Evaluation Report: Emulex® OCe14102 10GbE and OCe14401 40GbE Adapter Comparison with Intel® X710 10GbE and XL710 40GbE Adapters

Evaluation report prepared under contract with Emulex

Executive Summary

As enterprises and cloud computing providers consider current and future application workload patterns, they find that networking infrastructure is a key element that can help determine the overall success of their operations. Networking utilization is growing due to the increasing demands of virtualized server environments, virtual desktop environments, multi-tiered application database architectures, streaming video applications, web-based applications and emerging public, private and hybrid cloud computing architectures. In addition, the adoption rate of solid-state storage technology, especially in large datacenters, places new performance demands on network infrastructure.

The EmulexEngine™ (XE)100 series (Skyhawk™) of Ethernet Controllers powers the latest generation of Emulex OneConnect® 10Gb and 40Gb Ethernet (10GbE and 40GbE) Network Adapters and Converged Network Adapters (CNAs). Emulex commissioned Demartek to compare these adapters to the equivalent new adapters from Intel Corporation, the X710 10GbE adapter and the XL710 40GbE adapter. Specifically, Emulex was interested in IP networking tests that are frequently used to evaluate these types of adapters, and features used in virtualized data center and cloud environments.

Key Findings

The Emulex OneConnect OCe14102 and OCe14401 Network Adapters generally outperformed the Intel X710 and XL710 adapters, and have better support for advanced features typically found in virtualized data center and cloud network environments.

- The Intel "Fortville" X710/XL710 adapters utilize a new i40e driver architecture that is incompatible with their previous IXGBE NIC drivers.
- The Emulex OCe14000 family of 10GbE and 40GbE Network Adapters demonstrated up to 5x greater RFC2544 small packet performance compared to the Intel X710/XL710 adapters.
- The Emulex OCe14102 10GbE Network Adapter has 62% lower (better) average TCP latency and 55% lower (better) average UDP latency than the Intel X710 adapter.
- We found that the Intel X710/XL710 adapters are currently missing features necessary for virtualized data center and cloud network environments, such as VMware Virtual Extensible Local Area Network (VXLAN) hardware offloads, Single Root I/O Virtualization (SR-IOV) for VMware and Remote Direct Memory Access (RDMA) support.

Adapter Features

The Emulex OCe14102 10GbE and OCe14401 40GbE Network Adapters support a wide variety of features for native operating systems and for hypervisor environments. These include a variety of TCP/IP checksum offloads and Large Send offloads for IPv4 and IPv6 that would be expected for any server-class Network Interface Card (NIC). Emulex also supports virtualization offload features, such as VXLAN, Network Virtualization using Generic Routing Encapsulation (NVGRE) and SR-IOV for VMware vSphere and Windows Hyper-V.

The Intel X710 and XL710 adapters support the expected TCP/IP checksum offloads and Large Send offloads for IPv4 and IPv6 that are expected for a server-class NIC. However, the virtualization support for features such as VXLAN, NVGRE and SR-IOV, are not yet fully supported. According to the VMware Compatibility Guide (http://www.vmware.com/resources/compatibility/search.php), the Intel X710 and XL710 do not support VXLAN and SR-IOV for VMware. SR-IOV is supported for Windows Hyper-V environments.

RDMA support is another area where the Emulex and Intel Ethernet adapters differ. The industry is adding RDMA support to a growing number of Ethernet adapters. The Emulex adapters support RDMA over Converged Ethernet (RoCE). The Intel X710 and XL710 adapters do not support RDMA. Intel has made public statements that suggest RDMA support, in the form of Internet Wide Area RDMA Protocol (iWARP), is planned for future server platforms.

