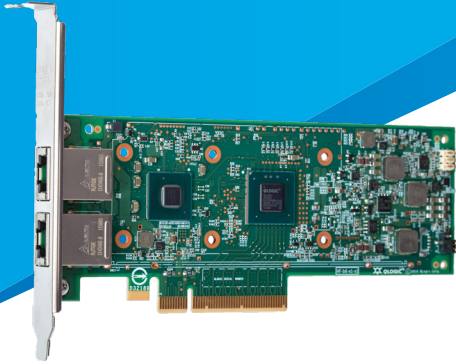


Investment Protection with High-Performance 10GBASE-T from Cavium



Cavium FastLinQ adapters with 10GBASE-T connections provide investment protection to easily transition from 1GbE to 10GbE performance while reducing cost instead of migrating to the higher-priced SFP+ optical connectivity.

KEY FEATURES

- 10Gbps bandwidth, backward compatible with 1GbE (auto negotiation)
- Compatible with CAT6a/7 UTP cabling up to 100 meters and CAT6 cabling up to 40 meters
- Extensive virtualization support
- Universal remote direct memory access (RDMA)
- Support for iSCSI over Ethernet with RDMA (iSER)
- iSCSI and FCoE storage offload
- Switch-independent NIC Partitioning (NPAR), with up to eight partition assignments per 10GbE link
- VLAN support with VLAN tagging
- Full suite of stateless offloads

WHEN CUTTING COSTS RESTRICTS POTENTIAL PERFORMANCE

The high cost of 10GbE top-of-rack switches and optical cabling has slowed the migration from legacy 1GbE infrastructure to new higher performance 10GbE. Many enterprise customers using the latest generation servers from OEMs (like Dell®, HPE®, Lenovo®, and others) are still connecting to legacy 1Gb Ethernet (1GbE) networks. This makes it virtually impossible for these customers to reach the full potential of the compute capability of these servers since they simply don't have enough network bandwidth available.

The alternative is to utilize 6-10 1GbE connections, which increases complexity and can impact reliability due to the large number of connections. In most cases, settling for 1GbE connectivity was a trade-off made because many IT departments don't have the budget to upgrade both the compute and network infrastructure at the same time, and thus new server technology was deployed connected to legacy 1GbE networks.

OVERCOMING THE COST BARRIER

Cavium™ FastLinQ® 41000 Series 10GBASE-T adapters overcome the cost barrier by offering higher performance with the low-cost CAT6A cabling. 10GBASE-T adapters are fully backward compatible with 1GbE networks and utilize the same RJ-45 connectors as 1GbE adapters. This eliminates the need to use expensive SFP+ optics or DAC cables. Cavium 10GBASE-T adapters support cable length of up to 100 meters compared to DAC cables limited to 7 meters. In addition, CAT6A cable cost averages \$1-2 per foot and comes in a variety of colors, which helps to easily identify specific network connections in a server rack.

Table 1 compares the typical cost of these cable types.

Table 1. Typical Cost by Connector Type

Connector Type	Used with	Typical Cost*
SFP+ Transceiver	10Gb SFP+ I/O Adapter	\$600-\$900 each
10GbE Direct Attach Copper (DAC) Cable	10Gb SFP+ I/O Adapter	\$60-\$200 per meter 1/3/5/7 meter lengths
CAT6-A Copper Cable, RJ-45	1Gbase-T or 10GBASE-T Adapter	\$1-\$2/meter, up to 100 meters

*Source: Internet Price from CDW.COM for OEM-branded/supported products



Figure 1. Low-cost CAT6A Cabling

OPTICAL VERSUS COPPER CONNECTIVITY

There are tradeoffs to consider when comparing optical to copper connectivity options. With 10BASE-T connections, power consumption increases approximately 2-3 watts per port and latency increases from 1-2 microseconds with Optical to 1-2 milliseconds using RJ45 connections. For applications that are not sensitive to latency (like any application running on a 1GbE network) or where cost is a key driver, 10GBASE-T makes great economic sense.

For example, let's compare deploying 10 servers with a pair of 10GbE connections per server using optical, DAC, or 10GBASE-T connections. The cost comparison would break down to look like Table 2 below. As you can see, deploying 10GBASE-T can save 46% compared to the SFP+ optical transceiver implementation.

