

## A Brand New Day for Data Center Storage

The Sun Rises on Converged Network Adapters

Steven Hill

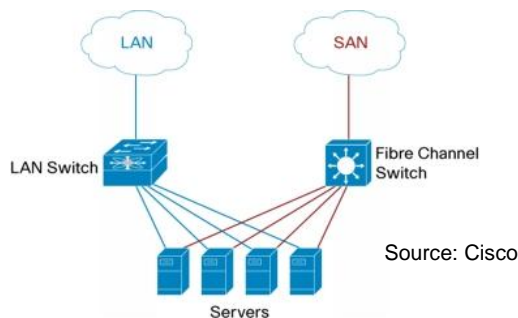
January, 2010

### Blowing The Doors Open

For the first time in over a decade, there will finally be a real option for enterprises to challenge the dominance of Fibre Channel-based storage networks. The July 2009 introduction of the Fibre Channel Backbone-5 (FC-BB-5) specification for Fibre Channel over Ethernet (FCoE) by ANSI's T-11 group has blown the doors open for converged networking based on 10Gb Ethernet – and now is the time to start adjusting your plans for your data center network of the future.

Current best practice for companies that use Fibre Channel Storage Area Networks (SANs) for consolidated storage requires two different redundant fabrics, Gigabit Ethernet for Layer-2 network traffic plus a separate 4 or 8Gb Fibre Channel network for storage connectivity. Adding that second fabric for Fibre Channel alone means that you also add the substantial cost of two really expensive Fibre Channel ports per server, as well as all the redundant switches, routers and management costs associated with a second, storage-only network. This duplication was necessary when Fibre Channel was the only game in town for the performance and reliability needed for SAN storage, but at 10Gb speeds, Ethernet now presents a serious consolidation option for companies looking at the costs of upgrading both their Ethernet and Fibre Channel networks.

**Diagram 1 – Current Best Practice: Dual Redundant Fabrics**



**FCoE offers the promise of consolidating LAN and SAN traffic onto a single network**

The adoption of the FC-BB-5 standard effectively eliminates some of the long-term issues storage users have had with Ethernet as a storage fabric, the key being to define a “lossless” Ethernet environment for storage traffic. Not that Ethernet is inherently problematic; rather, it was designed with the ability to deal with packet loss because of the extended nature of Ethernet networks. To facilitate storage traffic (which really hates out of order packets), BB-5 has specified that FCoE traffic will utilize Convergence Enhanced Ethernet (CEE)—also known as Data Center Ethernet or Data Center Bridging—that includes major quality of service (QoS) extensions, such as Congestion Notification, Enhanced Transmission Selection and Priority-based Flow Control, to facilitate high-performance FCoE traffic.

## Full Converged Network Adapters

Aside from the additions to 10GbE's QoS extensions, adding a whole new storage fabric involves fitting Fibre Channel's command and data packets into Ethernet frames, a nifty trick done through the use of 2.5k "baby" jumbo frames to carry the 2,158 bytes – 14 bytes (FCoE Header), 24+2112+4 bytes (Fibre Channel Header + Payload + CRC) and 4 bytes (FCoE End of File) needed to carry FCoE. This allows a Converged Network Adapter (CNA) to completely encapsulate FCoE into seamless Ethernet frames on a 1:1 basis. But, of course, this means that all parts of a 10GbE converged network must accept jumbo frames; this is not a major problem because even most existing Gigabit networks offer support for jumbos. This also means that a network adapter must now be responsible for converting the Fibre Channel stack into Ethernet frames on the fly and then converting them back to present a Fibre Channel stack to the device or Operating System on the other end.

**Diagram 2 – Fire Channel over Ethernet**



**FCoE allows transmission of Fibre Channel traffic over an Ethernet fabric by encapsulating native Fibre Channel frames into Ethernet packets**

FCoE conversion can be done by a Fibre Channel/Ethernet switch with Fibre Channel Forwarder (FCF) capabilities that can be used to connect to Fibre Channel storage systems directly to a 10GbE network, but the majority of heavy lifting for these new Ethernet demands on the client side will actually fall to the latest generation of Ethernet adapters, the CNA. The reason that convergence is so intriguing is that a CNA not only offers the new FCoE capabilities, but also target iSCSI and IP acceleration as well, with the goal being to migrate all connectivity to a single physical infrastructure. The universal adoption of an open, standards-based Ethernet strategy will serve the IT industry well by streamlining data center networks, thereby reducing overall port and related management costs.

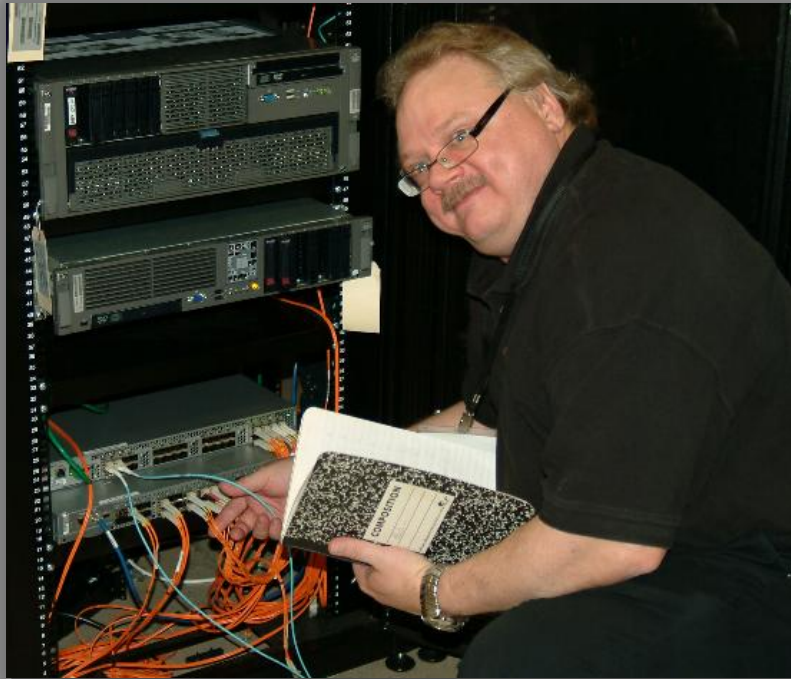
As 2010 begins, there are only three companies that offer 10GbE products that qualify as full-service CNAs: Brocade, Emulex and QLogic. Intel's X520 platform mentions FCoE capabilities, but there is currently no software or drivers that support this functionality. The challenge for us was to find an accurate way to compare these products relative to the rest of the market, because CNAs offer all the capabilities of existing 10Gb network interface cards (NICs) with the addition of FCoE capabilities. With this in mind, we've chosen to offer a drill-down comparison test of 10Gb adapters, starting with storage performance tests of FCoE, followed by iSCSI storage acceleration and concluding with TCP/IP network tests.

