

Emulex OneConnect and the Drive toward Network Convergence

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Network convergence remains an attractive but elusive concept in computing - attractive because of the significant cost and management saving benefits; elusive because there are huge corporate investments in existing networks. In response, storage and server vendors have been working toward combining Fibre Channel storage networks and Ethernet data networks in ways that preserve the best of both worlds. This has taken the form of network convergence based on Data Center Bridging (DCB), also known as Converged Enhanced Ethernet (CEE), which unifies IP, iSCSI and Fibre Channel using Fibre Channel over Ethernet (FCoE).

Network convergence is the next step for data center consolidation, leading to significantly reduced capital expenses (CAPEX) and operational expenses (OPEX). When done correctly, users can achieve significant cost reductions while largely preserving their existing investments in server and storage infrastructure and associated management processes. It is also clear that for networking and storage vendors that bet on the right technologies and approaches, network convergence will provide a long-term, lucrative market opportunity.

In order for the promise of network convergence to become widespread, several key pieces must fall into place. First, industry bodies must standardize. This work has already been completed for FCoE, and the DCB standard is well on its way with standardization expected later this year (2010). That is not to say that development is not happening - it is. Leading vendors must also develop converged network product offerings that provide the level of performance, reliability and availability demanded by enterprise users, along with a unified framework to efficiently manage the various components.

One of the most critical technology components to enable convergence is the Converged Network Adapter, or CNA. The successful development and production of CNAs requires a considerable blend of technical expertise and market experience in both the storage and network domains. We believe that Emulex, with its OneConnect adapter family, is one of an elite handful of suppliers with the technological muscle and market pedigree to become a major CNA supplier, and by extension, a leader in the network convergence market.

In this piece, we'll discuss major networking challenges in today's data center, and in that context, we'll examine the technical and market forces that are driving convergence. Next, we'll

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take a closer look at the CNA as a core technology enabler and will focus specifically on Emulex OneConnect CNA offerings.

Vexing Challenges in Data Center Networks

Data center networks are awash in complexity. Most enterprise data centers maintain separate, dedicated fabrics for data networking and storage networking, respectively Ethernet and Fibre Channel. These networks typically have complex configurations including large numbers of adapters, switches and cables.

Along with the separate fabrics come different network management systems and practices, usually relying on specialized tools and skill sets. Together, these factors contribute to a number of pain points:

- *Pain Point #1: Unacceptably long network provisioning times.* This is due in large part to static configurations and the difficult process of data growth planning and management.
- *Pain Point #2: Increased management cost and complexity.* The data center's complex architecture comes from two or more separate fabric infrastructures, including dedicated adapters, controllers, switches and cabling. Each fabric is complex in and of itself, making for an even more challenging environment.
- *Pain Point #3: Inflexibility.* Data center administrators cannot easily re-configure traditional Host Bus Adapters (HBAs) and Network Interface Cards

(NICs) to accommodate growth in storage or data network traffic, or shifts in user demand.

- *Pain Point #4: Error-prone environments.* Given data center complexity and the large amount of manual effort required to maintain it, these environments are extremely error-prone. A few errors might not be disastrous, but over time, they multiply to the point where they may threaten critical processes.

Next let's look at how these enterprise networking challenges are combining with technical and market forces to drive the industry toward network convergence.

Forces Driving Convergence

A number of technology, market and business factors are working together to accelerate the drive toward network convergence.

Ethernet as the Convergence Platform

Ethernet technology has advanced to the point where it can serve as the convergence platform. The standards for Converged Enhanced Ethernet (CEE) are in the process of being finalized by the IEEE 802.1 DCB Task Group, which will enable truly lossless Ethernet. This lossless environment includes traffic-specific, configurable bandwidth allocation based on the Enhanced Transmission Selection (ETS)

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IEEE 802.1Qaz standard and priority-based flow controls (PFC) ICC 802.1Qbb to enable quality of service (QoS). Both of these standards are expected to be completed later this year (2010).

