Converged Storage Infrastructure for VMware® vSphere™ 4.1

with Broadcom® 10GbE and 1GbE iSCSI C-NICs

The purpose of this document is to inform architects and administrators about how they can increase the value of their VMware vSphere 4.1 platform by implementing a converged storage infrastructure solution based on Broadcom's NetXtreme II® 1G/10G Ethernet and iSCSI technologies.

August 2010


**Introduction**

Enterprise and cloud/data center storage requirements, costs, and management investments continue to increase exponentially. With the availability of 10 Gigabit Ethernet (10GbE) technology and its favorable economics, IT managers are no longer able to justify a completely separate Fibre Channel (FC) capital expenditure (CAPEX)/operation expenditure (OPEX) network investment just for storage. Ethernet with iSCSI protocol enables a converged data center fabric with zero host-connection costs, extreme performance, enterprise-class functionality, and lower total cost of ownership (TCO). Further benefits of an iSCSI-converged Ethernet storage solution include:

- The existing IT infrastructure, knowledge base, and expertise can be leveraged.
- Routable technology can be used for easy LAN or WAN deployments.
- Technology generations (1GbE, 10GbE, 40GbE, and beyond) can be seamlessly scaled using standard Ethernet.
- Operations are functional across all Ethernet cabling plant technologies such as 1GBASE-T and 10GBASE-T.
- The solution complements other virtualization deployment features such as migration, clustering, and disaster recovery.

The data center benefits of consolidation through server virtualization are well known, and new virtualized data center architectures are being deployed by IT managers at a very rapid pace. Virtualization with VMware® vSphere™ 4.1 offers many innovative new storage facilities such as iSCSI Storage Area Networking (SAN) boot, storage array hardware assist (Storage API for Array integration [VAAI]), and iSCSI hardware offload. The benefits of these innovations include improvements in efficiency, scalability, performance, and availability as well as a reduction in the infrastructure TCO. Broadcom and VMware have partnered to bring several of the new 10GbE and 1GbE iSCSI SAN technologies into the VMware vSphere 4.1 platform, completing a comprehensive converged storage infrastructure for modern data center virtualized architectures. Furthermore, the solution is packaged "in-box" within VMware vSphere 4.1, enabling seamless installation and unified management.

The following checklist identifies some of the key features and benefits available with the Broadcom and VMware vSphere 4.1 iSCSI SAN converged storage infrastructure solution:

| ✔ Converged 1GbE and 10GbE NIC (C-NIC) architecture for iSCSI and Ethernet |
| ✔ iSCSI Boot technology enabling virtual diskless server deployments |
| ✔ Standard and integrated management |
| ✔ Improved CPU effectiveness for lower data center TCO and improved power usage effectiveness (PUE) |
| ✔ VMware vSphere 4.1 in-box packaging support for easy installations |
Converged Networking (C-NIC) Architecture

On July 13, 2010, VMware announced the introduction of VMware vSphere 4.1 to "advance the foundation for cloud computing." Within the category of enhancements called "increased performance through open integration with storage environments," the announcement mentions that VMware vSphere 4.1 now enables Broadcom's 10GbE and 1GbE full iSCSI Host Bus Adapter (HBA) and iSCSI Boot solution.

Before VMware supported 10GbE iSCSI offload, IT managers connected their VMware ESX servers to 10GbE iSCSI SANs using a combination of disparate NIC or converged network adapter (CNA) hardware and fat iSCSI device drivers, a configuration in which most of the iSCSI protocol processing is done by the VMware ESXi™ server. Now with VMware vSphere 4.1, VMware supports the latest Broadcom C-NIC that has thin iSCSI drivers and a suite of advanced hardware-based engines. The hardware-based engines within the C-NIC provide most of the iSCSI protocol processing, dramatically increasing platform efficiency and performance. Broadcom's advanced on-chip iSCSI processing is fully integrated with the VMware vSphere 4.1 stack, offering a tightly integrated and optimized data path for iSCSI.

Furthermore, networking facilities are not compromised and are available within the same framework. There are multiple on-chip networking performance enhancements such as Transparent Packet Aggregation (TPA) for coalescing TCP/IP packets in the hardware and achieving line rate performance and lower CPU utilization for networking traffic. Additionally, VMware Netqueue™ eliminates single-queue bottlenecks. The architecture for this configuration is illustrated in Figure 1.

Figure 1: Broadcom and VMware iSCSI and Ethernet Converged Storage Architecture
Virtual and Diskless Servers with iSCSI Boot

VMware vSphere 4.1 implements the iSCSI Boot Firmware Table (iBFT), which is a component of the Advanced Configuration and Power Interface (ACPI) 3.0b standard. ACPI 3.0b provides operating systems a standard way to boot iSCSI protocol on devices such as Broadcom 1GbE and 10GbE C-NICs. The value of the iBFT is that in addition to booting virtual machines (VMs), it will now allow the VMware vSphere 4.1 vmkernel to boot without local storage and will enable diskless servers in a virtual environment. Users can now boot VMware ESXi with iSCSI Boot capability. This iBFT capability for Broadcom 1GbE and 10GbE C-NICs has been newly introduced in the latest release of VMware vSphere 4.1.

iSCSI Boot is a powerful technology because it allows a server to boot an operating system (OS) over an iSCSI SAN, completely eliminating the need for local disk storage, and thereby eliminating the number one source of failures in computer systems—hard drive failures. Besides enhancing system reliability, the use of diskless servers simplifies the IT administrator's workload by centralizing the creation, distribution, and maintenance of server images; reducing the overall need for storage capacity through increased disk capacity utilization, and adding increased data redundancy through the use of data mirroring and replication.

iSCSI Boot support from Broadcom's NetXtreme II 1GbE and 10GbE C-NIC with VMware vSphere 4.1 ensures the feasibility of deploying diskless servers on iSCSI SANs, furthering lowering the TCO.