## Test Methodology

For this test series we traveled to the Emulex test lab at their corporate headquarters in Costa Mesa, California, to do some hands-on testing of the three key CNA products, along with some additional products for the comparison of iSCSI and 10GbE TCP/IP performance. To ensure objectivity, we directly coordinated these tests in advance with the test group at Emulex and went to their location to verify their test beds for all three protocols. We also ran additional, random tests on all three configurations to audit the accuracy of their results and establish repeatable baseline performance.

We are pleased to confirm that, not only was the testing methodology sound and impartial, but our support team at Emulex had gone to great lengths to ensure that all products under test were portrayed as fairly as possible. Substantial pre-test evaluations were done with each card to determine the highest possible performance capabilities, and only the best repeatable statistics for each device will be used for this comparison. We also ensured that the products tested were using the most current firmware, set to factory defaults and were in no way tuned or optimized to ensure that the results in this report were not skewed for any product.

**Picture 1 – Tester and Contributing Analyst Steven Hill**



Steven Hill has been testing adapters and switches for Network Computing Magazine since 2003.

## FCoE Comparisons – “Full” CNA Products

By definition, to be considered a CNA, a product must offer FCoE capabilities, so we'll begin with our findings of the three full-featured products that currently fit that description. You'll notice that all three of these companies have roots that run deep in the world of Fibre Channel, which may be part of the reason why they're the first out of the blocks with a viable CNA solution. The challenge for a CNA is to handle the Fibre Channel/FCoE conversion, so that means substantial horsepower must be applied at card-level to offload all FCoE operations.

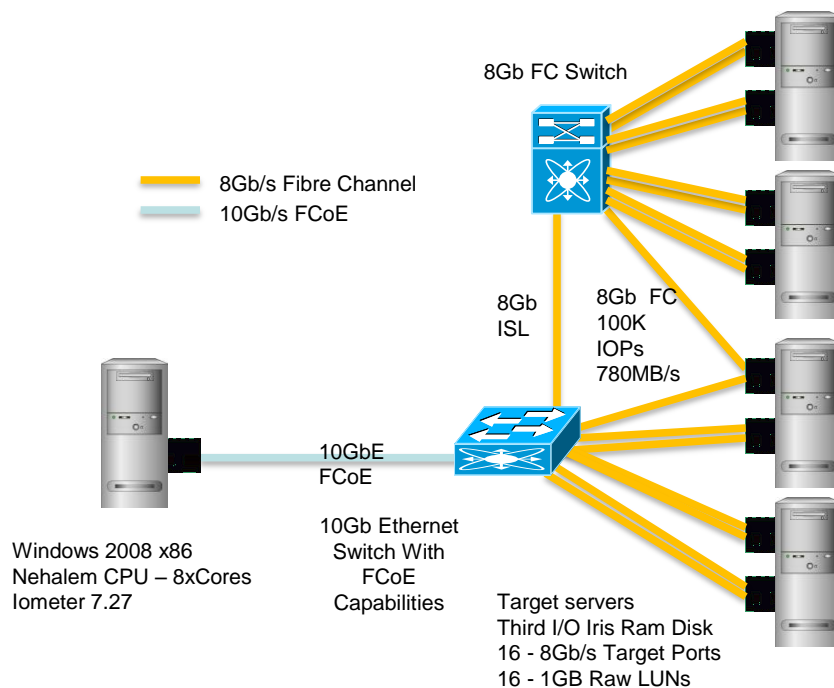
**Table 1 – 10GbE CNA Products Tested**

Brocade	Emulex	QLogic
<b>Full CNA</b> CEE, TCP/IP, iSCSI, FCoE	<b>Full CNA</b> CEE, TCP/IP, iSCSI, FCoE	<b>Full CNA</b> CEE, TCP/IP, iSCSI, FCoE

A “full CNA” includes released support for Converged Enhanced Ethernet as well as TCP/IP, iSCSI and FCoE protocols.

To test FCoE performance we used four target servers connected to several Third I/O Iris Ram Disk arrays to fill 16x 8Gb Fibre Channel ports presenting 16x 1GB raw logic unit numbers (LUNs). The Iometer disk performance application was run in local mode on the test server to generate performance statistics.




**Diagram 3 – FCoE Test Bench for Iometer**



## FCoE Players

The environment required to test full CNA performance and multi-protocol support included a 10Gb CEE (Converged Enhanced Ethernet) switch with support for FCoE; an 8Gb Fibre Channel switch; 10Gb CNAs from Emulex, QLogic and Brocade; and solid state disks from Third I/O Inc.

