10GbE Comes of Age

July 2012

Table of Contents

List of Figures

Introduction

The IEEE standard for 10 Gigabit Ethernet (10GbE) network technologies was ratified over ten years ago, and vendors have been shipping products for over a decade now. However, use cases and economic conditions have not been compelling enough to justify broad adoption – until now. Both technical and economic reasons are creating an environment in the data center primed for 10GbE adoption. So, will 2012 be the year for 10GbE?

Technical Drivers

Virtualization: Virtual machine adoption is growing rapidly, with estimates as high as 40% and many analysts citing that virtual server shipments now exceed physical servers. Whatever the real number is, it is safe to say that adoption of server virtualization has reached the mainstream market. And these servers supporting virtual machines require the increases in bandwidth to satisfy the incremental I/O necessary to support multiple hosted applications. As virtual machine density continues to increase on the server, 10GbE becomes more attractive.

For many years, and for many organizations, Gigabit Ethernet (1GbE) offered enough bandwidth to satisfy the performance requirements of most business applications. Basic file serving and support for applications like email and databases can be supported with Gigabit Ethernet.

Server virtualization is changing the requirements for networking, and more importantly, storage networking. More and more servers are being deployed running virtual operating systems, or virtual machines (VM), with Ethernet storage protocols, whether Network Attached Storage (NAS) protocols, such as Network File System (NFS) and Server Message Block (SMB) or Common Internet File System (CIFS), as well as Storage Area Network (SAN) protocols such as Internet Small Computer System Interface (iSCSI), or Fibre Channel over Ethernet (FCoE). And we can't forget HTTP or new protocols for clouds, such as Cloud Data Management Interface (CDMI). These physical servers previously running only one application are now hosting tens of applications all in protected memory spaces, effectively increasing the I/O bandwidth required by a factor of 10 or more. This increase in VM density is clearly fueling the need for increased I/O capacity at each server and storage device.

Benefits of a 10GbE Network

By moving away from the traditional model of separate storage and local area networks (SANs and LANs) to a converged 10GbE network infrastructure, you can remove inefficiencies from your infrastructure while increasing flexibility, Benefits include:

- Cutting the number of ports, cables, and switches by up to 50%
- Reducing the physical footprint
- Simplifying management
- Cutting operational and capital costs
- Increasing bandwidth

SNIA

Network Convergence: Another complementary trend in the data center is the consolidation of resources. The open computing era introduced a decentralization of compute resources. Mainframes were replaced with independent file servers with direct attached storage. Networked storage, such as SANs and NAS, introduced the first new wave of resource consolidation. We have seen the second wave introduced with server virtualization. The third wave of consolidation seems focused on network convergence.

Traditional SANs run on a dedicated network. As this network continues to grow, the costs to deploy and manage begin to compete for costs and resources from the rest of the IT organization. And LANs aren't going away. So, as Ethernet continues to increase in capability to support not only iSCSI, but now Fibre Channel traffic with FCoE, the opportunity to consolidate both the LAN and the traditional storage network is a reality.

But this isn't available with 1GbE; 1GbE cannot support FCoE. The incremental investment in Ethernet by technology vendors to support converged network traffic is being made with 10GbE and faster speeds. 10GbE offers the required bandwidth for converged traffic while also introducing some significant economic benefits.

Economic Drivers

Hardware Cost: The economic challenges over the last two years have raised the priority of cost reduction and increased efficiency for IT organizations. Solutions that can both increase business performance as well as reduce cost are in high demand. 10GbE delivers both increased performance and economic value. Fewer adapters, fewer cables, and fewer switch ports are required to support the same data traffic of previous generation products. And for some, the reduction in cabling alone is reason to deploy 10GbE.

Not only is the added bandwidth essential to address the new requirements of server virtualization, but with that increased bandwidth comes greater economic efficiency. Price reductions for 10GbE are now at the point where the cost per Gigabit of bandwidth is less for 10GbE versus 1GbE. Per port costs for 10GbE switches are dropping rapidly as demand for 10GbE is now driving volume.