The Reality of FCoE

The FCoE market is finally poised to take off over the next 12 to 18 months. FCoE-enabled CNAs and Ethernet switches are already available, and we have seen many test bed environments throughout 2009 and into 2010. In 2011, we expect an increasing wave of production deployments. Note that one of the strongest adoption trends is to use FCoE within modular pods (server, storage and network modules) and to rely on native Fibre Channel-to-Storage Area Network (SAN) traffic outside the pods.

At present, a majority of Fibre Channel storage systems gain FCoE functionality with external FCoE-enabled switches and CNAs. However, there are a growing number of natively supported FCoE interfaces in storage arrays. NetApp is a prime contender in this space with native FCoE support in their Fibre Channel SANs.

Some Fibre Channel storage systems natively support FCoE, such as NetApp's SANs. Other Fibre Channel storage systems can benefit from FCoE

Rapid Adoption of Virtualization and Blade

The third major factor driving convergence is the rapidly growing adoption of server virtualization and blade server computing. By consolidating multiple virtual servers onto a single physical platform, server virtualization creates the need for multiple Ethernet Local Area Network (LAN) and Fibre Channel SAN connections to accommodate the virtual machines' (VMs) bandwidth and QoS requirements.

However, this process complicates server I/O and greatly increases management complexity. Blade servers have a similar effect. Consolidating multiple blades drives

Key Standards for Enabling Network Convergence	
<u>Standard</u>	<u>Status</u>
10 Gigabit Ethernet (10GbE)	Published as IEEE standard
Fibre Channel over Ethernet (FCoE)	Certified as ANSI standard
Data Center Bridging (DCB)	Expected as IEEE standard in 2010

the need for external bandwidth and external I/O connectivity, increasing power and space requirements, as well as administrative complexity.

Compelling TCO Benefits

The final and perhaps most important factor driving convergence is the compelling total cost ownership (TCO) benefit, from both a CAPEX and OPEX standpoint. Convergence reduces CAPEX by streamlining network infrastructure. This reduces the number of adapters, switch ports and cables needed to maintain a separate, dedicated fabric. The potential OPEX advantages are even more

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significant. The simplified infrastructure leads to ongoing reductions in power, space and cooling costs, as well as decreased management expenses.

The overall TCO savings can be substantial, running into the hundreds of thousands of dollars per year for a medium to large data center. And since converged, CEE-based networks can be phased into existing SANs, IT managers can minimize the transitional impact while largely protecting and preserving their investments in infrastructure and administrative skill sets.

Based on the interplay of these economic and technology forces, we believe the adoption of converged networks in medium to large enterprises will increase steadily over the next one to two years.

CNAs Play a Critical Role

Of all the infrastructure components that enable a converged CEE-based network, perhaps the most critical is the Converged Network Adapter, or CNA. The CNA resides at what has become the choke point on many networks: the external server I/O interface.

In traditional networks, storage and data network I/O flow through a multiplicity of HBAs and NICs. This common configuration is generally complex to maintain and administer, and provides limited ability to scale beyond hard-wired configuration limits. In addition, traditional server I/O interfaces often fail to dynamically allocate bandwidth to meet

peak I/O demands -- let alone to guarantee QoS.

In contrast, the CNA eliminates many of the issues that have plagued traditional server I/O. By combining 10Gb Enhanced Ethernet NIC functionality and Fibre Channel HBA functionality into a single adapter, CNAs greatly decrease the complexity of server I/O configurations. CNAs also reduce network management requirements, freeing up administrators for more productive activities.

With the advancements embodied in the DCB standards under development by the IEEE 802.1 DCB Task Group, administrators will be able to dynamically allocate bandwidth and guarantee QoS for particular applications.

