Host Bus Adapters (HBAs):
What you need to know about a storage networking workhorse

By Alan Earls
February 2003
OVERVIEW

Host Bus Adapters (HBAs) are not the sexiest part of a SAN's architecture. They attract relatively few headlines and, to the uninitiated, might look almost like a commodity product. However, there are things worth knowing about HBAs, how they are differentiated and how selecting the right HBA can strengthen your infrastructure.

Let's look at what an HBA is and what it does. The Storage Networking Industry Association defines an HBA as an I/O adapter that connects a host I/O bus to a computer's memory system. HBAs are important enablers to storage networking, providing a critical component for connecting systems and storage devices to a Fibre Channel fabric.

What's so big about an HBA? Basically, HBAs, which reside in the server, connect the server and the storage. HBAs can have a role in both networked and direct-attached storage and across interconnect technologies such as Fibre Channel, iSCSI, FICON or SCSI. Their importance lies in the intelligence they possess -- which allows the server to focus on application requirements. HBAs provide critical server CPU offload, freeing servers to perform pure application processing. More specifically, this intelligence makes possible handy features like fail-over, load balancing, and other valuable management attributes. And as storage networks grow in complexity, with thousands of devices connected to a fabric, the need for standard network management capabilities increases exponentially.

The work done by NICs, by comparison, is comparatively simple: framing packets and controlling the flow of data to the link layer. Thus it is easy for I/O requests that pass through a NIC to end up putting a strain on the host, slowing down the CPU and negatively impacting system performance. Indeed, in some circumstances this "extra" work can take up the majority of the CPUs power. Thus, while NICs have a low initial cost, they can impose hidden costs that are often far greater.

What's in an HBA? Most have their own processor, a controller ASIC, or buffer memory. While a NIC needs help from the server CPU for protocol processing, HBAs by comparison, can themselves keep an eye on error detection, keeping packet sequences in order and so on. All of this requires practically no involvement by the host CPU. One of the big bottom line benefits of the HBA approach is that HBAs can deliver throughput at close to link speed with minimal CPU impact.

Within a SAN, HBAs perform functions that include IO translation and CPU offload. SANs are built around transferring block-level data. When the data is moved from a drive that uses SCSI, the HBA maps that SCSI data to the SAN protocol for network traffic such as Fibre Channel. To help offload the CPU, HBAs provide buffering for the data arriving from the storage array. This function can reduce or eliminate bottlenecks associated with CPUs tied up on storage tasks.

For the most effective functioning of a SAN, the information that is available on the HBA needs to be accessible to SAN management software. A few years ago, SNIA proposed an HBA API. This is now a fairly widely available feature of HBAs but there are still "gotchas." For instance, sometimes HBAs are shipped with the API disabled. So, the configuration of the API needs to be determined and enabled if your software requires it. Older HBAs sometimes don't support the API but some have patches available from the vendor.

The HBA API was first extensively demonstrated in 2000. According to SNIA, the HBA API provides a single interface to common functions. This common interface allows host software to support host adapters from
multiple vendors in the same server using a single interface, resulting in a multitude of benefits to consumers such as increased functionality, interoperability and availability of solutions. Additionally, notes SNIA, independent software vendors are better able to develop solutions and can bring them to market quicker, allowing them to focus on further extending software functionality and management tools.

The API was developed with the initial backing of 25 vendors/industry groups, including, at the time: Adaptec, Agilent Technologies, BMC Software, Brocade Communications, Connex, EMC, Emulex, Fibre Channel Industry Association (FCIA), FibreAlliance, Hewlett-Packard, HighGround Systems, Hitachi Data Systems, Interphase, InterSAN, JNI Corporation, Legato, McDATA, Prisa Networks, QLogic Corporation, StorageNetworks, Tivoli, Troika Networks, Veritas Software and Vixel.

In the study titled "Storage Management Enabled With APIs" released early in 2003, Gartner Dataquest analyst Carolyn DiCenzo reviewed management strategies and storage device APIs for leading storage, switch and HBA providers. The Gartner Dataquest report focused on the need for storage device vendors to construct partner programs that will encourage software developers to provide strong support for vendor's devices.

Included in the report findings was a section titled HBA Vendors Deliver HBA API. In a statement, DiCenzo noted, "Before the adoption of HBA APIs, software vendors had to rely on custom, vendor specific support to obtain the required information for a given HBA." Now, she continued, "HBA vendors providing sophisticated APIs to storage software vendors are uniquely positioned to help deliver significant storage networking improvements such as simplified management and reduced system downtime."

**SELECTING AN HBA**

Choosing an HBA can be as simple as looking at the price -- which can range from a few hundred to several thousand dollars.