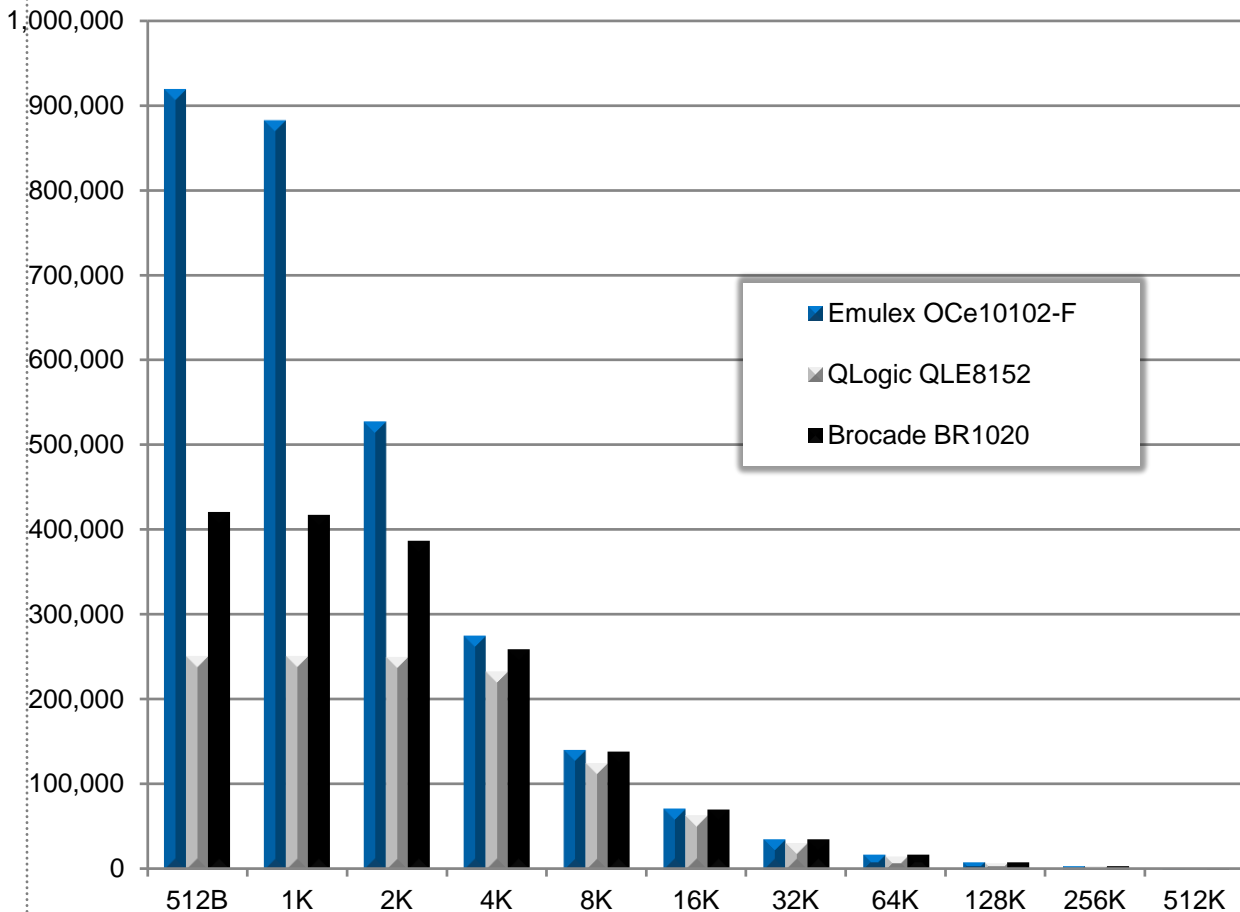
**Table 2 – CNA Test Environment**

Product	Description
<p><b>Brocade 1020</b></p> 	<p>The 1000-series is Brocade's first-iteration, PCI-E x8 Gen2 CNA, and is available in either single- or dual-port configurations. The low-profile card is based on a single, Brocade-branded ASIC with full-FCoE offload and offers SFP+ connectivity for optical modules. The 1000-Series CNAs from Brocade mark their first foray into network adapter manufacture, as well as one of their early entries into the 10GbE market.</p>
<p><b>Emulex OCe10102-F</b></p> 	<p>Founded in 1979, Emulex is one of the long-beards of the adapter industry and their 10000-series of OneConnect™ Universal Converged Network Adapters (UCNAs) is based on a single-ASIC, low profile PCI-E 8x Gen2 card. Available with dual 10GbE ports, the 101002-F can connect to either SFP+ twin-ax copper or 10GBASE-SR optical cabling.</p>
<p><b>QLogic QLE8152</b></p> 	<p>Spun off from Emulex in 1994, QLogic has been going toe-to-toe with their parent company in the Fibre Channel market ever since. The 8100-series CNA is a low-profile card that currently supports PCI-E 8x Gen1 or 4x Gen2 and is offered with options for single and dual ports with SFP+ connections to either fiber or copper cabling. Of the three cards in the CNA test series, this is the only card that doesn't support 8x Gen2, which means it can provide only half the PCI-E 8x performance of the others.</p>

**FCoE Performance**

It will always be a challenge for test labs to come up with performance statistics that have relevance to the actual capabilities of products in production and the same is true here. The best we can hope for is to highlight performance differences under extremes and look for trends that could carry over to the real world. This is what we found for our CNA tests.

**Chart 1 – FCoE IOPS Performance**



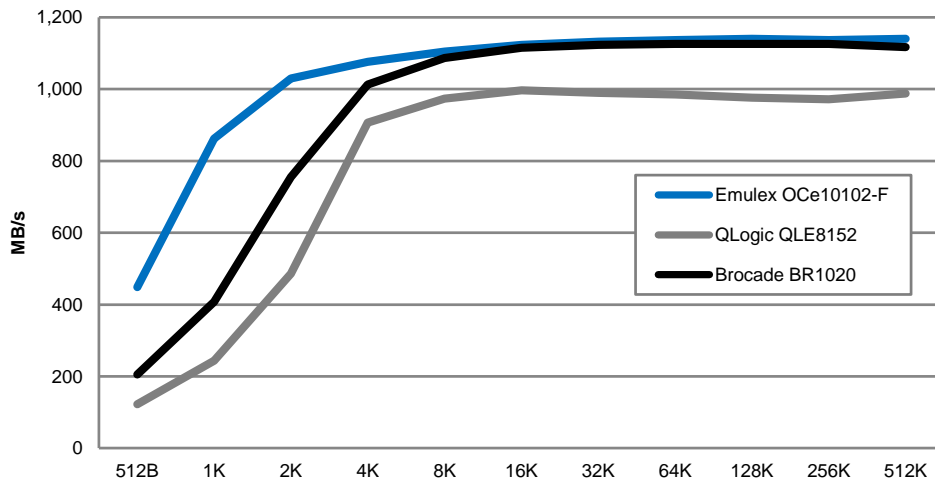
One of the standout statistics in our CNA performance test series was the 919,268 IOPS (Input/Output Cycles Per Second) generated by Emulex’s OCe10102-F card during our FCoE IOPS run. As a rule we usually include IOPS as one of the key indicators of overall device performance, even though it’s not always directly tied to real-world performance expectations. Every application places different demands on a storage subsystem - with reads and writes of different sizes - but we usually find that IOPS performance is a pretty good indicator of overall performance.

About 3 years ago you could expect to get around 150K small-transfer IOPS with a typical 4GB Fibre Channel HBA, but it’s really impressive when you start showing numbers approaching a million IOPS on a FCoE adapter that had a lot more work to accomplish than a native FC HBA. If you look at the attached performance chart you’ll notice that the separation begins to appear at the 4K transfer size and at 512bytes the Emulex card’s performance is more than double that of its nearest competitor.

### FCoE Read Throughput Performance

We anticipated that most of the cards we tested would ramp up to line rate fairly quickly for reads and as you can see all three reached that at around the 16K transfer size. The cards from Emulex and Brocade maxed out at just over 1,100 MB/s, but we were surprised to see that the QLogic card was barely able to reach the 1,000 mark. The edge here goes to Emulex's consistently higher performance across the entire range of block sizes.

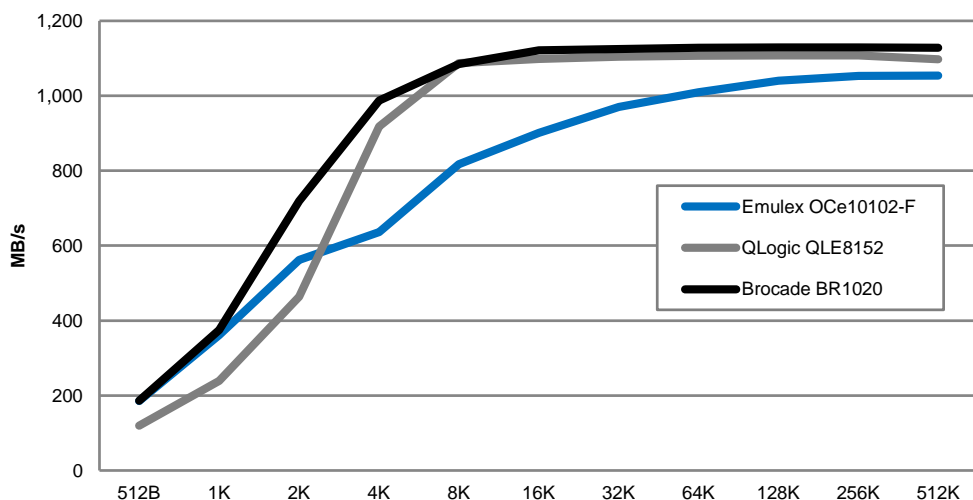
**Chart 2 – FCoE Read Throughput Performance**



### FCoE Write Throughput Performance

Writes to conventional storage systems are always slower than reads, but in this case our RAM disks mitigated that particular difference. In writes, the offering from Brocade performed well throughout, with top write performance that ran about 6% lower than the others. This test clearly shows the massive potential of FCoE write capabilities, but it certainly merits further testing on conventional SAN technology to confirm real-world performance capabilities.