Green Initiatives: Environmental considerations are becoming a more prominent consideration in IT decision making. Not only is social responsibility a part of the equation, but there are some significant economic advantages to deploying new "greener" technologies. Servers have historically been the largest consumers of energy in the data center[1] and server virtualization has helped to reduce the number of physical servers drawing power and cooling. But, the added application density comes with increased I/O requirements. Consolidating onto 10GbE from 1GbE reduces the number of adapters, cables and switch ports required to support the same I/O requirements. Reductions in equipment

[1] Source: U.S. Environmental Protection Agency "Report to Congress on Server and Data Center Energy Efficiency"

SNIA

translate into less power and cooling requirements in additional to the reduction in equipment costs. Fewer cables mean improved air flow and less chance of human error during setup and maintenance.

Why 2012 is a big year

Romley Platform: The latest Intel server and workstation platforms, the Intel® Xeon® processor E5 family, launched March 2012 will also significantly help drive broad adoption of 10GbE in 2012. The Intel Xeon processor E5 family introduces three major advancements to facilitate high bandwidth and low latency Ethernet traffic under the umbrella name, "Intel Integrated I/O." First, the PCI Express interface is, for the first time, on the processor itself rather than on a separate I/O Hub. This eliminates a bottleneck and a hop over the QPI bus for Ethernet data to get to and from the processor. Second, the E5 family leads the industry in implementing PCI Express® 3.0, which doubles the bandwidth per pin compared to PCI Express 2.0. Two channels of 10GbE will run no faster on PCIe3 than on PCIe2. But PCIe3 will support four channels of 10GbE or one channel of 40GbE on a single PCIe x8 connection. Lastly, the E5 introduces Intel Data Direct I/O (DDIO), a radical re-architecting of the flow of I/O data in the processor with tremendous benefits for Ethernet traffic in terms of increased bandwidth and lower latency. There are platform benefits as well in terms of lower power consumption.

The easiest way to understand Data Direct I/O is in contrast to the "classic" way processors previously handled I/O. Once upon a time, when the first processors were designed with chisels on tablets, processor caches were very small and hence, a scarce resource. Also, I/O data was relatively slow. Given that context, the right way to handle Ethernet traffic was for a Network Interface Card (NIC) to Direct Memory Access (DMA) blocks of I/O data to and from main memory. The processor then could access that data when required with minimal impact on cache resources. But the world has changed. The E5 processors have last-level caches as large as 20MB.

The innovation of Intel Data Direct I/O is to allow Ethernet NICs and controllers to talk directly to the processor's last-level cache without a detour to main memory in either direction. Coherency algorithms don't change. It's just that the "gold copy" of I/O data with DDIO is in the last-level cache rather than main memory. It is the elimination of this detour to main memory that underlies the bandwidth and latency benefits of DDIO. With the previous generation of processors, the Intel® Xeon® processor 5600 family, the maximum internal I/O bandwidth is about 70 Gbps, according to Intel testing. With the E5 family, Intel has measured internal I/O bandwidth of 250 Gbps, over three times more headroom than the earlier generation. The Intel Xeon E5 family with DDIO can effectively do packet processing for the first time and will be used in network appliances and telecomm applications previously requiring specialized processors. The E5 family's Integrated I/O also reduces half-round-trip latency by about a microsecond. This will be especially attractive in the financial services industry. All these new capabilities in the Intel E5 family will help facilitate the broad deployment of 10GbE in 2012.

PCIe 3.0: With the PCIe 3.0 standard now released, supported products will continue to hit the market throughout 2012. PCIe 3.0 is the latest generation I/O bus standard and offers twice the I/O

bandwidth of the previous specification or 8Gbps per lane per direction. Coupled with next generation server processors the increased bandwidth of PCIe 3.0 provides the needed bandwidth to support the I/O capabilities of 10GbE networks. As an example, 8-lanes of PCIe 3.0 can support up to 128 Gb/s of total bidirectional bandwidth, over three times the total amount of bandwidth of a 2-port 10GbE NIC. The bandwidth of 16-lanes would be able to support almost 2x the bandwidth of two 40GbE ports.