You can shop for HBAs in 1 or 2 Gigabit per second varieties -- with the 1 Gigabit option usually being less expensive. Although you may want to match the speed of your fastest equipment, there is no requirement to do so. The 2 Gb/s equipment is downward compatible and in some cases, 1 Gb/s is adequate and far more affordable. In fact, most switch vendors provide an auto negotiate capability. If a 2Gbit HBA is connected, it will run at that speed while if a 1Gbit HBA is connected, that whole path to your storage will be set to run at 1Gbit.

HBAs are not a one-size-fits-all choice when it comes to operating systems, though. For example, different HBA vendors support Solaris, Linux, AIX and other Unix flavors.

Then there is the choice of transmission medium -- optical fiber or copper (each is available for 1Gbps or 2Gbps and optical comes with the additional choices of 850 nanometer and 1310 nanometer). The choice will depend on your requirements and the compatibility needs of existing equipment.

Ultimately, though, the most important factors in selecting an HBA are the operating system, the hardware platform, and your own experience with the vendor. At a minimum, the HBA vendor needs to support the operating system that is required by your operations. Secondly, demonstrated compatibility with servers and with storage devices is also key.
If you are running more than one type of host, with different operating systems and multi-vendor storage devices, HBAs can end up conflicting. This can result in problems storing and retrieving data. Sometimes devices simply won’t work.

To minimize problems, HBAs must still connect to compatible servers. For example, as one reseller noted, there are countless combinations and variations of HBA firmware, driver version, OS version, OS patch level, disk connectivity, tape connectivity, router/bridge firmware, and manufacturer support. HBA specifiers should consider those factors, perhaps using a decision matrix. (Few in the industry can provide a comprehensive matrix because information changes almost daily.)

While decision matrices can be helpful, in the real world, experience with the HBA in the exact kind of environment you are operating is crucial. That’s because specifications and matrices can tell you only a small portion of the picture. Without known operating experience, businesses should be cautious when selecting an HBA. Finally, there is simply the kind of experience you may have had with the vendor generally -- a subjective but important factor.

Recognizing that HBAs can develop problems, it is also worth determining how long it takes for failover.

**VENDORS**

There are many, many HBA vendors. This paper does not attempt to list them all. Four well-known vendors are included below, with a brief description of their HBA offerings.

**Emulex**

According to Emulex, their family of HBAs offers high-performance, standards-based connectivity solutions for both Fibre Channel and Internet protocol (IP) storage networking environments. Emulex host bus adapters provide a combination of features required for mission-critical enterprise environments that deliver reliability, high bandwidth, server CPU offload, low latency and scalable connectivity. Emulex HBAs also offer a driver architecture that enables compatibility of a single operating system driver across Emulex's entire product line and a firmware-based architecture.

Emulex LightPulse family of Fibre Channel HBAs offers full fabric support, high data integrity, full-duplex operation, data buffering for up to 100km of cabling and support for all Fibre Channel topologies. The Emulex LightPulse family of Fibre Channel products includes the 2Gb/s LP9802, LP982 and LP9802DC PCI-X HBAs, the LP9002L and LP952L PCI HBAs, the LP9002C CompactPCI HBA, the LP9002S SBus-based HBA and the market-leading LP8000.

According to the company, the Emulex family of IP-based storage networking host bus adapters includes the GN9000/SI iSCSI host bus adapter and the GN9000/VI VI/IP host bus adapter. The Emulex GN9000/SI is designed to provide the high performance iSCSI connectivity over gigabit Ethernet for PCI-based systems. The Emulex GN9000/VI VI/IP HBA enables network attached storage (NAS) appliances and hosts to exchange file system data over IP networks, while gaining the high throughput, low latency and reduced CPU overhead benefits of the virtual interface (VI) architecture.

In addition, Emulex offers its HBAnyware solution, designed to simplify storage networking management and reduced planned downtime by allowing HBAs to be independently configured and managed from a single point. Utilizing HBAnyware also enables IT managers to obtain complete visibility of Emulex HBAs.
within a SAN, and allows for simultaneous firmware upgrades to any or all Emulex HBAs across the network. HBAnyware can be integrated into third party management software via Emulex's API extensions, which will enable end users to utilize HBAnyware's capabilities within their preferred or existing management applications.


QLogic

The QLogic SANblade 2310 Series provides throughput performance of up to 2 Gb/s and features aimed at a wide range of applications ranging from the workstation to the data center. According to QLogic, SANblade 2310 offers HBA components integrated into a single chip; high performance -- over 40,000 I/O operations (IOPs) per second; support for PCI-X; support for storage, server and cluster applications and SCSI protocols, and; operating system support through QLogic device drivers.