The Universal Converged Network Adapter (UCNA) takes the CNA capabilities one step further, providing multiple options for combining storage and network traffic over a 10Gb Enhanced Ethernet infrastructure. As the second generation of CNAs, UCNAs offload both Fibre Channel and iSCSI protocol processing from the server CPU. This allows the server to provide increased performance for I/O-intensive applications, as well as to support more VMs in a virtualized server environment. As FCoE software initiators do not support server offloads, UCNAs offer higher performance per watt of energy, better compute performance and unified storage management for both CNAs and existing HBAs.

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In an end-to-end converged network, UCNAs (or CNAs) will handle all server I/O and will connect directly to FCoE-capable, 10Gb Ethernet switches. The switches provide the communications link between the server UCNA and DCB network. The DCB network in turn will support Fibre Channel devices, some of which will offer native FCoE interfaces. The DCB network will also support iSCSI devices and connect to legacy Ethernet networks.

In summary, UCNAs are the linchpin of a comprehensive, end-to-end, converged network deployment solution. UCNAs not only support Fibre Channel and iSCSI SANs, but also offload protocol processing, allowing the servers to do what they do best: provide high compute performance for production applications.

What It Takes to Be a Market Leader

A number of vendors are currently vying to be top suppliers of CNAs. There is a short list of factors that characterize the frontrunners.

- 1. Deep Fibre Channel experience.** Vendors must have considerable expertise in storage and networking technology along with the engineering resources to execute. Suppliers must also have a deep and positive relationship with the market. Fibre Channel customers must be convinced that network convergence is in their best interest, so intimate knowledge of their operational needs is a big advantage.
- 2. Unified architecture.** CNA/UCNA vendors should have a single architecture and unified hardware platform for their convergence solutions. A single card should provide support for every type of network, including 10Gb NIC, FCoE and iSCSI. This single platform should support superior 10GbE network performance.
- 3. Full product suite.** Suppliers must offer a full suite of protocol offloads as well as unified management of storage and networking environments. Offerings should support offloads for all major types of networks (TCP/IP stateless and TOE) and storage (FCoE, iSCSI, plus NAS protocols). The offering should also be optimized for virtualization technology. Ideally, all storage and networks should be managed from a single console.
- 4. Strong partnerships.** Leading vendors will develop strong ecosystems to enrich their baseline adapter offerings. No vendor can realistically provide every aspect of a convergence solution, so they will partner to deliver best-in-class components such as FCoE switches that have been tested for interoperability.
- 5. Flexibility.** Leading convergence suppliers must provide customers with a flexible menu of offerings, including modular packaging. End users are coming from a variety of starting points, including different mixes of existing storage and networking protocols, and will have differing needs. There will be

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no “one-size-fits-all” solution in this market.

Why Emulex as a UCNA Supplier?

Emulex is a major manufacturer of storage networking infrastructure solutions including Fibre Channel HBAs, storage I/O controllers and SAN storage switches. We believe that Emulex meets our criteria for network convergence-leading vendors, specifically their CNA/UCNA offerings.

Emulex has been in the storage networking market since 1979. They provide a wide range of technologies centered on efficiently connecting servers to storage systems and data networks. The company’s Fibre Channel technology is already in its 10th generation, allowing it to meet advanced data center requirements for reliability and interoperability.

Emulex has participated in the Fibre Channel market since its inception, and is a trusted supplier of Fibre Channel connectivity solutions to thousands of data centers around the world. The company’s products are sold by leading OEMs such as EMC, HDS, IBM and Network Appliance.

Emulex provides its OneConnect UCNA, a high-performance 10GbE platform that supports TCP/IP, FCoE and iSCSI. Emulex delivers all of these capabilities on a single-chip platform based on a single hardware architecture -- a distinction that sets Emulex apart from much of the rest of the CNA provider field. In addition, Emulex

delivers OneConnect in a variety of form factors to satisfy different types of deployments, including server LAN-on-Motherboard (LOM), mezzanine cards for blade servers and standalone adapters for rack servers.

