

# End-to-End NVMe

## NVMe networking, NVMe controllers & NVMe drive controllers

**Broadcom: Your go-to partner for NVMe and NVMe solutions**

<b>NVMe over Fibre Channel</b>	✓
<b>NVMe over Ethernet</b>	✓
<b>PCIe switching for NVMe</b>	✓
<b>NVMe RAID</b>	✓
<b>NVMe JBOF (Just a bunch of flash)</b>	✓
<b>NVMe Disk Controllers</b>	✓

Broadcom is the leading supplier and expert in NVMe solutions and the one-stop shop for almost anything NVMe related. Broadcom brings leadership solutions for:

- Server OEMs
- Storage OEMs
- Hyperscale Cloud

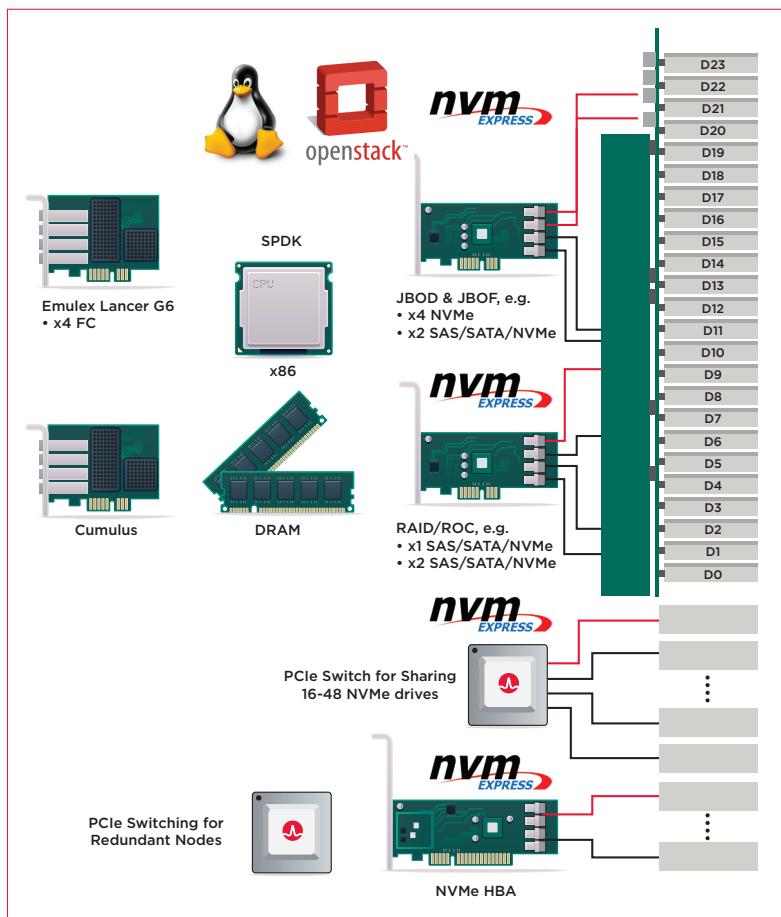
The Broadcom reference architecture highlighted here can be ordered either with off-the-shelf components from leading OEMs, or leveraged to architect your own storage solution utilizing Fibre Channel, PCIe or Ethernet connectivity.

### Introduction

Data storage is consistently getting faster, delivering improved economics for data centers large and small. Flash memory-based storage is a key technology that has significantly increased performance of storage systems. Solid state disks (SSDs) are so fast, that it has resulted in SCSI becoming the bottleneck. The industry has solved the problem with non-volatile memory express (NVMe), whereby solid state storage is connected directly to the PCIe bus.

NVMe significantly improves both random and sequential performance by reducing latency, enabling high levels of parallelism, and streamlining the command set while providing support for security, end-to-end data protection, and other client and enterprise features users require. NVMe provides a standards-based approach enabling broad ecosystem adoption and PCIe SSD interoperability.

### Broadcom NVMe Reference Architecture



## Broadcom Software Defined Storage Solution

Broadcom, the leader in NVMe solutions, provides all of the building blocks needed to build a software defined storage solution as shown in the diagram above.

