IDC
Analyze the Future

Global Headquarters: 5 Speen Street Framingham, MA 01701 USA P.508.872.8200 F.508.935.4015 www.idc.com

WHITE PAPER

Evaluating the Value Proposition of the IBM eServer BladeCenter with InfiniBand

Sponsored by: IBM

John Humphreys Lucinda Borovick

November 2004

EXECUTIVE SUMMARY

Every day, CIOs face more complex challenges (e.g., transaction volumes, performance requirements), and end-user demands keep growing at an accelerating pace. Meanwhile CIOs are facing an ever-increasing need to cut costs and deliver services with fewer resources while finding new sources of revenue. To maintain business-critical operations and provide their organizations with a competitive edge, enterprise CIOs are seeking to create a simpler and easier-to-manage datacenter topology, with an infrastructure that increases application availability and performance, reduces support costs, and adjusts quickly to unpredictable workloads and changing business needs. In short, the datacenter infrastructure needs to provide much greater flexibility.

Blade servers are providing the first step in creating a datacenter infrastructure that is more flexible. Many organizations are consolidating their rack-optimized, datacenter servers into a blade server chassis for greater efficiency and simplicity. Blade servers enable customers to react quickly to changing business needs by seamlessly scaling server, storage, and network infrastructure. Their ability to increase availability and manageability makes blade servers an attractive option for adopting scale-out computing. Additionally, datacenter managers are increasingly adopting infrastructure virtualization to improve service levels, integrate and deploy applications faster, and respond quickly to changing business needs and market conditions.

As CIOs deploy a new datacenter infrastructure, they will need to consider not just the server environment, but the entire spectrum of solutions available in the datacenter. When attempting to improve flexibility, enhance performance, and increase uptime, CIOs must evaluate the server interconnect technology. InfiniBand offers high-bandwidth and low-latency features that provide the flexibility needed to support migration to scale-out virtualization.

To meet CIO requirements, IBM has integrated the Topspin InfiniBand switch into IBM eServer BladeCenter in order to provide a solution that provides both the high-performance, low-latency benefits of InfiniBand as well as the strategic benefits of blade servers and scale-out computing.

CIO CHALLENGES IN THE DATACENTER

Enterprises need a vast amount of IT resources to address the challenges of running all the facets of a complex business. To manage these resources effectively, CIO's are increasingly looking beyond point solutions and treating the datacenter more holistically. This holistic approach enables CIOs to address challenges on the business service level. These challenges include:

- **Application availability.** Enhancing application uptime through intelligent provisioning of server, storage, and network resources increases critical business service levels.

- **Application performance.** Enterprise customers are deploying applications to a global constituency of employees, partners, and suppliers. The performance of these applications in the datacenter, and throughout the enterprise, is critical to enabling business benefits from the IT infrastructure.

- **Datacenter scalability.** The ability to fluidly scale the infrastructure to support more users and new applications means that CIOs can begin to rapidly respond to peak workloads without sacrificing application performance.

- **Aligning IT resources with businesses' priorities.** The ability to rapidly shift IT resources to meet changing business requirements is critical to unlocking the value of the IT investments. To improve the cost of ownership, organizations must squeeze more flexibility from their infrastructure.

- **Simpler infrastructure management.** To reduce costs and minimize mistakes that cause downtime, enterprises must streamline the infrastructure management process.

- **Reduce total cost of ownership.** Demands to reduce the total cost of IT expenditures continue unabated. Opportunities for cost reduction are most promising when IT managers can contain and lower the cost of managing datacenter infrastructure. IDC estimates that, on average, approximately 60-70% of server life-cycle costs are associated with datacenter infrastructure management.

To meet these challenges, datacenter infrastructure and topologies will need to change. Applications will need to take advantage of real-time provisioning of server, storage, and network resources. IT staff, aided by supplier service offerings, will have to provide an infrastructure that is always available and that is capable of adjusting to rapidly shifting user demands and server resources. In effect, the IT infrastructure will need to provide much greater flexibility. Three key trends that enable this greater flexibility is the migration to scale-out computing, blade servers, and virtualization technologies.

BLADECENTER WITH TOPSPIN SOLUTION

In keeping with customer need and demand for unified scale-out architecture, IBM and Topspin are jointly developing an InfiniBand switch for IBM's eServer BladeCenter. This effort provides the low-latency, high-performance benefits of InfiniBand in addition to the provisioning, scale-out benefits of BladeCenter, facilitating server virtualization and simplified I/O architecture. The solution provides the following:

- Daughter card that provides dual connectivity to switch modules. Similar design to the IBM Gigabit Ethernet daughter card and the IBM Fibre Channel daughter card.
- The InfiniBand switch module, which has 14 ports interfacing to the blades and four ports to the network.