All of this additional bandwidth and processing power and memory will enable next generation servers to support higher quantities of VMs, all of which contribute to increased I/O throughput at the server.

10GBASE-T: Vendors have been shipping 10GbE controllers and NICs for ten years. 10GbE technology has now penetrated 10-15% of the Ethernet connections in the data center. 2012 will be the year the ramp of 10GbE really takes off, triggered in no small part by the second and third generations of lower power, smaller, and cooler 10GBASE-T, the interface technology that uses the familiar RJ-45 jack and low-cost Categories 6 and 6a twisted pair cables. Most 10GbE connections today use the (Small Form-Factor Pluggable)SFP+ "Direct Connect" cables. The SFP+ solution, however, has limitations. The cables are restricted to 7m and are relatively expensive compared to Cat 6a twisted pair. These Direct Attach (DA) cables must be purchased in fixed lengths from DA cable vendors. Most important, they require a new connector that must be supported on all switches connected to the 10GbE adapters, and that connector is not backward compatible with 1GbE's RJ-45 jack. 10GbE with SFP+ does not easily integrate into a data center with 1GbE already broadly deployed. That's where 10GBASE-T comes in. Because switches that support 10GBASE-T can also support 1GbE, data center administrators can deploy 10GbE in an evolutionary manner based on changing requirements.

10GBASE-T supports run lengths as long as 100m using Cat 6a cables. The system administrator can cut and crimp the cables to the lengths required – at substantially lower costs. 10GBASE-T has been tested to deliver the reliability and low bit error rates required by specifications. All major switch vendors now have 10GBASE-T switches in production. We are also beginning to see the first production of single-chip 10GBASE-T adapter silicon, driving lower power requirements and lower prices than the two-chip Physical Layer (PHY) and Media Access Control (MAC) 10GBASE-T adapter solutions from earlier designs. Server OEMs will be deploying 10GBASE-T broadly in 2012 which is another factor making 2012 a transformational year for 10GbE.

Expanded LOM: Traditionally, server OEMs have offered their customers Ethernet technology in three forms. The customer can purchase PCI Express (PCIe) Ethernet Network Interface Cards (NICs). Or the customer can purchase Ethernet delivered by an integrated circuit soldered to the server's motherboard called "LAN on Motherboard' (LOM). Or lastly, the server OEM may make Ethernet options available via a mezzanine or "daughter" card. This is particularly popular with blade servers where a PCIe card wouldn't fit. The disadvantage of the mezzanine card is that it is relatively expensive compared to LOM. Beginning in 2012, we have seen server OEMs introduce a fourth option which could be called "flexible LOM." Server vendors will have different names for and implementations of flexible LOM. But the idea is to simplify and cost-reduce the traditional daughter card. The goal is to be able to provide the option of 10GbE at LOM-like costs.

Adapter Virtualization

With the widespread adoption of server virtualization, several technologies are being developed to partition or virtualize network adapter ports to fully utilize the 10GbE bandwidth.

NIC Partitioning

With NIC partitioning, multiple NIC functions are created for each physical port. These functions are equivalent to unique physical devices so there is no requirement for new virtualization capabilities in operating systems or hypervisors.

As an example, a 10GbE adapter port with four NIC functions would be similar to a quad-port 1GbE adapter, and also provide key benefits that include fewer cables and switch ports, more total bandwidth (10Gb vs. 4Gb) and the ability to allocate bandwidth as needed to each function. One of the partitions can be an iSCSI or FCoE function with adapters that support networked storage.

Single Root I/O Virtualization (SR-IOV)

Single Root I/O Virtualization (SR-IOV) is a PCI Special Interest Group (PCI-SIG) standard that was developed for virtualized servers. The SR-IOV specification allows an I/O device to appear as multiple physical and virtual devices, using the concept of physical and virtual functions:

- **Physical function (PF)**—There is at least one PF for each physical port on an adapter. The key differentiation is PFs have full configuration capabilities. They are associated with the hypervisor and can be managed like physical devices.
- **Virtual function (VF)**—VFs are associated with VMs and are limited to processing I/O streams, basically moving data. They don't support management of the physical device. The number of supported VFs will vary and will likely center around 64 VFs per physical adapter.