In 2002 the SANblade QL2300 was honored as a "winner" by CMP Media LLC's Network Computing in two categories: "Fibre Channel Host Bus Adapter" and the broader category of "Data Management and Storage Technology." The SANblade QLA2300 was chosen for its driver implementation, ease of use and performance.

The SANblade family currently consists of board-level solutions based on Fibre Channel that QLogic says will be extended in the future to include InfiniBand and iSCSI products. QLogic claims its SANblade HBAs are the industry's highest-performing and most widely deployed host adapter solutions for server, networking, storage and clustering solutions.

The SANblade 2300 Series HBAs have an integrated RISC processor, the Fibre protocol engine and transceivers in a single, Fibre Channel controller chip. They have been validated by major OEMs including Dell, EMC, HDS, HP, IBM, and Sun.

More information is available at www.qlogic.com.

JNI

JNI’s industry family of SAN and Cluster connectivity solutions are noted for the their performance and enterprise software capabilities. JNI was the first Fibre Channel HBA company, the first with 2Gb HBAs and the first Enterprise class driver technology. JNI FibreStar HBAs include controllers for PCI (FCE-6460), PCI-X (FCX-6562), cPCI (FCC-6460) and Sbus (FCE-1473) architectures for Solaris, Microsoft and Linux environments. JNI’s drivers have been adopted in some of the world’s largest and most complex SAN environments. The company notes that many JNI installations have over 1000 HBAs running mission critical applications. Customers include FEDEX, CommerzBank, NTT DOCOMO and many others.

JNI driver features provide ability to dynamically load and unload drivers, change parameters or add/remove SAN devices without re-booting the server. Traditional updates to HBA drivers require removing the existing driver, installing the new driver, and then rebooting the server in order for the new setting to take effect. In an enterprise SAN environment with a large amount of HBAs this can be a time consuming task for IT professionals. JNI’s "dynamic trio" features allow the user to load and unload HBA drivers, update the HBA default settings, and dynamically add or remove new Fibre Channel devices to the OS without having to reboot the server. The JNI EZ Fibre configuration utility allows you to change HBA default settings and configure specific targets and LUNs you want visible to the Solaris or Windows OS. All of this capability plus
support for industry management standards such as SNIA cHBA API and SMI (BlueFin) are controlled via JNI’s EZ-Fibre management software.

JNI’s TruePath DMP (Dynamic MultiPathing) software provides both host and target side load balancing and fail over capabilities. The ability to recover from failures on the target side of the SAN is unique to the JNI TruePath HBA software, according to the company. Mission critical applications require high availability storage area networks (SANs). Host bus adapters (HBAs) are a critical component in the SAN. JNI’s TruePath high availability solution provides dynamic multipathing (DMP) between HBAs based on I/O traffic conditions and automatic failover and failback. TruePath also maximizes the performance of all available paths by loadbalancing I/O traffic through the available HBAs. This frees more server CPU cycles to work on applications (not managing I/O). Configuration of the failover/failback and loadbalancing features is provided by the SAN Command software graphical interface. JNI’s TruePath solution also includes the dynamic trio features.

For more information on JNI product please go to www.jni.com.

ATTO

ATTO ExpressPCI host adapters include both SCSI host adapters for direct attached storage as well as Fibre Channel/iSCSI adapters for networked storage. ATTO says its key software component is the ATTO configuration utilities tool that allows users to easily update the firmware, run performance benchmarks and change settings such as "NVRAM" in order to optimize the HBA for their specific workflow. The company also says its board design enables ATTO FC HBAs to transmit a clear data signal with fewer bit errors than the industry standard. The 2-Gbs optical Fibre Channel ExpressPCI FC 3300 host adapter provides data-delivery rates of 400 MB/sec.

More information is available at www.attotech.com.

THE FUTURE

What role HBAs will play in the future is a subject of some debate. If InfiniBand fulfills is potential it could gradually replace the aged Peripheral Component Interconnect (PCI) system widely used in PCs and servers. What is less clear is whether that development will change the role of the HBA. Some see a reduced role for HBAs. Others believe that HBAs may take on new roles, for instance providing a bridge between Fibre Channel and InfiniBand. At this point, with InfiniBand still in the earliest stages of acceptance, it is simply too soon to tell.

ABOUT THE AUTHOR

Alan Robert Earls has written about business and high technology for more than 20 years. He is the former editor of Mass High Tech, Chicago Software News and Boston Digital Industry as well as a frequent contributor to periodicals such as Computerworld, CIO, NetworkWorld, and Software Magazine. For the past few years, storage-related topics have been a regular part of his beat.