White
Paper

**Simplify Your Network
with Broadcom Converged IO Solutions**

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May, 2011

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Introduction

The globalization of business in the twenty-first century continues to intensify. A steady stream of new Internet technologies is eroding the old barriers between people and the information they seek, the products they want, and the connections to like-minded communities they have come to expect. In such a world, market changes are rapid and unrelenting. Business success in this modern environment comes to companies that embrace adaptability as a core principle and adopt business strategies that treat change and uncertainty as opportunities to gain a competitive advantage over those who cling to old assumptions.

These companies know that their IT strategies can mean the difference between success and failure. Even as current economic conditions continue to drive cost containment as a top concern, trends in corporate IT spending suggest that business leaders are beginning to shift from a defensive to an offensive posture. ESG research shows that, while reducing operational expenses is still the primary concern, its grip on the top spot has slipped considerably (nearly 20 percentage points) since 2009. Meanwhile, over the same time period, improving business processes is now on nearly equal footing with OPEX reduction (see Figure 1).[1]

Figure 1. Justifying IT Investments

Which of the following considerations do you believe will be most important in justifying IT investments to your organization's business management team over the next 12-18 months? (Percent of respondents, three responses accepted)

2009 (N=492)	
2010 (N=515)	
2011 (N=611)	

Reduction in operational expenditures: 62%, 54%, 43%
Business process improvement: 37%, 42%, 39%
Return on investment / speed of payback: 31%, 33%, 37%
Improved security / risk management: 32%, 36%, 35%
Reduction in capital expenditures: 37%, 30%, 24%
Improved regulatory compliance: 20%, 23%, 19%
Reduced time-to-market for our products or services: 17%, 10%, 16%

Source: Enterprise Strategy Group, 2011.

One way organizations deal with this evolving atmosphere is to deploy new technologies. It is safe to say that server virtualization—which, a few years ago, was seen by some organizations as a specialized application of server technology that existed separately from the "core" of the corporate IT infrastructure—is now nearly ubiquitous. In fact, it has topped the list of IT priorities in ESG research for the last two years (see Figure 2). While there is no doubt that cost reduction (hardware consolidation, real estate, cooling costs, etc.) strengthens the justification to virtualize, server virtualization's most strategic value for many is that it creates a far more agile and responsive IT infrastructure, enabling the business to rapidly meet the changing requirements of today's global environment.

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[1] Source: ESG Research Report, *2011 IT Spending Intentions Survey*, January 2011.

Figure 2. Top IT Initiatives

Which of the following would you consider to be your organization's most important IT priorities over the next 12-18 months? (Percent of respondents, N=611, ten responses accepted)

Increase use of server virtualization	30%
Manage data growth	24%
Information security initiatives	24%
Major application deployments or upgrades	23%
Improve data backup and recovery	22%
Desktop virtualization	21%
Data center consolidation	21%
Business continuity/disaster recovery programs	20%
Large-scale desktop / laptop PC refresh	19%
Regulatory compliance initiatives	18%

Source: Enterprise Strategy Group, 2011.

The purpose of deploying highly dynamic, virtualized IT infrastructure is to provision the right service with the appropriate workload in the right place at the right time—virtualization enables IT to meet the precise needs of the business in a constantly changing business world. Creating this ideal, however, is not as simple as deploying virtualization technology. In order to take advantage of the advanced mobility functions server virtualization offers, networked storage is also required. In many cases, storage environments were built on separate and technically isolated networked storage architectures with each topology designed to provide specific performance characteristics. A typical large enterprise environment might include, for example, separate storage architectures utilizing combinations of Fibre Channel SAN, iSCSI, and NAS.

 At issue is that each storage architecture has its own connectivity requirements and the deployment of each represents its own discrete network. The resulting separate storage "silos" can undermine the capabilities of the virtualized environment as VMs can be mobilized only within the resource pools in their specific networks. The disparate network environment constrains the ability to balance server workloads and optimize storage capacity on the fly, reducing the value of the virtualized environment. To realize the true benefits of a dynamic, virtualized data center environment, the storage network architecture needs to be simplified and moved away from 'silos' into mainstream networks. Ideally, multiple architectures will converge onto a single, centrally managed network. The converged network would enable the use of common transport technology, allowing any server to connect with any other server or storage device in the data center environment. The idea is to "wire once" to enable multiple connections between multiple, disparate devices and technologies. IT professionals have begun to feel the constraining effects that traditional, complex network topologies have on virtualization initiatives: networking respondents to a recent ESG research survey on server virtualization indicated that simplifying and consolidating data center switching was key to enabling more widespread use of server virtualization technology. The purpose of this paper is to outline some of the perceived and real challenges, review the future needs, and discuss how Broadcom's converged IO solutions will enable organizations to simplify and consolidate their data center networks.