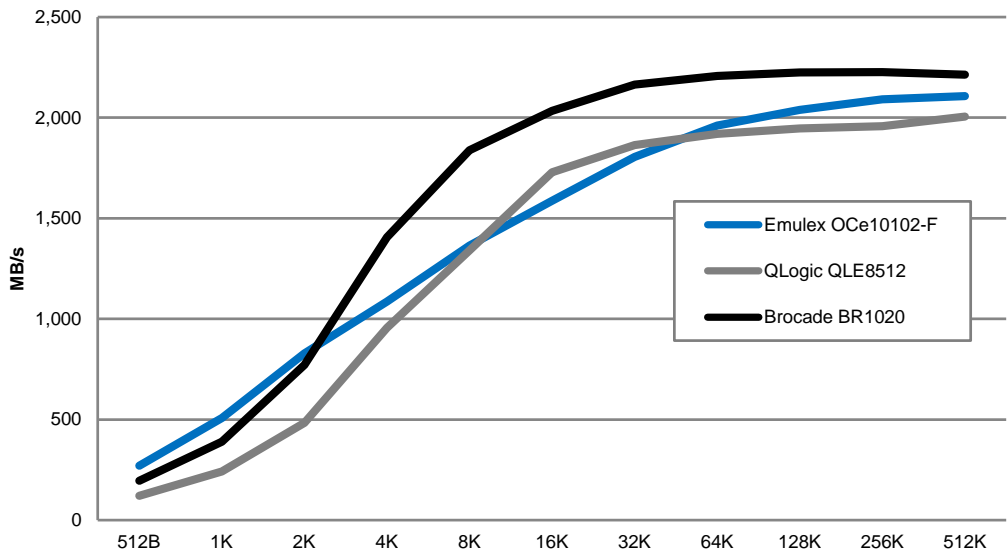
**Chart 3 – FCoE Write Throughput Performance**



## FCoE Mixed Read/Write Performance

The workload for most servers requires both reads and writes, and this chart shows that all three products performed well, with Emulex slightly on top during smaller transfers and Brocade slightly on top on larger ones. This would probably be a wash in most production environments, but one might be able to see a minor performance difference under certain specialized applications.

**Chart 4 – FCoE Throughput: Mixed Reads/Writes**



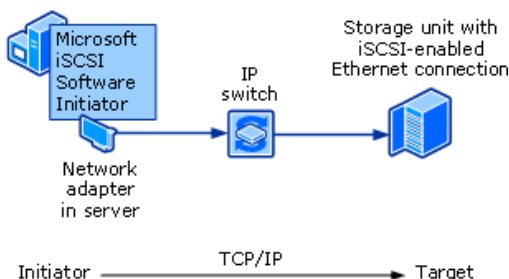
## FCoE Performance Conclusions

Though we found that there were substantial similarities in the transfer-rate performance in all three CNAs, we felt that the amazing IOPS capabilities of the Emulex OCe10102-F gave it an FCoE edge over the other products in our review. This was accomplished somewhat at the cost of higher CPU utilization, but it was clearly a turbo-boost for small block sizes that wasn't available from our other vendors.

## Comparison of CNAs and 10GbE NICs Running iSCSI

All Ethernet-based devices already have native support for the iSCSI protocol through the use of software such as Microsoft's iSCSI Initiator, which means that all CNAs are iSCSI-ready. Basic iSCSI access is one thing, but if you have server-based applications running on iSCSI storage moving at 10Gb speeds, it makes more sense than ever to look for an adapter capable of hardware-level iSCSI acceleration.

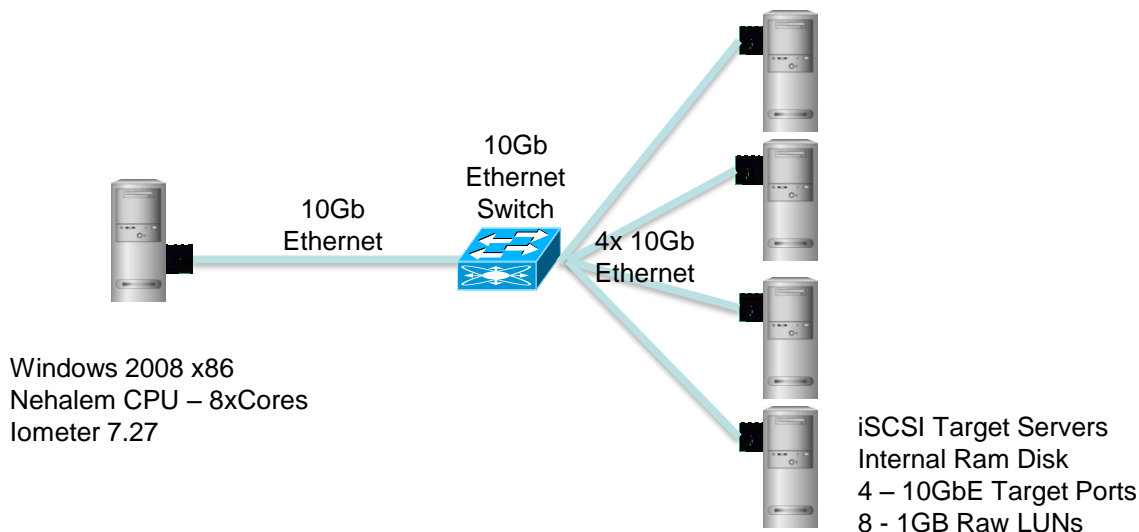
**Diagram 4 – Microsoft iSCSI Initiator** (source: Microsoft.com)



**An advantage of using a network adapter in the server is that network adapters are a standard component in all computers, and the Microsoft iSCSI Software Initiator is a free download.**

To deliver 400k+ IOPS of performance that a full-speed 10GbE iSCSI port could potentially require, we needed to find an iSCSI target that would not restrict that capability. Since nothing on the market currently exists that could provide that level of performance, we utilized an iSCSI target using a RAM-based initiator running on multiple servers. This emulated the behavior of a top-performing iSCSI disk array by providing storage LUNs that utilize system RAM memory for disk space while operating externally using the industry-standard iSCSI protocol. For performance ratings, we used lometer running locally on the initiator system.





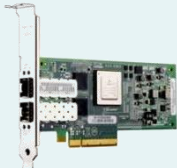
**Diagram 5 – iSCSI Test Bench for lometer**



## iSCSI Players

The environment required to test iSCSI performance and multi-protocol support included a 10Gb Ethernet switch; and 10Gb CNAs from Emulex, QLogic and Brocade.

