Bringing converged iSCSI storage to virtualized environments

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Key technologies from Dell, Broadcom, and VMware enable IT organizations to create converged iSCSI storage networks that help them control costs, boost performance, and keep up with the growing storage demands of virtualized environments.

Demands on enterprise data storage have been growing for years, and this trend has been accelerated by the advent of cloud computing. But two evolving technologies have the potential to help organizations keep up with these growing workloads.

The first of these is 10 Gigabit Ethernet (10GbE), which allows IT departments to avoid investing in separate Fibre Channel technology just to accommodate storage requirements. Instead, they can use Ethernet with the Internet SCSI (iSCSI) protocol to create a cost-effective converged data center fabric that leverages existing IT infrastructure and expertise while providing high performance, enterprise-class functionality, and reduced total cost of ownership (TCO).

The second key technology is virtualization. The benefits of consolidation through virtualization, such as increased efficiency and flexibility, are well known in the data center. As a result, IT departments are deploying virtualized architectures at a rapid pace.

These two technologies can work well in concert. A converged 10GbE-based iSCSI storage infrastructure can enhance virtualized environments by enabling data center consolidation and performance increases using Ethernet. In addition, 10GbE-based iSCSI complements other virtualization deployment features, such as migration, clustering, and disaster recovery. However, IT departments have typically had to piece together various technologies to use iSCSI in virtualized environments, which often results in less-than-optimal performance and efficiency.

Now, however, that is changing. As Dell, Broadcom, and VMware have pursued various virtualization- and iSCSI-related initiatives, they have coordinated their efforts. As a result, organizations can now take advantage of Dell™ PowerEdge™ servers, Dell EqualLogic™ PS Series storage, Broadcom® NetXtreme II® converged network interface controllers (C-NICs), and VMware® vSphere™ 4.1 virtualization to create a comprehensive, end-to-end solution that helps them cost-effectively keep up with growing data center demands.

Creating a converged storage platform

In recent years, Broadcom and Dell have worked together on many fronts to bring their technologies together. Today, the combination of Dell PowerEdge servers, Dell EqualLogic PS Series storage, and Broadcom NetXtreme II iSCSI host bus adapters (HBAs) and iSCSI boot solutions offers a comprehensive approach to using iSCSI in the data center.
In environments based on EqualLogic storage and Broadcom C-NICs, each port can connect to multiple cluster elements. The EqualLogic Session Manager handles both session management and path selection. It builds paths on demand, and the system adapts as the configuration changes—enabling optimal use of the host ports and storage ports.

This platform is enhanced by the collaboration of Broadcom and VMware, which has brought key Gigabit Ethernet (GbE) and 10GbE storage area network (SAN) technologies into VMware vSphere. VMware announced the introduction of vSphere 4.1 in July 2010 as a release that “advances the foundation for cloud computing.” Among other features, this version enables integration with devices such as Broadcom GbE and 10GbE iSCSI HBAs and iSCSI boot solutions—an enhancement that VMware classified as supporting “increased performance through open integration with storage environments.”

Before VMware support for 10GbE-based iSCSI was in place, IT managers had to connect their ESX servers to these SANs using a combination of disparate network interface cards (NICs) or converged network adapter (CNA) hardware along with fat iSCSI device drivers. In these configurations, the majority of the iSCSI protocol processing is performed by the ESX server.

vSphere 4.1, in contrast, supports the latest Broadcom C-NICs, which have thin iSCSI drivers and a suite of advanced hardware-based engines. Using these hardware-based engines to handle the majority of the iSCSI protocol processing can dramatically increase platform efficiency and performance. The advanced on-chip iSCSI processing in Broadcom C-NICs supports comprehensive integration with the vSphere 4.1 stack, providing a tightly integrated and optimized iSCSI data path (see Figure 1).

This approach helps avoid compromising networking facilities, and makes those facilities available within a single framework (see Figure 2). Broadcom C-NICs also provide 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 reduced processor utilization for networking traffic. At the same time, the VMware NetQueue feature helps eliminate single-queue bottlenecks.

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Figure 1. iSCSI-based configuration using a Dell PowerEdge server, a Broadcom NetXtreme II C-NIC, and VMware vSphere 4.1

Figure 2. iSCSI-based converged storage architecture using a Broadcom NetXtreme II C-NIC and VMware vSphere 4.1

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Integrating Broadcom C-NICs and VMware vSphere 4.1

VMware vSphere 4.1 implements iSCSI Boot Firmware Table (iBFT), a component of the Advanced Configuration and Power Interface (ACPI) 3.0b standard. ACPI 3.0b gives operating systems a standard way to boot the iSCSI protocol on devices such as Broadcom NetXtreme II GbE and 10GbE C-NICs.