Ethernet Adapter Feature	Emulex OCe14xxx	Intel X710/XL710
TCP/IP Checksum Offloads	Yes	Yes
Large Send Offloads	Yes	Yes
SR-IOV for Windows Hyper-V	Yes	Yes
SR-IOV for VMware	Yes	No (future release)
VXLAN for VMware	Yes	No (future release)
In-box drivers	Yes	No
RDMA	Yes	No

Installation and Drivers

Emulex adapters have in-box drivers for Windows Server 2012 R2, VMware vSphere 5.1 and 5.5, and several versions of Linux, which makes installation quite simple. The Emulex adapters are based on the same driver architecture as previous versions of these adapters. Newer drivers and firmware can be downloaded from the Emulex website, as needed.

The Intel X710 and XL710 do not have in-box drivers for Windows or VMware environments. The Intel adapters are based on a new driver architecture known as x40e. From the end-user standpoint, the drivers for the X710 and XL710 must be downloaded from the Intel Download Center website by searching for the adapter name, and installed by running the installation application. The Intel Ethernet Connections CD provides drivers for Windows, Linux and FreeBSD. The VMware 5.1 and 5.5 drivers for the X710 adapter are available on VMware's download page.

The Intel X710 and XL710 adapters use a new driver architecture that is not backwards compatible with their previous adapter architecture. This means that developers, independent software vendors and platform providers may need to perform additional qualification steps to support these adapters.

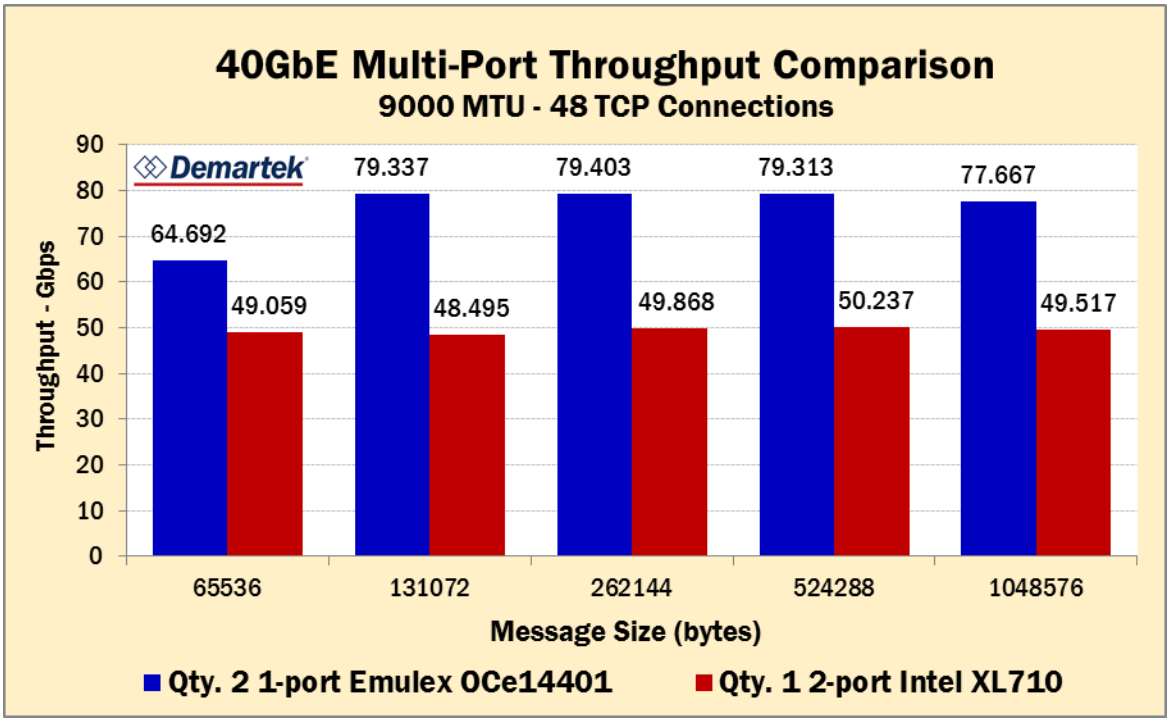
40GbE and PCIe Slots in Servers

PCI Express (PCIe) 3.0 slots provide approximately 1 gigabyte per second, per lane of available bandwidth. This newest generation of Ethernet adapters requires a PCIe 3.0 x8 slot. Eight lanes of PCIe 3.0 provide a theoretical maximum of 8 gigabytes or 64 gigabits per second of available bandwidth.

