Storage Overview

Broadcom and Bernstein Storage Teach-In

July 21, 2021
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Broadcom Speakers

Hock E. Tan  
President and CEO

Jas Tremblay  
VP and GM, Data Center Solutions

Jack Rondoni  
SVP and GM, Brocade Storage Networking

Dan Dolan  
Sr. Director of Marketing, HDD Storage
How Broadcom Became a Global Technology Leader
Category-Leading Franchises: 8 in 2009 → 23 Today

Revenue
($ in Billions)

R&D
($ in Billions)

16X Growth

25X Growth

84X Growth in Operating Profit from 2009 → 2020
Heritage of Innovation

One of the industry’s broadest IP portfolios with >20,000 patents
Category-Leading Franchises in Diverse End Markets

- **Broadband**
- **Networking**
- **Wireless**
- **Storage**
- **Industrial**

**Storage & Fibre Channel (~$4B*)**

- Enterprise Server Connectivity
- Fibre Channel Storage Networking
- Nearline HDD

*In FY20*
Connecting the Enterprise Storage Ecosystem

Data Center

Server
- Fibre Channel Adapters
- Ethernet Adapters
- PCIe Switch Adapters
- Storage Adapters

Network
- Fibre Channel Switch

External Storage
- Fibre Channel Adapters
- Ethernet Adapters
- PCIe Switch Adapters
- Storage Adapters

Storage Drive
- Nearline HDD
Enterprise Server Connectivity

Jas Tremblay
Vice President and General Manager,
Data Center Solutions
Enterprise Data Protection Approaches

**Mission Critical**
- Server
- Fibre Channel Switch
- External Storage
- Enterprise HDD

**Enterprise Grade**
- Server
- Enterprise HDD

**Cloud**
- Server
- Nearline HDD
Broadcom Server Storage: Most Trusted Data Protection Solution

Enterprise Grade Storage
1. Drive protocol conversion
2. Drive failure protection
3. Server power failure protection

Broadcom Data Protection Usage
- Sector: Financials, health care, manufacturing, etc.
- Application: Databases, ERP, CRM, etc.
- 10 of top 10 server OEMs use Broadcom data protection

Used in 70% of Enterprise Servers
## Broadcom Server Storage: Leadership for 30+ Years

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<th>Industry First</th>
<th>700</th>
<th>320</th>
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<td>Simplified Driver Firmware</td>
<td>PCIe Gen 3</td>
<td>Tri-Mode Controller</td>
<td>PCIe Gen 4</td>
<td>Hardware Accelerated Control</td>
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<td>SAS</td>
<td>SAS</td>
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<td>NVMe</td>
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Broadcom Storage Adapter Leadership

Most Trusted Data Protection Software

Highest Performance Silicon

Strongest Ecosystem Support

CentOS, citrix Hypervisor, debian, FreeBSD, Linux, ORACLE, CentOS, SUSE, ubuntu, VMware, vSphere, ESX, Windows, ORACLE, CentOS, SUSE, ubuntu, VMware, vSphere, ESX, Windows,

Operating System

Drives

Best-in-Class Technology + Ecosystem Support
Server Storage Delivers Across Global Market Routes

Server OEM

Server ODM

Channel

System Builder | Distributors | Integrators

Enterprise | Telecommunications | Cloud
Largest Enterprise Server Connectivity Portfolio

- Storage
- Ethernet
- PCIe
- Fibre Channel
## Leader in Server Connectivity

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<thead>
<tr>
<th>Storage</th>
<th>Ethernet</th>
<th>PCIe</th>
<th>Fibre Channel</th>
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Broadcom: Leader in Large and Growing Market

Largest Portfolio

Storage
Ethernet
PCIe
Fibre Channel

Storage Leadership

Critical Data Protection for 70% of Enterprise servers

30 Years of Sustained Innovation

Over 100 Million Units shipped
Storage Networking Overview

Jack Rondoni
Senior Vice President and General Manager,
Brocade Storage Networking
The Network Matters for Mission Critical Applications

General-purpose Ethernet networks aren’t good enough

• Mission critical applications require servers, storage, and networks that deliver
  ✔ Reliability and resiliency
  ✔ Low latency
  ✔ Security

• On-premises infrastructure is required to meet service level agreements

• Brocade and Emulex brands are the trusted names in Fibre Channel SAN

Sources: https://siliconangle.com/2021/04/01/no-foolin-microsoft-cloud-outage-takes-azure-teams-office-365-offline/

