

Fibre Channel Networked Flash Storage

Fibre Channel Dominates Flash

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Disclaimer

- Opinions expressed during this presentation are the views of the presenters, and should not be considered the views or positions of the Ethernet Alliance.

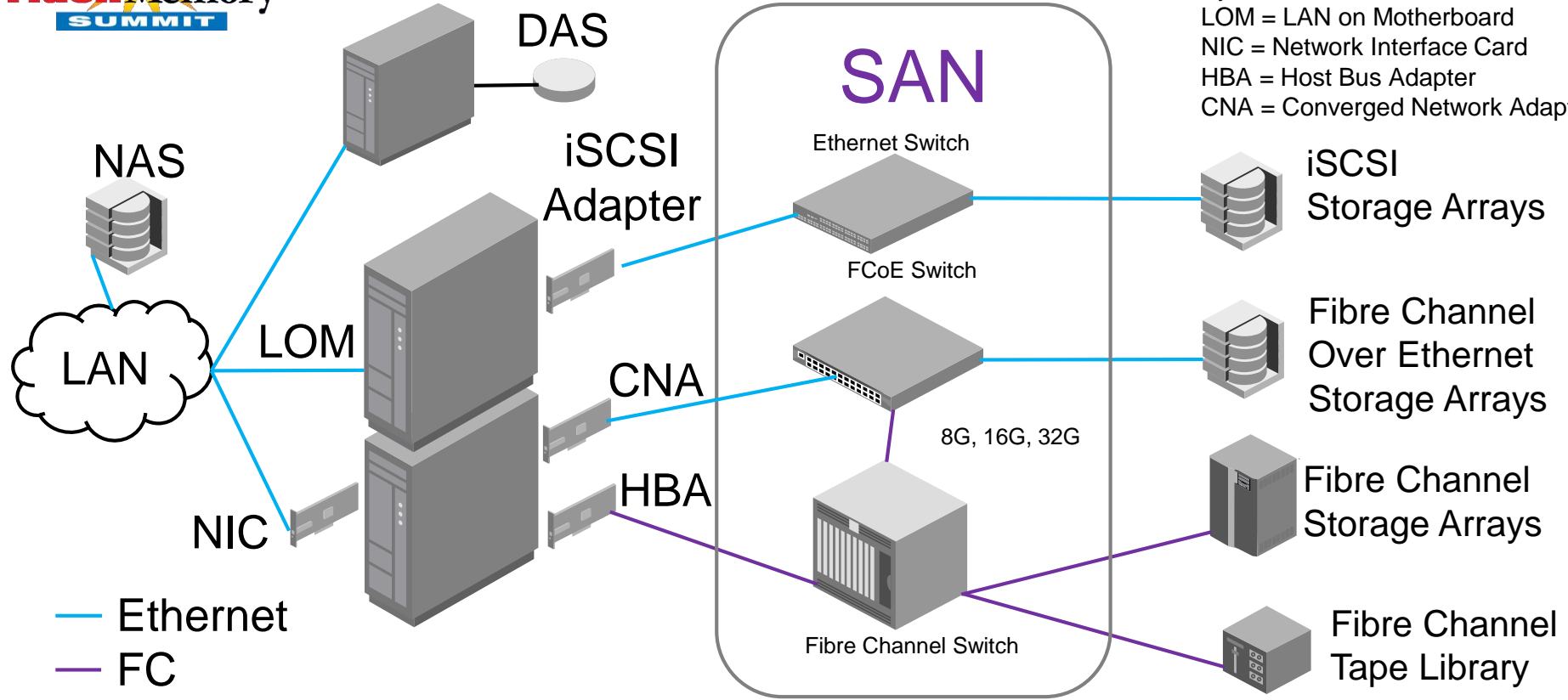
Why Fibre Channel Dominates

- Economies of Scale
 - FC dominates enterprise storage sales/shipments
 - Volume drives prices down and investment up
- Experience and functionality
 - FC has proven reliability and scale
 - FC has wide support from management to disaster recovery
- Complete Ecosystem
 - FC has complete ecosystem of support for hardware, software, extension and tape
 - From Mainframes to HPC