Both InfiniBand and server blades are seeing success in highly computational environments. The combination of blades and InfiniBand enables IBM to broadly position the BladeCenter platform in the market for high-performance, low-latency solutions. IDC expects that, with the inclusion of an InfiniBand switch, IBM will be able to extend and enhance these high-performance features further while also offering new features and benefits, including easier manageability, easier scalability, and greater flexibility to support on-demand computing. In addition, a blade server with integrated InfiniBand switching allows IT managers to build a massively scalable server farm that meets business benefits with blades and I/O interconnects virtualization.

Topspin VFrame

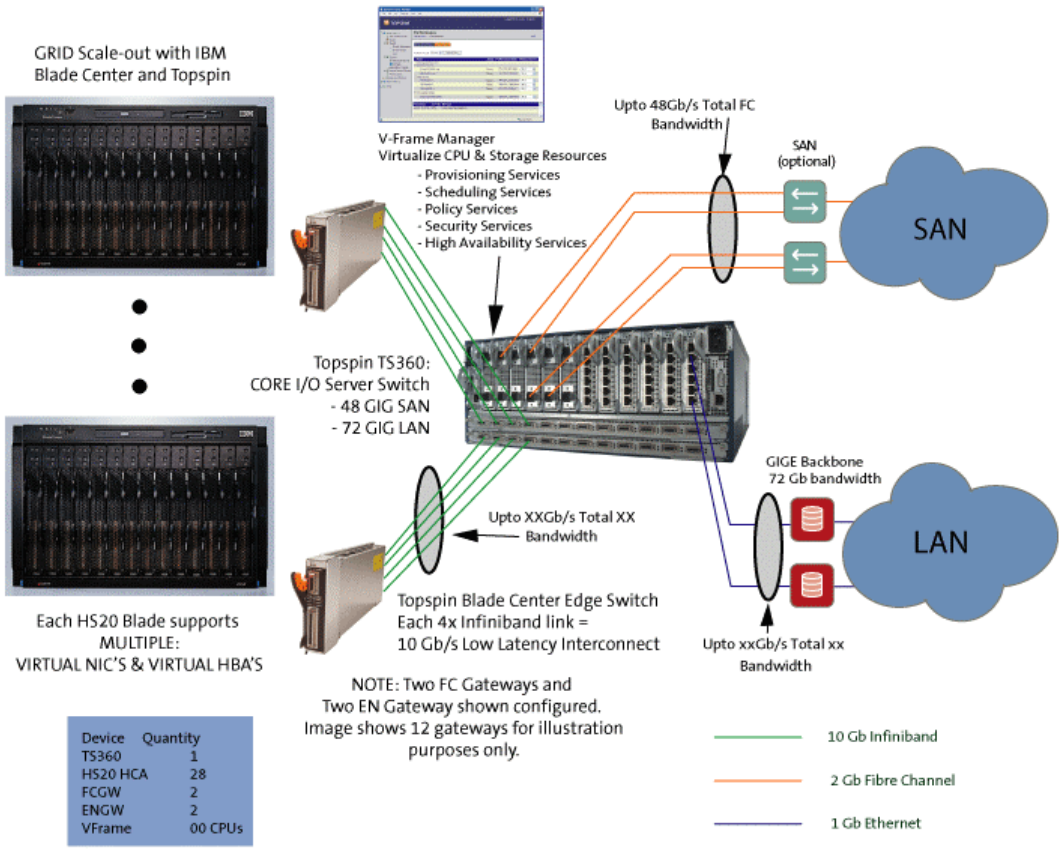
The IBM partnership with Topspin is positioned to bring significant advancements in both server and I/O virtualization through the addition of Topspin's standard external server switch platforms and VFrame™ software along with the integrated InfiniBand solution for BladeCenter.

Not only is the partnership with Topspin tactical, giving IBM BladeCenter another interconnect in order to deliver more customer choice, but it is also very strategic. Topspin offers IBM a broader solution for provisioning both servers and I/O, dramatically consolidating and virtualizing I/O and storage interfaces, and effectively deploying BladeCenter as the foundation of a flexible blade-based grid or utility computing solution.

Topspin's external server switch portfolio is a collection of InfiniBand switches and I/O chassis that allows large server fabrics or grids to be built out of many servers and then provides centrally managed virtual I/O and storage connections to that entire pool of servers (see Figure 1). Combined with the integrated Topspin InfiniBand switch for BladeCenter a fabric of hundreds or thousands of server blades can be built. Topspin's server switches have been IBM Server and IBM TotalStorage proven.

FIGURE 1

BladeCenter and VFrame for Virtualized Infrastructure



Source: IBM and Topspin, 2004

Topspin's VFrame virtualization framework is a management and virtualization software suite that works in conjunction with the Server Switch fabric and allows the user to create virtual servers by mapping individual server CPUs, I/O, and storage resources together on demand. The technology works by centralizing the I/O and tying the provisioning of applications and OS images to servers and the allocation of I/O and server resources to user-defined business processes.

