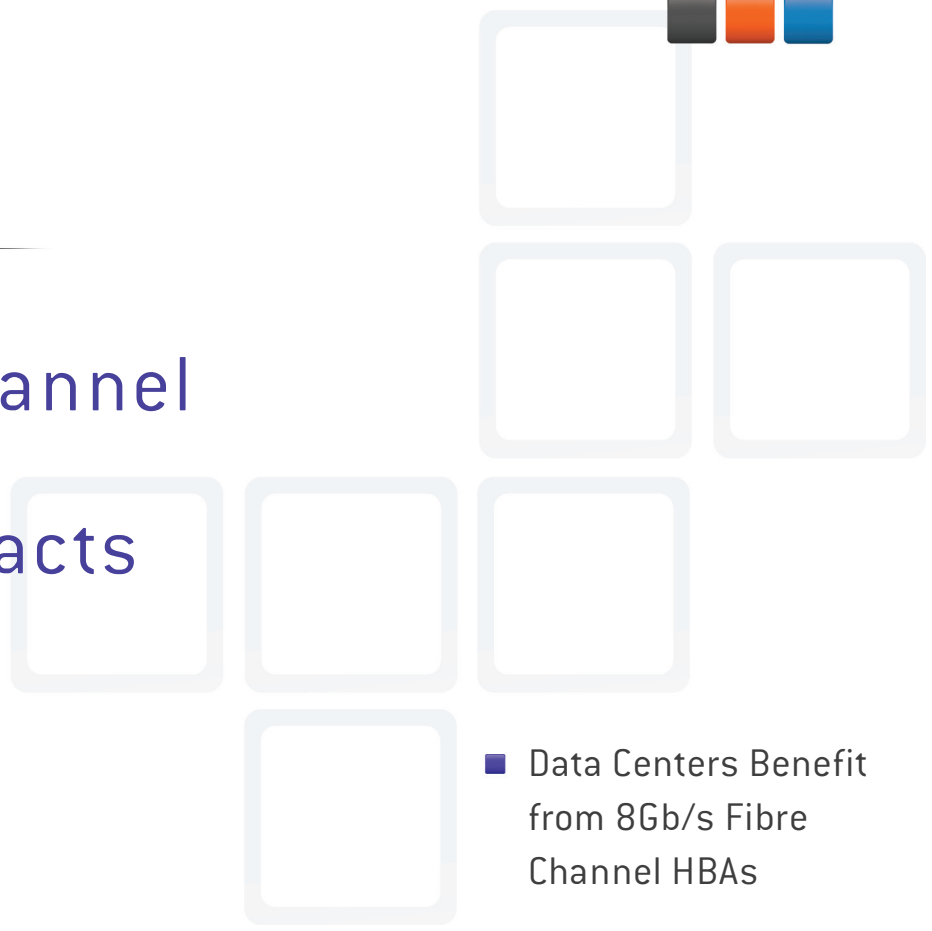




WHITEPAPER

8Gb/s Fibre Channel HBAs — All the Facts



■ Data Centers Benefit from 8Gb/s Fibre Channel HBAs



Advanced Connectivity for SANs

■ Industry Trends—Forces Driving 8Gb/s Bandwidth Needs

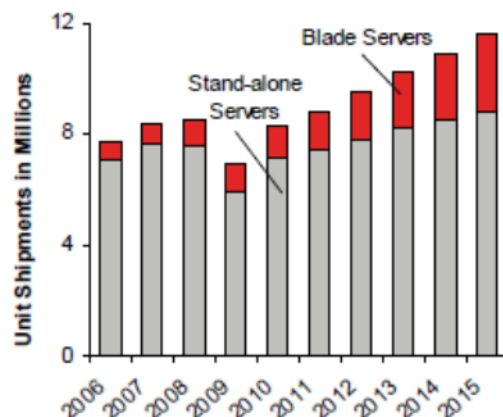
Data is the by-product of the information age and is being generated, processed and stored at an exponential rate. Storage area networks (SANs) are the infrastructure of choice for networking and transporting data traffic. As this trend continues, SANs may become congested. To alleviate congestion and increase network bandwidth, the enterprise is looking to 8Gb/s Fibre Channel technology. This technology provides the bandwidth required to support the increase in data traffic brought about by organizations that are:

- Consolidating servers through server virtualization and blades
- Leveraging higher performance next-generation PCI Express (PCIe) 2.0-enabled servers
- Deploying or enhancing storage networking infrastructure to address transaction intensive and data streaming applications
- Increasing data center power efficiency
- Developing more web- and cloud-enabled applications

Blade servers and server virtualization

According to Gartner's Dave Cappuccio, chief of infrastructure research, "Most IT assets are underutilized—for example, x86 servers are running at 12 percent utilization." IT administrators are being challenged to increase server utilization and reduce operational costs. To address these challenges, IT administrators have adopted server virtualization and blade server technologies. This trend is supported by Dell'Oro data, shown in Chart 1, which shows historical server shipments and estimates blade server shipments will continue to grow into 2015, making blade servers the fastest growing segment within the server industry.

Chart 1
Server shipments
(Dell'Oro Group,
1/31/11)



Additionally, in a March 2011 report, Gartner reports that the number of installed x86-based virtual machines (VMs) has been nearly doubling every year since VMs were introduced in 2001. That growth will continue through 2012, however, the growth will then shift from on-premises VMs to VMs in the cloud¹ (see Chart 2). In fact, according to the 2011 Cloud Computing Outlook survey, only 20 percent of 500 respondents reported that they have no cloud strategy at all. The need for higher I/O bandwidth connectivity increases with blade and virtual server deployments.

