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Realizing TCO Savings with HP BladeSystem Virtual Connect Flex-10 Technology

Sponsored by: HP

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May 2009

EXECUTIVE SUMMARY

In today's datacenter environment, server systems and data transfer volumes are increasing exponentially, presenting challenges to IT managers in terms of bandwidth bottlenecks and connectivity costs. IT organizations are seeking solutions to simplify the complexity of the server, LAN, and SAN environments as well as to increase the scalability of the IT infrastructure.

Over the past decade, the industry has shifted to a distributed environment as customers have implemented low-cost, pay-as-you-grow architectures. However, as they deployed applications onto servers on a one-to-one basis, IT organizations found themselves with a tremendous amount of unused capacity and inflexible installations. Adoption of x86 virtualization not only has enabled more applications to consolidate on a single server system but also has placed additional demand on network input/output (I/O) while adding to the complexity of managing the numerous virtual connections.

For the past several years, IDC has been reporting on the natural fit between blades and virtualization, as the integrated architecture of the blade platform matches well with the goals of virtualization. IDC forecasts that the virtual machine (VM) density on servers will continue to increase as companies utilize virtualization to reduce physical server sprawl and lower hardware expenses. Until recently, there have been limited choices for network I/O on blade-based deployments, with a typical blade supporting only the bare minimum number of Ethernet connections to effectively support virtualized applications. To facilitate this increasing VM density and to ensure the operation of enterprise applications running inside the VMs, the amount of system, memory, and I/O bandwidth in blade systems must increase.

HP Virtual Connect technology is an interconnect option for HP BladeSystem designed to simplify the connection of blade servers to datacenter networks. Virtual Connect creates pools of LAN and SAN addresses that can be assigned dynamically to server bays. HP Virtual Connect Flex-10 builds on the core HP Virtual Connect technology by extending I/O virtualization to the network interface card (NIC) ports on each blade server. Networking hardware costs and support burdens are reduced as only a single HP Virtual Connect interconnect module is required to support up to four "FlexNICs" compared with the four switches that would have been required with previous-generation blade I/O technology. Additionally, Flex-10 has the capability to throttle the bandwidth to ensure a more efficient use of networking resources. As attested to by customers who have implemented early Flex-10 deployments, it can reduce management complexity, increase IT utilization, and improve the total cost of ownership (TCO).

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SITUATION OVERVIEW

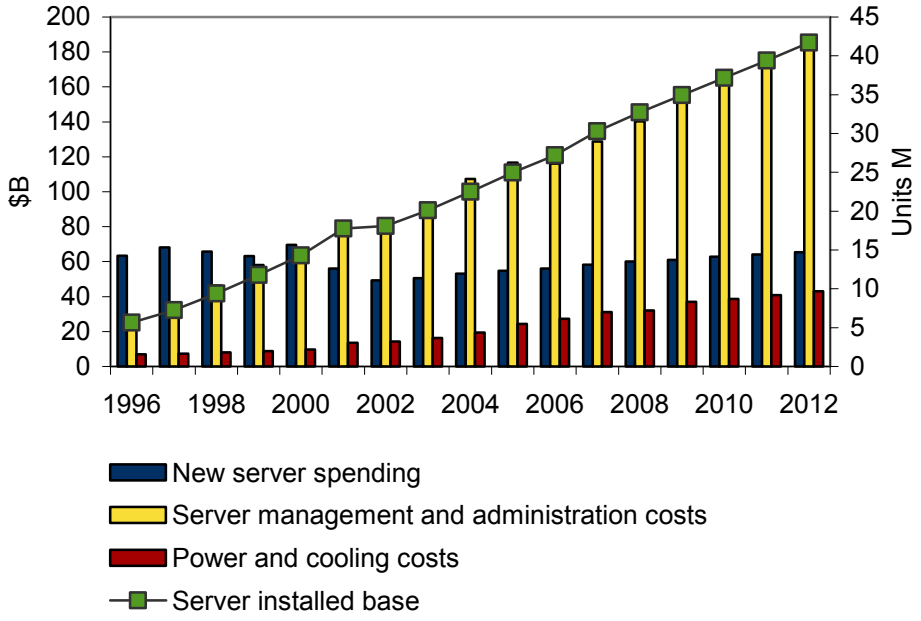
Datacenter Network and Operational Costs Continue to Escalate

The massive proliferation of physical servers in today's datacenter has led to exponential increases in data transfer volumes, bandwidth bottlenecks, and connectivity costs. As a result, IT managers face significant obstacles in their attempt to discover more cost-effective, scalable ways to deal with the increasing complexity of servers and their associated LAN and SAN environments.