**Table 3 – iSCSI Products**

Product	Description
<p><b>Chelsio N310</b></p> 	<p>The N310E is the single-port, low profile 10GbE NIC based on the Terminator 3 ASIC. Also available in a dual-port configuration, this PCI-E 8x card is available with either SFP+ or 10GBASE-CX connectivity. It is primarily marketed as a 10GbE server adapter with iSCSI acceleration capabilities.</p>
<p><b>Brocade 1020</b></p> 	<p>Currently offers only software-level iSCSI running over the NIC device in addition to its FCoE capabilities.</p>
<p><b>Emulex OCe10102-I</b></p> 	<p>Identical from a hardware perspective to the OCe10102-F, OCe10102-I is the iSCSI acceleration-enabled version of the 10000-series. Based on their current modular strategy, you have the option to purchase the card optimized for either FCoE or iSCSI acceleration, but not both at the same time. This doesn't mean that the FCoE version can't do iSCSI using a software initiator; it just means that both protocols will not be accelerated concurrently.</p>
<p><b>Intel X520</b></p> 	<p>The X520 is Intel's flagship 10Gb CEE (FCoE ready) adapter and is a low-profile, single-ASIC, PCI 8x Gen2 card. This adapter is also available in single- and dual-port SFP+ configurations, supporting either fiber or copper connectivity and iSCSI acceleration.</p>
<p><b>QLogic QLE8152</b></p> 	<p>Currently offers only software-level iSCSI support running over the NIC device in addition to its FCoE capabilities.</p>

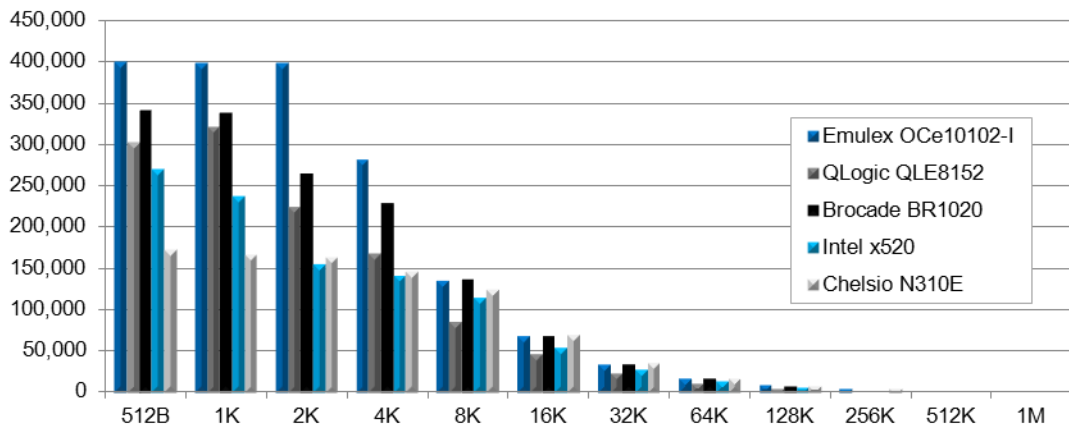
## iSCSI Performance

Testing iSCSI storage is no different than any other system, so we've provided the same performance points as those of our FCoE tests. Here's what we found.

## iSCSI IOPS Performance

The IOPS capabilities of the Emulex card exceed those of the others by a substantial margin in small transfers, but not by the same huge differential as observed in our FCoE tests. At about 8K block sizes and above the IOPS performance specs were very close to those found in our FCoE tests.

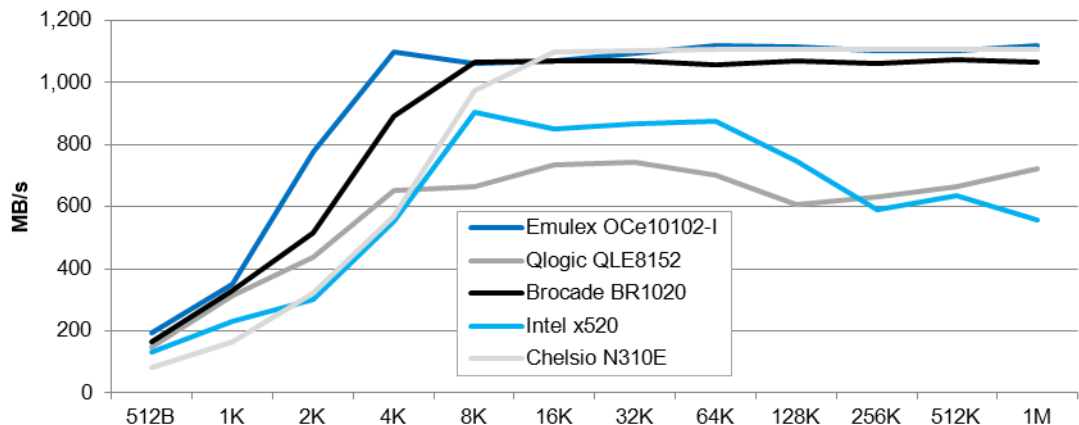
**Chart 5 – iSCSI IOPS Performance**



## iSCSI Read Throughput Performance

This is where the differential starts to show up between products, with Emulex leading the way from the start. Interestingly, both the cards from Intel and QLogic were unable to perform at line rate, more than likely due to the limitations they may have with the software-based iSCSI Initiator and their lack of iSCSI acceleration capabilities.

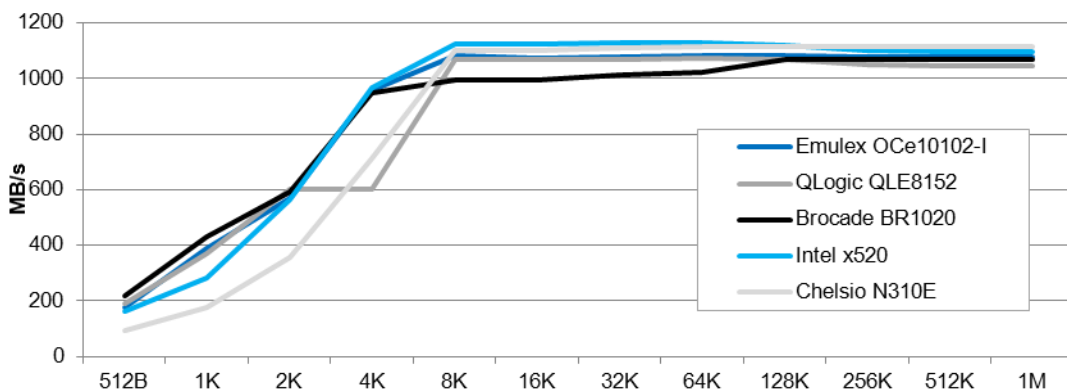
**Chart 6 – iSCSI Read Throughput Performance**



### iSCSI Write Throughput Performance

The difference is much less noticeable on the write side, where all the products performed very well. Notice that all were able to reach full like rate at about the 8K block size.