At a Glance

Emulex 8Gb/s Fibre Channel technology complements IT trends such as blade server and server virtualization deployments. It increases network bandwidth and performance while maintaining backward compatibility with existing 2Gb/s and 4Gb/s Fibre Channel technologies.

Products

- Emulex LightPulse® LPe12000 8Gb/s Fibre Channel Host Bus Adapters (HBAs)
- Emulex OneCommand™ Manager
- OneCommand Manager for VMware® vCenter™
- Emulex OneCommand Vision

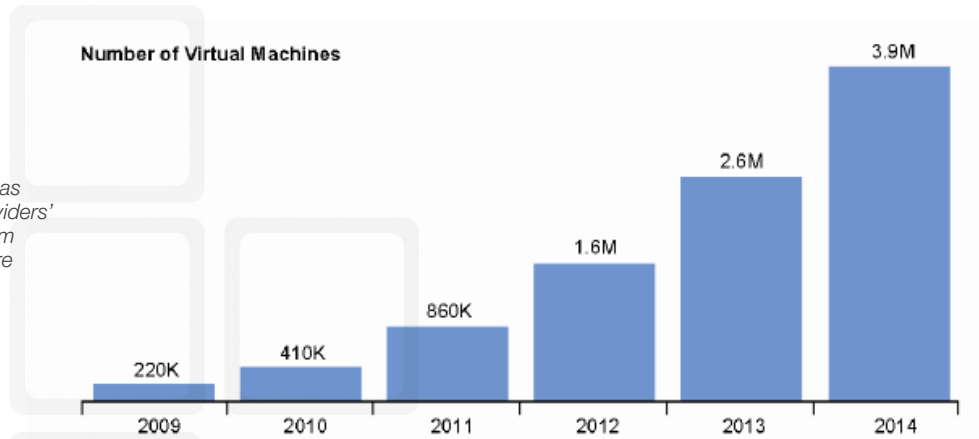
Applications

- Large-scale enterprise SANs
- Virtualized server environments



Advanced Connectivity for SANs

Chart 2
VMs in use as service providers' cloud system infrastructure offerings



Note: The systems infrastructure market includes computing, storage and backup services in the cloud.

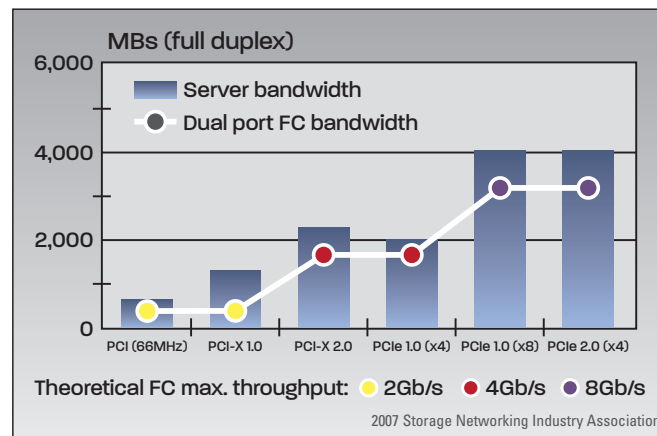
Next-generation servers

Next-generation servers, such as those with the Intel® Xeon® E3-1200 processor, are also driving the requirement for higher I/O bandwidth connectivity. New systems support multiple processors with multiple cores. In addition to faster CPUs, each processor in a multi-processor system has a dedicated memory controller and memory to deliver optimization capabilities that were previously limited to mainframes. As these systems enable more data intensive applications and higher virtualization ratios, there is an increased demand for faster I/O.

In addition to increased processing capacity, new servers have advanced bus architectures that need increased I/O bandwidth for maximum benefit. PCIe has become the dominant I/O interconnect technology and new servers are shipping with support for the faster, higher bandwidth PCIe 2.0 server bus interface. PCIe 2.0 doubles the transfer rate of PCIe 1.x, enabling transfer of 5Gb/s of un-encoded data in each direction. The enhancements in PCIe 2.0 were necessary to address bandwidth requirements driven by server consolidation strategies and server virtualization technologies. The new 8Gb/s Fibre Channel technology is a natural complement to the PCIe 2.0 bus architecture and provides servers with ample bandwidth and throughput performance.

Historically, to maintain I/O balance throughout a SAN infrastructure, from the host server to back-end storage systems, the Fibre Channel link speed was increased, doubling with each generation (1Gb/s to 2Gb/s to 4Gb/s and now to 8Gb/s). In short, Fibre Channel technology has evolved to keep pace with the effective bandwidth of server bus architectures (Chart 3).

Chart 3
Server bus performance and Fibre Channel bandwidth



¹ Gartner, 4 March 2011/ID Number: G00210732.



Advanced Connectivity for SANs

In addition to the technological innovations noted above, regulatory requirements, transformations in digital entertainment, data retention and compliance requirements, along with data protection needs are also driving the demand for increased network performance.