A single-port 40GbE adapter can achieve full line rate, in one direction, in a PCIe 3.0 x8 slot. A dual-port 40GbE adapter would require 80 gigabits per second of available bandwidth to achieve full line rate for both ports in one direction.

We question the value of producing a dual-port 40GbE adapter that requires a PCIe 3.0 x8 slot, because both ports of such an adapter cannot both achieve full line rate at the same time. For users that require two ports of 40GbE functioning a full line rate, we recommend the deployment of two single-port 40GbE adapters into two different PCIe 3.0 x8 slots.

The following chart shows the benefits of using two separate Emulex OCe14401 40GbE Network Adapters, rather than one Intel XL710 adapter, to provide two ports of 40GbE connectivity.



RFC2544 Small Packet Performance Tests

Ethernet networks use standard frame, or packet, sizes of 64, 128, 256, 512, 1024, 1280 and 1518 bytes. There are standard tests that can be performed on network devices, such as network adapters, to evaluate the performance of these devices at these standard frame sizes.

For these tests, we used specialized test equipment from Ixia to configure and automate the test scenarios for each of the 10GbE and 40GbE adapters. Using the capabilities of Ixia test hardware, such as wire-speed traffic generation, filtering, capturing, and statistics collection, we utilized the IxAutomate suite of pre-built tests based on industry-standard RFCs requirements.

These tests handle packet routing between the test hardware and the adapter installed in the host server. These tests focus on small packets and utilize the adapter, driver and IP portion of the TCP/IP stack.

Test Measurements

These tests measure the best performance achieved, without dropping packets. The test hardware performs the test and increases the load, until packets are dropped. The best results are recorded at the highest levels achieved, before packets are dropped. The metrics are:

- No Drop Rate: the percent of line rate achieved
- Throughput: the frames per second achieved
- Tx Rate: the transmit rate achieved, in Kbps
- Rx Rate: the receive rate achieved, in Kbps

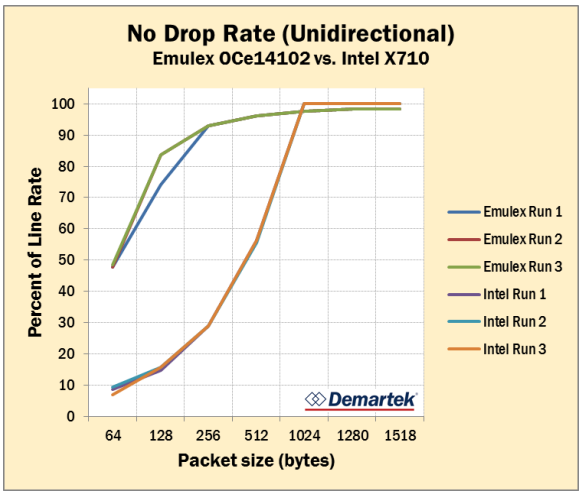
The transmit rates and receive rates are measured separately because they may not always be equal, depending on the implementation of hardware, firmware and software.