Emulex provides a comprehensive set of protocol offloads including TCP stateless offloads, a TCP offload engine (TOE) for Windows Server 2003/2008, iSCSI offloads and FCoE, which offloads encapsulation of Fibre Channel frames and includes HBA functionality. The UCNA also features a hypervisor (e.g., ESX) offload for Tx/Rx processing, and N_Port ID Virtualization (NPIV) support for dynamic provisioning and granular, VM-specific QoS support in a Fibre Channel environment.

All of these protocols and capabilities can be managed from Emulex’s OneCommand Manager, which centralizes discovery and management of Emulex adapters in a single console. The console provides a uniform interface and feature set across major Windows, Linux and server virtualization environments.

Emulex has built an impressive set of partnerships covering all enterprise-level features and components required for an end-to-end convergence solution. Current partners include companies such as BLADE Network Technologies, Brocade, Cisco, Dell, EMC, HP, IBM and VMware.

Emulex also provides modular packaging and “pay-as-you-go” pricing for its CNA and UCNA capabilities. For example, Emulex sells a CNA card as a base 10GbE NIC for a

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competitive MSRP, and allows customers to add functionality such as iSCSI and FCoE over time for an incremental fee. This approach sets Emulex apart from competing vendors whose integrated feature sets are an all-or-nothing deal.

Let's now take a look at several customers' real-world experience with Emulex's network convergence products.

OneConnect in the Real World

We spoke with IT representatives at two major server and storage vendors and at a busy hospital to see how they were using Emulex OneConnect adapters in their data centers.

Server and Storage Vendor: Customer Service Offerings

This major server and storage vendor has deployed FCoE and DCB in their internal testing centers with an eye to extending the protocols into their customer service offerings. These offerings will be targeted to large enterprise data center customers who want a better ROI for their storage and data networking dollars.

This is not a trivial task. These customer environments are characterized by football field-sized installations with all of their attendant complexity and cost. By replacing discrete networking equipment with highly efficient CNAs, switches and cables, the vendor can significantly lower operational costs.

For example, energy costs represent a huge area of savings in these large installations. The vendor's initial cost-saving focus is at the data center edge, where customers can achieve healthy cost and power savings by having far fewer adapters and wires. A single server deployment replaces 10 to 15 copper wires with just one to two fiber cables. Multiply that by hundreds to thousands of servers, and the customer has realized tremendous ongoing savings.

The vendor prefers to standardize on just one or two Fibre Channel adapter vendors, and already uses Emulex HBAs and NICs in its internal environment and in customer offerings. They are now testing Emulex Universal CNAs for inclusion in its new FCoE service offerings.

Emulex provides everything that their customers need, including top-flight customer support and customized drivers. This has been true even in the vendor's beta code testing of Emulex's CNA and UCNA cards. They report that Emulex is a strategic partner in their expansion of network convergence offerings.

Server and Storage Vendor: Consulting to End User

This second major server and storage vendor serves as the data center consultant to a large military retail customer.

The customer has a robust storage infrastructure with a strong emphasis on data warehousing. The data center's client/server architecture houses nearly 5 petabytes of data on EMC Symmetrix and

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CLARiiON storage systems. Networked retail terminals across the world capture Point of Purchase (POP) transactions and load the data into their local back-end servers. From there, the servers replicate data to the main data center, which in turn replicates to a remote disaster recovery site.

This large customer was intrigued with the capability of converging IP and Fibre Channel, as they have large investments in both networks. Specific business needs included Payment Card Infrastructure (PCI) qualification and certification. The customer wanted to use Fibre Channel and 10GbE technology as a converged solution to help them meet security and performance requirements.

Energy savings was another driver. The customer and its board of directors are heavily committed to the green data center. (The storage and server vendor's energy-efficient focus is one of the reasons that the customer works so closely with them.) CNAs directly translate into space and energy savings.

They chose the Cisco Nexus 5010 switch with Emulex OneConnect CNAs. The test bed deployment was highly successful and the customer is rolling out to more segments of the data center. The deployment was deliberately non-proprietary so the customer is not locked in to a single networking vendor.