80% of
Networked
Flash is on
Fibre Channel*

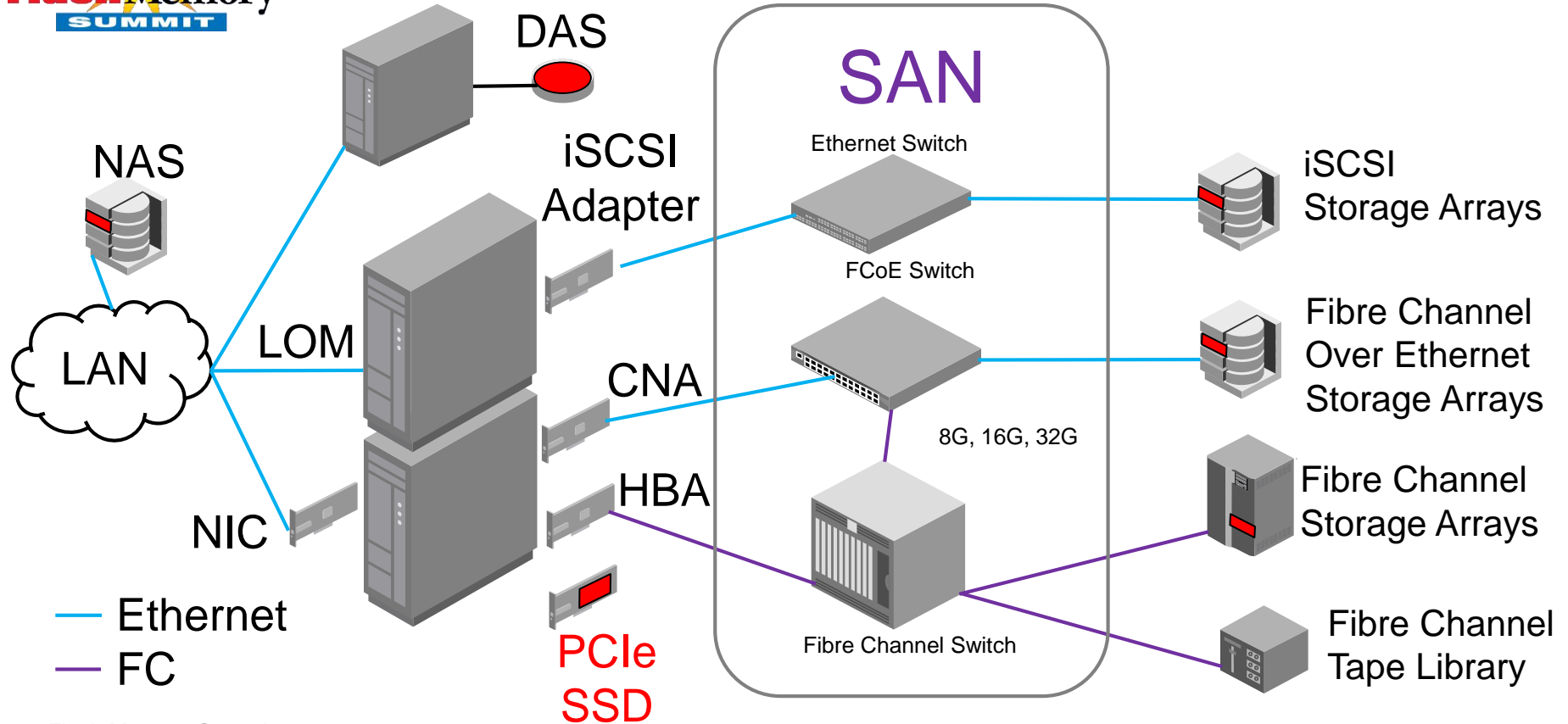
Storage Types

DAS = Direct Attached Storage
 NAS = Network Attached Storage
 iSCSI – Internet Small Computer Systems Interface
 LOM = LAN on Motherboard
 NIC = Network Interface Card
 HBA = Host Bus Adapter
 CNA = Converged Network Adapter