Challenges to Simplifying the Network

With organizations rapidly deploying server virtualization and citing "simplified networks" as a major enabler to accelerate effective deployments, why are converged networks not a standard feature in every data center? There are a variety of factors, but these are temporary hurdles and none seem high enough to challenge the widespread adoption of converged network architectures. These hurdles include:
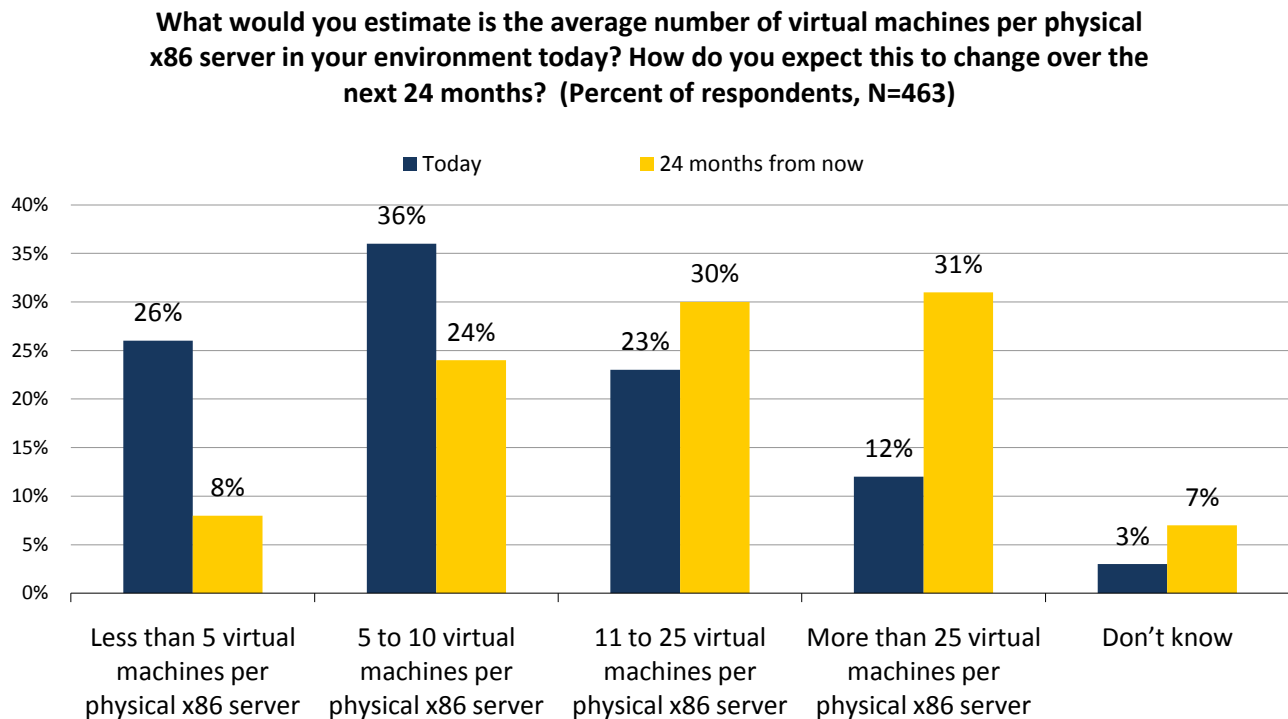
- **Existing investments:** Organizations have spent millions of dollars building out their existing networked storage teams, tools and environments. Typical legacy environments might include separate Fibre Channel and iSCSI SANs, NAS, and LANs. However, these siloed environments stifle agility and can impede optimization.