Table 2. Total Cost by Connector Type

Connector Type	Adapter Costs	5M Cable Costs	Transceiver Cost	Total Cost
10GBE SFP+ with Optics	\$600 x 10 = \$6000	\$50 x 20 = \$1000	\$600 x 10 = \$6000	\$13,000
10GbE SFP+ with DAC	\$600 x 10 = \$6000	\$300 x 20 = \$6000	N/A	\$12,000
10GBASE-T	\$700 x 10 = \$7000	\$5 x 20 = \$100	N/A	\$7,100

The Cavium FastLinQ 41000 Series 10GBASE-T adapters can auto-negotiate with Ethernet switches and connect to either a 1GbE switch port or a 10GbE switch port. Given that the network infrastructure will eventually be upgraded, 10GBASE-T technology provides a way to “future proof” server configurations to connect to 1GbE networks today, and 10GbE networks tomorrow.

THE CAVIUM DIFFERENCE

Cavium FastLinQ 41000 Series 10GBASE-T adapters support several advanced features that reduce CPU utilization and improve performance and server virtualization scalability. The Cavium 10GBASE-T adapters also have added intelligence including stateless and tunnel offloads, network partitioning (NPAR), and support for SR-IOV when operating in both 1GbE or 10GbE modes. The Converged Network Adapter (CNA) offerings also provide full storage protocol offload capability for both iSCSI and FCoE.

These advanced features reduce CPU utilization and optimize server I/O connectivity in virtual server environments. The result is faster applications and more VM scalability for the servers they are installed in.

Universal Remote Direct Memory Access

All Cavium FastLinQ 41000 Series adapters support Universal RDMA. This includes support for RDMA over Converged Ethernet (RoCE), RoCEv2 (sometimes referred to as Routable RoCE), and iWARP (Internet wide area RDMA protocol). The Cavium adapters support any of these RDMA types concurrently. This enables customers to run RoCE on port 0 and iWARP on port 1 of the same adapter.

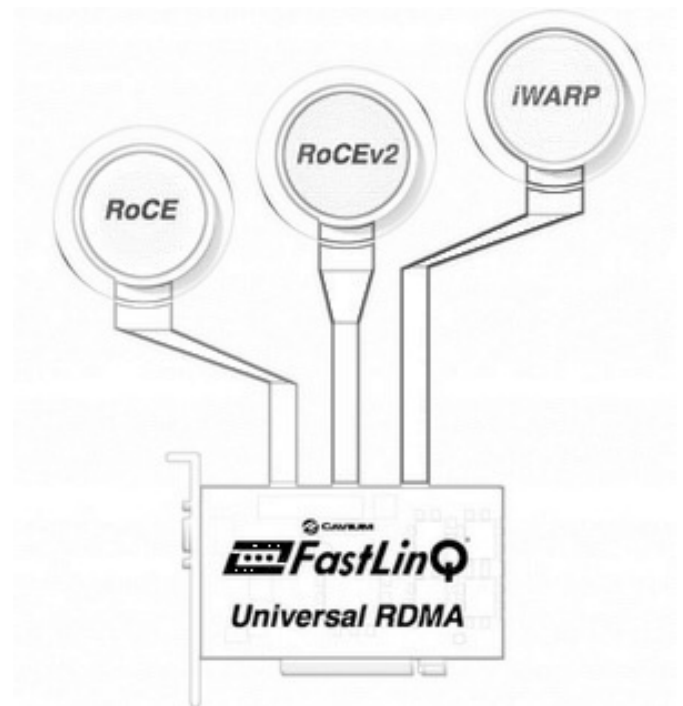


Figure 2. FastLinQ Adapter Support Multiple RDMA Protocols Concurrently

With RDMA, latency is reduced significantly. Table 3 shows the latency improvement compared to standard L2 NIC performance for each of the three different types of RDMA implementations.