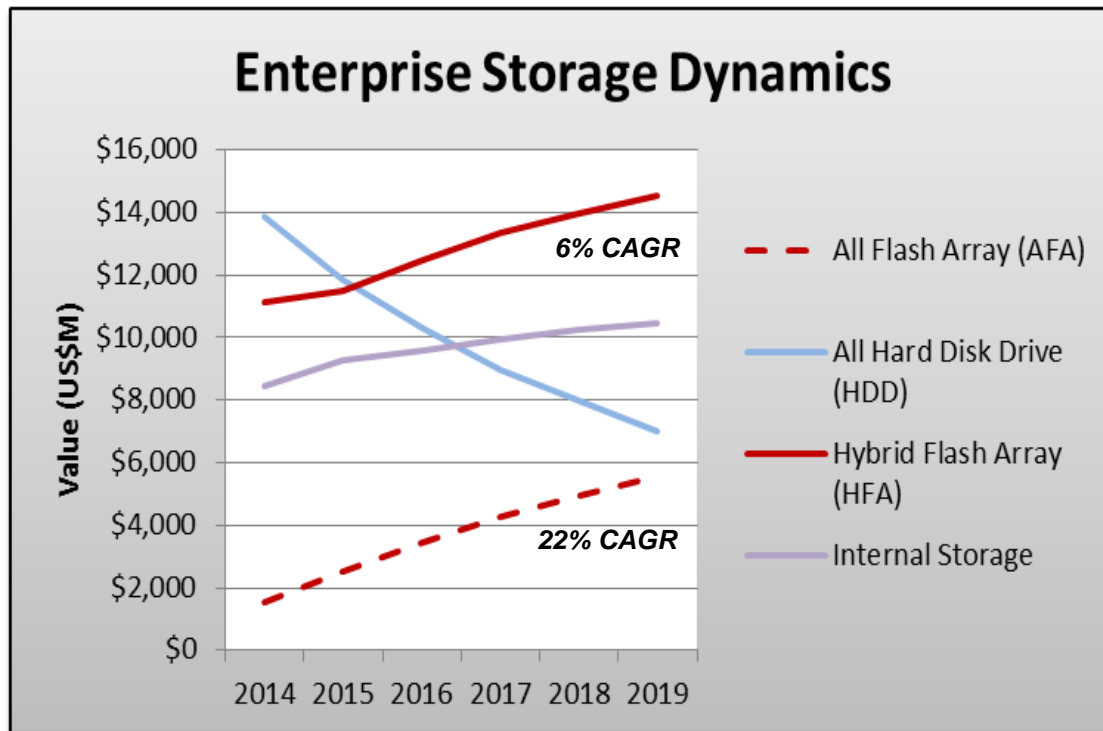


Flash in Red

SSD = Solid State Drive
PCIe = PCI Express



Enterprise Flash Growing Well



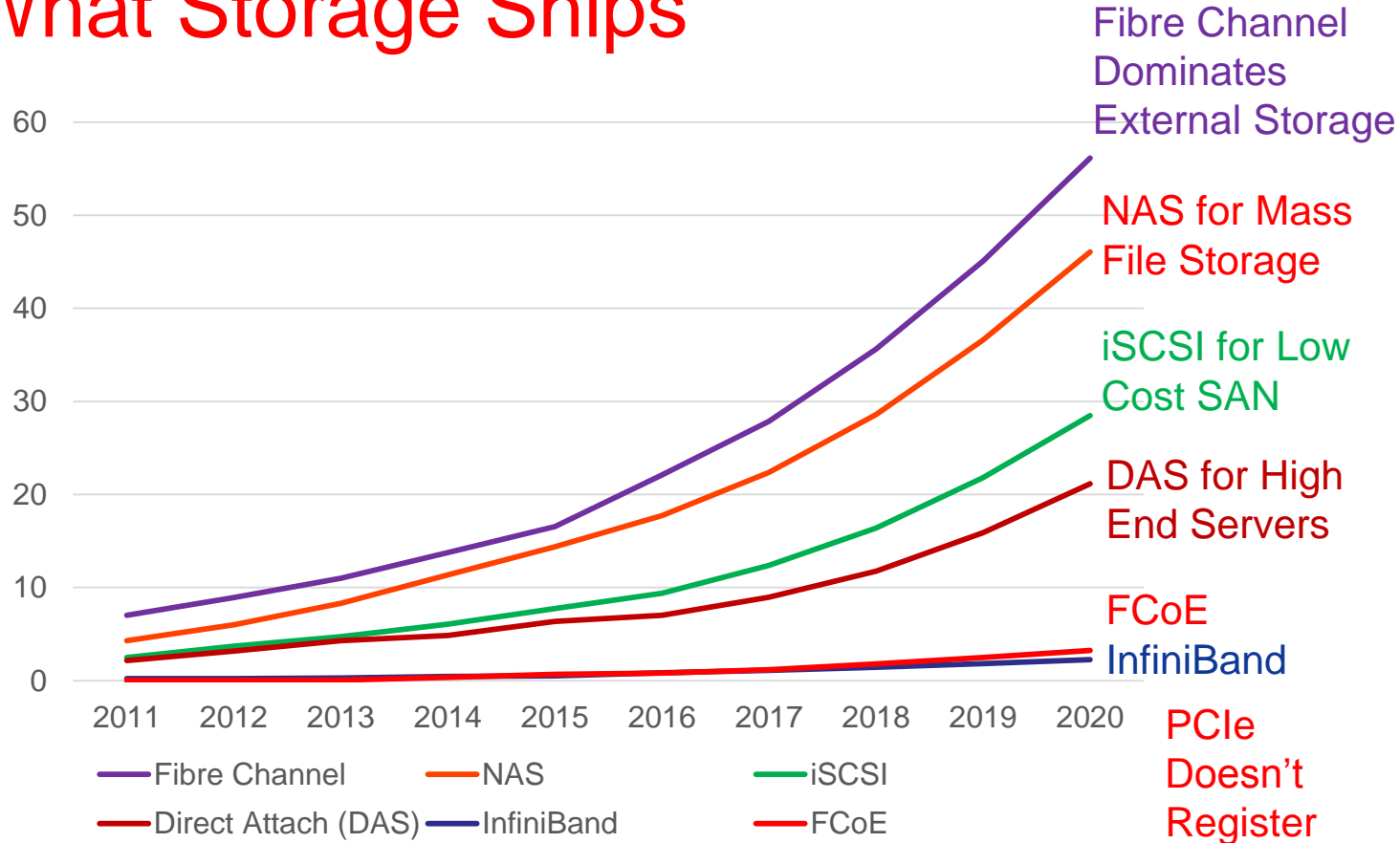
Focus of This Panel

- Compare and contrast networked Flash:
 - Fibre Channel -Storage focused
 - Ethernet -Network focused
 - InfiniBand -HPC focused
 - Switched PCIe -Startup mode

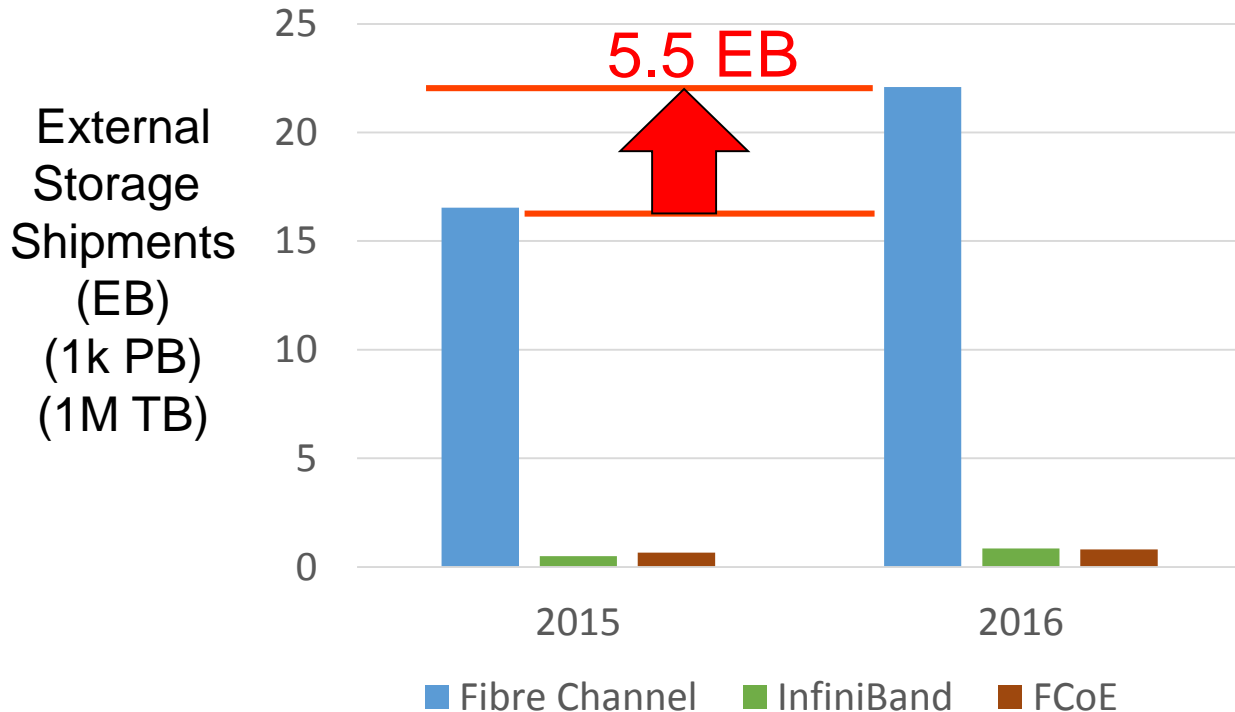
What Storage Ships

External Storage Shipments (EB) (1k PB) (1M TB)

2016 Total Sales ~59PB



2015-2016 External Storage Sales



Cumulative Storage Shipped 2011-2016 (EB)