VFrame is made up of the following:

- **VFrame Director.** A user interface that includes a network topology mapper, an interface to third-party software (such as IBM's Tivoli), as well as the Topspin UI for configuring and creating virtual server groups. Vframe Director includes the ability to not only group individual servers to them but to also provision the application and OS images, storage, and LANs, and assign policies based on business needs.

- **Firmware**. Firmware runs Topspin's server switch platforms, essentially making them programmable with "triggers" and "actions" for creating the right resource mappings at the right time.

- **APIs and protocol standards.** These are used in programming the server switches, including SNMP, DCML, DMTF and others.

The centralization of the I/O and server allocation allows users to reduce their datacenter complexity with a unified fabric for IPC (clustering), LAN, and SAN traffic. VFrame not only allows for the granular provisioning of servers through centralized, automated virtualization and boot services, but also to provision new applications to servers so that "supply" of services is directly tied to "demand" in a way that reduces downtime by allowing the IT administrator to quickly respond to network or server failures.

Beyond the technology, the VFrame suite is open, nondisruptive technology that not only allows the user to choose their server type and/or vendors, but also reuse the existing infrastructure that is already in their datacenter. This avoids the rip-and-replace approach, which in turn helps to drive up return on investment.

Topspin is making the VFrame technology available as part of its "grid-to-go" utility computing starter kit, which includes the software suite as well as a TS360 server switch with two Fibre Channel ports, six Ethernet ports, and 24 PCI-X host adapters for SAN, LAN, and IPC network consolidation.

The combination of Topspin's integrated solution for BladeCenter, along with the external server switch portfolio and VFrame software suite offers a compelling solution for BladeCenter allowing it to be deployed equally well for either high-performance computing clusters, or for commercial grids, or utility datacenters.

SYNERGIES WITH INTEGRATION: BLADECENTER SCALES GRACEFULLY

The integrated IBM BladeCenter and Topspin solution targets a number of customer requirements. IBM is exploiting their partnership with Topspin, and the unique capabilities of InfiniBand, to deliver solutions to problem's being faced by today's datacenter CIOs.

Reliability is multiplied. The inherent reliability benefits that BladeCenter offers, including hot-swappable blades, power supplies, and fans, coupled with the inherent reliability built into the Topspin switch fabric with multiple redundant paths, offers compounded reliability in the overall platform.

Provisioning. To become more productive, IT administrators need to offload their mundane, day-to-day tasks to software and hardware solutions that can "automate" certain tasks, allowing them to focus on higher-value projects, such as planning for new application and service rollouts. Provisioning — the allocation of software (including patches, upgrades, operating systems, and applications) — is a particular area of focus in terms of enhancing IT administrator productivity as well as driving consistency across datacenter resources. By offloading processes to the automation

software, administrators are able to accomplish tasks more efficiently and deliver changes in near real time.

Granular scalability. Enabling customers to react quickly to changing business needs by seamlessly scaling server storage and network infrastructure is a key requirement for IBM. The BladeCenter architecture offers customers a pay-as-you-grow computing model. This model, coupled with Topspin, allows customers to apply granular scalability to storage and network connectivity by shielding the network from physical changes on the server cluster.

Management. This includes the instrumentation of the hardware through some platform monitoring tools as well as platform manageability and remote system management capability. IBM has recognized that, by consolidating servers into a chassis, users have the ability to streamline the infrastructure management process to improve the operational efficiency of the datacenter and reduce the demand on the IT administrator. IBM is aggressively addressing this need with its Director product, which comes standard with the BladeCenter. Director allows users to manage the entire device holistically, while also delivering granular monitoring and management of the individual server, switch, or component on the device. IBM includes integrated systems management processors on all the blades, as well as a chassis-based redundant management module that offers aggregated management and advanced features, such as streamlined blade software deployments. Increasingly, IBM is working to integrate Director with third-party solutions in order to deliver enhanced value to its customer base.

Storage virtualization. The IBM BladeCenter and Topspin solution provides a flexible deployment option for customers interested in storage virtualization. With the ability to appear like a Fibre Channel host the Topspin switch enables IT managers to decouple the network connection of server assets from storage assets. A flexible deployment option is a critical building block step toward the migration of storage virtualization.

Performance. The IBM BladeCenter and Topspin solution provides a high-performance platform. Depending on the configurations, estimates from IBM illustrate latencies as low as 7 usec and throughputs per blade as high as 1.9Gbps. With the new Topspin solution, Blade Center Chassis-to-Chassis and Chassis-to-I/O and Storage throughput is enhanced from a max of 24Gbps without Topspin to a max of 80Gbps with Topspin.

BENEFITS OF INFINIBAND

As datacenter managers look to provide an IT infrastructure that can fluidly scale to meet rapidly changing business requirements, they are evaluating all the technologies available in the datacenter. In addition to migrating to new server and operating system platforms, companies are looking for further opportunities to increase flexibility and functionality within the datacenter architecture. One option is a server interconnect technology, called InfiniBand, which offers a high-speed serial bus architecture. Its specification was first completed in October 2000.