An overview of the iSCSI Boot process is illustrated in Figure 2.
Standard and Unified Management with VMware® vCenter™

VMware vCenter is a built-in system management tool that simplifies the various tasks associated with configuring and managing virtualized servers. VMware vCenter recognizes Broadcom NetXtreme II C-NICs along with other types of hardware and displays them in the GUI. Users can then configure and set up iSCSI connections to specified targets. Logical unit numbers (LUNs) that have been mapped to an iSCSI device can then be used to boot VMware vSphere images over the network.

Typical iSCSI HBA configuration and boot configuration screens are shown in Figure 3.
iSCSI Data Center Performance

Broadcom NetXtreme II C-NICs with iSCSI provide the broader performance that is necessary for cloud storage and data center operation by improving power usage effectiveness (PUE) through leading performance-per-watt profiles. No longer being overlooked, power costs are now one of the most tracked data center TCO metrics.

The following four factors enable a lower PUE from the deployment of Broadcom C-NIC technology:

1. The hardware-based iSCSI engine within the Broadcom C-NIC architecture has been proven to provide power savings of approximately 60W per port or 120W per server in other environments (see Figure 4).

![Figure 4: Power Savings of Approximately 60W per Port with Broadcom C-NICs with iSCSI Technology](http://www.dell.com/content/topics/global.aspx/power/en/unified_networking?c=us&cs=555&l=en&s=biz)

2. iSCSI Boot enables removal of per-server hard drives, saving approximately 10W per drive and lowering per-server power because of the approximately 10W per drive power reduction and lower airflow requirements.

3. The low CPU utilization (high CPU effectiveness) enables VM occupancy rates to increase. This provides further opportunity for removing additional physical servers and their high power demands across the data center.

4. Broadcom NetXtreme II C-NICs support the IEEE 802.3az Energy Efficient Ethernet™ (EEE) standard, providing power savings during periods of low link utilization.

The end result across a medium-to-large deployment can significantly improve PUE and offer permanent cloud computing and data center power savings by right-sizing the non-IT infrastructure. Right-sizing HVAC, generators, and the like saves, on average, an additional 50–70% on power!

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VMware vSphere 4.1 "In-Box" Driver Support

The Broadcom NetXtreme II 10GbE and 1GbE iSCSI HBA and iSCSI Boot solution is packaged "in-box" with VMware vSphere 4.1. The driver and environment have been tested through VMware's world-class quality and qualification processes. Searching individual server driver pages or direct engagement with the device manufacture is not required. Therefore, administrators can experience a seamless installation over the network and a support model for homogenous or heterogeneous server environments; no separate driver upgrades are required. This convenience spares administrators wanting to enable iSCSI from having to copy separate OEM driver images for each OEM server.

Summary and Conclusions

The growth rates for storage, networking, and virtualization are all accelerating. Without convergence, optimized resource utilization is difficult to achieve. Broadcom and VMware, leaders in networking and storage virtualization, have partnered once again to bring innovative data center and cloud storage solutions to market.

Converged storage infrastructure for VMware vSphere 4.1, based on 1G/10G iSCSI technology, enhances the virtualized environment and provides radical data center consolidation and performance improvement from well-known Ethernet technology. Data center improvements are derived along with improved PUE opportunities, unified management, and simple administrative installation.

For network architects and administrators of enterprise networks or cloud storage/data centers who have already migrated to 10GbE technology, or those who are planning to do so in the near future, the strategy of deploying VMware 4.1 with Broadcom NetXtreme® iSCSI C-NICs to achieve high-performance...
virtualization is both necessary and prudent: no one else in the industry, including CNA vendors, can provide a complete vSphere 4.1/iSCSI solution.

More About VMware vSphere 4.1
For more information about VMware vSphere 4.1, visit:


More About 10GbE from Broadcom
For more information about Broadcom's 10GbE Ethernet controllers and adapters, visit:

http://www.broadcom.com/products/Ethernet-Controllers/Enterprise-Server

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http://www.vmware.com/company/news/releases/vsphere-4-1.html

A unified networking approach: iSCSI storage with Broadcom Controllers

http://www.dell.com/content/topics/global.aspx/power/en/unified_networking?c=us&cs=555&l=en&s=biz

iSCSI HBA Offload and 10GBASE-T

http://www.infostor.com/index/blogs_new/Frank_Berry/blogs/infostor/frank-berry_s_blog/post987_855043080666472366.html


FCoE I/O convergence and virtualization

http://www.infostor.com/index/articles/display/4348346471/articles/infostor/san/fibre-channel/2010/april-2010/fcoe_i_o_convergence.html

3G C-NICs Address Mass Migration To 10GbE

http://www.networkcomputing.com/data-networking-management/3g-c-nics-address-mass-migration-to-10gbe.php

Energy-Efficient Ethernet (EEE)

http://www.altaterra.net/members/blog_view.asp?id=288668&post=101773
http://www.altaterra.net/members/blog_view.asp?id=288668&post=105517
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Acknowledgements

Andy Banta is a Senior MTS at VMware and is focused on virtual storage management. We acknowledge and appreciate his contributions and reviews.

Paul Manning is a Storage Architect in the Technical Marketing group at VMware and is focused on virtual storage management. We acknowledge and appreciate his contributions and guidance.

Glossary

CAPEX capital expenditure
CNA converged network adapter
DR disaster recovery
FC Fibre Channel
HBA Host Bus Adapter
IOPS input/output operations per second
LUN logical unit number
OPEX operating expenditure
PUE power usage effectiveness
TCO total cost of operation
TPA Transparent Packet Aggregation
VAAI Storage API for Array integration
VM virtual machine