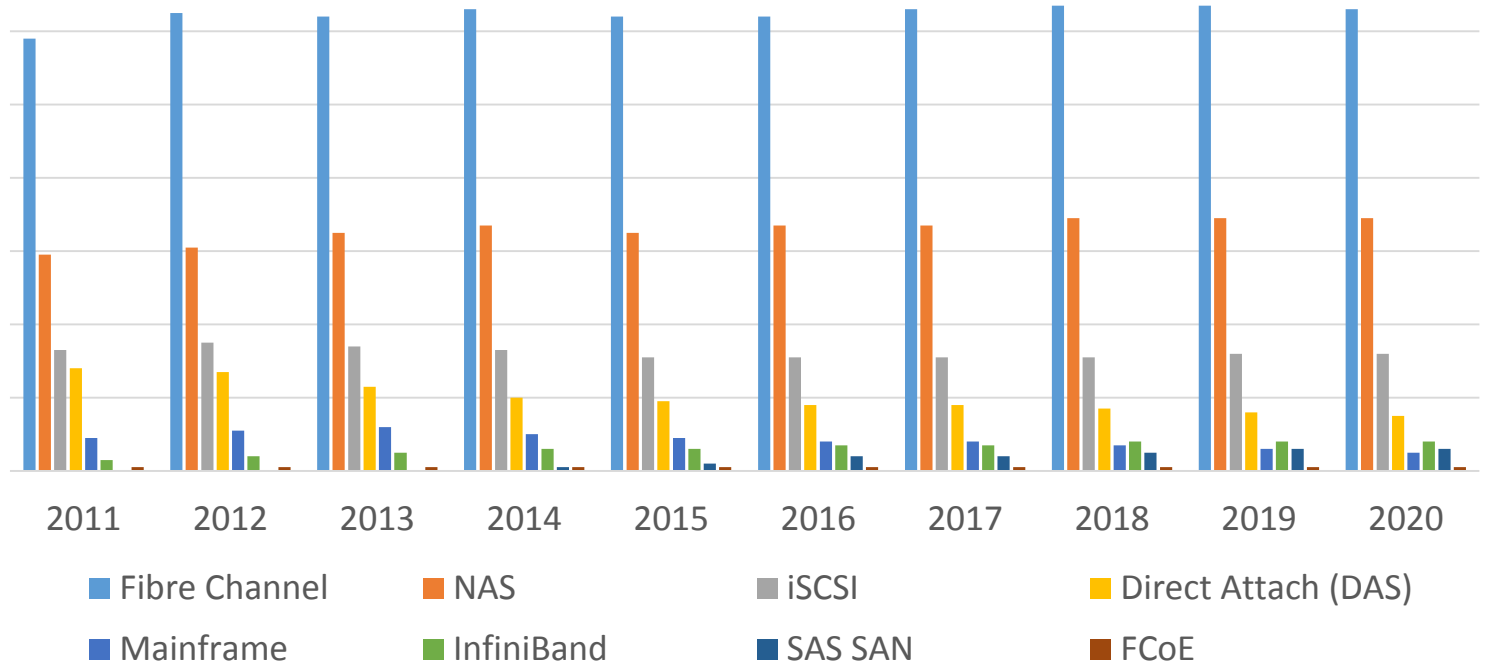
InfiniBand	2.5
FCoE	1.9
Combined	4.4

In 2016, Fibre Channel grew more than InfiniBand and FCoE have ever shipped

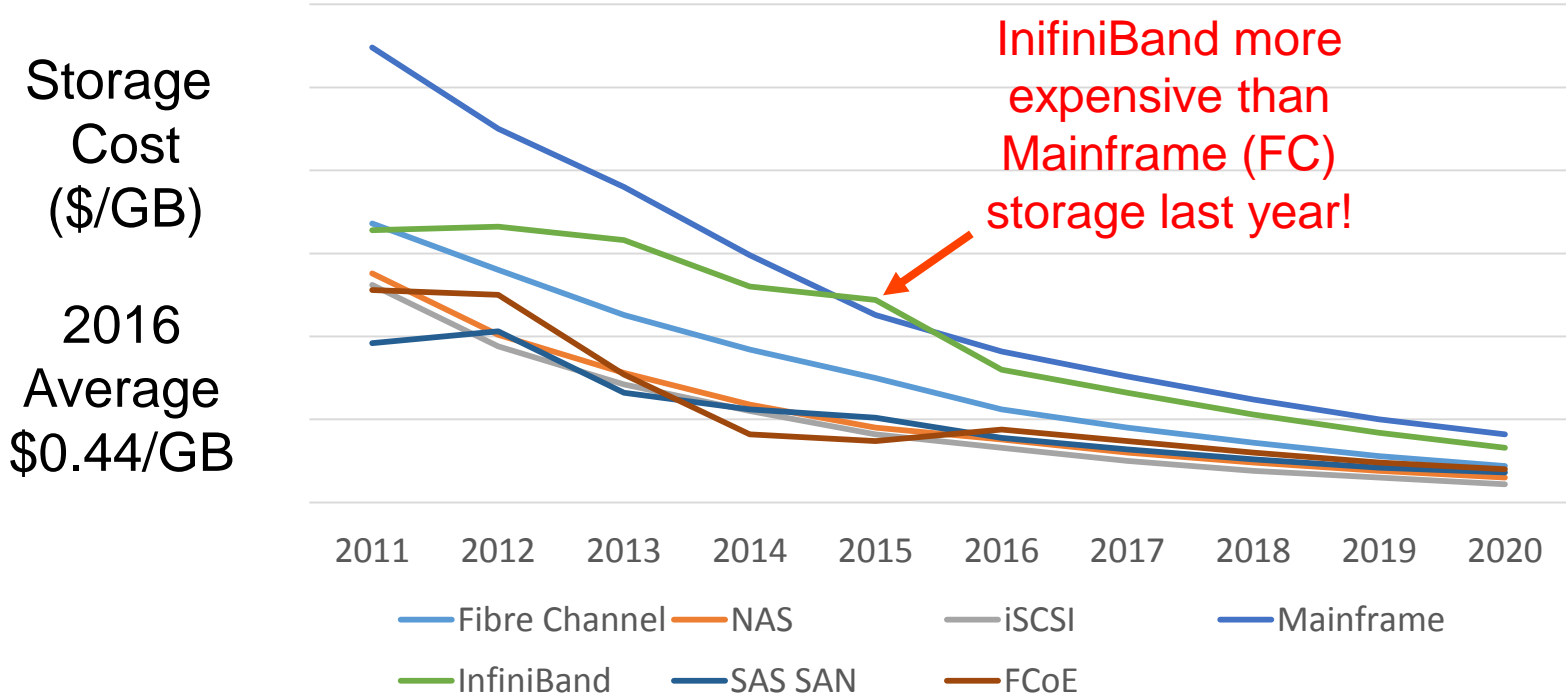
Fibre Channel Dominates Revenue for Storage Systems