As companies grew their use of IT over the past decade, they increasingly installed applications on individual servers — resulting in expensive, unused capacity and inflexible installations. There has been a shift in the server mix to distributed architectures built on new, lower-priced x86-based systems and a rapid expansion of the server footprint. These two trends have contributed to a dramatic increase in the worldwide server installed base as well as the cost to manage and power and cool those servers, as shown in Figure 1.

FIGURE 1

Worldwide IT Spending on Servers, Power and Cooling, and Management/Administration



Source IDC, 2008

Worldwide spending on servers has been relatively flat over the past few years at approximately $55 billion. In contrast, over the same period, the explosion of servers in the datacenter has resulted in a sharp increase in spending on server management and administration, which grew from $22.7 billion in 1996 to $102.8 billion in 2005. As a result, management and administration costs now greatly outpace the cost of server acquisition.

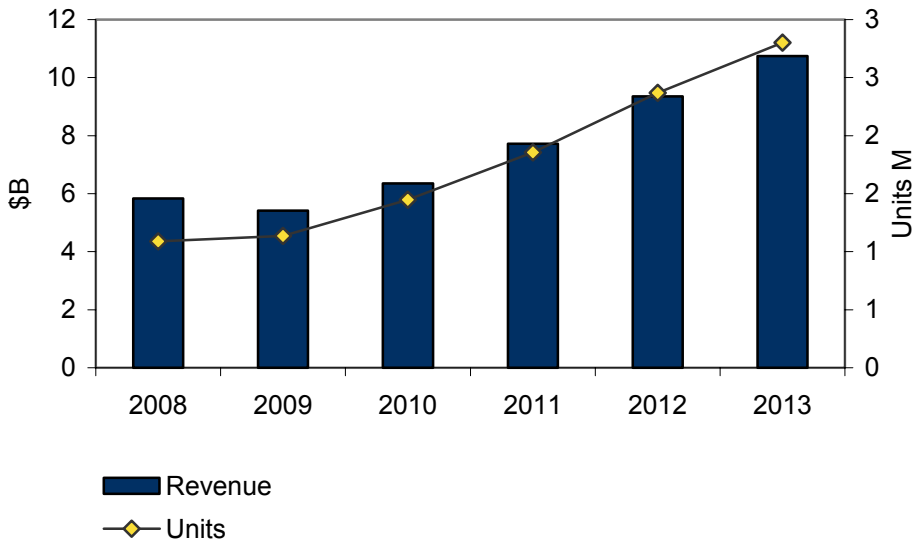
Controlling Costs by Deploying Virtualization and Blades

To control operational expenses and avoid expensive datacenter buildouts by consolidating systems, many companies have turned to server virtualization. IDC studies show that customers have been extremely bullish on virtualization due to the many benefits it delivers to both capital budgets and operational budgets.

Blade adoption has followed hand in hand with the adoption of virtualization, as blades' consolidated architecture matches well with the goals of virtualization. IDC believes that blades are the only server form factor that will experience positive unit growth in 2009 and that from a revenue perspective, blades will perform much better than the overall server market. IDC's outlook for the blade market is provided in Figure 2.

FIGURE 2

Worldwide Blade Server Revenue and Shipments, 2008–2013



Source: IDC, 2008

Virtualization on Blades Introduces I/O Challenges

As companies roll out blade-based virtualization deployments, many find that they have limited choices for network I/O. Virtual machines not only help bring more applications onto each server but also place additional demand on network I/O while adding complexity and increasing network costs and density.

Today's typical blade servers support a maximum of six to eight Ethernet connections, which is the bare minimum required to support VM applications, and that's without accounting for extra mezzanine slots for other network fabrics such as Fibre Channel, InfiniBand, or SAS. To work within these limitations, companies find they are forced to compromise network applications.

As companies continue to use virtualization to reduce physical server sprawl, IDC believes virtual server density in datacenters will rise to eight or more VMs per server over the next few years, up from an average of two to four VMs per physical server today. To facilitate this increasing VM density and ensure the operation of enterprise applications running inside the VMs, the amount of system, memory, and I/O bandwidth in blade systems must increase.