■ Overview: The importance of 8Gb/s Fibre Channel HBAs

Server consolidation strategies and virtual server technologies aggregate an expanding I/O workload onto fewer HBA ports, which increases data traffic through each physical HBA port. To prevent bottlenecks between the server and storage resources, data center administrators must ensure their networks provide sufficient capacity. Emulex 8Gb/s Fibre Channel I/O connectivity solutions are designed to provide the required bandwidth for a balanced flow of data traffic between these resources as well as deliver the following key pieces data centers need to achieve the highest return on investment (ROI):

1. High performance
2. Centralized, streamlined adapter management
3. Virtualization and blade server support
4. Dependable, reliable performance
5. Ability to scale up and down
6. Data integrity
7. Interoperability across any switch, operating system (OS) and other network components

This white paper explores the Emulex LightPulse 8Gb/s Fibre Channel HBA and how it meets each of the above requirements.

1. High Performance

To accommodate the needs of the ever-changing business environment, SANs are designed to be dynamic, with fluctuating workload and traffic load patterns. Emulex 8Gb/s Fibre Channel HBAs deliver excellent performance across a wide range of application environments with varying server workloads. By managing performance, network traffic can flow at optimum levels, giving enterprises the required system performance.

Emulex Fibre Channel HBAs include the following features that enable scalable performance:

- Dynamic interrupt coalescing uses specially developed algorithms that monitor, adjust and manage I/O interrupt processes. By leveraging I/O interrupt models, dynamic interrupt coalescing improves CPU efficiency and I/O performance.
- Frame-level multiplexing continuously determines the optimum use of the Fibre Channel network to ensure maximum link utilization.
- Out-of-order frame reassembly reorders data frames in the proper sequence, minimizing data retransmissions and enhancing overall network performance.
- Auto-negotiated link speed optimizes performance based on available network connections, ensuring Emulex 8Gb/s Fibre Channel HBAs can communicate with Fibre Channel switches at the highest supported speed.
- Support for multiple concurrent direct memory access (DMA) reads scales up I/O performance for high-transaction applications.
- Message-Signaled Interrupts eXtended (MSI-X) is an interrupt handling mechanism that is used to allocate a separate set of interrupts for each adapter port on a server. This allows interrupts from each port to be processed in parallel, eliminating the delays with a single interrupt process.
- Non-Uniform Memory Access (NUMA) is supported with next-generation, multi-processor servers that have local, dedicated memory for each processor. When supported by the OS, interrupts are directed back to the CPU that initiated an I/O process, using memory that's local to the processor to provide optimum performance.

Selected for high performance characteristics, Emulex 8Gb/s adapters were chosen to power the #1 fastest database system in the latest Transaction Processing Performance Council-C reports.*



* TPC-C Benchmark Report, December 2010



Advanced Connectivity for SANs

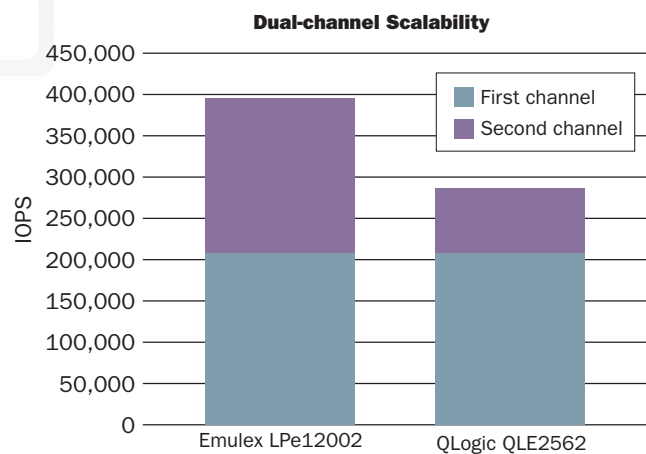
With solid-state drives (SSDs), you see further improved data performance in a SAN. By saving only the most active blocks of data and automatically migrating older data down to spinning disks, SSDs automate the movement of inactive data, improving overall data performance. For SSDs attached to a SAN, Emulex delivers reliable and high performance connectivity to enable fast and reliable storage tiering with its LightPulse 8Gb/s Fibre Channel HBA while Emulex OneCommand Manager, described in section 2, provides centralized management of all Emulex adapters in the tiered storage environment.

Superior performance across all channels for optimum performance

Dual port and quad port performance is critical in a virtualized environment. As the number of VMs in a single server increases, so do the I/O requirements of the host (physical) server. As I/O traffic is consolidated from multiple VMs onto a single HBA, greater per-port performance is required.

Emulex HBAs provide optimum throughput across multiple channels, to shorten back-up windows and speed up data replication migration, as well as significantly improve the performance of data warehousing applications. As shown in Chart 4, with only one channel working at optimum levels, other competitor's dual-channel HBAs cripple the performance of the server. In contrast, Emulex HBAs provide maximum throughput on both channels, requiring less server resources, which helps to reduce acquisition and operational costs.