External
Storage
Shipments
(\$B)

2016
Total
Shipped
~\$26B



Cost Per Gigabyte



Flash Targets \$1/GB*

- Flash storage is about twice as expensive as disk drives
- Most demanding apps can justify the extra expense
- Flash prices dropping quickly, but Flash still costs more and has less capacity than HDD

General Categorization

	Cost*	Performance	Reliability	Maturity
Fibre Channel	1.00	High	High	High
NAS	0.68	Low-Medium	Medium	High
iSCSI	0.59	Medium-High	Medium	High
DAS	0.46	High	High	High
Mainframe	1.63	High	High	High
InfiniBand	1.43	High	High	Low
SAS SAN	0.70	Medium	Medium	Low
FCoE	0.79	High	Medium	Medium

Servers, SANs and Storage

80% of
Networked
Flash is on
Fibre Channel*

Servers

SANs

Storage

High End



More
Fibre
Channel



More
Flash

Mid Range



Low End



More
Ethernet





FC Dominates Flash Too

SearchStorage

Fibre Channel is most popular networking choice with flash-based storage

by **Carol Sliwa**
Senior Writer
Published: 30 Jan 2015

Fibre Channel is the top storage networking technology choice for customers of all-flash arrays and hybrid systems, according to a survey of storage vendors.

Flash Memory Summit 2016
Santa Clara, CA

☰ Forbes / Tech

EMC All Flash Products And 128 Gbps Fibre Channel

MAR 1, 2016 @ 07:24 AM 1,426 VIEWS



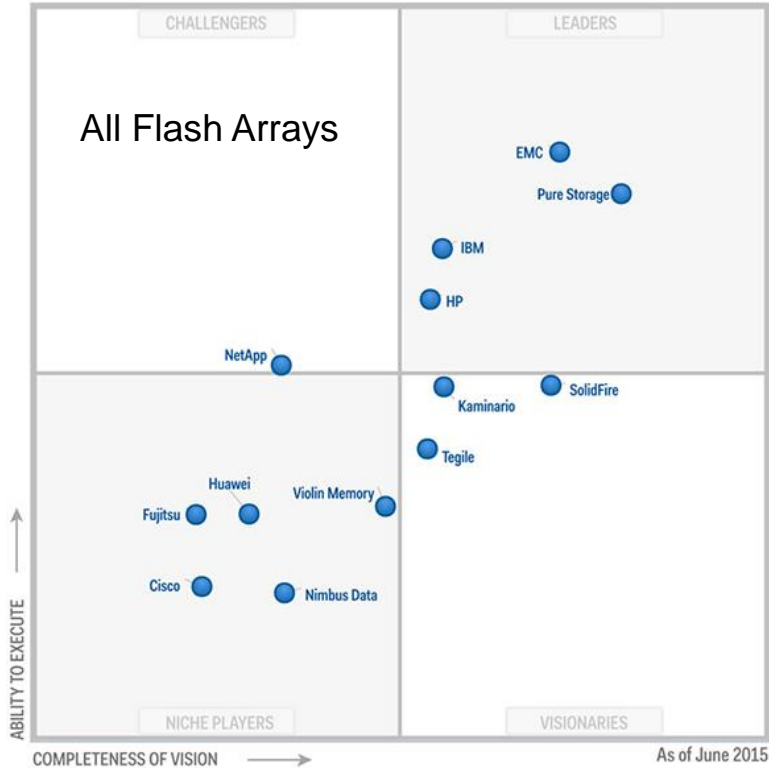
Tom Coughlin, CONTRIBUTOR

I write about data storage [FULL BIO](#) ▾

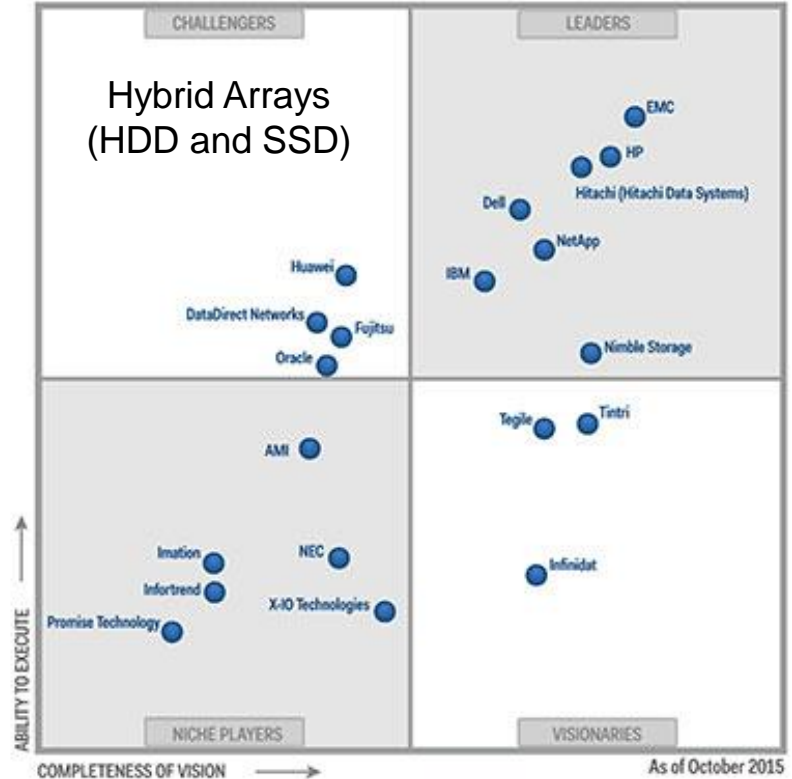
Opinions expressed by Forbes Contributors are their own.