With SR-IOV, VFs can be assigned directly to VMs, bypassing the I/O overhead in the hypervisor. This allows one adapter port, switch port and cable to support many VMs as if they had direct access to a physical device. If appropriate, multiple VFs can be assigned to one VM. For example, a VM could be assigned VFs from each physical port of a two-port adapter for high availability.

For received I/O, the server core that is assigned to the VM and its associated VFs executes all of the processing for a packet. There's no need to interrupt cores that are assigned to other VMs. To further enhance performance, I/O's between VFs on the same PF can be processed by the adapter using an internal Layer 2 switch, eliminating routing through a physical switch. Finally, SR-IOV is compatible with migration of running VMs.

SR-IOV requires support by suppliers of adapters, switches and hypervisors. It also requires management tools for the server to fully enable robust solutions. SR-IOV is currently supported with Kernel Virtual Machine (KVM) in Red Hat Enterprise Linux 6 and SUSE Enterprise Linux 11 (and later). Microsoft has announced support for SR-IOV Windows Server 2012 Hyper-V. Other hypervisor providers are expected to announce SR-IOV support.

Data Center Bridging (DCB) Enhancements made to the Ethernet protocol, collectively referred to as Data Center Bridging (DCB), enable support of FCoE and converged data storage traffic over a shared Ethernet wire. These enhancements offer the ability to allocate bandwidth as well as improve management of traffic flow to ensure lossless transmission characteristics. The most commonly deployed enhancements are Enhanced Transmission Selection and Priority-based Flow Control. Data Center Bridging Exchange (DCBX) over Link Layer Discovery Protocol (LLDP), is implemented with DCB to facilitate discovery and configuration of features enabled between endpoints.

Enhanced Transmission Selection (ETS) as defined in the IEEE 802.1Qaz standard facilitates the allocation of Ethernet bandwidth into 8 virtual lanes which can each be assigned a minimum amount of bandwidth. If the overall bandwidth of the wire is not being fully used, individual lanes can consume excess bandwidth until needed by the other lanes assigned. ETS allows IT administrators to ensure minimum performance levels for specified applications.

Priority-based Flow Control (PFC) improves flow control on a shared wire by incorporating a PAUSE mechanism assigned to each virtual lane to limit data flow during times of heavy traffic. Rather than using the TCP method of dropping packets and retransmitting, PFC pauses traffic until the receiving queues can clear to receive additional data. Given that the Fibre Channel protocol expects a lossless medium, the PFC mechanism is used to satisfy FCoE traffic requirements.

Disruption of Flash Technology

The availability of solid state devices based on NAND flash technology is dramatically changing the performance and efficiency dynamics of storage systems. As a new price/performance tier between Dynamic Random Access Memory (DRAM) and Hard Disk Drives (HDD), flash can offer between 10 and 100 times the speed of HDD at one quarter the price of DRAM. As flash is increasingly integrated into the storage layer, there will be implementation options based on specific workload requirements. For workloads which require every read and write IO to be extremely fast, it is possible to configure storage arrays which consist entirely of flash technology with many terabytes of solid state disk drives (SSD). For most workloads, however, flash will provide a suitable complement to HDDs whereby caching algorithms will allow most high performance Input/Output Operations per Second (IOPS) to be serviced from flash. The caching approach will yield maximum overall efficiency. With caching approaches, the benefits of flash will mostly apply to random read and write operations. Write through and write back caching techniques will be deployed but it will be important to support the write back model with protection schemes such as RAID to ensure that no data loss occurs. These faster storage systems increase the need for 10GbE.