Table 3. Latency Improvements¹

RDMA Types	Latency Improvement vs. L2 NIC, no RDMA (Frame Size - 64 Bytes)
RoCE v1/v2	53% lower
iWARP	10% lower

For details on the network requirements and differences in these RDMA implementations, refer to Cavium's Universal RDMA page (<http://www.cavium.com/universal-rdma.html>).

iSCSI over Ethernet with RDMA (iSER)

Cavium FastLinQ 41000 Series 10GBASE-T adapters also support iSCSI over Ethernet with RDMA (iSER) capability. With iSER, the Cavium FastLinQ adapters deliver 120% higher IOPS compared to iSCSI with software initiators². These Cavium FastLinQ adapters support iSER with RoCEv1, RoCEv2, or iWARP RDMA. Competitor offerings are usually limited to only RoCEv1, making the Cavium FastLinQ adapters much more flexible in the data center.

NVMe Direct

These advanced adapters from Cavium also support NVMe Direct. NVMe Direct allows the NIC to execute read/write commands directly on the solid-state drive (SSD), bypassing the host CPU. This dramatically reduces CPU utilization since the host CPU is not involved the read/write operations.

Management

All Cavium FastLinQ adapters are managed using any of the following management utilities from Cavium:

- Cavium QLogic® Control Suite (QCS) CLI
- QConvergeConsole® (QCC) GUI
- QCC PowerShell Cmdlets
- QCC VMware vCenter Plug-in

¹ Statistics based on head-to-head performance benchmarks conducted in Cavium Labs.

² http://www.cavium.com/Documents/WhitePapers/Adapters/WP_iSER_RDMA_Accelerates_Storage.pdf

CAVIUM FASTLINQ 10GBASE-T ADAPTER FEATURES

- x8 PCIe™ Gen 3 (8 GT/s) host bus interface
- 20Gbps full-duplex per port, backward compatible to 1GbE
- Compatible with CAT6a/7 UTP cabling up to 100 meters and CAT6 cabling up to 40 meters
- Extensive virtualization support
 - Single root I/O virtualization (SR-IOV), Microsoft® VMQ, and VMware® NetQueue™
 - Network Virtualization using Generic Routing Encapsulation (NVGRE) packet task offloads, Virtual Extensible LAN (VXLAN) packet task offloads, Generic Routing Encapsulation (GRE) offloads, and Message Signaled Interrupt (MSI-X)
- Universal remote direct memory access (RDMA)
 - RoCEv1, RoCEv2, iWARP
 - Concurrent RoCE and iWARP on single adapter
- Support for iSCSI over Ethernet with RDMA (iSER)
- Storage offload
 - iSCSI
 - FCoE
- Switch-independent NIC Partitioning (NPAR), with up to eight partition assignments per 10GbE link
 - gives the appearance of multiple adapter ports to the operating system, and each can be customized to allocate bandwidth as needed
 - flexible configuration of either 8 NIC, 7 NIC + 1 HBA or 6 NIC + 1 HBA configurations per port
- VLAN support with VLAN tagging
- Full suite of stateless offloads
 - Large send/segment offload (LSO)
 - Large receive offload (LRO)
 - Giant send offload/generic segmentation offload (GSO)
 - Receive segment coalescing (RSC)
 - Interrupt coalescing
 - TCP segmentation offload (TSO)
 - Receive side scaling (RSS)
 - Transmit side scaling (TSS)
 - IPv4 and IPv6 TCP/UDP
 - Checksum offloads (CO)
- VxLAN, NVGRE, GENEVE stateless offloads

SUMMARY

When the time comes to upgrade servers, using 10GBASE-T adapters will provide significantly better performance and capabilities, even if connected to a 1GbE network. When connected to 10GbE networks, the Cavium FastLinQ 41000 Series adapters provide the industry's most flexible, scalable high performance 10GbE connectivity option available today.

ABOUT CAVIUM

Cavium, Inc. (NASDAQ: CAVM), offers a broad portfolio of infrastructure solutions for compute, security, storage, switching, connectivity and baseband processing. Cavium's highly integrated multi-core SoC products deliver software compatible solutions across low to high performance points enabling secure and intelligent functionality in Enterprise, Data Center and Service Provider Equipment. Cavium processors and solutions are supported by an extensive ecosystem of operating systems, tools, application stacks, hardware reference designs and other products. Cavium is headquartered in San Jose, CA with design centers in California, Massachusetts, India, Israel, China and Taiwan.



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