EMC says that 2016 is the year of all flash memory for enterprise primary storage. As the price of flash memory has gone down and with steady improvements in reliability,

Leaders in Flash Lead in FC too



Source: Gartner



Wide Selection of FC Flash

Violin
MEMORY

Violin Flash Storage

HPE 3PAR Store

Born for the All-flash
With blazing fast speed—
millisecond latencies—
demand with the reliable
service levels. All at a
based storage. It's All

- Watch Now: Is
- Applications
- Infographic:
- Flash
- Learn More
- Infograph
- Flash Da



Data Sheet: FSP 7300/7300E

EMC²

EMC VMAX 400K



Achieve performance, available
400K, the fastest and largest
use industry's leading Tier 1
including mainframe, file, b

Get ready to automate, mod
400K makes it radically sim
storage you can present thro
the service level objective fo

Storage System

f in 8+



Multiple I/O Supported

- Most Flash Arrays support Ethernet and Fibre Channel interfaces
- Which one is best?



Protocol	
	Fibre Channel
	GbE
	iSCSI
	FCoE
	FICON

Comparisons are Challenging

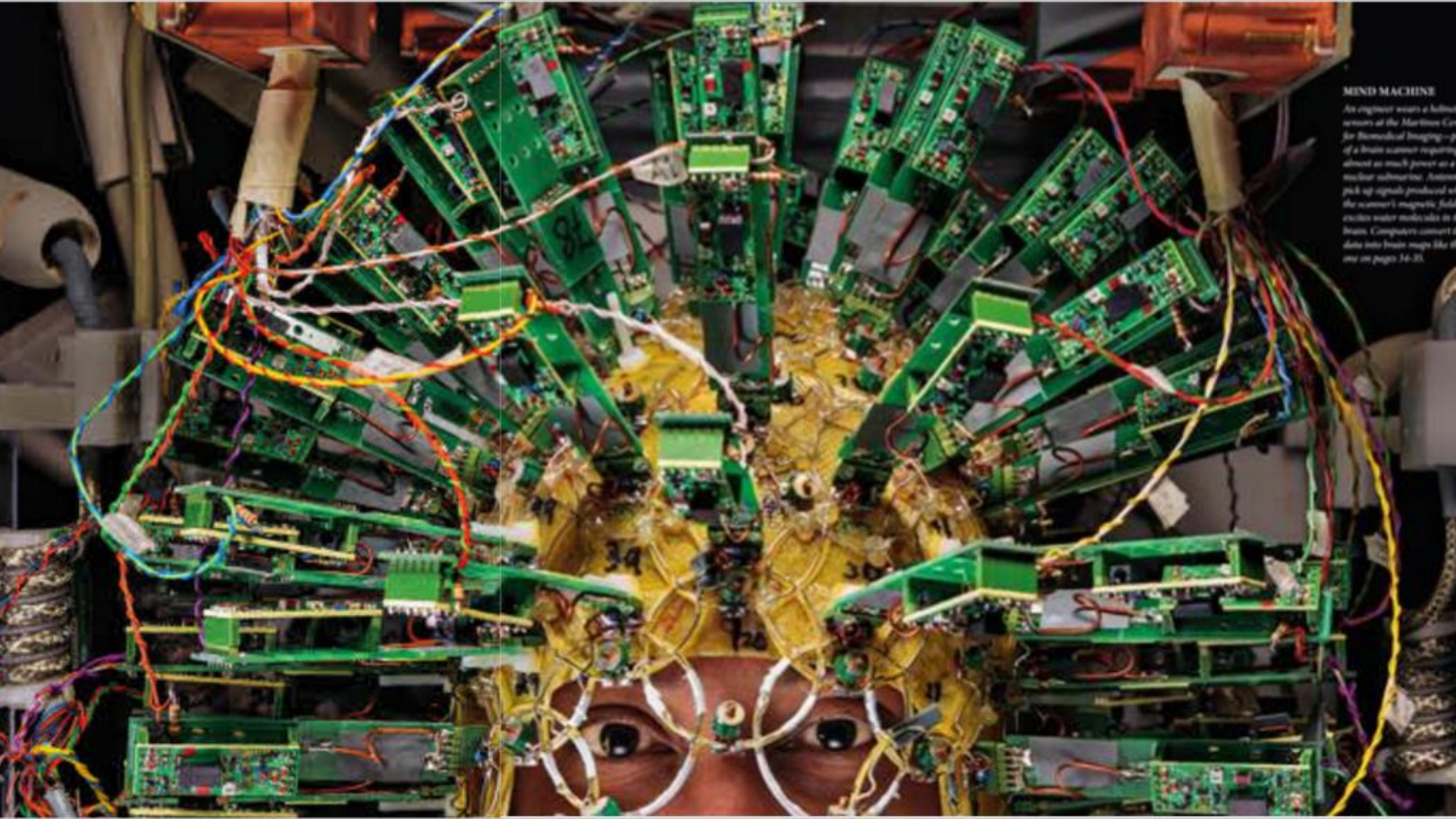
- Protocol comparisons are challenging because they use different:
 - Applications – High throughput, high transaction rate, virtualized
 - Hardware – High end, low end, reliability, disaggregated
 - Protocols – Credit buffers, Lossy networks, distance limitations
 - Configurations – Topology, scale, tuned performance
- Regardless of these challenges, I'll do a couple comparisons
 - Each system could be tuned to perform better on some metric

Bit Rates vs Throughput

	Line Rate (Gb/s)	Comment	Throughput (MB/s)
1GFC	1.0625	8b/10b	100
8GFC	8.5	8b/10b	800
10GbE	10.3125	Headers and footers not included	1,125
16GFC	14.05	64/66b	1,600
25GbE +		Similar	

When does Throughput Matter?