Cloud Services

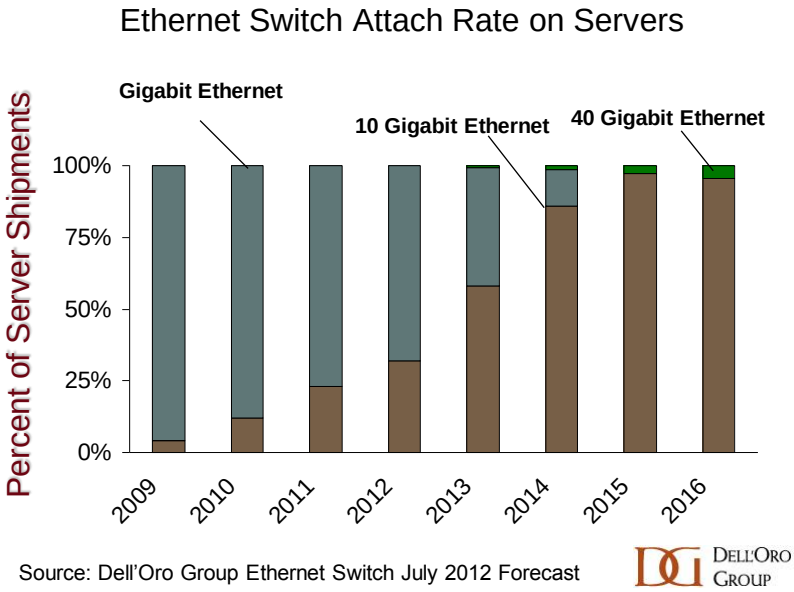
Cloud demands bandwidth, especially network bandwidth. Traditional file-based access to selected parts of files is often replaced by complete object retrieval in a cloud environment; for instance, a request for a virtual machine (VM) image may require the transmission of hundreds of MB to many GBs worth of data in a single request. Full motion video (FMV) objects are very large indeed, and must

be streamed efficiently (and even copied several times to edge servers) if the end user experience is to be acceptable.

These cloud storage demands make 40GbE very attractive indeed, as both data-center backbone for private cloud and cloud storage vendors, but also further out beyond the data-center to the network edge. And while bandwidth relief may be a good reason for investing in 40GbE, the effect of reduced latency mustn't be forgotten; providing cloud-based storage for cloud-hosted applications such as databases is made practical over the WAN by the reduction in latency that 40GbE brings.

What do the projections look like?

With all of these reasons to deploy 10GbE in the data center, should we expect to see rapid adoption in the second half of 2012? If you were to ask most technology vendors, the answer would be a pretty strong "yes". However, we have said this before. Many of the reasons to deploy 10GbE have existed for over a year. However, the rate of adoption has been slower than many predicted. But that may be changing.



Although most accept that adoption will increase in 2012, not everyone thinks 2012 will be the break out year. Depending how you interpret the data, recent research from Dell'Oro Group suggests that 2013 may in fact be the great year for 10GbE. However, in order to hit the market share numbers for 2013, adoption rates better be pretty brisk before exiting 2012. So, perhaps both the vendor community and the analyst community are right? Regardless, whether we declare 2012 or 2013 as "the year for 10GbE", the requirements and benefits are clear today and all of the pieces are quickly falling into place to enable rapid adoption of 10GbE moving forward.

What additional technologies will benefit from 10GbE deployment?

iSCSI: iSCSI and 10GbE were both ratified ten years ago. iSCSI is the block-based storage protocol utilizing Ethernet as its fabric and has grown in popularity over the years with a compounded annual growth rate (CAGR) of 92% from 2003 through full year 2011 (based upon IDC WW Storage Tracker, Q1 2012) because of its integration with OS vendors, and maturity of its application integration. iSCSI is supported by all of the OS vendors with built-in support for initiators that support multi-path I/O (MPIO) to provide redundancy and network throughput between servers, the switching infrastructure and storage. Several vendors have developed offload engines that support the iSCSI protocol in hardware and server chipsets. However, the trend for iSCSI is to move protocol processing to system software.

iSCSI rides on top of TCP/IP and Ethernet and benefits from all of the enhancements and improvements that come along with both. Customers can easily take advantage of the higher throughput of 10GbE and can undertake a phased deployment of 10GbE wherever they may need it first without forklift upgrades.