- **Skill sets:** Organizations have invested heavily in the development and training of their IT staff to create capabilities in specific network technologies. In the typical large enterprise, these specialized teams tend to stay in their own technology domains. Before virtualization's rise, these teams remained isolated and only focused on their view of the data center. Virtualization is changing the game—in order to stay competitive, organizations are creating virtualization teams that converge server, storage, and network teams**.**

- **Emerging technology:** Enterprise organizations tend to be very conservative in choosing and deploying new technology. In addition to industry certifications like IEEE, ANSI, and others, organizations tend to place a good deal of trust in specific vendor certifications and support. It should be noted that vendor certification often arrives long before the official governing bodies ratify a final, industry standard. A great example is that of 802.11n: millions of PCs were shipped with this technology in the market before the standard was officially ratified. This is now the case for converged IO networks.

- **Cultural issues:** Far more problematic in most IT environments than technical issues is resistance to change, especially in production environments. Most data centers live by the mantra "if it ain't broke, don't fix it." This is a stark contrast to today's globalized business environment that demands agility, flexibility, and sometimes bold shifts in strategy. The winners in this environment will be those that embrace change and expand their skill sets to enable a more dynamic data center that meets business needs. . .

Moving Forward

Despite challenges that slow the march of network convergence, organizations are moving forward. As virtualization and dynamic data center technologies become more ubiquitous, it becomes harder for corporate IT leadership to ignore the downstream infrastructure requirements that must be met if the twenty-first century data center is to be made a reality. Specifically, ESG sees the need for the following:

- **Dynamic infrastructure.** The strong interdependencies between server virtualization and the supporting infrastructure necessitate increased utilization of storage networking environments. However, it is important to note that these networks will require more throughput than legacy environments if they are to deliver server virtualization's advanced mobility functions. ESG research indicates that organizations are increasing the number of VMs per physical host: while most respondents average 10 or fewer VMs, that number will increase dramatically in the next 24 months. Most organizations will have 10 or more and 38% project that they will have 25 or more. Keep in mind that in the legacy compute model, most applications had a dedicated server and network connectivity, so IO wasn't an issue—but with 25 or more applications sharing the same network connection, throughput and IO will be critical. In fact, the number one impact server virtualization has had on the network is that is has created more network traffic in the data center.

Figure 3. VM Density Now and in 24 Months

What would you estimate is the average number of virtual machines per physical x86 server in your environment today? How do you expect this to change over the next 24 months? (Percent of respondents, N=463)
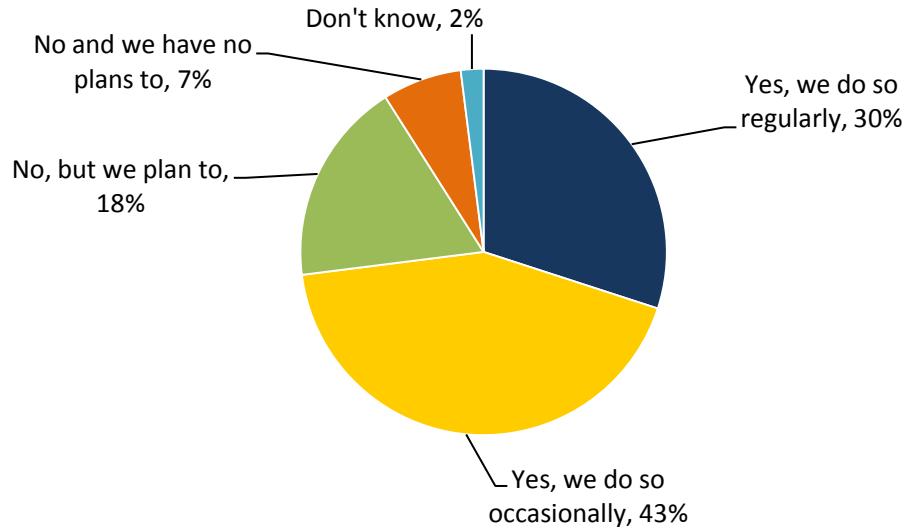

Source: Enterprise Strategy Group, 2011.

- **Greater use in production environments.** Adequate throughput and performance becomes even more of an issue when you consider more organizations are going to be deploying VMs in production environments. Based on ESG research, respondents reported having about 38% of their production applications running on VMs, but over the next two years they expect that to increase to 58%. This will put more pressure on IT to deliver the same levels of performance and availability as they had in legacy physical data center environments. The network controllers will need to provide a very high performance architecture supporting millions of IOPS to process the IO requests within these dense VM environments. High IOPS and line rate performance will be a big part of removing the IO blender effect which leads to VM stall.