InfiniBand offers the following benefits to enterprise datacenters:

- **Low latency.** A tightly coupled server architecture depends upon a network that is low in latency in order to support highly sophisticated applications. Highly computational environments and database clusters are two examples where low latency is critical. To provide low latency, the InfiniBand I/O fabric is designed to scale without encountering the latencies that some shared-bus I/O architectures experience as workload increases.

- **High bandwidth.** The bandwidth available from InfiniBand solutions range from 2.5 to 10Gbps throughput, with a promise of 120Gbps throughput in the future. InfiniBand's 2.5Gbps bandwidth is on equal footing with 2Gb Fibre Channel and roughly twice that of Gigabit Ethernet.

- **High performance.** The combination of low latency and high bandwidth enables InfiniBand to offer a high-performing solution.

- **Attractive price.** At an average price per port of under $300, InfiniBand is comparable in price to Gigabit Ethernet and 10 times less expensive than 10 Gigabit Ethernet. For customers who have high-bandwidth, low-latency requirements, InfiniBand is the most attractive option in pricing. Figure 2 compares the average price per port of InfiniBand, Gigabit Ethernet and 10 Gigabit Ethernet. Additional benefits in pricing for InfiniBand over Ethernet include the inherent reliability of the platform and the ability to halve the number of ports purchased due to the architecture's reliability. Infiniband ports are also less expensive than Fibre Channel ports currently at one-third of the price of Fibre Channel.

- **Reliability.** The InfiniBand architecture has a number of features that increase reliability. The architecture connects directly to the channel I/O — as with mainframe computers — and it has an efficient message-passing structure to transfer data. With multiple redundant paths between nodes, the architecture isolates the impact of failures

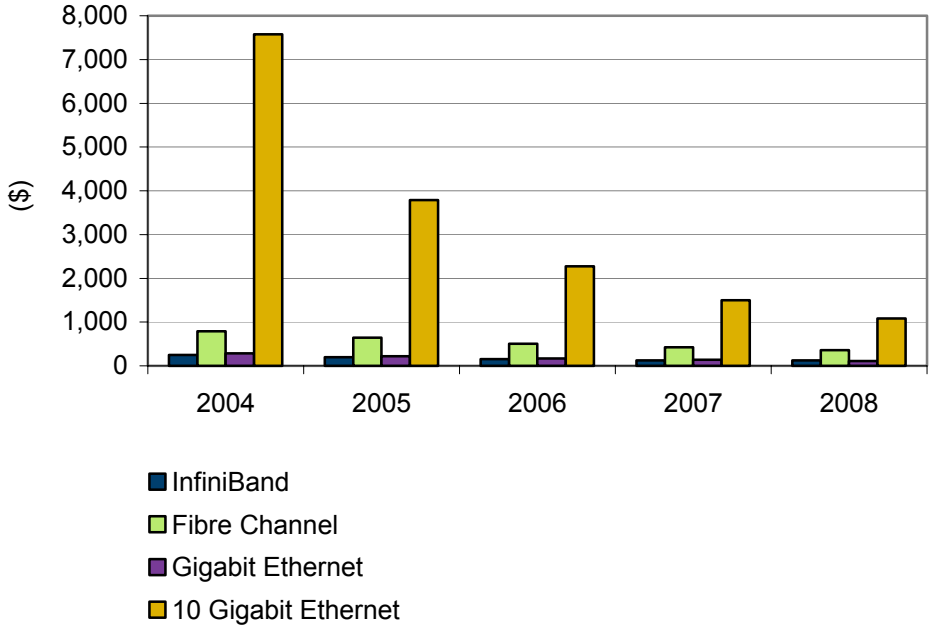
- **Unified I/O fabric.** The cabling environment within today's datacenters is complex at best and unwieldy at worst. A resilient IT infrastructure is the highest priority, but the demand for resiliency adds complexity to cabling, increasing the probability of errors. Today, servers at high-end datacenters are connected to both LAN Ethernet switches and Fibre Channel switches, and each of these connections is doubled to create redundancy in the architecture. For even a midsize datacenter the cabling requirements are massive. InfiniBand offers customers an alternative from these cabling headaches with the ability to unify and minimize the compute fabric in the datacenter. This enables a cleaner connection to the communications and storage fabric in the datacenter. Additionally, since InfiniBand takes the I/O outside of the server, it provides a way to share I/O interconnects across multiple servers and enhances scalability.

- **Standards based.** In the past, customers needed to resort to proprietary interconnects to create high-performance server clusters. InfiniBand's design criteria were molded by the major systems vendors, including IBM, HP, Dell, and

Sun, bringing a wide range of needs to the specification. InfiniBand offers the benefits of high-performance computing in an industrywide standard. It supports both copper and fiber-optic cabling and is designed to coexist in the datacenter with Fibre Channel and Ethernet.