Chart 4
Emulex delivers greater IOPS on the second channel

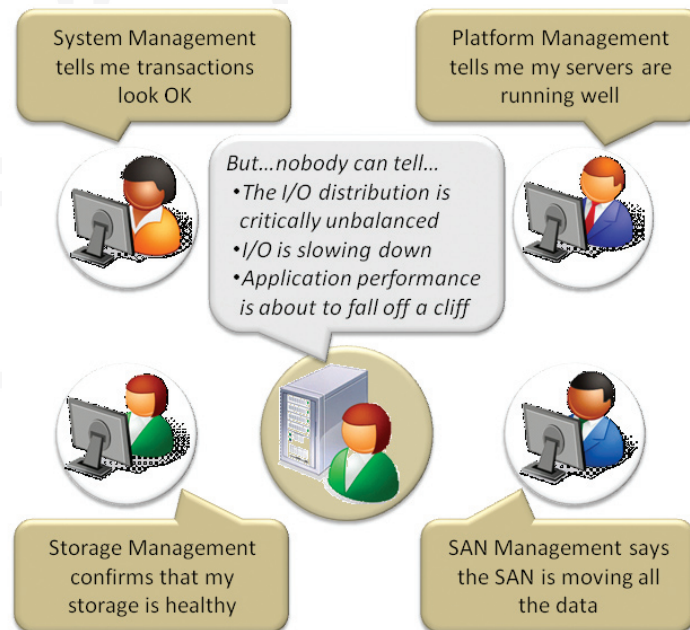




I/O monitoring for optimum performance and reduced down-time

In today's IT environments, data center administrators are challenged to deploy, monitor and control extensive networking resources to meet Quality of Service (QoS) requirements. Enterprise customers need real-time analysis for I/O performance to ensure applications are achieving peak QoS performance. As shown in Figure 1, it is often difficult to know where I/O problems occur.

Figure 1
Isolating I/O related performance issues can be difficult



As data centers become more complex, enterprise users can benefit from real-time, as well as historical, data about end-to-end I/O performance. The award-winning OneCommand Vision I/O Management application provides detailed I/O related data which can be used to address, or even avert, I/O bottlenecks, helping data centers maintain the highest level of application performance while maximizing utilization of existing resources. OneCommand Vision delivers the following advantages:

- Introduce I/O management—a missing component in the management toolbox
- Improve asset utilization and reduce capital expenditures
- Increase application performance
- Deliver on service level agreement (SLA) commitments
- Provide scalable, heterogeneous support
- Reduce I/O bottlenecks
- Increase management efficiency and reduce operational costs



I/O management is a critical tool for optimization of performance and maximization of resources within a data center. Chart 5 shows an example of the type of information OneCommand Vision provides:

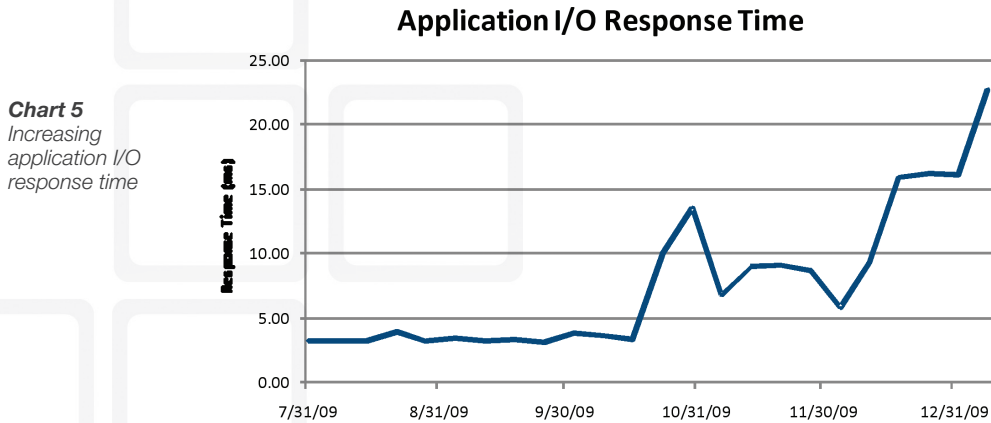


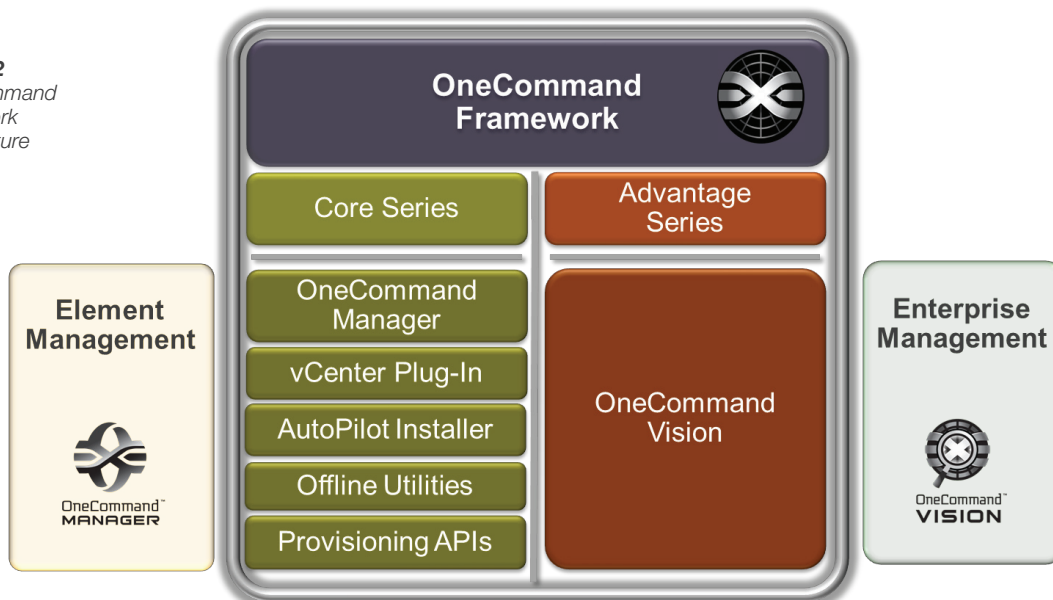
Chart 5 shows application I/O response time increasing on specific dates, with a general degradation over the last month. Alerting administrators of these issues can help identify problems, enabling necessary action before there is further I/O response time slow-down or even downtime.