Built into iSCSI is a mechanism, TCP/IP, which protects against dropped packets from physical or network layer errors caused by network congestion. To relieve congestion on the network IT managers have turned to higher speed networks, such as 10GbE, and in the future might consider 40GbE and 100GbE. Today, iSCSI easily and seamlessly interoperates at both 1GbE and 10GbE, within the same SAN, and will do the same in the future along with Ethernet. But sometimes just throwing more bandwidth at congestion doesn't solve the problem; the need for greater control of which applications should get the bandwidth, or giving priority to those applications that IT deems need it most. Enter iSCSI over DCB; the most recent grouping of IEEE standards for 10GbE, that together with iSCSI, add control and management, eliminate TCP/IP retransmits, provide bandwidth shaping, deterministic performance, and prioritization or QoS (Quality of Service).

Again, iSCSI, because it is Ethernet, takes advantage of everything that DCB offers to its underlying fabric. iSCSI over DCB can be deployed in stages and rolled out when and where it is needed most; server, switching, or storage. As opposed to FCoE, iSCSI doesn't require DCB to function on Ethernet, iSCSI over DCB provides the ease of managing a network on Ethernet with the powerful tools necessary in today's virtualized, converged data center. Is this a coincidence? Perhaps not. The future is bright for iSCSI and Ethernet with a roadmap that includes seamless integration with 40GbE and 100GbE for future performance improvements.

The NAS Protocols: Parallel NFS (pNFS) and SMB: Parallel NFS (pNFS), now officially NFS 4.1, represents a major step forward in the development of NFS. pNFS benefits workloads with many small files, or very large files, especially those run on compute clusters requiring simultaneous, parallel access to data.

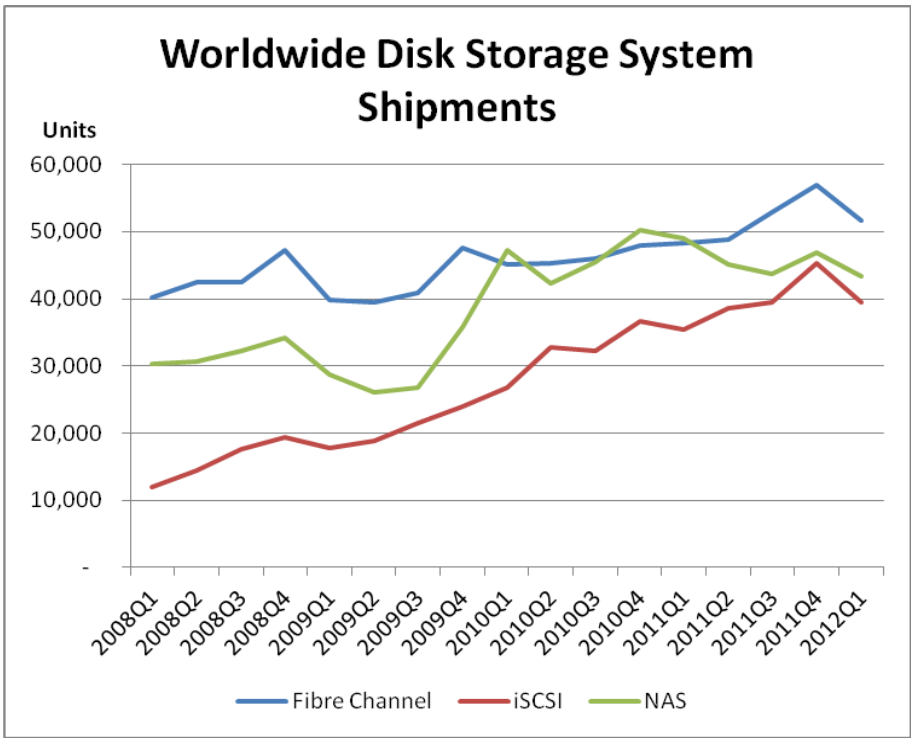


Figure 2 Source: Worldwide Quarterly Disk Storage Systems Tracker - 2012 Q1, IDC, June 2012

By allowing the aggregation of bandwidth, pNFS relieves performance issues that are associated with point-to-point connections. With pNFS, clients access data servers directly and in parallel, ensuring that no single storage node is a bottleneck. pNFS also ensures that data can be better load balanced to meet the needs of the client.