FIGURE 2

Interconnect Pricing: InfiniBand Versus Fibre Channel, Gigabit, and 10 Gigabit Ethernet



Source: IDC, 2004

INFINIBAND MARKET OPPORTUNITY

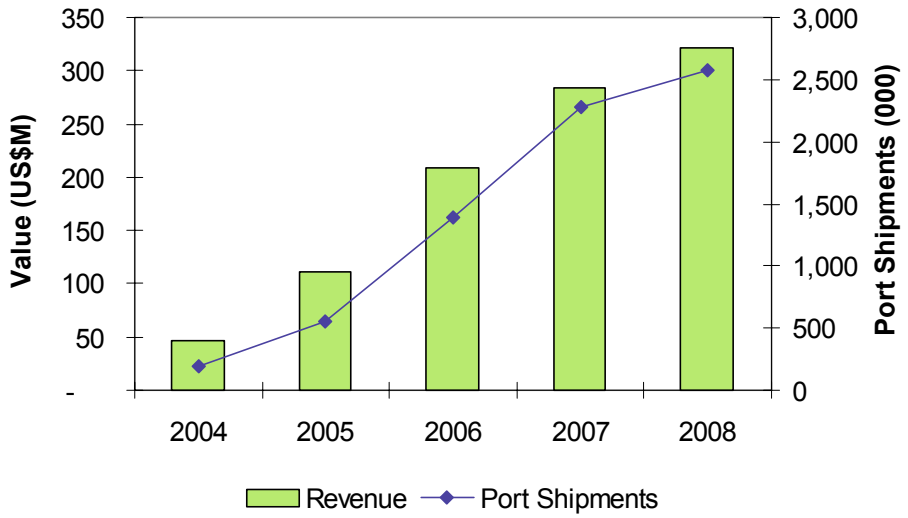
The enterprise datacenter architecture is transforming to support a dynamic IT environment that meets critical business requirements. IDC believes that InfiniBand will offer an important option for customers looking to meet this new agility challenge, and will provide the necessary availability and performance required in datacenters.

The worldwide market for InfiniBand will grow from $56 million in 2004 to reach $324.7 million in 2008, representing a CAGR of 55%. The total number of InfiniBand ports will increase from 186,727 in 2004 to 2,575,167 (see Figure 3). While the early sweet spot of the InfiniBand market will be in high-performance computing and server clusters, the market is expanding into the commercial space both through the adoption of scale out databases as well as through early customer interest in the

benefits of utility computing — as InfiniBand helps to drive network consolidation and more unification in the network fabric.

FIGURE 3

Infiniband Adoption: Port Shipments and Value, 2004–2008



Source: IDC, 2004

High-Performance Computing

Both server blades and InfiniBand have developed a strong early following in the high-performance computing (HPC) space as the market transitions from large standalone SMP machines to clusters of smaller systems. This transition, along with the emergence of Linux, has helped to rapidly open a new market opportunity just as blades and InfiniBand were coming to market.

The move to Linux has led to the ability to handle a large number of nodes in a cluster. IDC estimates that upward of 35% of the HPC market is now running on Linux clusters. This move is buttressed as new cluster management and automation software help to streamline cluster operations, bringing users to consider installing commodity clusters. Figure 4 shows the penetration of cluster-based systems into the HPC market over the last eight years.

IDC believes that both blades and InfiniBand have initially emerged in the HPC market for a variety of reasons, including:

- **Applications turnover.** As problem scope expands, so do requirements for more sophisticated simulations/applications. Users that are continually modifying

or upgrading their apps, and thus continually recompiling and testing, are more open to the use of new architectures.

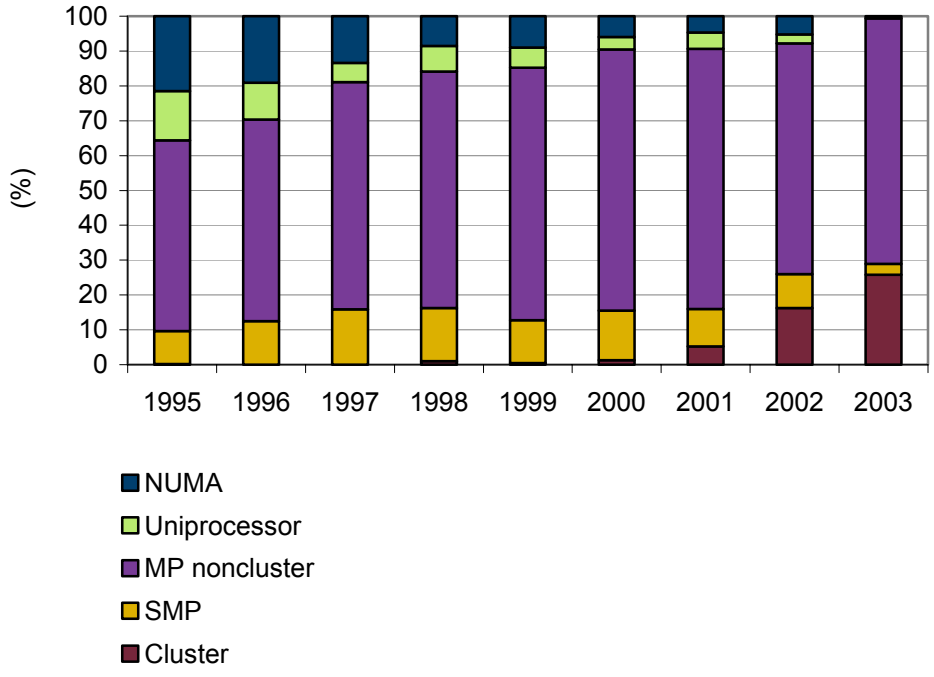
- **Systems turnover.** The above analysis also leads to a relatively short life cycle for systems (something on the order of three years, at least as primary systems). This reduces the risk of using new technology: Unless it is a catastrophic failure, a system can be kept busy for three years or so and then quietly retired.

