

Scalable Storage Network Connectivity for the Data Center

AT A GLANCE

One of the most important determinants of storage area network (SAN) scalability is the host bus adapter (HBA). Emulex HBAs, AutoPilot Installer® and HBAnyware® management software uniquely improve installation, configuration, management, troubleshooting and performance. For large enterprise SANs this translates into increased availability, enhanced manageability and simplified ease-of-deployment — bottom-line Emulex HBAs provide a lower total-cost-of-ownership with greater availability and performance.

TECHNOLOGY

Emulex LightPulse® Fibre Channel HBAs
AutoPilot Installer®
HBAnyware®

APPLICATIONS

Large-scale enterprise SANs

Why Emulex HBAs are “Generations Ahead” for the Enterprise

Scalability is an important concern for IT organizations grappling with expanding infrastructures, resource-hungry applications and rapidly proliferating data. Storage administrators dealing with such challenges know that the right Fibre Channel host bus adapter can help make the SAN more scalable. Emulex HBAs are “Generations Ahead” of the competition for the data center because they deliver the performance and unique features required for enterprise-scale SANs.

Introduction

For IT organizations deploying infrastructure solutions in the data center or extended enterprise, scalability is a major decision factor. Few scenarios are worse than standardizing on a product or solution, only to find out that it runs out of bandwidth or becomes unmanageable in large-scale deployment.

This is no less true when it comes to storage solutions. As administrators grapple with ever-expanding storage capacity and rapidly growing storage area networks, the scalability of that storage infrastructure is a major concern. While it is easy to focus on the capacity of the storage arrays or the port count of switches, one of the important determinants of SAN scalability is the connection point between the SAN and the servers connected to it – the host bus adapter.

Unfortunately many people, including some IT vendors, confuse scalability with performance. While performance is an important aspect of a scalable solution, experienced IT architects recognize that other aspects are equally important. When it comes to HBAs, these attributes include: the ease with which new HBAs can be connected to an existing SAN; the simplicity of configuring or reconfiguring one or multiple HBAs; the ability to manage many HBAs from a single management point; and the speed with which problems can be pinpointed and resolved. These

considerations, along with performance, all contribute to the overall scalability of the storage solution.

Scalable SAN Connectivity Defined

Scalability is normally thought of in two dimensions – “scale up”, or adding more resources to a system, and “scale out”, or adding additional systems to the configuration. Both of these dimensions apply to the question of HBA scalability.

“Scale up” is typically a concern for large servers hosting mission-critical business applications. As the application grows, it typically needs access to additional storage capacity or additional I/O bandwidth, often requiring the use of multiple HBA ports. Scalability of performance across multiple ports is a key consideration here.

“Scale out” comes into play for distributed applications which can be scaled by adding more nodes, or servers. These applications may be equally critical to the business, and each additional server would, of course, need to be connected to the SAN. Here, performance of the individual HBA may be less important than the ability to easily add HBAs to, and manage many HBAs within, the configuration.

The attributes of a scalable HBA solution can be thought of in the following dimensions:

- ▶ Installation considerations
- ▶ Configuration considerations
- ▶ Management considerations
- ▶ Diagnostics and Recovery issues
- ▶ Performance

We'll examine each of these in more detail.

Installation

When it comes to installing HBAs, scalability comes down to how quickly new HBAs can be added to a configuration. For scale-out applications, that can include pre-provisioning servers with HBA drivers and software, and replicated install strategies.

The Emulex AutoPilot Installer application for Windows begins with a simple wizard for interactive installation. However, for larger IT organizations, the power is with automated installations that are based on customizable scripts.

Key AutoPilot Installer features include:

- ▶ Automated silent installation – AutoPilot Installer supports a command line installation that can be included in an automated installation procedure. The customizable configuration file also allows default parameters to be changed as needed.
- ▶ Replicated installation from a reference server – The AutoPilot configuration file can also reference an installation server that has all the needed files maintained in a single location that can be used for installations throughout the enterprise.
- ▶ Single installation for driver and utilities - One process is used to install a qualified package of driver and management utilities. A single installation kit provides a complete bundle with all the ingredients for a successful installation.