Although pNFS is new, the experience of users with proprietary precursor protocols to pNFS shows that high bandwidth access to data with pNFS is of considerable benefit. Potential performance of pNFS is definitely superior to that of traditional NFS for similar configurations of storage, network and server.

Paralleling developments in the NFS world, the SMB protocol hasn't stood still either. Developments in SMB have been driven by the requirements of server workloads, and SMB 3.0 Multi-Channel supports multiple connections to improve throughput for typical server workloads, such as database or virtualization.

As with pNFS, much of the demand for better performance and higher throughputs can be met by smarter network protocol stacks. But the potential with 10GbE is much greater still; the capability of pNFS and SMB2.2 to make use of the increased bandwidth available with 10GbE makes these NAS protocols attractive both for High-Performance Computing (HPC) and data center use alike.

FCoE Maturity: Fibre Channel over Ethernet (FCoE) holds promise of significant reduction in data center costs, cable, switches, and power by unifying storage and data networks over Ethernet. Brocade and Cisco announced FCoE switches in 2008 that can connect an Ethernet network carrying Fibre Channel protocols to a traditional Fibre Channel SAN. But FCoE requires 10GbE, which is only now becoming broadly deployed in the data center. Also, vendors supporting the Open FCoE host-based initiator have had to work closely with system software vendors to incorporate and validate Open FCoE. By August 2011, Open FCoE was supported in Linux, Windows, and VMware and qualified for Brocade and Cisco switches and EMC and NetApp SANs. FCoE is now a proven and mature technology and will ride the ramp of 10GbE in 2012.

HPC/RDMA: Another capability that 10GbE brings to the data center's Remote Data Memory Access (RDMA) technology. RDMA is the capability to write data directly from the memory of one computer into the memory of another with minimal operating system engagement. RDMA enables very low-latency data transmissions. RDMA can enable zero-copy data transmission. The benefits of RDMA include lower latency and reduced "jitter," that is a reduction in the variability in the transmission time of a group of packets over an Ethernet network. There are two RDMA-over-Ethernet technologies being deployed today over 10GbE, iWARP (internet Wide-Area RDMA Protocol) and RoCE (RDMA over Converged Ethernet). iWARP is layered on top of TCP/IP. In contrast, RoCE uses the InfiniBand transport – over an Ethernet wire. Both support the Open Fabrics Alliance software stack whose goal is that software cannot detect any difference between the underlying iWARP or RoCE technologies

High-performance computing (HPC) workloads written to the OpenFabrics Alliance (OFA) stack for InfiniBand can run on a 10GbE network supporting either iWARP or RoCE, creating a point of entry for the HPC community to take advantage of the many benefits of Ethernet. Also, Microsoft has announced that Windows Server 2012 will take advantage of RDMA capabilities, if available in the network, to support network file system called "SMB Direct 3.0." RDMA is yet another new capability that 10GbE brings to the data center and the cloud.

Where do we go from here and when?

The inexorable shift toward cloud computing, the exponential growth of mobile networking and high-speed consumer broadband, as well as a slew of other data intensive applications are relentlessly driving the need for higher-speed connectivity. Carriers are upgrading their transport networks to 100G, underscoring the need for 100G interfaces to the data center. Within the data center, server performance growth coupled with server virtualization gone mainstream has been fueling the 10GbE adoption, which in turn is putting the strain on data center networks, paving the way for 40G interfaces in the aggregation layer (such as End-Of-Row switches) and 100G uplinks at the core layer (backbone switches).