- **Willingness to take risks.** Academic and sometimes national labs have a charter to extend the world's knowledge. This philosophy allows them to take risks with new technology and often be credited if they can demonstrate why an idea does not work well. Industrial users will take some risks on new approaches if they believe there is a good chance they will lead to a competitive breakthrough.

- **Price/performance.** Many users are simply cycles-hungry and are thus willing to take on new technology or vendors that allow them to maximize the number of cycles purchased for their budgets.

FIGURE 4

Worldwide HPC Shipment Share by Architecture, 1995–2003



Source: IDC, 2004

While the HPC market has provided a good proving ground for these technologies, individually as well as collectively, both blades and InfiniBand have shown strength in

the commercial market as well. The early success in HPC has directly led to a greater interest by users to understand how these technologies can be applied to their enterprise environments.

Commercial Enterprises

The market for blade servers appears to be ready to rapidly expand beyond early adopters in HPC and Web-serving niche markets, as the breadth of computing solutions designed on blades expand as well as the market shifts from early adopter to more mainstream users.

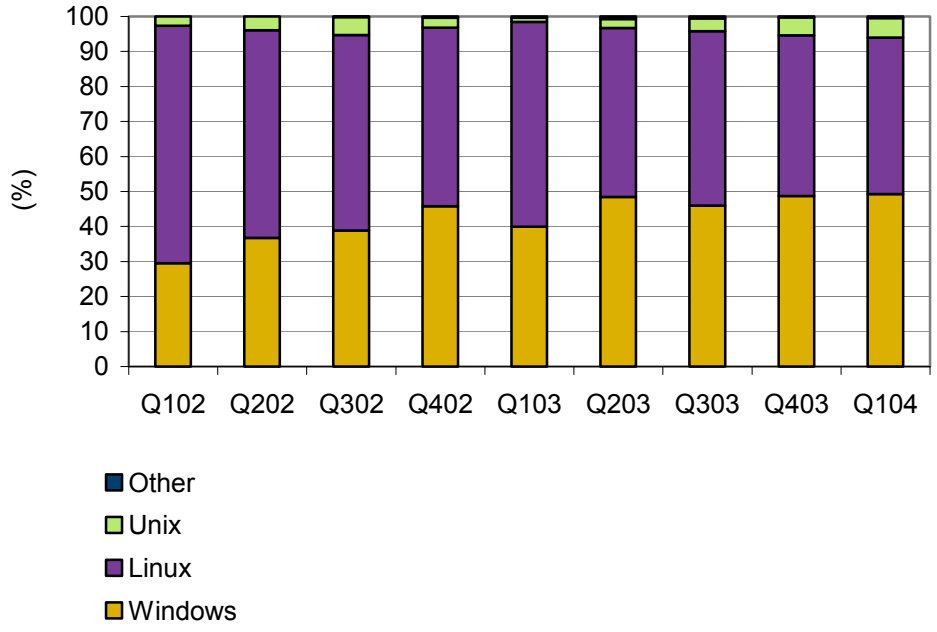
One indication or proxy to measure this shift of blade servers into the mainstream market is the shift in deployments by operating system, as shown in Figure 5. In 2002, nearly 70% of all blade server adopters in the United States ran Linux as the OS on the blade. In 2003, as the market has expanded and more traditional customers have begun to migrate to the blade platform, the share of blade servers using Windows has experienced a steady increase, with Windows shipments surpassing Linux shipments for the first time in Q403. This trend suggests that blade servers are being adopted outside of HPC and Web infrastructure environments and are increasingly being deployed to support scale-out commercial applications, database workloads, and the virtualization of datacenter resources — all areas that are also of increasingly relevant for InfiniBand-based solutions as well.

Increasingly, because of options such as InfiniBand in the blade server chassis, blades are moving beyond the information access tier and increasingly being used in the application and database tier. The combination of blades with InfiniBand is gaining particular traction in the database tier as users move to implement scale-out databases.

