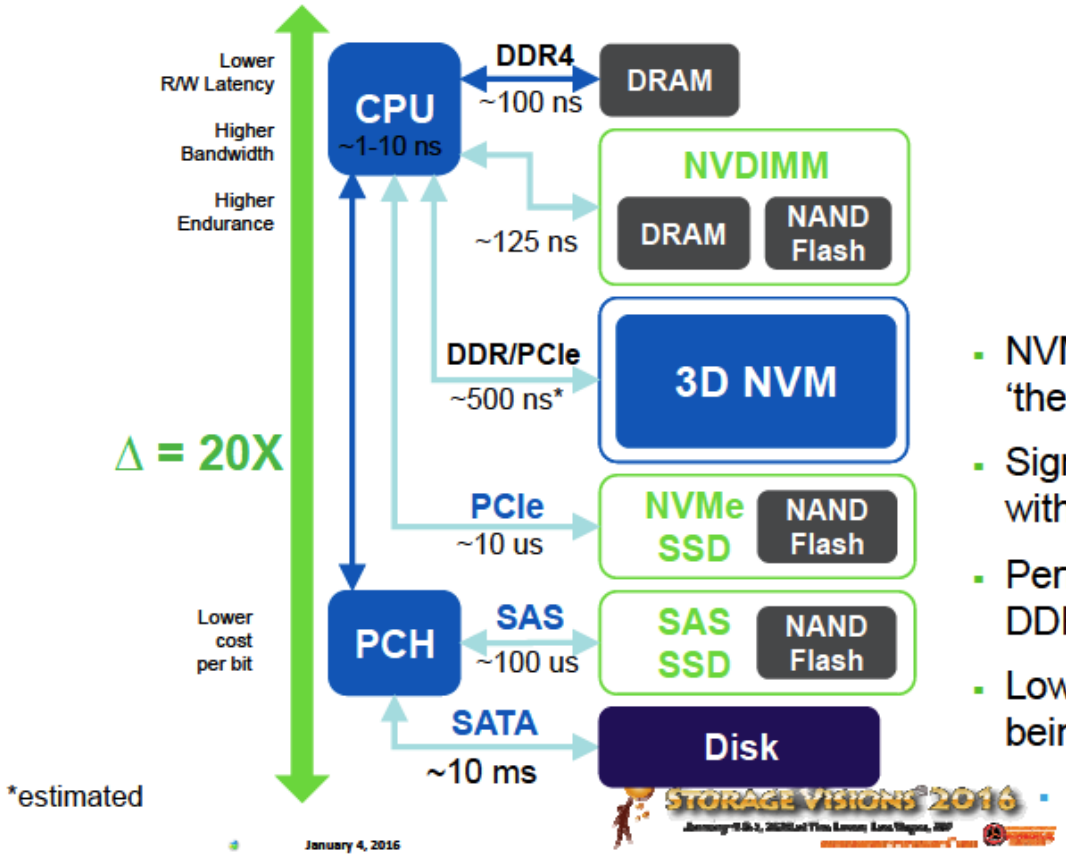
January 4, 2016

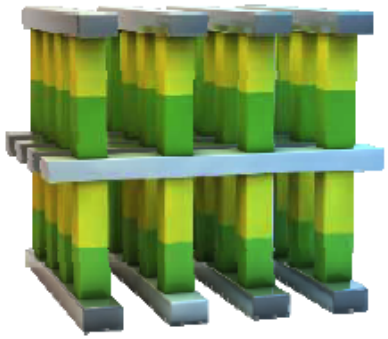
STORAGE VISIONS 2016

Rob Peglar, Micron Keynote

3D X-Point
(Rob Peglar, Micron SV 2016 Keynote)