- ▶ **Single-instance driver installation** – The driver is automatically installed or updated for all HBAs on a server. This becomes an important time-saver as servers are scaled up for mission-critical applications.
- ▶ **Software-first installation** – Larger enterprises will often pre-configure servers with a standardized installation of the Windows operating system that can include the Emulex driver and utilities. As Windows is started, HBAs will be detected and the driver and utilities installed automatically with no further action needed.

The installation features available with AutoPilot Installer are unique (see Table 1 for a comparison between installation features offered by Emulex compared to QLogic).

The value of a robust HBA software installation package can be measured in time and mouse clicks. For example, a typical installation process for Emulex HBA drivers and utilities requires less than a minute and just seven mouse clicks; whereas, a comparable installation of QLogic product can take more than seven minutes and 55 mouse clicks.

Table 1: Emulex HBAs are more suited for large enterprise environments because of the unique ease of installation features in AutoPilot Installer.

SCALABILITY FEATURES	Emulex	QLogic
Customizable automated silent installation	✓	
Replicated installation from a reference server	✓	
Combined wizard-based installation for drivers and utilities	✓	
Single-instance driver installation across multiple HBAs	✓	✓
Software-first installation (pre-configure of servers)	✓	

Configuration and Management

Once installed, HBAs must be configured and on occasion configuration changes will need to be made. And, of course, day-to-day management tasks will need to be performed. In these cases, scalability of the HBA solution is primarily a function of how easy it is to perform these tasks for multiple HBAs at one time, and how well management of the HBAs fits into IT's overall systems or storage management regime. The capabilities that should be considered include:

- ▶ Batch mode updates for firmware and driver settings
 - As a matter of SAN Management best practices, experienced storage administrators typically establish and fine tune standard configurations, and then propagate them across their SANs uniformly. For the HBA component, this boils down to an approved firmware image and carefully selected driver parameter settings for any given family of compatible HBAs. Emulex HBAs' stand-alone firmware images and driver profiles allow for these standards to be easily captured and propagated effortlessly using the batch mode available in HBAnyware. That delivers a powerful, yet simple, foundation for automation.
- ▶ Global Parameter setting — Within the same system, driver parameters can be set either globally (for all HBAs) or locally (for a given HBA). This not only makes configuration a breeze, but it prevents errors. Furthermore, it reinforces commonality across HBAs.
- ▶ Single driver for multiple HBA generations — Backward compatibility of Emulex drivers across multiple hardware generations is a critical cornerstone for standardizing on a single driver version across the SAN. Some vendors instead roll multiple driver and firmware versions into a single package, which makes it difficult or impossible for the end user to distinguish the versions that are qualified from the ones that aren't.
- ▶ Scriptable management interfaces — Some homegrown IT policies and processes require complex and specific administration tasks that can't fit the mold of predefined management utilities, no matter how powerful. The scriptable command-line interface from Emulex is the perfect answer in these scenarios, providing storage administrators with the flexibility they need to tailor their HBA management actions using customized scripts. Furthermore, the advanced scriptable management interface is another popular scheme to implement automation.
- ▶ Integration with storage or systems management tools
 - Emulex management instrumentation is based on open, standards-based interfaces and components, with the design goal of enabling integration into higher-level storage or server management solutions. This can be accomplished at either an application level, or a native API level. That paves the way for a single pane of management by allowing Emulex HBA management from within end-users' favorite storage or server management applications.
- ▶ Flexible management both in-band and out-of-band
 - Emulex pioneered centralized, cross-platform management of HBAs from anywhere in the SAN with the launch of the HBAnyware framework back in 2002. HBAnyware provides for state-of-the-art, powerful management capabilities, no matter where the HBAs are located, what platform they are running on, and how they can be accessed, meaning in-band (over FC) or out-of-band (over LAN).