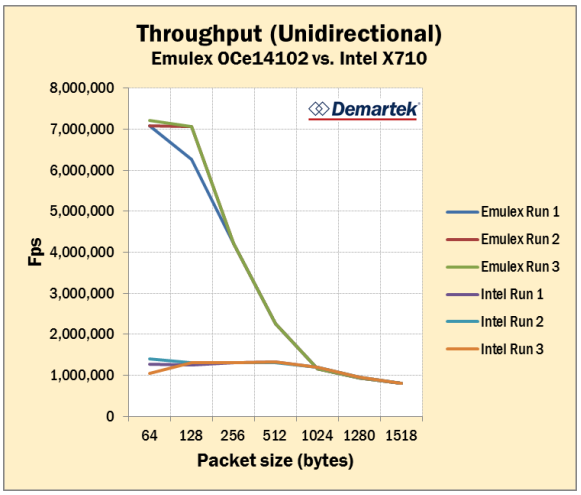
The tests were performed unidirectionally and bidirectionally for the 10GbE adapters and unidirectionally for the 40GbE adapters. This is because these adapters use PCIe 3.0 x8 slots that have a maximum theoretical bandwidth of approximately 64 Gbits/sec. Normally, bidirectional transmission through an Ethernet adapter would yield an aggregate of twice the rated speed of the adapter. However, the PCIe 3.0 x8 slot cannot provide 2x40Gbits/sec of bandwidth.

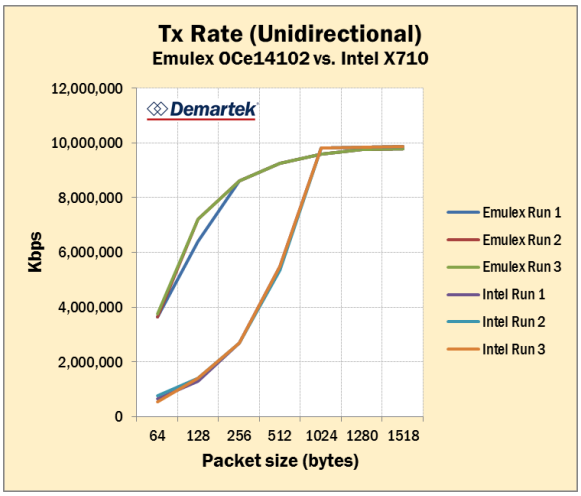
Three runs of each test were performed and charted below. Overall, the Emulex adapters matched or exceeded the performance of the Intel adapters.

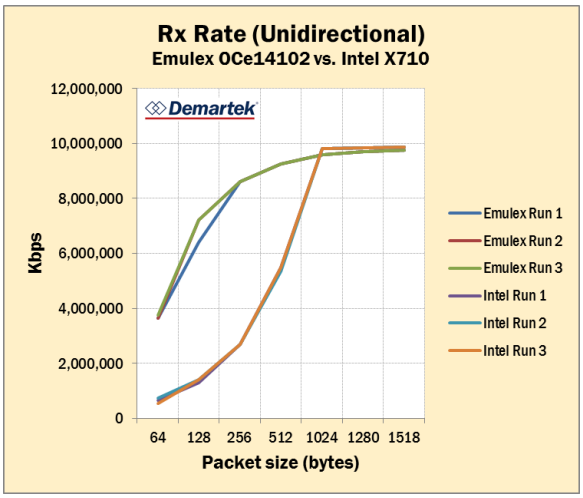
- **No Drop Rate:** The Emulex adapters outperformed the Intel adapters by up to 3x. For bidirectional 10Gb and unidirectional 40Gb, the Emulex adapters significantly outperformed the Intel adapters at every packet size.
- **Frames/Packets Per Second:** The Emulex adapters outperformed the Intel adapters by up to 5x.
- **Throughput Rates:** The Emulex adapters generally outperformed the Intel adapters, especially for bidirectional 10Gb and unidirectional 40Gb.