With four times the capacity of 10GbE and the ability to cost-effectively migrate to 100GbE, 40GbE is the next logical step in the evolution of the data network. 40GbE is starting to be deployed today in aggregation links within data center networks, and by 2016 its scope is expected to reach the network

edge with 40G access links to connect servers directly. Complementing 40GbE, 100GbE is a perfect choice for carrier service providers and core links in data centers.

What's the future of GbE and even Fast Ethernet?

With all of the discussion around 10GbE, 40GbE, and 100GbE, what about just Fast Ethernet or Gigabit Ethernet? Most data centers still have use for lower speed Ethernet products. Some use cases include:

- Management networks for storage, servers, switches, etc.
- Low demand storage applications such as print servers, basic file services, and active directories
- Low demand or medium demand block storage, such as iSCSI storage for email applications

Outside of the data center, and excluding consumer uses, there are many additional uses for slower speed Ethernet networks, which include:

- Voice over IP (each desk requires wired connection)
- Video surveillance
- Virtual desktops (VDI)
- And general client networking

What's interesting about the last bullet is that the increased use of laptops within enterprises increases the need for wireless networks as common practice is to bring laptops or tablet devices into meetings to facilitate collaboration. As wireless networks become the norm, the number of Gigabit Ethernet wires will reduce, but will still be required for the rest of the uses listed above, such as telephony and VDI.

Moving forward, it is very possible that wireless networks will even be able to replace the requirement for telephone cables as virtual telephone consoles are manages on PCs, rather than as a physical device on a desk. We are a little ways off from that adoption and there are practical reasons why that wouldn't work, like voice quality and wireless network performance. But, that future may be a reality before long.

Conclusion

Advances in disruptive technologies such as virtualization and flash are creating an environment that requires increased storage networking performance and improved manageability. And these new technologies are enabling consolidation while providing significant reductions in cost. Virtualization reduces both capital and operational costs associated with reduced physical servers, while flash media enables I/O acceleration to either improve upon high performance disks or to provide comparable performance with lower cost /higher capacity disk drives. In each of these cases, increasing the density of applications running on servers and accelerating I/O with flash technology will drive new requirements for network bandwidth and performance.

SNIA

Additionally, advances in Ethernet technology are allowing end users to reduce network infrastructure costs by consolidating SAN and LAN traffic onto a shared Ethernet network. The introduction of FCoE compliments iSCSI to provide greater flexibility for IT administrators looking to deploy applications over a shared network. Data Center Bridging provides that capability and promises to extend its value to other traffic over Ethernet.

Economies of scale will drive down prices for 10GbE products, and as we see 10GbE common on server motherboards and the introduction of 10GBASE-T with 10GbE, adoption should accelerate throughout the rest of 2012.

Is this the year of 10GbE? For all the reasons presented in this paper, we believe 10GbE will ramp steeply in 2012 toward mass adoption in the data center.

About the Ethernet Storage Forum

The Ethernet Storage Forum (ESF) is the marketing organization within the Storage Networking Industry Association (SNIA) focused on Ethernet-connected storage networking solutions. Through the creation of vendor-neutral educational materials, ESF thought leaders leverage SNIA and Industry events and end-user outreach programs to drive market awareness and adoption of Ethernet-connected storage networking technologies, worldwide. For more information, visit the SNIA web site at www.snia.org/forums/esf and the ESF blog at http://sniaesfblog.org/. Follow the ESF: @SNIAESF.

About the SNIA

The Storage Networking Industry Association (SNIA) is a not-for-profit global organization, made up of some 400 member companies spanning virtually the entire storage industry. SNIA's mission is to lead the storage industry worldwide in developing and promoting standards, technologies, and educational services to empower organizations in the management of information. To this end, the SNIA is uniquely committed to delivering standards, education, and services that will propel open storage networking solutions into the broader market. For additional information, visit the SNIA web site at www.snia.org. Follow SNIA: www.facebook.com/snia.org, @sniaupdates, www.linkedin.com/company/snia.

SNIA