- **Greater use of advanced mobility.** While not quite ubiquitous, organizations are leveraging advanced mobility features. ESG research indicated that 30% of respondents reported regularly performing online migrations of VMs and another 43% stated they do so occasionally (see Figure 4). ESG expects this number to rise as business demands require much faster responses to changing market conditions; as demands for server mobility mount, the ability to provide stateless server deployments will be critical. This means that the network connectivity needs to support any workload (L2, iSCSI, NAS, FCoE, RDMA, etc.) concurrently on any port or virtual network interface card (vNIC)/virtual host bus adaptor (vHBA) from a single firmware image and driver model that is configurable from industry standard management.

Figure 4. VM Online Migrations

Does your organization perform online migrations of virtual machines (i.e., virtual machines are moved from one physical resource to another while applications remain available to users)? (Percent of respondents, N=350)

Don't know, 2%

No and we have no plans to, 7%

Yes, we do so regularly, 30%

No, but we plan to, 18%

Yes, we do so occasionally, 43%

Source: Enterprise Strategy Group, 2011.

- **Network simplification.** The ability to wire once and connect to any device with any service will be imperative to delivering dynamic, flexible services. Ethernet already enables LAN, NAS and iSCSI SAN traffic to be consolidated and it can now be leveraged to converge FC and HPC environments.

    1. **Fibre Channel over Ethernet (FCoE)**. In order to converge FC on to Ethernet a few changes had to be made to create a lossless Ethernet environment. The resulting changes are reflected in data center bridging (DCB) which was formerly referred to as Converged Enhanced Ethernet, and enable FCoE to provide the same performance characteristics. Given the popularity of FC SAN in large enterprises, this is a key step in enabling full convergence.

    2. **HPC environments**. In many HPC environments, having high bandwidth and predictable low latency is more than sufficient. These server to server connectivity requirements can now be satisfied by leveraging Ethernet as well. Technologies like iWarp or RDMA over Converged Ethernet or RoCE (pronounced Rocky) enable this convergence. Plus Ethernet's path to 40 and 100 Gbps is also critical to consideration for HPC environments when consolidating onto Ethernet.

- **Virtual machine support.** Much of today's IT transformation is focused on server virtualization; it will be important for the network to be fully aware of the VMs it is connecting to. Technologies like NIC partitioning (NIC-P) or single root IO virtualization (SR-IOV) enable a single PCIe device to effectively provide dedicated support to multiple VMs, helping drive valuable features like multi-tenancy and quality of service. As organizations continue to drive higher VM to physical server ratios and move more VMs into production, these services will be necessary to guarantee performance. For service providers, the ability to segment services will be critical.

- **Substantially more bandwidth.** Ethernet offers a very attractive roadmap, providing 10 Gbps now, with 40 and 100 Gbps speeds on the way. By comparison, Fibre Channel provides, 8 Gbps now, with 16 just emerging and 32 projected. This rapid growth in bandwidth will be important as organizations continue to grow and scale. ESG research showed that advanced server virtualization users indicated that the biggest impact to the network environment was that they had deployed 10 Gb switches. However, those organizations with less mature environments were already thinking that they would need to deploy 40 Gb

technology to provide adequate bandwidth. Following current trends, this need will surely extend to 100 Gb in the not-too-distant future.

- **Business agility will trumps costs.** Justifications for converged networks shouldn't be based solely on CAPEX or OPEX. As noted in Figure 1, many organizations are sharpening focus on business process improvement. The ability to create an agile IT environment to better handle requests from the business may soon take precedence over cost concerns. It doesn't mean costs are not important, especially on the OPEX side, and converged networking should help to reduce operational costs as well. From a CAPEX perspective, as more organizations deploy converged solutions on 10 Gb Ethernet, the initial costs should begin to decline as the volume increases.

Broadcom Solutions

Broadcom, a $6.8B Fortune 500 company, is well known for its semiconductor offerings to support consumer products; it has design wins at Apple (iPod, iPhone), Nintendo (wireless controllers), and many other well known organizations. Less well known, however, are its design wins in SMB, enterprise, and cloud infrastructure OEMs such as Dell, HP, IBM and Cisco. In fact, any organization with a network using Ethernet controllers and switches from Avaya, Cisco, Dell, HP, or IBM is already using Broadcom products. Granted, the brand probably isn't recognized because many of its products carry an OEM label, but Broadcom has been a major supplier of networking semiconductors and cards for many years. It has over 14,000 patents and ships over ten million Ethernet controller ports—*to the data center*—annually.