“Microsoft cloud outage takes Azure, Teams and Office 365 offline”

“Prolonged AWS outage takes down a big chunk of the internet”
What is a Storage Area Network (SAN)?
A purpose-built network for mission critical servers and storage

Fibre Channel Protocol Differentiation

- Lossless Network
- Speed Doubling Every Generation
- Integrated Security
Fibre Channel Revenue (TAM) Trends

1. Market has remained **stable since 2010**
2. After strong growth in 2018/19, industry revenue **declined in 2020** due to the pandemic, expect rebound in 2022
3. Expect **revenue to be sustainable for the foreseeable future**

Sources: Dell'Oro SAN Quarterly Report 1Q20
Quillin Research 4Q20 SAN Quarterly Market Report
Fibre Channel Revenue History by Product Generation

Sources:
Dell'Oro SAN Quarterly Report 1Q20
Quillen Research 4Q20 SAN Quarterly Market Report

1/2/4G  8G  16G  32G  ASP per Port
Tech Refresh Sustains Revenue

Tech refresh is required to keep up with increasing application demands

- SAN product generations have a ~5 year lifecycle
- New products enable price premiums reflecting faster speed and new capabilities that simplify operations

Fibre Channel install base

- 43M switch and adapter ports

Refresh dynamics

- ~90% refresh of existing footprint
- ~10% greenfield opportunities
  (5% new Fibre Channel installs, 5% alternative technologies)
- Introduction of Gen 7 64G in 2021 further enables a refresh cycle for 2022 and beyond

Sources: Dell'Oro SAN Quarterly Report 1Q20
Quillin Research 4Q20 SAN Quarterly Market Report
Broadcom is the SAN Industry and Market Leader

Continuous years of innovation

Switch market share leader for 10+ years

HBA market share

Sources: Dell'Oro SAN Quarterly Report 1Q20
Quillin Research 4Q20 SAN Quarterly Market Report
Broadcom’s Differentiated Portfolio

Market, industry, and technology leader

• Industry’s first end-to-end 64G portfolio
  – Brocade switches and directors
  – Emulex server and storage adapters

• End-to-end autonomous SAN technology
  – Self-learning, self-optimizing, and self-healing

• Proactive and automated support with Fibre Channel experts
Broadcom Fibre Channel Roadmap
Aligned with future enterprise storage requirements

**Storage Modernization**
Align portfolio with AFA/NVMe storage trends to enable the on-demand data center

**Analytics**
Transform SAN health and performance data into actionable insights

**Automation**
Empower IT with simple and open automation to increase productivity
Changing Profile of HDD Data Storage

~80% of Data Shipped in the HDD NL & SSD EP Space in 2025 is Expected to Reside on HDDs
Broadcom Electronics Are a Key Part of HDDs in Data Centers

Preamplifiers and SoCs

Enabling ~$10 Billion Per Year in the Growing Nearline Hard Disk Drive Market
Broadcom Products Play a Critical Role in the HDD

**Preamplifier**
- Complex, analog mixed signal, custom product
  - Semiconductor process optimized for HDD preamp applications

**System On Chip (SoC)**
- Intelligence of HDD
  - Read channel, processors, high speed interfaces and customer designed controller IP

Small Signal, Large Signal, High Speed, Laser Driver

Read Channel Signal Processing Provides Capacity Gain
Why We Win…

- Process Technology Leadership
- Leading IP & Performance
- Time to Market
- Proven Quality

Decades of Experience
• Broad System Expertise
• Leading Custom Products

Customers

BROADCOM

Preamp

SoC

VTC Inc.

agere systems

LSI

Avago Technologies

SEAGATE

TOSHIBA

Western Digital

Winning Strategy for More than 20 Years
HDD Innovation: Driving Increases in Capacity & IC Content

- Innovations Continue to Drive Increased Capacity
  - HAMR
  - MAMR
  - Next Gen CMR

- Enabling Innovation Adds IC Content
  - 2010: Preamp & SoC Content Increasing
  - Today: 20ch + Advanced Features

- Content Increase Driving Growth Above HDD Unit TAM

HDD Roadmap Requires Additional IP that Will Grow Broadcom Content for Many Years
Large and Growing Nearline Market

Broadcom HDD Nearline Storage

~20% Nearline Revenue Growth and Over 2 Billion Sold

HDD Nearline

HDD Client

Data Shipped


Note: Revenue CAGR from 2016-2020; units sold since 2010

Broadcom Leadership Supported by ~20% Nearline Revenue Growth
Q&A

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