OneCommand Vision's pure software architecture easily scales with the data center and does not require installation of in-line hardware components.

2. Management

Enterprises with traditional and virtual environments need a management framework that is flexible, scalable and integrated with key industry initiatives. Figure 2 provides the Emulex OneCommand management framework architecture. The applications in the Core Series (on the left side of this diagram) are available at no extra charge with the purchase of LightPulse Fibre Channel HBAs. The Advantage Series products are an optional upgrade.

Figure 2
OneCommand framework architecture





Advanced Connectivity for SANs

OneCommand Manager

With a management solution, such as OneCommand Manager, you achieve greater operational efficiencies, with the ability to manage HBAs and Converged Network Adapters (CNAs), no matter where they are located, what platform they are running on, or how they can be accessed—whether in-band (over the Fibre Channel link, an exclusive feature of Emulex) or out-of-band (over the LAN).

Testing has shown that by using OneCommand Manager, administrators can get twice the adapter management functionality in half the time compared to other management solutions (see Chart 6). In an enterprise setting with hundreds, or even thousands, of adapters, the productivity advantage is significant.

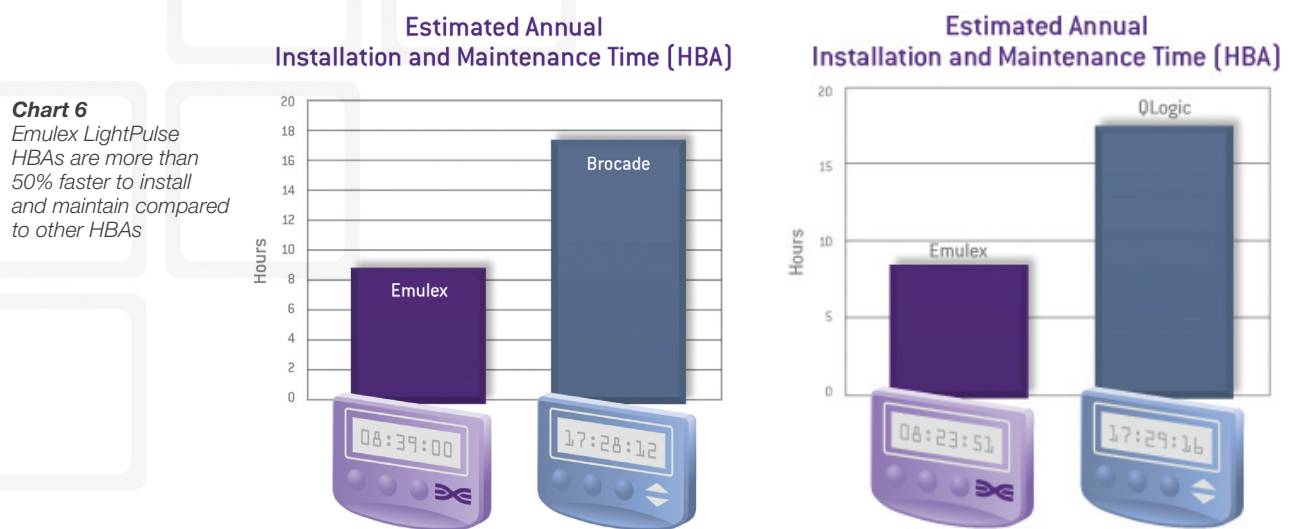


Chart 6 shows the management efficiency comparison of the time it takes annually to manage 175 HBA ports using Emulex OneCommand Manager versus two competitors. It is estimated that twice the time is required to install and manage 175 HBAs with competitor products and processes.

VMware vCenter plug-in

You can also manage adapters directly from the VMware vCenter management console with OneCommand Manager for VMware (OCM for VMware) for the ultimate in management simplicity. This comprehensive plug-in integrates the advanced capabilities of OneCommand Manager into VMware vCenter, enabling more efficient and centralized administration of Emulex adapters in ESX and ESXi environments. IT administrators can leverage OneCommand Manager's powerful suite of configuration, diagnostic and administrative tools to help optimize network performance and availability, increase productivity and reduce operating costs for VMware host systems.

3. Virtualization

New generations of servers and hypervisors have dramatically increased the number of VMs that can be deployed on a host. This allows data centers to fully leverage the savings in equipment, energy, data center footprint and administration costs that result from server virtualization. With higher virtualization ratios, there is a requirement to create more virtual ports (vPorts), uniquely defined using N_Port ID Virtualization (NPIV) technology (co-developed by Emulex), which can become a limiting factor in the number of VMs on a host server.

With an estimated 80 percent of virtual servers connected to a SAN, virtualization is clearly an important concern when deploying 8Gb/s Fibre Channel. Emulex Fibre Channel HBAs support server virtualization platforms from VMware, Microsoft® and Linux. Additionally all Emulex HBAs support NPIV, enabling the virtualization of physical HBA ports for a greater degree of network flexibility.



The Emulex Fibre Channel 8Gb/s HBA supports the most vPorts in the industry. Emulex conducted an analysis of vPort scalability with 8Gb/s HBAs from Emulex, QLogic® and Brocade®. The tests were completed by adding VMs with vPorts until errors were encountered with vPort creation, or limits were reached with server or switch resources. The following provides a summary of these tests.