## NVMe over Fibre Channel

Broadcom is delivering the first production release of standards-based NVMe over Fibre Channel to coincide with the Intel Purley server refresh. Broadcom is also sampling to OEMs a NVMe over Fibre Channel proof-of-concept for Emulex Gen 6 Host Bus Adapters (HBAs) that delivers 55% lower latency for NVMe drives compared to SCSI drives. NVMe over Fibre Channel builds on the performance improvements delivered by Emulex Gen 6 HBAs, which cuts latency in half versus the previous generation. The combination of Emulex Gen 6 HBAs with NVMe over Fibre Channel delivers a total reduction in latency of 75%.

Emulex HBAs provide a PCI Express solution that scales across the network and meets the newly ratified NVMe over fabrics (NVMe) standard to ensure interoperability across the eco-system. Broadcom has been a leading contributor to the NVMe working group and contributed the Fibre Channel driver code for the NVMe over fabrics Linux Driver working group. NVMe deployments are expected to ramp quickly in enterprise data centers with analysts forecasting shipments to grow at a rate of 78% (2016-2020 CAGR, IDC (2015).

Fibre Channel supports both standard storage arrays and new NVMe over Fibre Channel arrays on the same fabric. This dual-mode feature provides investment

protection by supporting SCSI storage arrays installed in the data center and new NVMe storage arrays, concurrently. The solution is also software defined storage-ready with the availability of a software development kit (SDK) for Emulex HBAs that provides all the tools needed to build an NVMe target based on standard server hardware.

## PCIe Switching

Broadcom's 6th generation PCIe Switches (PEX 9700) provide a robust and scalable solution to deploy NVMe drives in servers and external storage systems. The PEX 9700 series offers seven models from 12 to 97 lanes and industry-first features including NVMe surprise add/remove, sharing of SRIOV drives across multiple hosts with failover, and advanced QoS capabilities.

Broadcom also offers NVMe HBAs based on its PEX9700 product that relieves server/host CPU from managing NVMe drives' errors, hot add/remove, LEDs and other I/O related functions.

## NVMe/SAS/SATA Adapters

Broadcom's NVMe/SAS/SATA Storage Adapter brings NVMe performance benefits to the storage tier by providing connectivity and data protection that MegaRAID has provided for over 20 years for SAS/SATA interfaces. Broadcom has developed the industry's first storage controller with Tri-Mode SerDes, enabling system designs to support any combination of NVMe, SAS and SATA devices. This controller provides up to a

50% latency reduction and a 60% throughput increase compared to its previous generation. Broadcom is now sampling the industry's first NVMe hardware RAID solution.

## Broadcom Dual-Mode and Tri-Mode

### 100% NVMe Solutions by Broadcom:

The Broadcom reference architecture supports end-to-end NVMe for ultra-high performance, low latency, storage solutions connected with Fibre Channel and/or Ethernet.

### Concurrent NVMe and SCSI

**Solutions:** For customers wishing to leverage NVMe and lower cost SATA/SAS in a tiered architecture, Broadcom supports legacy storage as well as newer NVMe solutions with:

- **Dual-mode:** Concurrent SCSI over Fibre Channel and NVMe over Fibre Channel: Existing Fibre Channel networking that is widely deployed in enterprise environments can natively run NVMe and SCSI traffic. This dual-mode feature provides enterprise customers the flexibility to choose where and when they want to deploy NVMe over Fibre Channel, providing investment protection.

- **Tri-mode:** NVMe/SAS/SATA: Storage deployments optimizing for TCO can utilize Broadcom's tri-mode drive controllers including RAID controllers, JBOD controllers and HBAs.

## Open Source Software

Broadcom also leads in open source software used to build storage solutions. This includes storage performance development kit (SPDK) contributions to the Linux community, and support for open solutions such as OpenStack.

## Broadcom's Leadership

Broadcom is the trusted market leader in storage connectivity and continues to invest and innovate in the industry's broadest product portfolio. These include PCIe & NVMe switches, NVMe/SAS/SATA controllers and SAS/SATA expanders, HBAs, RAID adapters, Fibre Channel silicon, software and adapters, HDD/SSD SoCs and HDD preamps. With a 25-year history delivering high quality silicon, advanced firmware, innovative board design, and extensive HDD/SSD validation processes, Broadcom is the supplier of choice for server and external storage OEMs, system builders and hyperscale customers.

## For more information

[www.avagotech.com/products/server-storage/fibre-channel-host-bus-adapters/](http://www.avagotech.com/products/server-storage/fibre-channel-host-bus-adapters/)