The iBFT capability for Broadcom C-NICs was introduced in vSphere 4.1. Its value is that in addition to supporting the booting of virtual machines, it allows the vmkernel to boot without local storage and enables use of diskless servers in virtualized environments: administrators can use Broadcom C-NICs to boot VMware ESXi and other operating systems over an iSCSI SAN (see Figure 3). This approach helps to eliminate the need for local disk storage as well as a primary source of failures in computer systems—hard drives. In addition to enhancing system reliability, the use of diskless servers helps simplify IT administration by centralizing the creation, distribution, and maintenance of server images; reducing the overall need for storage capacity through increased disk capacity utilization; and increasing data redundancy through the use of data mirroring and replication.

vSphere 4.1 also provides native support for Broadcom iSCSI HBA functionality with both GbE and 10GbE, and for TPA with 10GbE. In environments using these technologies, each Broadcom port is a separate vmhba, and there is one vmknic per NIC for iSCSI use.

Together, Broadcom C-NICs and vSphere 4.1 provide standard, unified management through the built-in VMware vCenter™ Server systems management tool, which helps to simplify tasks associated with configuring and managing virtualized servers. vCenter recognizes Broadcom C-NICs along with other types of hardware and displays them in a graphical user interface. Administrators can then set up and configure iSCSI connections to specified targets. Logical units (LUNs) that have been mapped to an iSCSI device can then be used to boot vSphere images over the network.

The driver for Broadcom GbE and 10GbE iSCSI HBAs as well as Broadcom iSCSI boot solutions is packaged "in-box" with vSphere 4.1, and both the driver and the environment have been tested through VMware’s world-class quality and qualification processes. Administrators do not need to search individual server driver pages or engage directly with the device manufacturer—facilitating a seamless installation over the network and a support model for homogeneous or heterogeneous server environments, with no separate driver upgrades required. This approach also avoids the need to copy separate original equipment manufacturer (OEM) driver images for each OEM server when administrators want to enable iSCSI.

Increasing data center performance and efficiency

Converged iSCSI storage can help increase data center performance and efficiency in several ways. For example, Broadcom NetXtreme II C-NICs can...
help improve the Power Usage Effectiveness (PUE) metric through leading performance-per-watt profiles. In today’s cost-conscious environment, power costs are no longer being overlooked—they are, instead, one of the most commonly tracked data center TCO metrics.

Four factors can help lower PUE through the deployment of Broadcom C-NICs:

• Compared with a third-party NIC, the hardware-based iSCSI engine within the Broadcom C-NIC architecture can provide power savings of approximately 60 W per port or 120 W per server in other environments.\(^2\)
• iSCSI boot enables the removal of per-server hard drives, which can save approximately 10 W per drive while helping further lower per-server power consumption because of reduced airflow requirements.
• Reduced processor utilization (high processor effectiveness) enables virtual machine occupancy rates to increase, providing a further opportunity to consolidate physical servers and their associated power demands across the data center.
• Broadcom C-NICs support the IEEE 802.3az Energy Efficient Ethernet (EEE) standard, which can provide power savings during periods of low link utilization.

In medium-to-large deployments of iSCSI converged storage, these factors can help organizations to significantly improve PUE—and offer permanent cloud computing and data center power savings—by enabling them to rightsize non-IT infrastructure components such as heating, ventilation, and air-conditioning (HVAC) systems and generators.

### Enhancing virtualized environments
As the move toward cloud computing continues, demands on storage and networking are growing at an accelerating pace. Without the flexibility and low TCO offered by converged storage, IT departments will likely find it difficult to optimize resource utilization.

The combination of Dell PowerEdge servers, Dell EqualLogic PS Series storage, Broadcom NetXtreme II C-NICs, and VMware vSphere 4.1 enables IT departments to take advantage of converged storage using GbE- and 10GbE-based iSCSI SANs with relative ease. This type of infrastructure enhances virtualized environments and can provide dramatic data center consolidation and performance improvement using standard Ethernet technology, with unified management and simplified administrative installation. For network architects and administrators interested in cloud computing and virtualization, deploying these Dell, Broadcom, and VMware technologies facilitates high-performance virtualization through a comprehensive, end-to-end solution.\(^2\)

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\(^2\) For more information, see “A unified networking approach to iSCSI storage with Broadcom controllers,” by Dhiraj Sehgal, Abhijit Aswath, and Srinivas Thodati, in Dell Power Solutions, 2010 Issue 2, dell.com/content/topics/global.aspx/power/en/unified_networking.

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