Server

- HP Proliant DL160 G5
- Two quad-core processors
- 4GB RAM

VMware ESX drivers

- Emulex ESX 3.5 Update 2 in-box
- QLogic ESX 3.5 Update 2 in-box
- Brocade 1.1.0

Windows Server 2008 hyper-V drivers

- Emulex Storport Miniport 2.20.06
- QLogic Storport Miniport 9.1.7.18
- Brocade Storport Miniport 1.1.0.1

As summarized in Table 1, tests results showed that QLogic and Brocade HBAs were both limited in the number of vPorts that could be created. The limits were well within the number of vPorts that could be required with the increased scalability of new servers and hypervisors.

Table 1
Maximum vPort creation with Emulex, QLogic and Brocade HBAs

HBA	VMware® ESX 3.5 Update 2	Windows Server 2008 Hyper-V
Emulex LightPulse LPe12000	64 (server resource limit)	127 (switch limit)
QLogic QLE2560	15	15
Brocade 815	20	127 (switch limit)

4. Reliability

Emulex has embraced maximum performance through efficient cooling by designing its high performance LightPulse 8Gb/s Fibre Channel HBAs with passive cooling devices for optimum performance in a broad range of server environments. There is a direct correlation between heat and device longevity. Overheated parts generally exhibit a shorter lifespan and lower system performance.

Emulex Reliability

Emulex provides the most reliable Fibre Channel HBAs in the industry, averaging more than 10 million hours of field mean time between failures (MTBF). That is more than 30% greater than the nearest competitor.

Reduce device temperatures

Emulex I/O controllers are designed for performance, with every subsequent design having greater overall performance capabilities than its predecessor. Increasing the controller’s transistor count is generally how performance is increased. The challenge of how to increase the number of transistors without increasing the physical size of the I/O controller remains. For example, the higher-performance 8Gb/s Fibre Channel I/O controller, used on Emulex’s LPe12000 family, has 40 percent more transistors than its 4Gb/s predecessor used on the LPe11000 family of HBAs. However, the LPe12000 8Gb/s Fibre Channel I/O controller has similar physical dimensions as the LPe11000 4Gb/s Fibre Channel I/O controller. To effectively dissipate the heat generated by the new, higher-performance 8Gb/s controller, Emulex leverages passive cooling technologies (heat sinks), ensuring optimum performance and reliability in a broad range of operating environments.

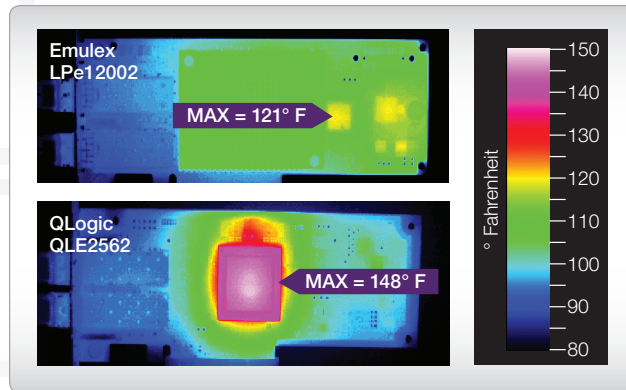
Emulex LPe12000 operates 27° F cooler

A test environment was created based on the QLogic QLE2562 environmental specification of 50lpm at 55° C to evaluate the thermal performance of the Emulex LPe12002 and the QLogic QLE2562 8Gb/s Fibre Channel HBAs. The results were as expected: running identical workloads, the LPe12002 I/O controller using a passive cooling device operated 27° F cooler than the QLE2562 I/O controller without a passive cooling device (see Chart 7).



Chart 7

I/O controller temperature performance: Emulex LPe12002 I/O controller operates 27° F cooler than QLogic's QLE2562 I/O controller when tested in environmental specifications defined by QLogic for its QLE256x family of 8Gb/s Fibre Channel HBAs

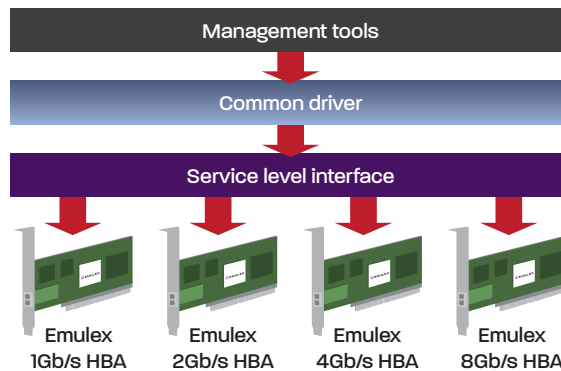


Emulex's design approach helps SAN administrators maximize their server performance and reliability, regardless of the server's configuration. The end result is improved SAN availability, which is a key objective for data center administrators.

5. Scalability

Enterprise SAN environments are dynamic. To that end, Emulex Fibre Channel HBAs, management tools, device drivers and firmware are designed to provide the greatest degree of scalability and flexibility (Figure 3). Emulex's management architecture helps IT organizations accommodate growth, while reducing the associated management complexity. The hallmark of Emulex Fibre Channel HBA solutions are the scalable and flexible management architecture they are based on.

Figure 3
Emulex delivers scalable architecture



The Emulex common driver model enables a single driver binary to work with all supported generations of Emulex LightPulse Fibre Channel HBAs and CNAs for a given OS platform. This approach simplifies management, requiring IT administrators to only deploy a single driver across Emulex 1Gb/s, 2Gb/s, 4Gb/s and 8Gb/s Fibre Channel HBAs and 10Gb/s CNAs.