- ▶ **Managing the Virtual Data Center** — Emulex is first to market with support for the ANSI T11 standard for N-Port ID Virtualization, built into all 4Gb/s LightPulse Virtual HBAs. This technology enables scale-up consolidation and virtual server deployment by providing optimal fabric connectivity to individual applications, containers or virtual machines. In addition, LightPulse Virtual HBA technology allows for easier, faster provisioning of physical resources (servers, storage and connections) nonstop, without the disruption of extensive server or fabric reconfigurations.
- ▶ **Management security** — With a centralized management scheme allowing an increasing number of HBAs to be managed remotely, one legitimate concern that comes to mind is the security provisions around all this. Emulex offers the industry's most advanced security, whereby HBAnywhere operations can be restricted by an access control list and cryptographically verified using FC-GS-3 Authenticated CT protocol. QLogic HBA security is limited to a simple password authentication scheme.
- ▶ **Highly available “Boot from SAN”** — Many large-scale data centers have centralized storage not only for applications and data but for operating system images. IT organizations deploy “Boot from SAN” as a way of standardizing and provisioning larger server pools. Emulex HBAs not only support “Boot from SAN” but can accommodate multiple boot paths to provide a high-availability solution.

Emulex management capabilities are geared toward increasing overall productivity and efficiency, helping storage administrators to cope with increasing pressure for managing an ever-expanding infrastructure. Emulex offers the most comprehensive management and configuration capabilities. Please refer to Table 2 for a comparison of Emulex and QLogic configuration features.

Table 2: Emulex HBAs offer the most comprehensive configuration features. Large SANs leveraging these features are significantly easier to manage.

SCALABILITY FEATURES	Emulex	QLogic
Centralized management support across in-band and out-of-band networks	✓	Out-of-band only
Batch mode updates for firmware and drivers	✓	
Global parameter setting	✓	Single Server Only
Scriptable management interfaces	✓	✓
Integrations with storage or system management tools	✓	✓
Advanced security through cryptographically verification using FC-GS-3 Authenticated CT protocol	✓	

Diagnostics and Recovery

When trouble occurs in a SAN, the first challenge is pinpointing the cause of the problem. As the SAN grows larger, with more storage devices and more connected servers, that challenge can grow along with it. HBA failure is relatively rare, and failure of Emulex HBAs is rarer still; in fact, the Emulex LP10000 family of 2Gb/s HBAs boasts a field Mean Time Between Failures (MTBF) of 5.8 million hours. Nevertheless, a scalable HBA solution must provide the capabilities to quickly diagnose problems with the HBA and in the SAN, and easily replace the HBA should that become necessary. Features to look for include:

- ▶ **HBA Beaconsing** — Quickly and unequivocally identifying a given HBA on the back-plane of a large server or across a stack of rack-mounted servers could not only be a challenge, but it exposes the SAN to human errors. The beaconsing feature of Emulex HBAs removes this hassle and mitigates associated risks altogether by allowing the storage administrator to pinpoint any specific HBAs that need physical intervention.
- ▶ **Online diagnostics** — While troubleshooting a SAN incident, storage administrators often need to check whether any given component along the value-chain is fully operational or not. Being able to do this online without impacting the environment is critical. Emulex HBAs feature a warm Power-On Self-Test and elaborate online diagnostics that can be invoked on-demand and non-disruptively to make sure the HBA checks okay.
- ▶ **Crash Dumps** — Should a problem occur, Tech Support turn-around time is often a key satisfaction factor for IT administrators. Emulex HBAs feature a unique capability whereby critical state information can be captured and saved, either automatically or on-demand. Such a snapshot in time allows Emulex Tech Support to quickly trace the problem back to root cause and provide adequate remedies for a quick recovery.
- ▶ **Streamlined HBA replacement** — In the unlikely event that an HBA needs replacement, Emulex HBAs are designed to streamline the replacement process and avoid configuration errors. Competitive products store HBA parameter information on the card itself in NVRAM;

when a card is replaced. all the parameters go with it. Worse yet, if the card is re-used those parameters may be unintentionally and inappropriately used when redeployed.

- ◊ Emulex HBAs store the HBA port parameters on the host so that when an HBA is replaced, the parameters associated with the previous port are inherited by the replacement card without user involvement.
- ◊ HBAAnyware also makes quick work of ensuring that all HBA parameters are correct by allowing the administrator to save port parameter information into a file that can be later applied to the HBA in the event the server is replaced or the operating system reloaded.