Unidirectional Results – 10GbE

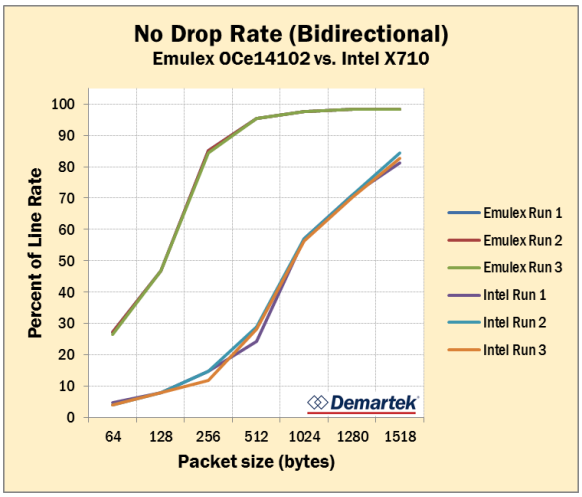


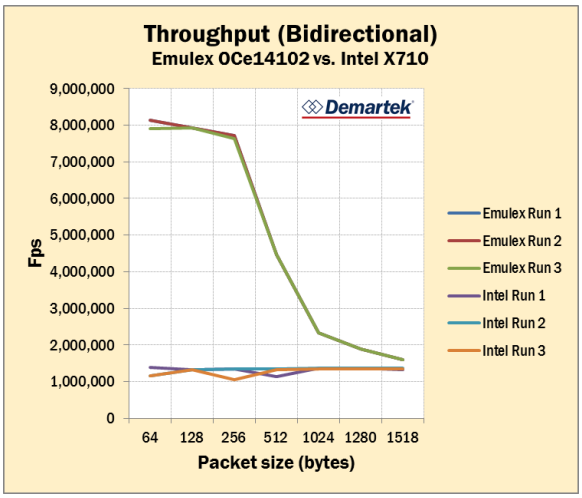


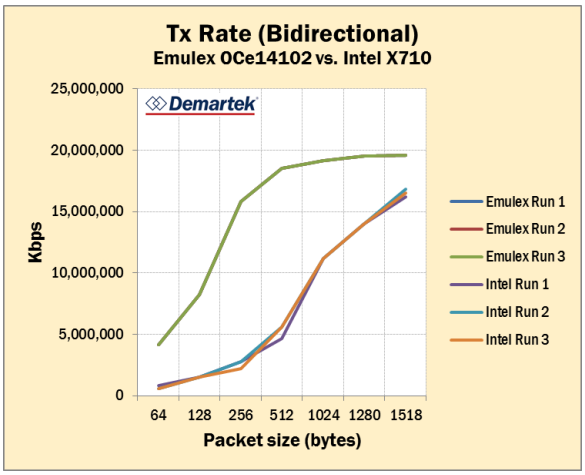


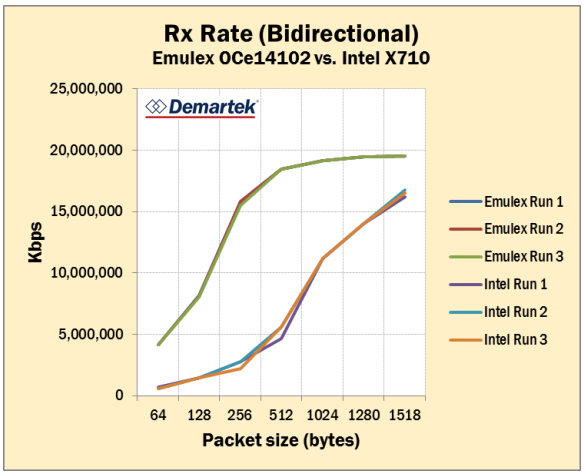


Bidirectional Results – 10GbE