The Future: 3D Nonvolatile Memories in Server Architectures





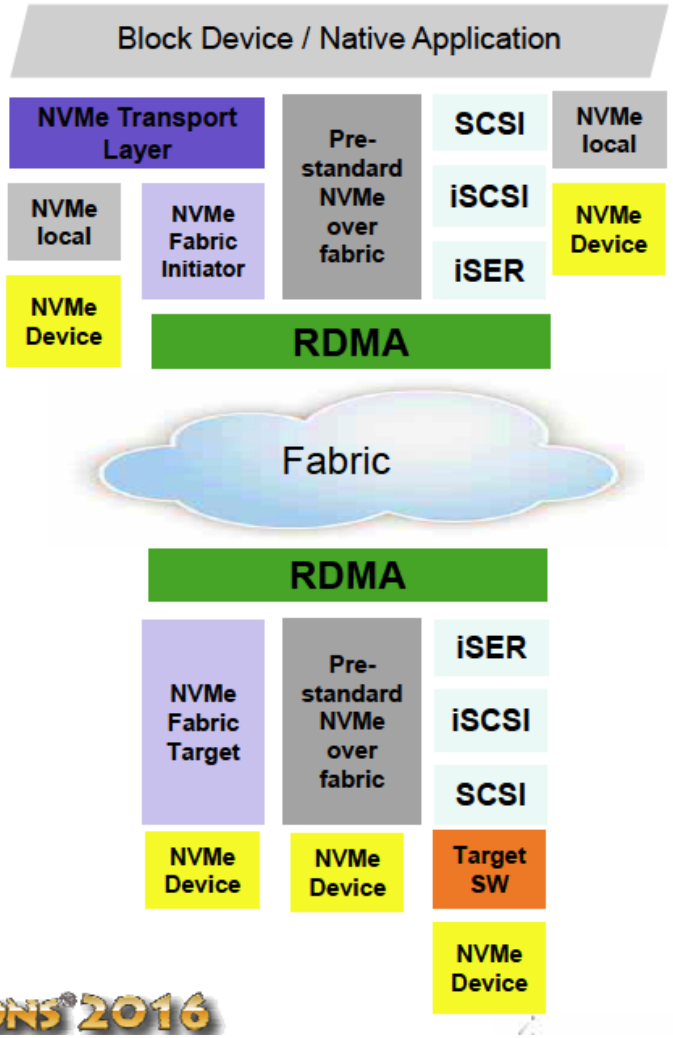
- NVM technology provides the benefit in 'the middle' – reduces the gap
- Significantly faster than NAND Flash with much higher endurance
- Performance can be realized on PCIe or DDR buses – storage or memory
- Lower cost per bit than DRAM while being considerably more dense
- Software-enabled via PMEM & others