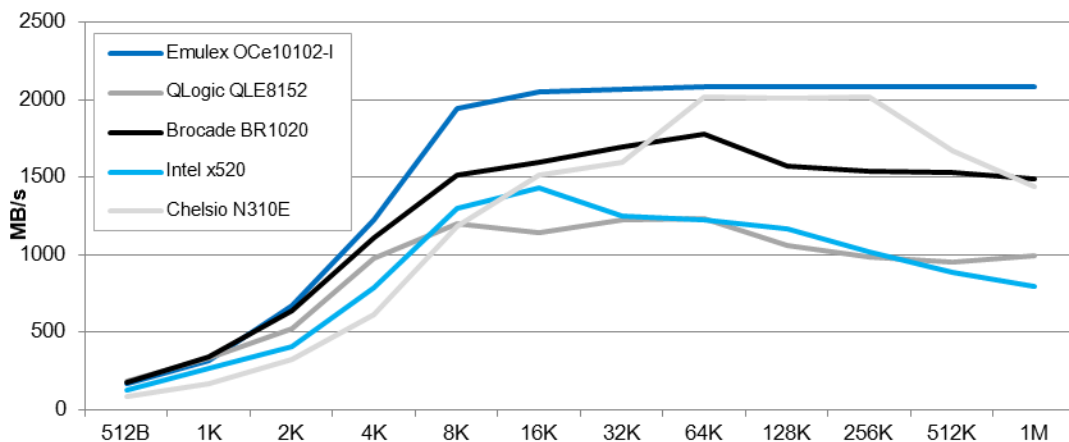
**Chart 7 – iSCSI Write Throughput Performance**



### iSCSI Mixed Read/Write Throughput Performance

This is where the differential starts to show up between products, with Emulex leading the way from the start. Interestingly, both the cards from Intel and QLogic were unable to perform at line rate, more than likely due to the limitations they may have with the software-based iSCSI Initiator and their lack of iSCSI acceleration capabilities.

**Chart 8 – iSCSI Mixed Read/Write Throughput Performance**



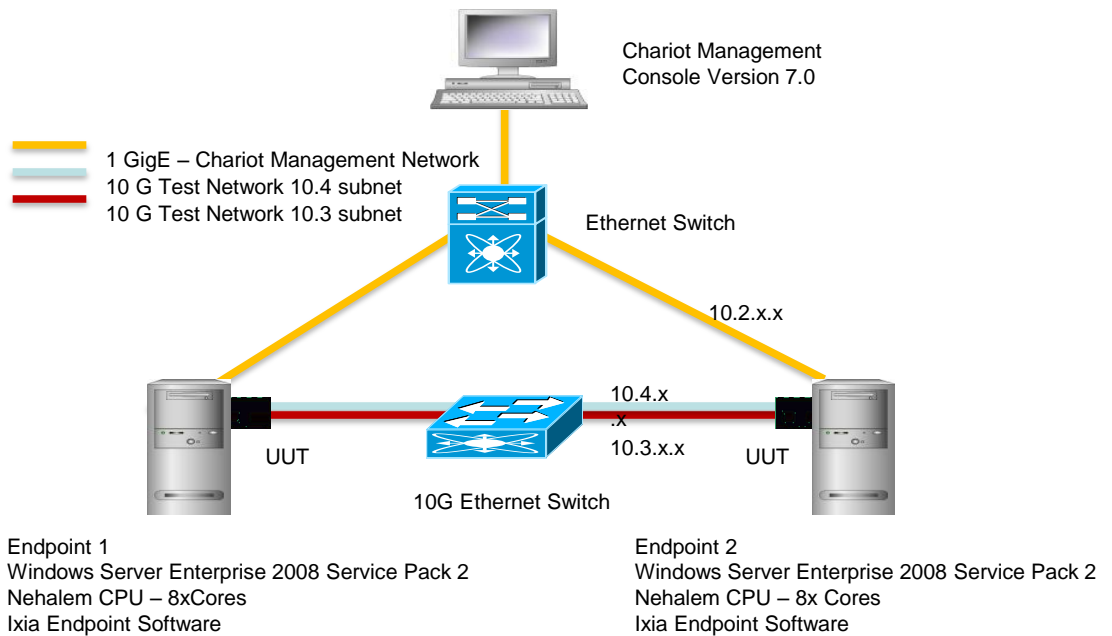
### iSCSI Performance Conclusions

Again Emulex led the field in the iSCSI tests, where only Emulex and Chelsio offer any hardware-based iSCSI acceleration capabilities. Brocade’s card did surprisingly well considering that it was using the same iSCSI initiator as everyone else, yet both Intel and QLogic showed some performance limitations due to their software-only iSCSI approach.

### Comparison of CNAs and 10GbE NICs Running TCP/IP

Above all, a CNA must fulfill the role of primary network adapter. To streamline the IP stack, all adapters provide certain degrees of stateless offload capabilities that reduce the amount of CPU resources to process network traffic. To test TCP/IP performance, we utilized matching eight-core Nehalem servers running Ixia IxChariot connected using dedicated 10GbE links. A separate Gigabit Ethernet link was used to conduct out-of-band monitoring to eliminate any possible bandwidth contention.






**Diagram 6 –IxChariot TCP/IP Test Bench**



## 10GbE NIC Players

The environment required to test 10GbE NICs included a 10Gb Ethernet switch and 10Gb CNAs from Emulex, QLogic and Brocade.

**Table 4 – 10GbE NIC Products**

Product	Description
<p><b>Chelsio N310</b></p> 	<p>Due to unresolved technical difficulties, we are unable to provide stable NIC results for the N310E in time for this report.</p>
<p><b>Brocade 1020</b></p> 	<p>Aside from its FCoE capabilities, this device also offers stateless offload capabilities.</p>
<p><b>Emulex OCe10102-F</b></p> 	<p>The “N” version of the OCe10102 is a base configuration supporting full TOE (TCP Offload Engine) and Windows Chimney support, as well as stateless offload capabilities.</p>
<p><b>Intel X520</b></p> 	<p>Aside from its FCoE capabilities, this device also offers stateless offload capabilities.</p>
<p><b>QLogic QLE8152</b></p> 	<p>Aside from its FCoE capabilities, this device also offers stateless offload capabilities.</p>