Looking forward, the emerging trend inside enterprise datacenters is to create pools of resources onto which applications can be provisioned to create business services on demand. IDC believes this trend represents the next phase in datacenter evolution as today's paradigm of scale-out IT growth runs up against economic constraints. Specifically, the challenges faced are associated with effectively managing and utilizing the resources, as well as delivering increased IT flexibility in order to respond to the rapidly changing business environment. The crux of these needs is addressed mainly through the virtualization of the datacenter infrastructure.

FIGURE 5

Shift in Blade Server Operating System Share, Q102-Q104



Source: IDC, 2004

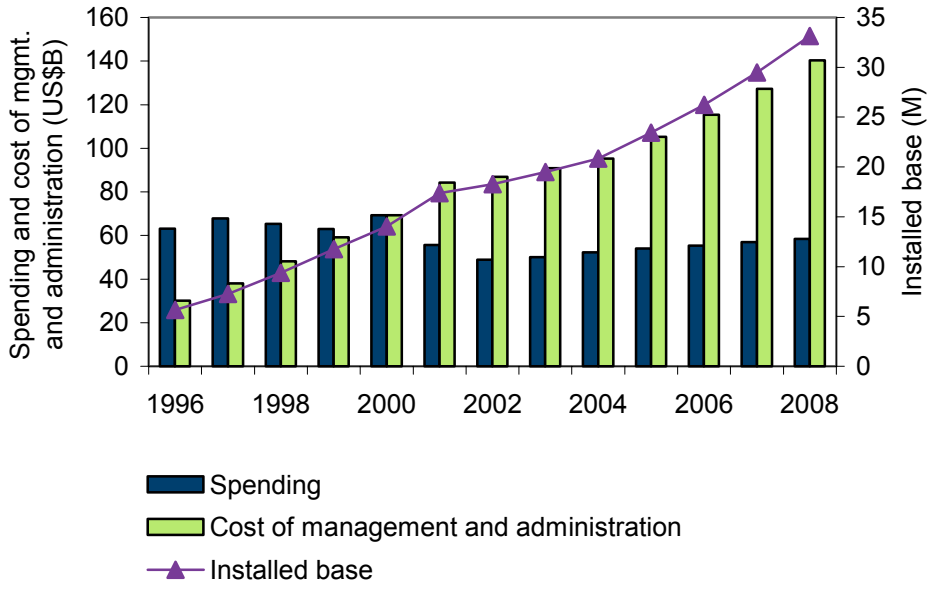
Infrastructure Virtualization

CIOs continue to face the challenge of managing costs while servicing a demanding user constituency. Figure 6 illustrates the challenge and opportunity for both suppliers of enterprise IT products and their customers as the market continues to mature. Over the 12-year period between 1996 and 2008, spending for servers is relatively flat — fluctuating between $50 billion and $70 billion spent by customers every year for new systems. During that same period, the installed base of servers in the market under management has increased from approximately 5 million servers installed in 1996 to approximately 20 million systems today, with an anticipated 35 million under management by 2008.

This trend in the increase of servers has spurred a second, much more important spending trajectory: the management and administration costs that are spent on people to deploy hardware, install software, patch and upgrade servers, and reprovision servers. In 2004, IDC estimates that more than $95 billion will be spent by companies and governments just to maintain their server infrastructure — far outpacing the expected $53 billion spent on new servers. Not only do operational costs far exceed the budgets for new hardware, they are growing at approximately two and a half times the compound annual growth rate — annually increasing at approximately 10% versus the 4% growth expected in the server market — over the course of the next five years.

FIGURE 6

Worldwide Server Spending, Cost of Server Management and Administration, and Server Unit Installed Base, 1996–2008