Rob Peglar, Micron Keynote

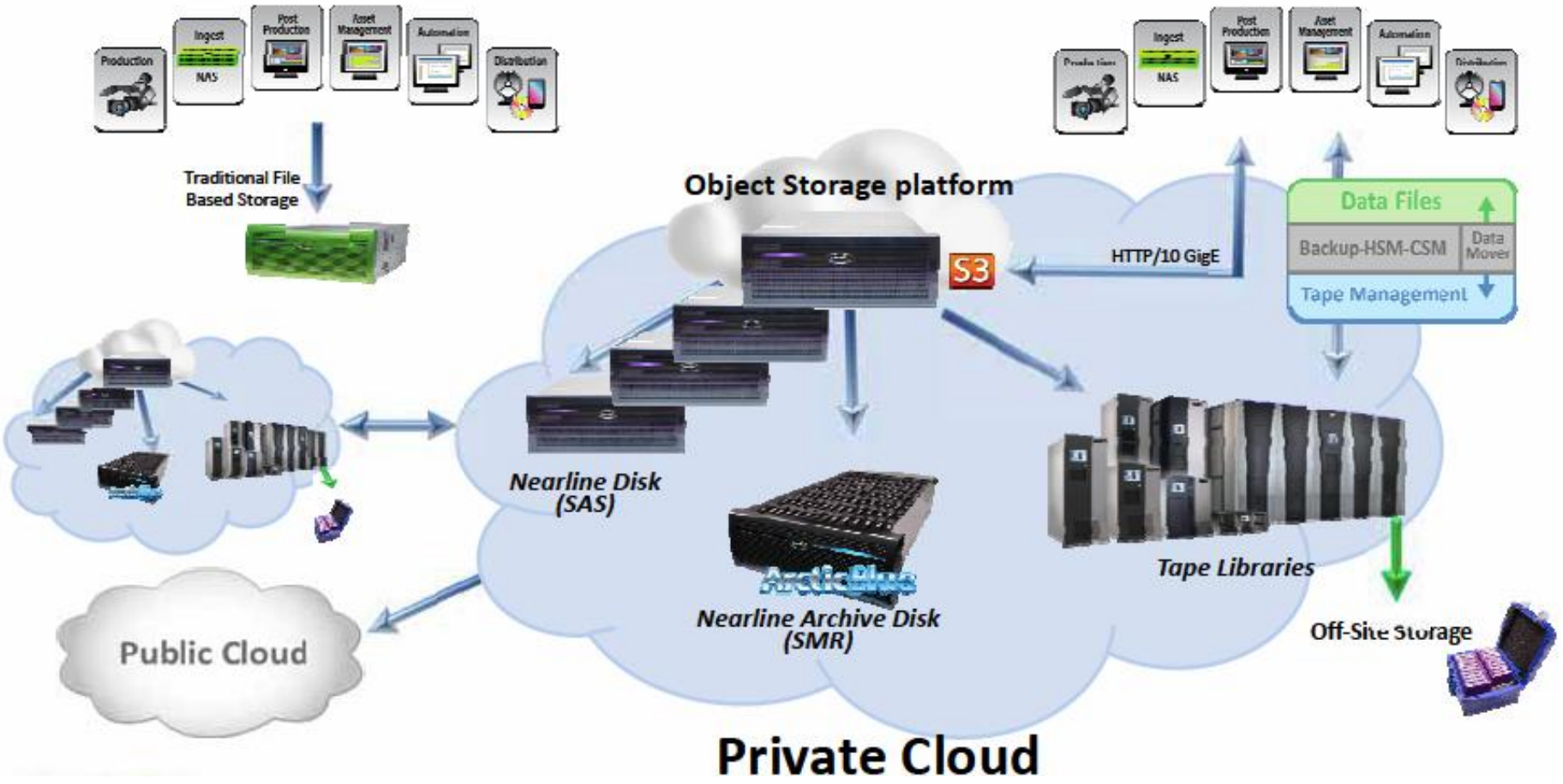
NVMe over Fabrics
(Mellanox SV 2016

NVMf

- The idea is to extend the efficiency of the local NVMe interface over the fabric
  - NVMe commands and data structures are transferred end to end
- Relies on RDMA for performance
  - Example: InfiniBand, RoCE
  - iSER uses SCSI for transport
- A few pre-standard versions are available today



Cloud Storage
(Spectra Logic at SV 2016)



Consumer Clouds and Storage

- Marvell introduced its Smart Home Cloud Center reference platform for home networking and automation, digital entertainment, secure storage and smart server with Kimono Software
- More companies including cloud storage with their external storage offerings—e.g. Seagate offering 2 years of 200 GB in the cloud with their ultra-slim drives
- At SV 2016 Storj said it cost them $3k for 1.5 PB of cloud storage using peer-to-peer technology

Cold Storage (Tape and Optical)

LTO Y BaFe Tape

- 6.0 TB native capacity
- 300 MB/s native transfer rate
- Roadmap to LTO 10
- BaFe tape shows no loss of signal in 30 years

- Panasonic announced its freeze-ray Optical Disc-Based Data Archive System for data centers in collaboration with Facebook.
- Targeted especially at cold storage of consumer photographs and videos
- Facebook is currently implementing the current 100 GB Blu-ray write-once optical technology but plans to move to 300 GB discs as they become available in 2016

Active Archives with HDD Object Storage (HGST Keynote at SV 2016)

HGST Active Archive

- 4.7 PB raw capacity
- Fifteen 9s of data durability
- Distributed erasure coding
- Cloud Scale Object architecture

Odds & Ends

Ehang Flying Drone

ASU Wearable Projector

Sensorwake
Alarm clock
aroma module

PicoBrew Home Brewery