- Throughput mainly matters on large data transfers
 - Transferring TBs of data mainly depends on speed
- Flash isn't much better than disk in large data transfers
- What is a large data transfer?

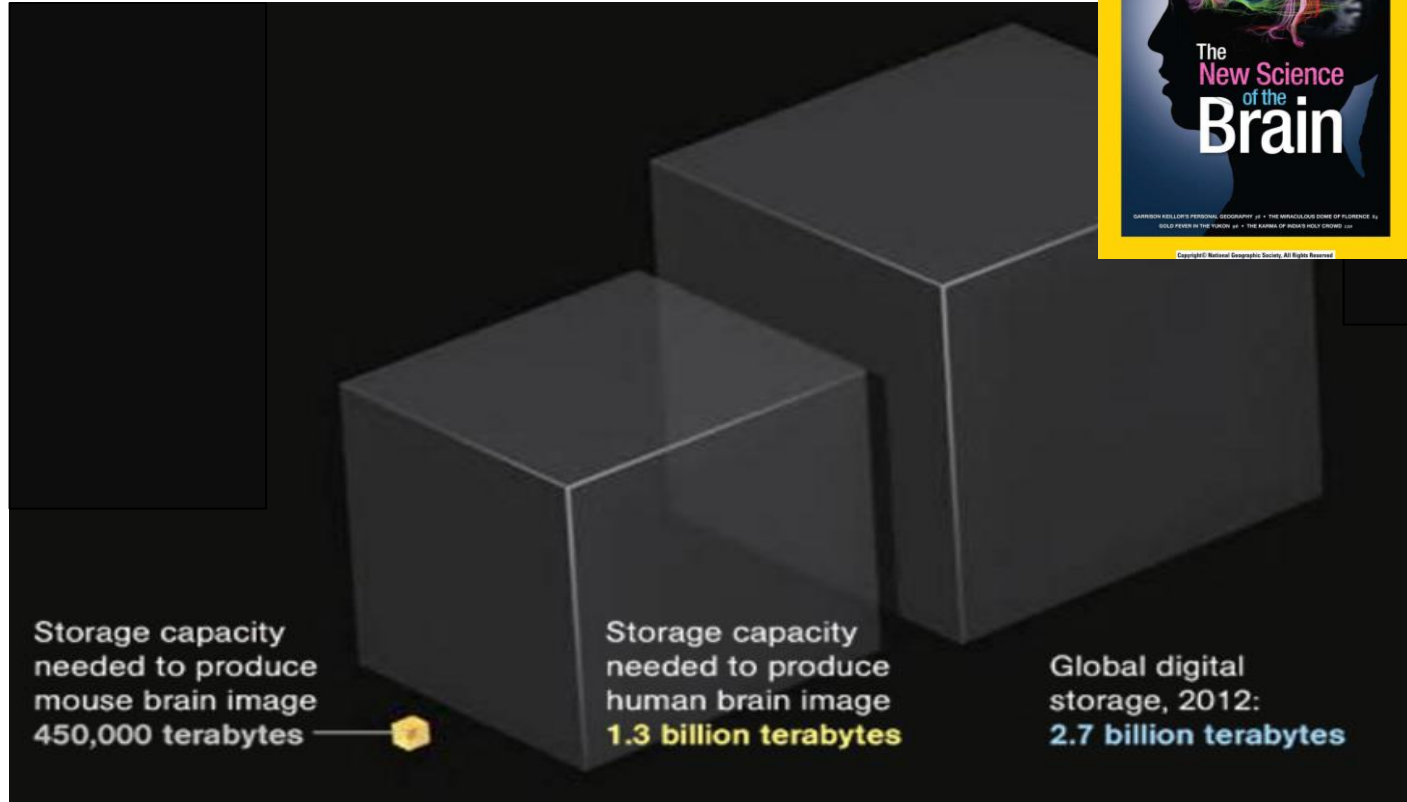


MEND MACHINE

An engineer wears a helmet of sensors at the Martin Center for Biomedical Imaging for a brain scanner that almost as much power as a nuclear submarine. Sensors pick up signals produced by the scanner's magnetic field excites water molecules in the brain. Computers convert the data into brain maps like the one on pages 14-15.

Big Brain Data

- 0.45 EB to simulate a mouse brain
- 1,300 EB to simulate a human brain
- 59 EB of external storage sold in 2016



Performance vs Speed

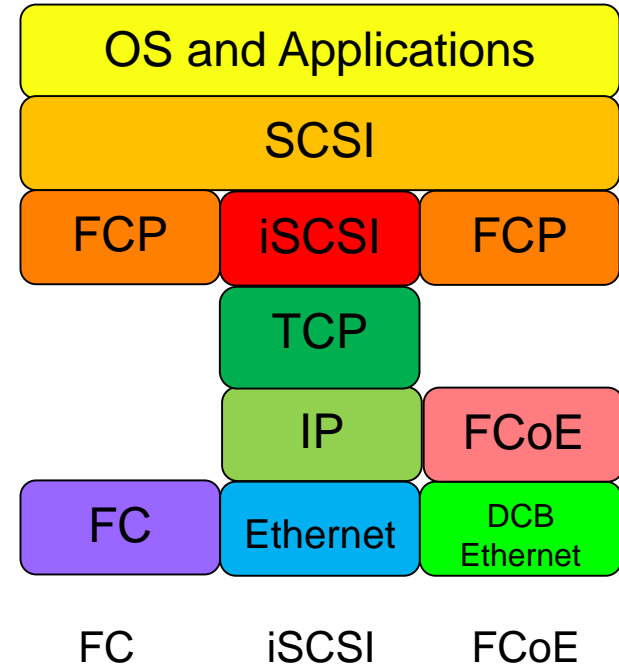
- How long does it take to transfer 1TB of data?