In large deployments, scalable manageability is also a critical consideration, as it directly affects IT efficiency and budgets. To meet these scalability requirements, Emulex provides an efficient, scalable GUI-based HBA management facility designed specifically for enterprise-class SANs. This provides comprehensive control of Emulex Fibre Channel HBAs within a centralized, cross-platform framework, combining flexible remote-management options with secure access control. Through a single console, SAN administrators can manage all of their Emulex Fibre Channel HBAs, leveraging either in-band or out-of-band management options and a host of automation features that simplify deployment and management.

These Emulex HBA management solutions allow IT organizations to easily deploy and integrate 8Gb/s Fibre Channel HBAs, while leveraging existing management and scripting tools. This flexibility improves asset utilization while reducing management costs and complexity.



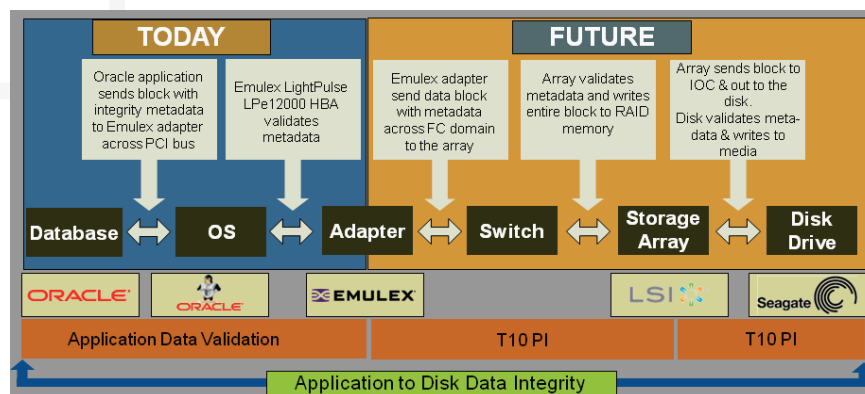
6. Data integrity

Database administrators face many challenges in developing and supporting applications that are often the lifeblood of their organization. One of the concerns is the integrity of data as it travels through the SAN between servers and storage arrays. Undetected data corruption, or “silent data corruption”, can have serious consequences when the database attempts to use that data.

T10 Protection Information

Emulex supports T10 Protection Information (T10-PI), formerly called T10-DIF, which has been developed in collaboration with Oracle to prevent silent data corruption and help ensure the integrity and regulatory compliance of user data as it is transferred from the application to the SAN. Emulex has implemented the T10-PI standard on its LightPulse 8Gb/s Fibre Channel HBA with its BlockGuard™ feature. Emulex BlockGuard is supported today with Oracle Linux via the Unbreakable Enterprise Kernel and the Emulex LightPulse 8Gb/s Fibre Channel HBA driver, which resides in the kernel. Emulex delivers the industry’s first T10-PI capable HBA (see Figure 4). The Oracle application to Emulex HBA portion of the protection process shown in Figure 4 can protect systems from half of the sources of silent data corruption alone, with 100% coverage available as the rest of the ecosystem implements T10-PI over the coming year.

Figure 4
Current and future support for enhanced data integrity



The important aspect of a silent data corruption event is that the application/database thinks data was correctly written or read, but it was not. Until T10-PI, no other mechanism was able to catch a data corruption event until the bad data was returned to the database.

Examples of silent data corruption include:

- Software bug in the OS or file system that corrupts a data block
- Software bug in the OS or file system that corrupts the address for a data block
- Bad hardware that causes a error that isn't detected by CRC or Parity
- A block is reported as written correctly, when it wasn't
- Torn writes

A silent data corruption event can take down a database or stop a critical process from completing. Since corrupted data may not be discovered for some time, the data may not be recoverable from backup tapes or database rebuilds. A database corruption can take down a data center, and it may take hours or days to recover to a point where the business can run normally. Because of this cost, some customers keep multiple logical copies of their databases, which increase costs in terms of storage, servers and operating costs.

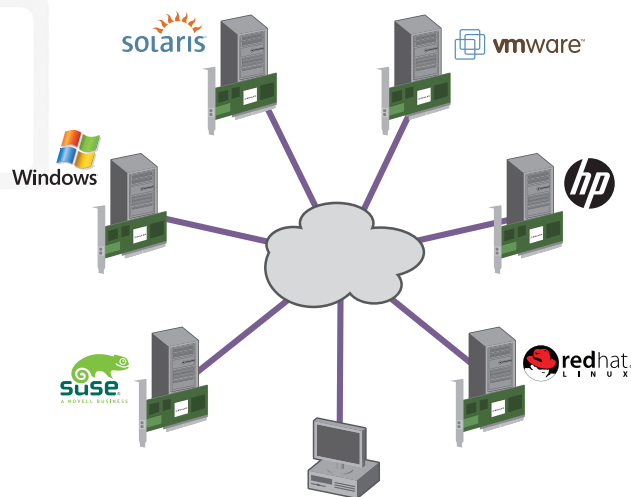


7. Interoperability

Long-standing collaborative partnerships with leading hardware and software vendors, spanning over **10 generations of adapters**, ensures the unparalleled interoperability and performance of Emulex Fibre Channel HBAs. The selection criteria for choosing SAN connectivity components, such as HBAs and switches, should be based on how well those components individually perform within the SAN. Seasoned data center administrators demand best-in-class products based on industry standards and best practices. The much touted “end-to-end” HBA and switch solutions offered by some vendors are designed to lock customers into a solution that may be mediocre at best—however, Emulex works with the leading Fibre Channel switch vendors for broader interoperability.