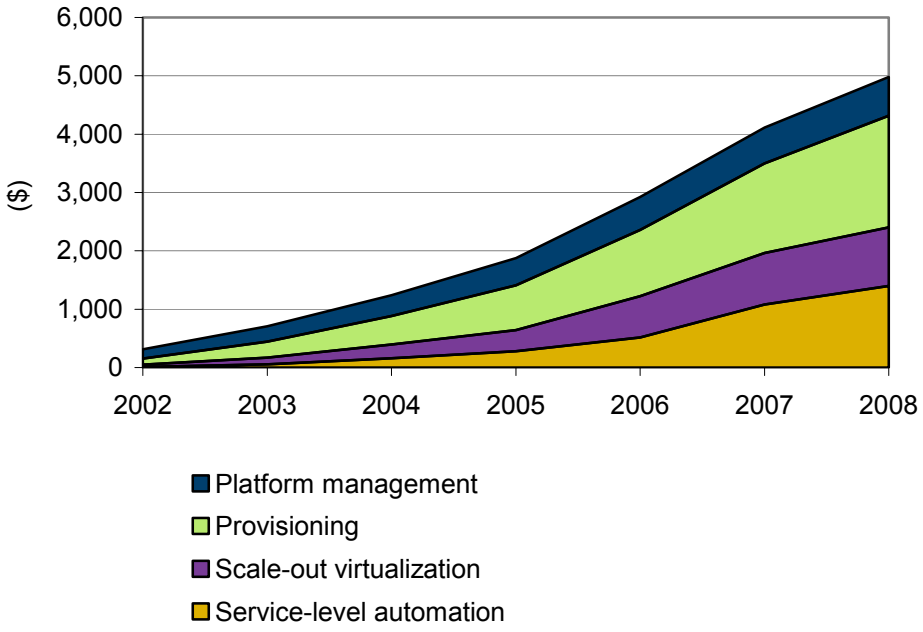
Source: IDC, 2004

This, then, is the opportunity for IT suppliers, as well as customers, to slow the velocity of growth in operating costs by automating and packaging some of the day-to-day tasks of IT managers and administrators — in effect, taking a large piece out of annual operational cost spending and transferring it into less expensive products and software that can do the tasks more efficiently.

IDC believes there is market opportunity in all of these segments and that the industry is moving toward a utility model. Figure 7 illustrates IDC's assessment of the revenue opportunity associated with server utility computing through 2008. IDC forecasts for the different product segments in creating dynamic IT operations. This opportunity assessment was completed leveraging both a value assessment and risk assessment for end users adopting each of these technologies. In the end, we found that while today the appetite for management technology is squarely focused at the platform management and infrastructure provisioning spaces, over time users expect to increasingly focus on scale out virtualization as a key investment area so that by 2008 nearly 50% of dynamic IT spending will be focused on virtualization and the associated service-level management.

FIGURE 7

Worldwide Spending for Server Management, Provisioning and Scale-Out Virtualization Solutions, 2002–2008



Source: IDC, 2004

Going forward we see early adoption of scale-out virtualization, such as offered through the combination of IBM and Topspin with the Tivoli Orchestrator and the VFrame happening largely on blades — the expectation is that a large percentage of these early implementations will be on a blade server platform, as increasingly blades are emerging as a key first step in the creation of more flexible and dynamic datacenters. In the end, we find that server blades are a key first step in the process to not only automate the mundane manual tasks inside the datacenter, but also to begin to virtualize the datacenter infrastructure.

CHALLENGES/OPPORTUNITIES

The challenge for IBM will be to expand the opportunity for InfiniBand into the broader opportunity of commercial server clusters, databases as well, long term into the datacenter virtualization market space. While InfiniBand is gaining acceptance in server clusters where high-bandwidth and low latency are key requirements, IBM will need to educate customers on the simplicity that InfiniBand offers in storage and LAN connectivity, and convince them that the benefits to utilizing InfiniBand and I/O virtualization outweigh the complexity of introducing an additional interconnect technology to the datacenter.

As part of that effort IBM will need to be able to clearly articulate how customers can map their needs to a complete blade portfolio, defining a succinct value proposition for the pragmatic market majority, continuing to drive down the cost of computing and networking, and more broadly expanding customer perceptions on their place inside the datacenter. Key to all these challenges is the development of a future road map for the customer that is both pragmatic in the near term and encompassing in the longer term.

As the blade market moves beyond the early adopters and technology enthusiasts, it is clear that demand for modular designs like blades servers is growing and that customers are increasingly interested in solutions that maximize network intelligence, computing power, availability, and density. In order to realize this vision, IBM must be willing to develop a portfolio of new application-specific network services that include security, quality of service, and service-level priorities. While this work has begun to address these challenges by articulating a strategy that emphasizes a coexistence with the existing networking infrastructure in the network, the executing of that strategy is where the real value is to be derived.

CONCLUSION

IDC believes that increased flexibility provides enterprises with the ability to unravel the complexity of their datacenters, and that the demand for high performance and availability is driving customer to evaluate new interconnect options. There is also a trend for technology customers to adopt a scale-out computing model that leverages a pay-as-you-grow model of hardware acquisition, which leads us to conclude that the blade server platform in combination with Infiniband is well positioned as an overall solution platform. Blades have already established momentum with early adopter customers and are beginning to become more widely deployed. Beyond the ease of use, ease of deployments, and density benefits, current users of the technology see blades as a platform that delivers scale-out flexibility, which translates into both reduced acquisition costs and a lower TCO. The IBM BladeCenter offering is now customizable with an embedded and integrated daughter card and InfiniBand switch module designed by Topspin.

As BladeCenter continues to experience increasing interest from end users, IBM has begun to expand the product line to meet emerging opportunities in high-performance computing and scale-out clusters. IBM's introduction of the InfiniBand switch clearly illustrates the company's intentions to focus on enterprise-class high-performance solutions to drive blades into increasingly mission-critical environments.

proposed document should accompany any such request. IDC reserves the right to deny approval of external usage for any reason.