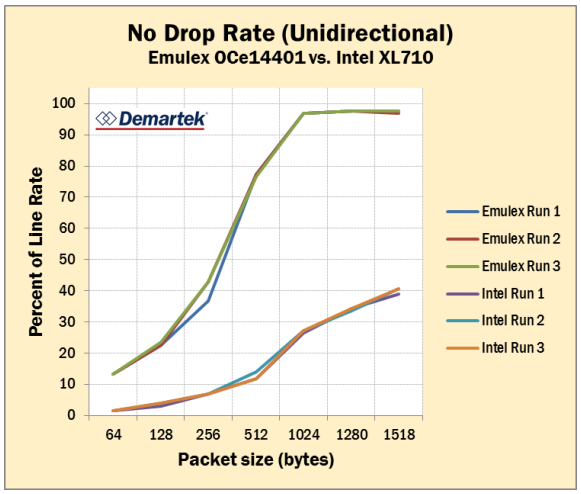


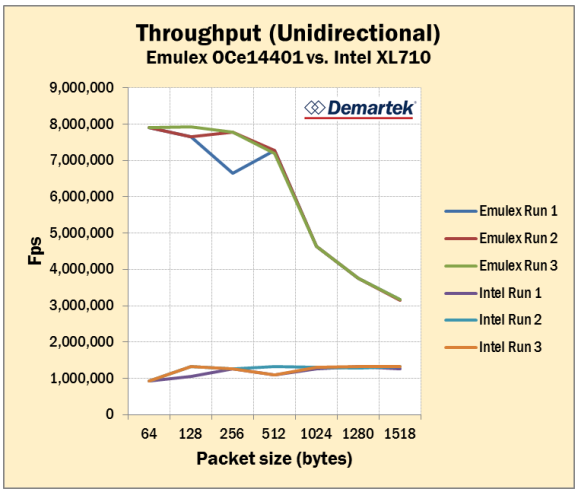


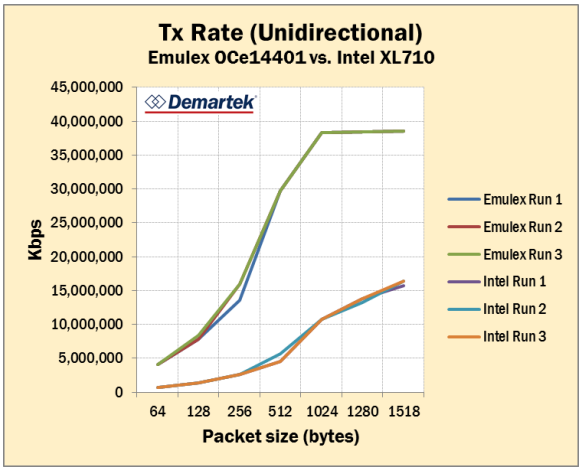


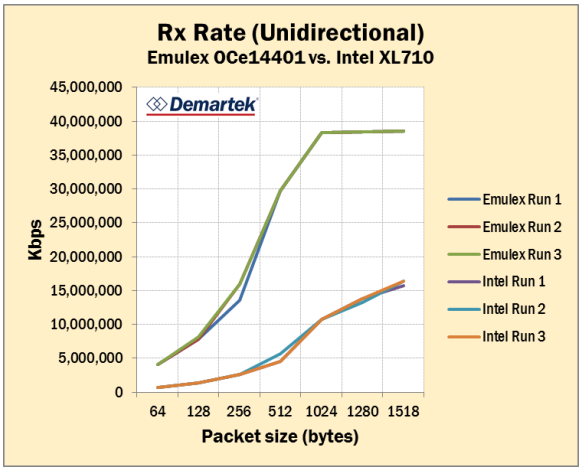


Unidirectional Results – 40GbE







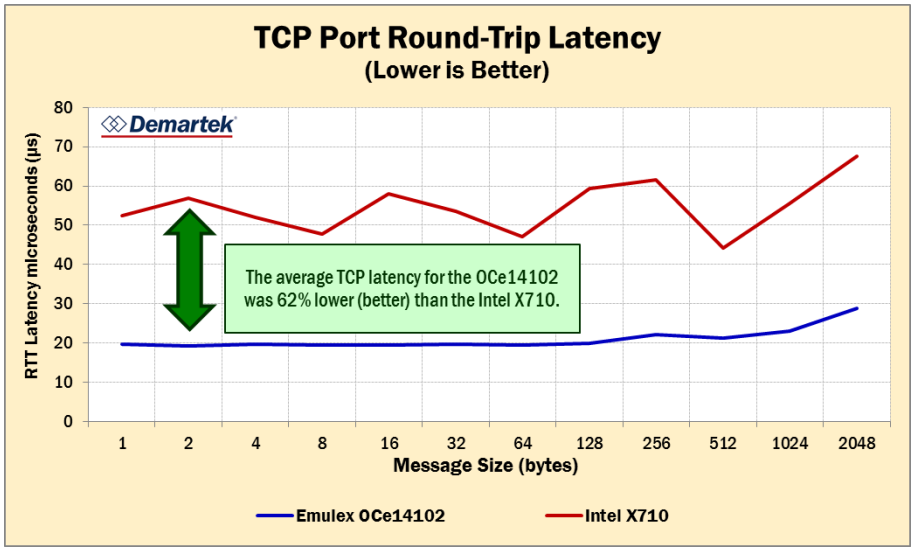