Table 3. Emulex offers a number of unique diagnostics and troubleshooting features that greatly improve administrative scalability.

SCALABILITY FEATURES	Emulex	QLogic
HBA beaconsing to quickly identify HBAs	✓	✓
Online diagnostics providing centralized/ remote inspection	✓	✓
HBA critical state information capture or "firmware crash dumps"	✓	
Online, non-disruptive Power-On Self-Test	✓	
Streamlined HBA replacement using common drivers / stored parameters	✓	

As shown in Table 3 above, Emulex offers industry-leading diagnostics and recovery capabilities. Powerful, effective diagnostics and recovery capabilities help storage administrators fulfill demanding service-level agreements.

Performance

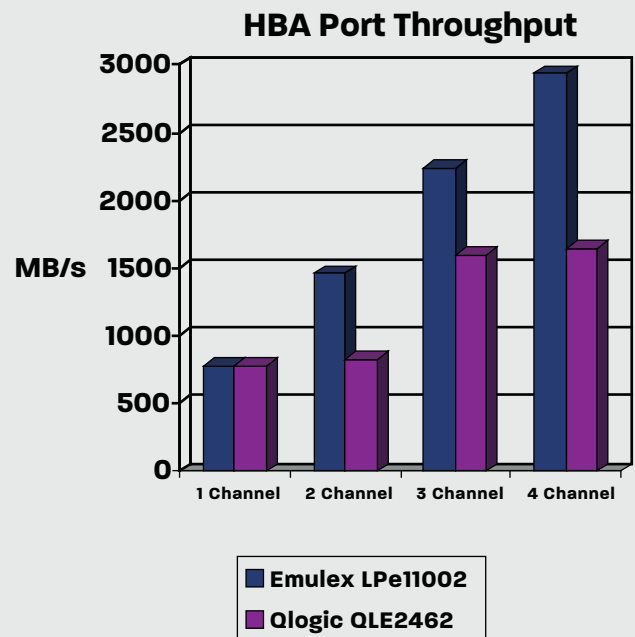
While most HBA vendors claim that their HBA can run at the maximum line rate possible, most often the performance is specified for a single HBA channel. The reality is that most enterprise customers require more than a single HBA channel for performance and redundancy reasons. How well an HBA performs when multiple channels are deployed is critically important. Emulex dual-channel HBAs are the clear leader when it comes to real-world performance and scalability. Emulex 4 Gb/s dual-channel HBAs boast throughput that is 78% greater than that of the nearest competitor and transaction rates that exceed the competition by up to 36%.

When scaling beyond two channels, Emulex HBAs prove to have a major throughput advantage. The chart below illustrates how Emulex HBAs can efficiently utilize limited server PCI expansion slots while keeping up with the performance needs of enterprise computing. In

the illustration, the four ports available using two Emulex LPe11002 HBAs have nearly a 1300MB/s throughput advantage over the competition.

Combined with Emulex's superior quality, reliability, and manageability it's no wonder that Emulex HBAs remain the deployment leader in the world's largest enterprises. For more information on multi-port performance scalability of Emulex 4Gb/s adapters, see the Emulex white paper entitled "Business Critical Applications: Full Throughput, All The Time" at <http://www.emulex.com/white/index.jsp>

Table 3. HBA Port Throughput



Conclusion

For very large enterprise SANs, HBA scalability considerations can be a critical factor. Emulex LightPulse Fibre Channel HBAs and Emulex HBA installation and management software (AutoPilot Installer and HBAAnyware) provide a comprehensive set of unique features to simplify installation, configuration, management and troubleshooting. These “scale-out” features can greatly save the SAN administrator time, enhance system availability and significantly reduce the total-cost-of-ownership. Similarly, Emulex enterprise-class performance on dual-channel HBAs provides a major throughput advantage over competitive products, giving a solid foundation for scale-up requirements.

Emulex leadership in scalability is one of the reasons why more than ninety of the Fortune 100 use Emulex LightPulse HBAs for their mission-critical applications. Emulex scalability features further demonstrate the fact that Emulex is “Generations Ahead” of the competition.

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