	Line Rate	Throughput	
	Gb/s	MB/s	Time (minutes)
8GFC	8.5	800	20.8
10GbE	10.3125	1125	14.8
12G SAS	12.3125	960	17.4
16GFC	14.05	1600	10.4
25GbE	25.78125	2812.5	5.9
32GFC	28.1	3200	5.2
40GbE	40.3125	4500	3.7
100GbE	103.125	11,250	1.5
128GFC	112.4	12,800	1.3

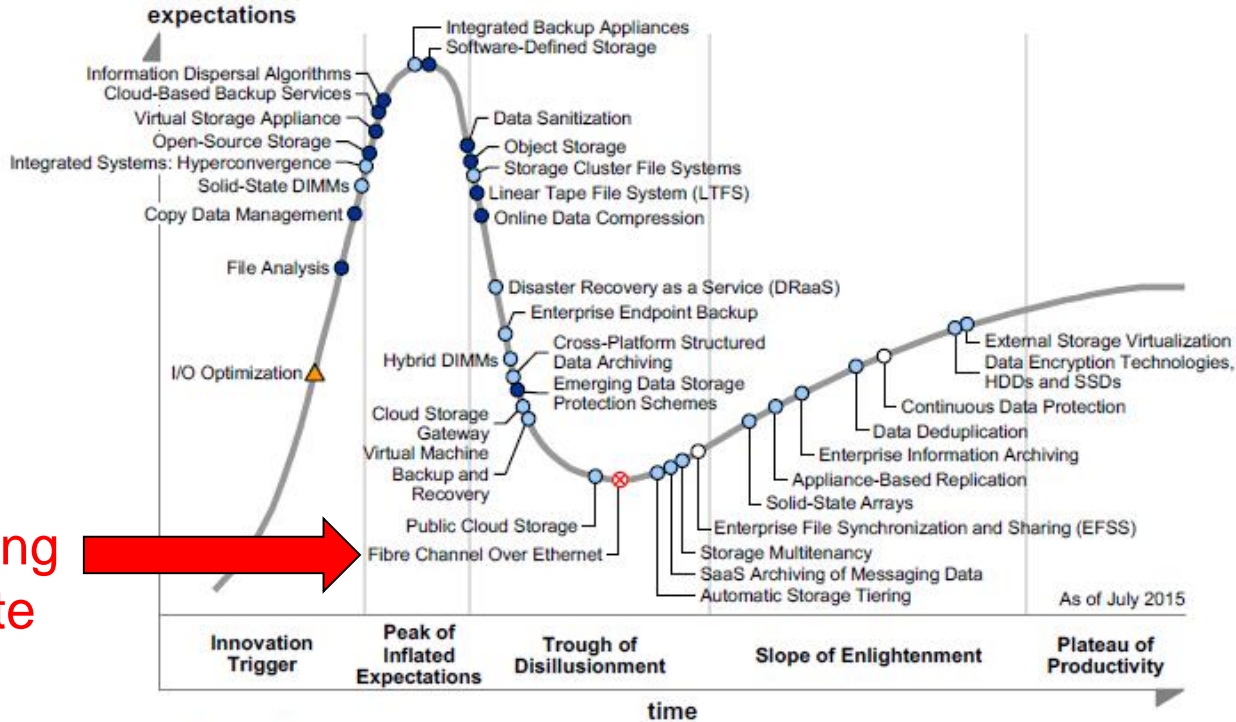
Latency Comparisons

TOE = TCP/IP Offload Engine
 TCP = Transmission Control Protocol
 IP = Internet Protocol
 FCP = Fibre Channel Protocol
 OS = Operating System
 DCB = Data Center Bridging
 FCoE = Fibre Channel over Ethernet

- Flash improves performance for random reads and writes where latency and protocol inefficiencies come into play
 - Disk Drives seek time latencies in the mS range
- Fibre Channel was designed for storage and has some of the lowest cut through latencies in the industry at ~700nS for 2kB frame
- iSCSI was designed for lossy Ethernet and requires TCP/IP processing that adds latency
 - TOE has only 200nS of latency while software implementation may add 50uS delay*
- FCoE requires lossless DCB Ethernet



Gartner Hype Cycle

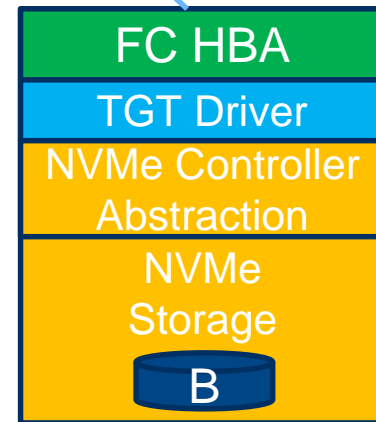
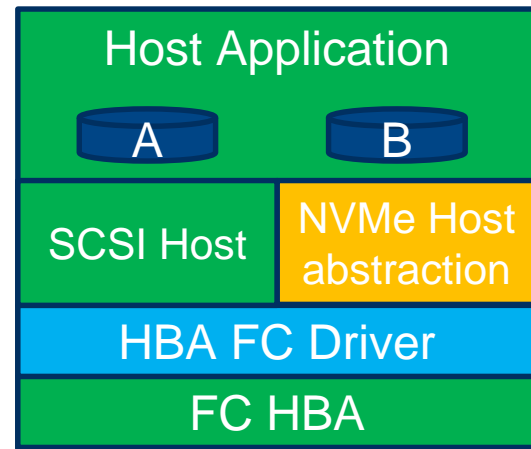


**FCoE
Becoming
Obsolete**



Fibre Channel and NVMe

- See NVMe running over Fibre Channel at FCIA booth!
- 36th FCIA Plugfest at UNHIOL in June tested:
 - NVMe and SCSI storage running over same link
 - 32GFC interoperating with 16GFC, 8GFC and much more



Existing

Update

Addition

Fibre Channel Dominates Networked Flash

- Ethernet takes second place to Fibre Channel and is well known and good
- InfiniBand is good for HPC
- PCIe is good for PC Boards
- Fibre Channel is great and provides the best performance for enterprise storage* because:
 - It's faster
 - 32GFC vs 25GbE now or 64GFC vs 50GbE later
 - It's protocol is tuned for high performance storage
 - It's established and highly available from many vendors