Additionally, Emulex drivers are in-box or in-distribution from the major operating system companies. Customers standardizing on Emulex are confident that they will have an Emulex-branded Fibre Channel solution for all components on their SAN. Similarly, customers know that their Emulex-connected SANs will be fully supported by all vendors (see Figure 5).

Figure 5
Centralized HBA
management within
heterogeneous
hardware and
software environments



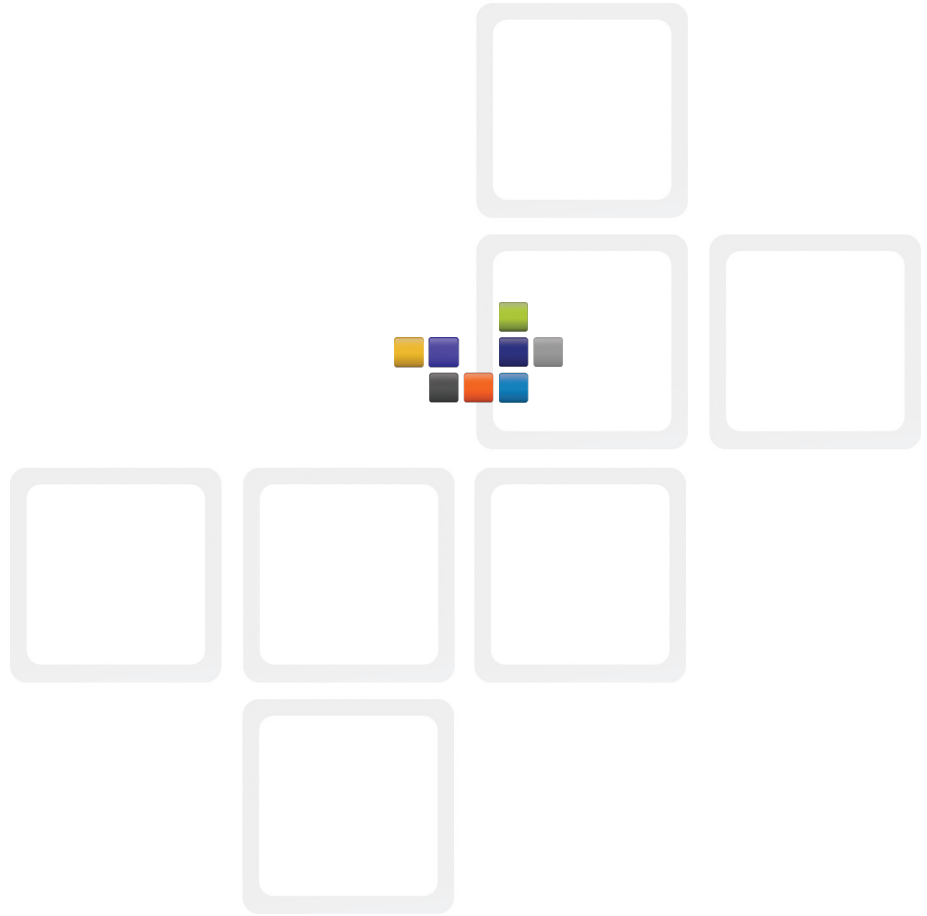
Summary

Enterprise data continues to grow at exponential rates, with new trends, such as web- and cloud-enabled applications, leading the way with data generation. Server virtualization technologies and server consolidation strategies, along with new multi-processor servers that support the PCIe 2.0 bus architecture require the bandwidth of an 8Gb/s SAN. Emulex 8Gb/s Fibre Channel technology addresses the SAN performance requirements of the expanding data center.

The architecture of Emulex LightPulse 8Gb/s Fibre Channel HBA solutions minimizes network disruptions and simplifies management, reducing costs for data centers with 8Gb/s Fibre Channel technology. In addition, Emulex 8Gb/s Fibre Channel HBAs offer enhanced virtualization capabilities and provide more robust data integrity features, delivering greater network flexibility and integrity.

When deploying and managing HBAs, streamlined operations save keystrokes, translating to saved operational costs. OneCommand Manager manages all your LightPulse HBAs in a single window and includes CNA management as well. Similarly, there are many reasons why your I/O response time is not where you want it to be, causing lost time across the organization. OneCommand Vision provides you the information you need to understand what is happening with your I/O response time, today and historically, and gives you information on how to fix any issues.

IT organizations should consider Emulex 8Gb/s Fibre Channel HBA solutions for new SAN deployments, or as an upgrade to an existing SAN. Emulex delivers seamless integration, while providing the highest level of performance, manageability, scalability and interoperability. With extensive support and experience in server and HBA virtualization technologies, Emulex is the clear choice for 8Gb/s Fibre Channel environments.



www.emulex.com

World Headquarters 3333 Susan Street, Costa Mesa, California 92626 +1 714 662 5600
Bangalore, India +91 80 40156789 | **Beijing, China** +86 10 68499547
Dublin, Ireland+35 3 (0)1 652 1700 | **Munich, Germany** +49 (0) 89 97007 177
Paris, France +33 (0) 158 580 022 | **Tokyo, Japan** +81 3 5325 3261
Wokingham, United Kingdom +44 (0) 118 977 2929