Hospital: 10GbE Connectivity

The hospital is located in the middle of a large recreational area. It may be compact

in terms of beds, but is the central hospital for large numbers of patients coming from surrounding recreational areas. Since recreation is year-round in this heavily toured area, they are busy year-round.

In order to serve this influx of patients and the resulting heavy patient record load, the hospital's IT department depends on a highly virtualized server environment. Their virtualized environment has nine ESX hosts and 11 physical machines that replaced 60 physical servers. They use 1GbE to the wiring closets, and 10GbE for the core virtualization network and to support an upcoming Citrix XenDesktop environment.

A Cisco Nexus 5000 switch and Emulex CNAs manage data between the 10GbE core and 1GbE closet connections. The original 1GbE virtualization network environment required a dozen or more cables per physical machine for multiple redundancies over copper, as well as network connections. This environment was highly complex and expensive and cooling was a major challenge.

Emulex CNAs support FCoE and allow the hospital to dispense with hot and expensive copper cables. Now each physical host just has two cables that each transport Fibre Channel and Ethernet without impacting performance. The second cable is purely redundant for high availability.

The hospital looked at other cards, but realized that other vendors only offered one protocol type per card. Emulex CNAs combine FCoE, Ethernet, and iSCSI support on a single platform. This translated to big

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savings for the hospital on operational costs by using far fewer connections and energy. It was also much simpler for them to change configurations as needed.

They were also impressed with Emulex customer support, which extended not only to their own products but also to the health of the networking environment. They pointed out that what matters over time is not the initial price of the product, but ongoing customer service. Emulex more than fits the bill at this busy hospital.

elusive reality of network convergence is finally drawing near. The triple forces of compelling economics, robust user demand and maturing technology are now coming together to drive the growth of this significant new market. Current customers of convergence solutions are already realizing considerable value, including streamlined management and reduced costs.

As new suppliers enter the market and the solution set expands to enable true end-to-end convergence, prices will progressively come down as well.

Key Takeaways

- (1) Network Convergence promises to offer users compelling benefits, including streamlined infrastructure, simplified management, and reduced costs (both CAPEX and OPEX).
- (2) After many years of hype and some false starts, network convergence is finally becoming a reality.
- (3) Converged Network Adapter (CNA) solutions are a key enabler and driver of this market.
- (4) To be a leader in network convergence, CNA suppliers must have deep Fibre Channel experience, and offer a full suite of protocol offloads and management solutions based on a unified architecture.
- (5) Only a few vendors have what it takes to become a market leader. Emulex, with its strong partnerships and rich storage and networking technology and expertise, is one of those players.

Initial FCoE deployment is best done at the edge, specifically with access-layer server I/O consolidation. FCoE will come fully into its own as lossless 10GbE is fully ratified and becomes available later in 2010. These enhanced Ethernet capabilities, which include Link Layer multipathing and multihop, will clear the way for larger FCoE networks. At this point, data center administrators can start introducing FCoE

into the data center core. This is where they will see major operation savings from infrastructure consolidation and simplified management.

At the focal point of the converged network infrastructure – and arguably, at the focal

Taneja Group Opinion

Network convergence has been an attractive but largely unrealized concept. That is now changing as it starts to deliver real value in the marketplace. We are confident that the

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point of the convergence movement – are CNA suppliers. The CNA is where critical server I/O functionality will reside, and where network I/O performance and QoS will be driven.

Though a number of vendors will offer CNAs, only a handful possesses the characteristics that will allow them to emerge as leaders in this market. We believe Emulex, with its stable of storage network technology and expertise, key

technology partnerships and many years of experience in the Fibre Channel market, is well positioned to become a leader in the network convergence market.

We look forward to seeing Emulex's continued innovations in this market, as they enable users to finally gain the upper hand in managing server I/O challenges and overcoming network complexity.

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