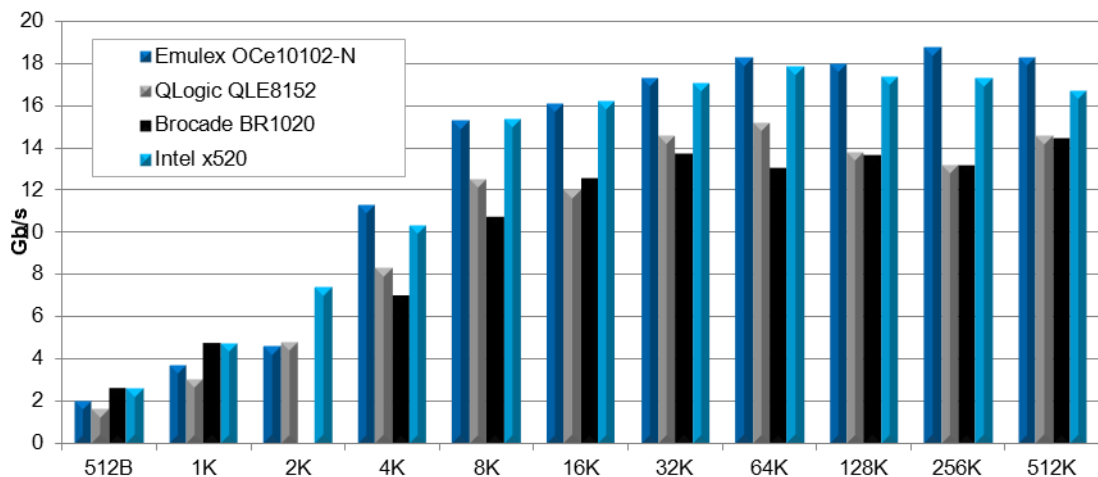
## NIC TCP/IP Performance

Generalized network testing is a somewhat different process than storage and our Ixia IxChariot tests were designed to barrage a matching pair of test cards on separate servers with a mix of all types of TCP/IP traffic. One card was set to send, the other to receive and for bi-directional testing the IxChariot console initiates from both endpoints allowing Tx and Rx to happen simultaneously. IxChariot then tracks the quantity of timing records received from those endpoints and reports the performance status back to the management console when the session is complete.

## Combined TCP/IP Throughput

The IOPS capabilities of the Emulex card exceed those of the others in small transfers, but not by the same huge differential as observed in our FCoE tests. At about 8K block sizes and above the IOPS performance specs were very close to those found in our FCoE tests.

**Chart 9 – Combined TCP/IP Throughput**



## TCP/IP Performance Conclusions

Again, Emulex shows better performance than the others in this review, a feat that most likely can be attributed to the Emulex’s TCP Offload Engine (TOE) and Windows Chimney capabilities as a 10GbE NIC. For companies looking to converge their existing storage networks the storage capabilities may be of greater interest, but generalized network performance should always be considered with equal weight because the CNA will become a server’s only link to the rest of your network.

## Overall Impressions of Non-performance Observations

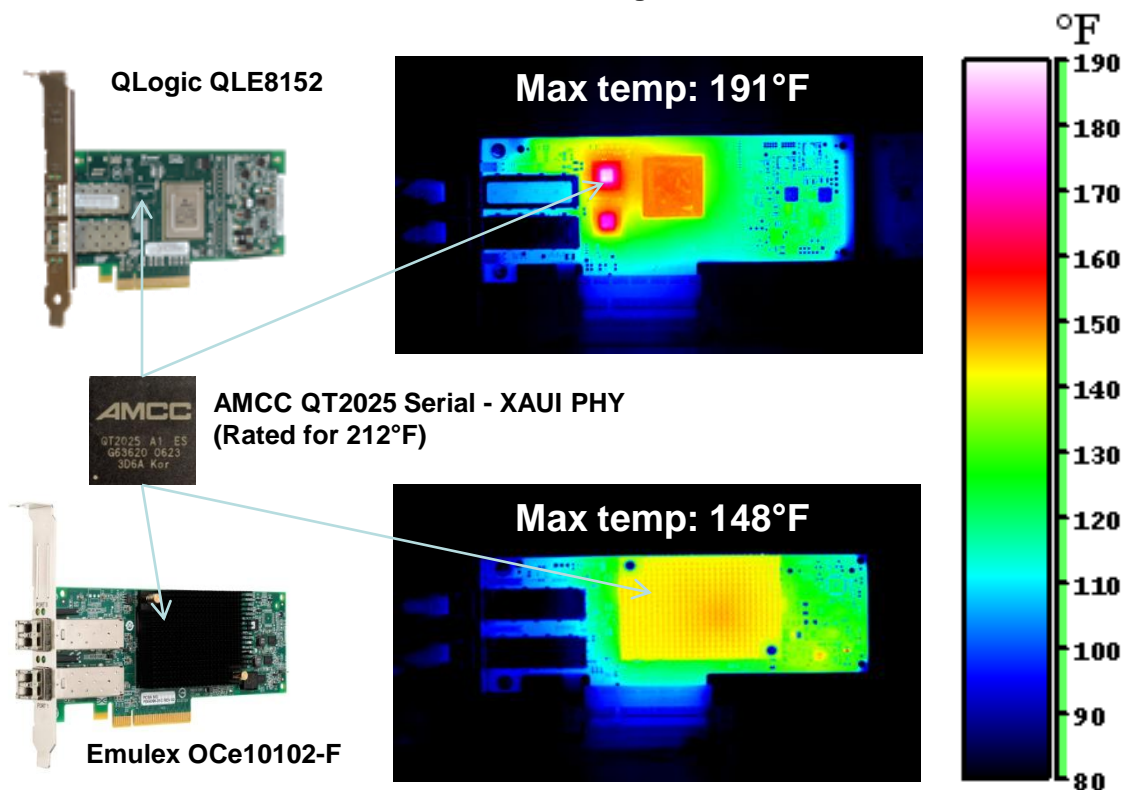
**User and Management Considerations** - Although we do this all the time, we still try to explore the same out-of-box experience as the typical user. There's a substantial variance in the level of networking expertise to be found in most IT shops and not every company wants or needs to dig deeply into the minutiae of performance tweaking that can be done to their networks. Simplicity is good, and reducing management costs is a top priority, so we test devices using factory defaults for this reason; aside from the expected addressing and protocol setup, installing these cards shouldn't be an exercise in failure and frustration. Chelsio and Brocade only offered the basics when it came to driver installation and configuration and expected users to drop to the Windows Control Panel or Device Manager for basic options, while Intel provided the standard PROset Utility included with all their NICs. QLogic provided a slightly updated version of the SANsurfer management tool used for their other Fibre Channel and iSCSI Host Bus Adapters (HBAs), which now supports the additional configuration options for FCoE and provides reporting, as well as an agent, to support discovery and management by third-party SAN applications. But of all that we tested, Emulex offered by far the richest and cleanest, single pane of glass management environment. The Emulex OneCommand™ Manager utility provides automated discovery, configuration, reporting and agentless performance analysis of any Emulex device in the network and a level of functionality usually reserved for expensive, third-party SAN management tools. A major feature of Emulex's management tool is the way it clearly associates the logical FCoE, iSCSI or NIC ports to its actual physical port in order to eliminate configuration errors. Even more interesting is that - unlike the other management tools - only OneCommand Manager offers a GUI-based NIC teaming tool that supports *other* NIC brands as well as their own.

**Investment Protection** - Many companies are already looking at upgrading to 10GbE to improve bandwidth and reduce port counts to their servers, so this is the ideal time to consider the benefits and cost savings offered by converged networking. Though any CNA can be used in NIC mode until you choose to implement FCoE, you would still be expected to pay full CNA pricing. On the other hand, opting to purchase less expensive 10GbE NICs alone would require rip and replace if you decided on FCoE at a later date. Emulex has chosen to adopt a cost-effective modular approach to their CNAs, which lets users purchase only the protocols they currently need on their "universal" 10GbE hardware platform. This means they have separate SKUs and prices for FCoE, iSCSI and NIC functionality, so companies can purchase a OneConnect UCNA with NIC-only capabilities and then additional features can be purchased as needed and instantly unlocked using a code-key. This is not a new concept—storage companies and software vendors already offer full-featured, pay-as-you-grow solutions—but this may be one of the first implementations of this idea at component level.