Those ten million controller ports represent a wide range of solutions that meet diverse business needs. While Broadcom has been focused on Ethernet solutions and, by most accounts, has industry leading market share in 1 Gb and 10 Gb Ethernet, it also has a very strong storage story. The Broadcom iSCSI HBA and LAN on motherboard (LOM) have been qualified by major OEMs including Cisco, Dell, HP, and IBM. In fact, Broadcom claims that its Ethernet products are used more than any other vendor for NAS and iSCSI, so it would only be natural that it participates in simplifying the network through convergence. Today, Broadcom is shipping products that can support converged LAN, NAS, and iSCSI and the company recently announced expanded support to include FCoE. More importantly, Broadcom's converged technology is capable of running and processing any of these protocols concurrently, which will allow for great flexibility and agility in configuring a complex network.

Figure 5. Converged Networking


Converged Networking
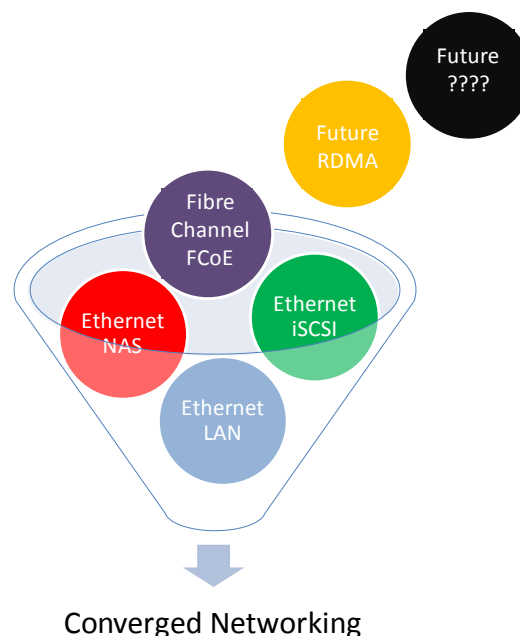
Source: Enterprise Strategy Group, 2011.

Broadcom offerings take different form factors to meet specific requirements and the company currently offers single chip LOM, Mezz cards, and standalone adapter cards, in dual or quad ports.

Broadcom delivers all these capabilities via its powerful and flexible CNA architecture, which is specifically designed to allow the solution to adapt to changing requirements while remaining energy efficient and delivering high performance. The architecture is:

- **Designed to adapt.** Broadcom's field-hardened CNA product line has evolved to support Stateless L2 offloads, iSCSI, and TCP/IP offload Engines (TOE). The CNA architecture has now expanded to include FCoE and will evolve to offer RDMA in the near future. Additionally, as server virtualization usage has grown, the CNA has incorporated IO virtualization technologies like single-root IO virtualization, multi-queuing/net queuing, and NIC partitioning—functionality that will be required to handle the expected VM to physical server ratios efficiently. It also has adapted to support DCB (lossless Ethernet), PCIe Generation 3, and virtually any cable plant.

- **Designed to be green.** Broadcom was an early supporter of the IEEE P802.3az Energy Efficient Ethernet (EEE) Task Force and has embraced this standard to drive down energy consumption in its CNA architecture. In addition to creating a program to drive compliance with EEE, aptly named Auto GrEEEn, Broadcom has developed solutions to bring older network equipment into EEE compliance by leveraging its wide range of EEE enabled physical layer devices (PHYs).

- **High performance.** The CNA has a wide array of offload engines including full iSCSI, FCoE, TOE – Chimney as well as TPA—and Stateless L2. The dual port cards provide full line rate, full duplex 10GbE performance at 40Gbp/s and more than 1.7M IOPs of FCoE performance and 1.1M IOPs of iSCSI performance. The full offload engine minimizes the CPU usage required for optimizing VM performance.