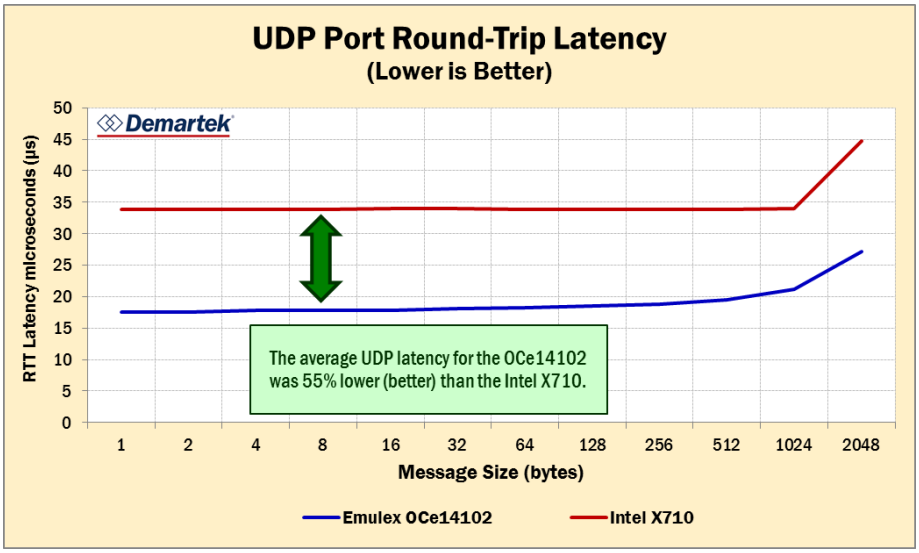
Latency Tests

The latency tests measure the round-trip latency of the adapter between two servers. The Ixia IxChariot test package was used for these tests. This test package tests latency of TCP and UDP in a host server.