**Overall Impressions of Non-performance Observations**

**Power and Cooling** – All of the cards that we reviewed require between 7.5 and 10.5 watts of system power depending on port configuration and workload. From a design standpoint, all of the cards—with the exception of QLogic—utilized passive heat sinks to dissipate the point source heat generated by their single ASIC. In all electronics, cooling is life, and in the data center, heat is cost, so every little bit helps when it comes to temperature management. We had the opportunity to examine thermal images of the different cards we tested under load and it was amazing to see that the QLogic QLE8152 was showing maximum operational temperatures of 191°F, almost 50°F hotter than the Emulex card under the same conditions. This runs dangerously close to the maximum operational limits for some of the components on these cards, and that heat actually radiates through the card in quantities that could potentially affect adjacent components on either side. This would likely be a cumulative effect in a multi-NIC environment (as used in most data centers), so we can only hope that this situation will be addressed in later iterations of QLogic's 10GbE NICs and CNAs.

**Picture 2 – Thermal Images of CNAs**



## Recommendations

**Start Testing Soon** – Like any other infrastructure change, the success of adopting a converged networking strategy depends on solid testing under conditions that match your current production environment. Based on our experience, you should expect to see substantial storage performance increases over all existing Fibre Channel HBAs, even while concurrently running normal levels of TCP/IP server traffic. Fibre Channel is still heavily entrenched in the enterprise, and regardless of how much savings you can show by eliminating the increasingly redundant Fibre Channel storage network, there will be those who will resist such a change. Storage and network administrators currently live in different worlds—with different expectations for their networks—so the challenge for vendors and buyers alike will be to find a way to instill the same level of trust in the hardware platform and independence of management capabilities found in existing, dual-fabric environments.

**Cabling Considerations** – There are multiple copper and fiber standards vying for position in the 10GbE space, but the main focus currently seems to be on SFP+ because it provides options for both twin-ax copper and short- or long-throw optical connectivity. Though standards for 10GBase-T on either Cat6A or Cat7 twisted-pair copper have been out for a while, adoption is taking an inordinately long time to come about. Both cables are relatively bulky and have bend-radius limitations, but perhaps the bigger issue is that the 5 or 6 watts/port power envelope for 10GBase-T Phys would more than double the draw of current 10GbE adapters. Another reasonably priced option to expensive conventional optics would be to look at optics-integrated fiber cabling like LaserWire from Finisar, but that would also require certification from your CNA vendor.

**Fight for Flexibility** – One of the key drivers for Ethernet has always been the goal of open standards for interaction between devices. This has not been the case in the history of Fibre Channel, where switch and HBA vendors have not always worked and played well together. There is plenty of motivation for Ethernet vendors to make 10GbE converged networking switching products a top-shelf, and, therefore, more expensive, option. Like any other cutting-edge technology, there will be a bit of an “early adopter penalty” for converged networking products, but IT buyers should push back as firmly as possible to ensure that 10GbE-based converged networking will evolve to be as open and ubiquitous as its Gigabit counterpart.

**Horsepower Needs Horsepower** – Don’t plan on dropping a 10GbE NIC or CNA into your older servers and expect to get the full performance and efficiency we’ve experienced out of them. For our tests, we used only brand-new, Nehalem-based i7 servers with eight processing cores and PCI-e Gen2 expansion slots. Though there’s no reason that these cards wouldn’t work fine in any PCI-e equipped server, we recommend that companies follow a similar strategy when exploring the adoption of any 10GbE initiative.

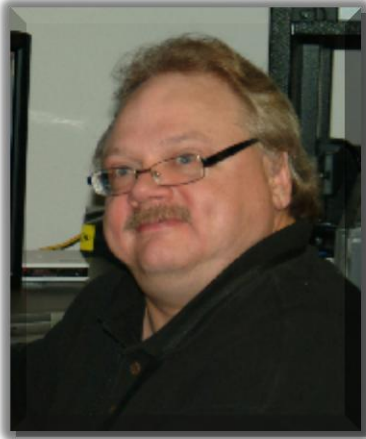
## Conclusions

If you look at the wins in our performance and usability testing, it seems that there's no reason why Emulex shouldn't get some real traction here at the start of the converged network movement, but the market for CNAs is still very, very young. In light of our findings, we can only assume that some of the big-name CNA partnership deals announced by other vendors may have been based on price or first-to-market availability, rather than on performance and features.

Converged networking is a really new market with some serious potential to change the enterprise storage networking landscape, and there are still a lot of moves to be played in this particular chess game. We've recently heard of new FCoE capabilities on Broadcom's existing ASIC, Intel is yet to clarify the FCoE capabilities of their platform and there are a surprising number of small players in the fledgling 10GbE market that will either eat or be eaten as the market sorts itself out. You can expect substantial movement in the converged networking market for the next 24 to 36 months and, for the good of the IT industry in general, we can't help but think that at some point, 10GbE will become as ubiquitous as Gigabit Ethernet is today.

Even the most basic servers purchasable today are multi-cored and capable of being filled with substantial quantities of memory, making virtualization the most effective way to use all that computing power. Server virtualization thrives on fast I/O to keep all those hungry little virtual machines busy, not to mention making them portable to other hosts. Physical servers are also trending smaller and 1U or 2U boxes limit the number of physical network ports you can add so I/O can easily become the main bottleneck in your virtualized production environment. Not only does 10GbE CNA technology offer a 10:1 reduction in Ethernet port counts right out of the box, but it also has the potential to eliminate the most expensive network in your data center: dedicated Fibre Channel.

There's no doubt that converging your storage onto a 10GbE converged network will be more expensive than adopting basic 10Gb, but take a moment to compare that to the cost of replacing your Gigabit Ethernet, as well as updating your slower 2Gb or 4Gb Fibre Channel storage network. This is one of those rare occurrences where a little research and testing could substantially improve the performance of your data center and eventually show the kind of long-term, hard cost savings that will make you a superstar in the eyes of your CFO.

**About the Author:****Steven Hill, Contributing Analyst – IT Brand Pulse**

As the Technology Editor of Storage and Servers for Network Computing Magazine, Steven Hill was responsible for the coverage of emerging technologies for the modern datacenter; and he personally tested, analyzed, and reported on some of the newest enterprise-level hardware and software offerings available today. Prior to Network Computing, his 35-year career provided production and problem-solving experience in small business as well as Fortune 500 corporate environments. Steven now serves as an independent IT consultant, writer, analyst and speaker on numerous Enterprise IT topics. He currently operates out of his secret test facility based in the deep woods of Northeastern Wisconsin; along with his Hound Dog/Network Administrator Tucker and Sheltie Mix/Security Officer Mia. Steven, Tucker and Mia can be contacted at: [shillpub@gmail.com](mailto:shillpub@gmail.com)

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