Figure 6. Broadcom High-Speed 10G Controller Architecture
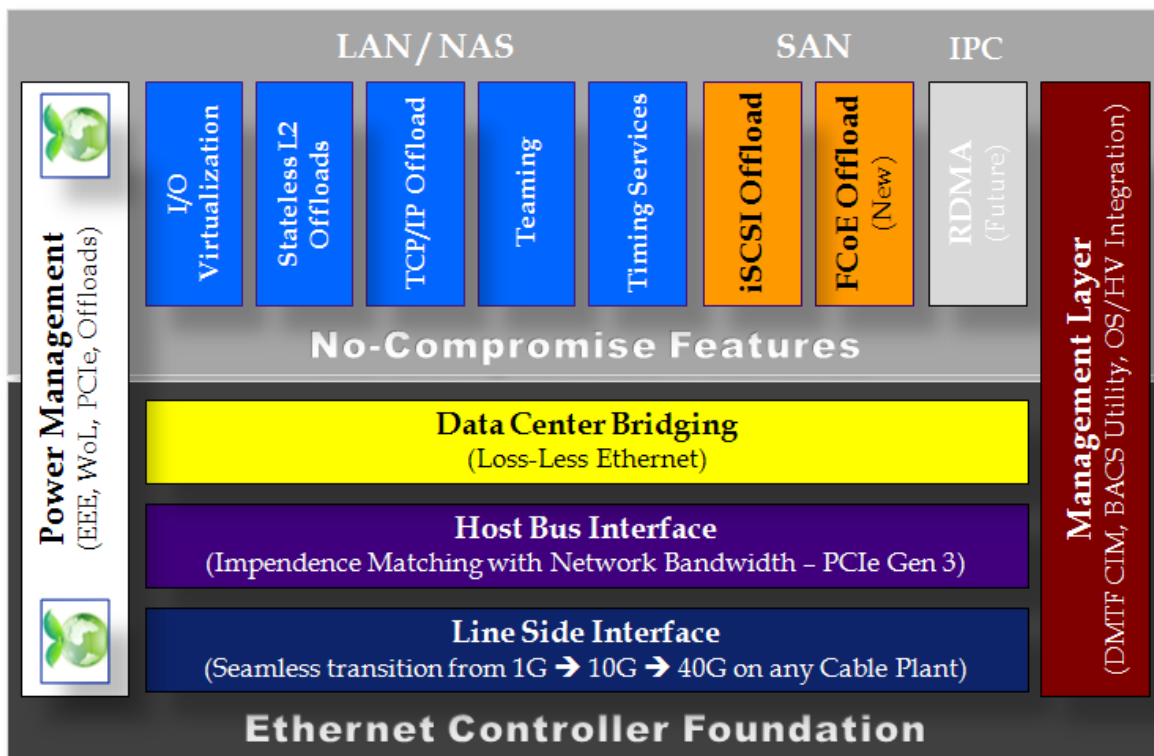
Source: Broadcom, 2011.

Broadcom has the solutions to deliver tomorrow's convergence-ready infrastructure today. For organizations involved in their own server virtualization initiatives, Broadcom CNAs are a great fit for new virtualized server environments, top of rack converged infrastructures, and converged environments.

The Bigger Truth

Organizations are rapidly transforming their IT environments into dynamic data centers capable of handling the demands of the twenty-first century. The central component of this transformation is server virtualization, which provides the agility to serve the business with appropriate levels of service and performance. Converged networks will play an increasingly important role in enabling the delivery of services to the right resources precisely when needed. Insightful IT executives should be evaluating how their organizations will transition from collections of disparate networks to singular, converged, highly flexible networks.

Broadcom has played a leading role in powering Ethernet-based networks for many years and most likely is already deployed in your data center environment. Broadcom is leveraging its deep knowledge, technology, and experience in delivering solutions—including those for NAS and iSCSI—to drive further consolidation with FCoE and in the future, RDMA. Broadcom's goal is to deliver high performance, low cost, energy efficient solutions that enable organizations to become "convergence ready." It has built in the IO virtualization technologies that will be required for the next phase of virtualization adoption and is architected to enable the future transitions to 40 and 100 Gb Ethernet in a seamless fashion.

Significant transitions to new technologies and IT strategies are always accompanied by challenges. Organizations with clear goals and willingness to embrace change will rise; those that do not will face the prospect of becoming marginalized. As Charles Darwin said, "It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change." Broadcom, armed with a clear view of the macro trends and inevitable transitions that are occurring in today's data center, is responding to the needs of the market by delivering high-performance, energy efficient, and convergence-ready solutions. Ask your vendor about Broadcom convergence solutions—chances are, you are already using them.