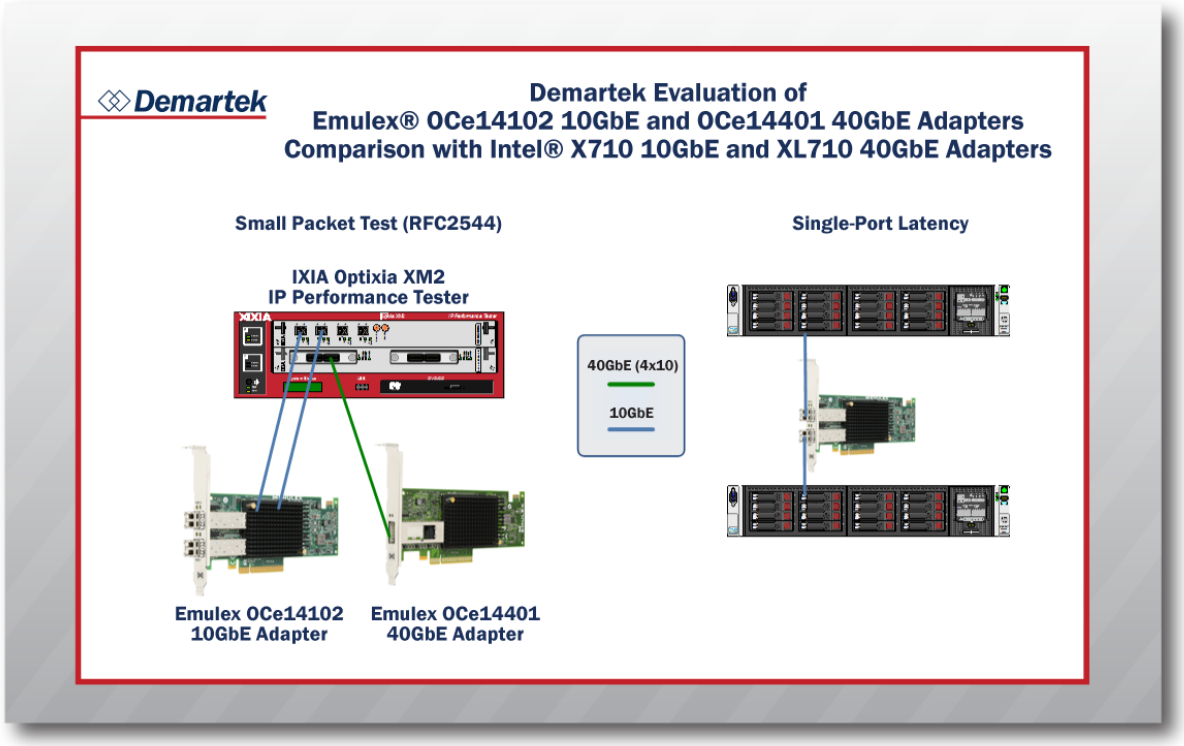
Several test runs were performed using the 10GbE adapters, and the results were reasonably consistent between runs for each adapter. The run with the best average latency for each adapter is shown below.

- The Emulex OCe14102 10GbE Network Adapter has 62% lower (better) average TCP latency and 55% lower (better) average UDP latency than the Intel X710 adapter.





Test Description and Environment



Servers

- HP ProLiant DL380p Gen8 Server
- 2x Intel® Xeon® E5-2690 v2, 2.9GHz, 16 total cores, 16 cores, hyper-threading disabled
- 96GB RAM
- RHEL 6.4 64-bit

Adapters

- Emulex OCe14102 10GbE, firmware 10.2.370.19, be2net driver 10.2.363.0
- Emulex OCe14401 40GbE, firmware 10.2.370.19, be2net driver 10.2.363.0
- Intel X710 10GbE, firmware f4.22 a1.2 n04.25 e8000013fc, i40e driver 1.1.23
- Intel XL710 40GbE, firmware f4.22 a1.2 n04.25 e8000013fc, i40e driver 1.1.23

Test Equipment

- Ixia Optixia XM2 IP Performance Tester

Summary and Conclusion

The latest generation of the Emulex OCe14100 family of 10GbE and 40GbE Network Adapters and CNAs, powered by the Emulex XE100 series of Ethernet controllers, consistently outperformed the Intel X710 10GbE and XL710 40GbE adapters in the small packet and latency tests. The Emulex adapters also have a more complete set of features required for virtualized datacenter and cloud environments. In our opinion, these latest generation Emulex adapters would be an excellent choice in datacenter and cloud environments for 10GbE and 40GbE applications.

The original version of this document is available at:
http://www.demartek.com/Demartek_Emulex_OCe14102_10GbE_OCe14401_40GbE_Adapter_Evaluation_2015-02.html on the Demartek website.