Specific challenges pertaining to virtualization and blade I/O include:

- **Bottlenecks introduced by virtualization.** As companies increase their VM density, they have run into memory constraints and I/O bottlenecks. To solve the memory problem, server vendors are developing systems that keep the memory capacity in line with the advancements in processors. I/O bottlenecks are caused by the fact that deploying more VMs per server requires a greater number of connections to that physical server. This is achieved through additional NICs and higher-bandwidth network connections, both of which come with an increase in cost, undermining the original goal of reducing datacenter costs.
- **Energy expense.** The energy expense necessary to operate a datacenter has risen sharply in recent years to a point today at which datacenter managers consider power and cooling their number 1 challenge. It is often the case that energy has become the primary limiting factor for financial budgets and the expansion of IT capacity. This surge in energy challenges is associated with the shift toward distributed environments; the energy required to power multiple smaller devices is exponentially greater than that required to power a single larger legacy system. The problem is exacerbated by supporting higher VM densities, which requires additional memory, NICs, HBAs, and core switch ports that increase the energy consumption of the system.
- **Time.** The cost of IT management and administration has increased to the point where it has eclipsed the costs of all other categories, and the time required to configure and manage network I/O is a contributing factor to this cost. Server configurations are typically static, hardwired, and relatively difficult to change. Virtualization further adds to the burden as administrators must set up and manage a vast number of VM connections. While the blade platform solves many issues by providing a unified management approach to the blades housed within the chassis, the interconnects between the blades and the LAN, and by extension to storage via SANs, still present a challenge.
- **Change management.** The industry shift toward a scale-out infrastructure has resulted in a significant increase in the number of individual systems within companies' IT environments. This has increased not only management cost but also network complexity, especially for tasks associated with server provisioning, reprovisioning, and maintenance. Change management in this environment presents challenges, particularly when altering interconnects between systems and the network and when adding networks and storage resources that boot volumes from virtualization.

- **Interconnect costs and complexity.** Most hypervisor vendors strongly recommend six to eight physical function NICs per physical server. A server blade with eight NICs requires two network expansion cards, and to support up to eight connections per server, blade enclosures require eight Ethernet switches and consume eight to 16 core ports per blade. The cost of all this equipment can be quite expensive. Further, deploying blades currently requires coordination between server, network, and storage administrators since the network addresses are encoded directly into the NICs and HBAs. This coordination is inefficient and time-consuming.

HP BLADESYSTEM VIRTUAL CONNECT FLEX-10 TECHNOLOGY

Virtual Connect for HP BladeSystem

HP Virtual Connect technology is an interconnect option for HP BladeSystem environments that is used in lieu of standard pass-through or managed switch offerings. It is designed to provide a simpler way to connect blade servers to datacenter networks by creating pools of LAN and SAN addresses that can be assigned dynamically to server bays in software, instead of being hardwired into the servers' NICs. To upstream switches, Virtual Connect Ethernet uplinks look like aggregated NICs.

Viewing connectivity resources in this way allows customers to reduce network connections, avoid switch management, and increase efficiency in operational management. IT managers minimize the touch points required for server and network administrators to add or replace servers and move workloads. Administrators can quickly and easily move resources to meet changing business needs, eliminate bottlenecks, or scale to accommodate spikes in demand.

If server administrators are managing the server I/O connectivity for more than four BladeSystem enclosures, they can use HP Virtual Connect Enterprise Manager (VCEM), an optional software package that can manage up to 200 Virtual Connect domains. With up to four BladeSystem enclosures per domain, VCEM can be used to set up and manage server I/O connectivity for up to 800 enclosures.

Virtual Connect Flex-10

HP Virtual Connect Flex-10 builds on the core HP Virtual Connect technology by extending virtualization to I/O, increasing the number of NIC ports as seen by applications on each blade server. It can maximize network utilization by partitioning each 10Gb Ethernet connection into up to four individual NICs, which HP refers to as "FlexNICs." To a virtual machine hypervisor, these look the same as physical NICs presented to vNICs and vSwitches. Because up to four FlexNICs can share a single 10Gb connection, only one HP Virtual Connect interconnect module is needed for four FlexNICs, compared with the four switches that would have been required with the previous-generation blade I/O technology. This can reduce the networking hardware costs and support burden.

With most hypervisor vendors recommending six to eight physical function NIC connections per server, VM deployments can consume all available traditional NIC and switch expansion capacity, and that's without considering Fibre Channel connectivity

requirements. Each HP Virtual Connect 10Gb Flex-10 module can support up to 64 FlexNIC connections instead of the usual 16 connections in a single HP c7000 blade enclosure, meaning that blades can take advantage of four times the number of NIC connections per server and network scalability is no longer limited by mezzanine slot and switch bay availability. Organizations can realize both cost savings and power savings because the additional network connections do not require additional NICs, blade switches, associated uplink cables, or core switch ports.

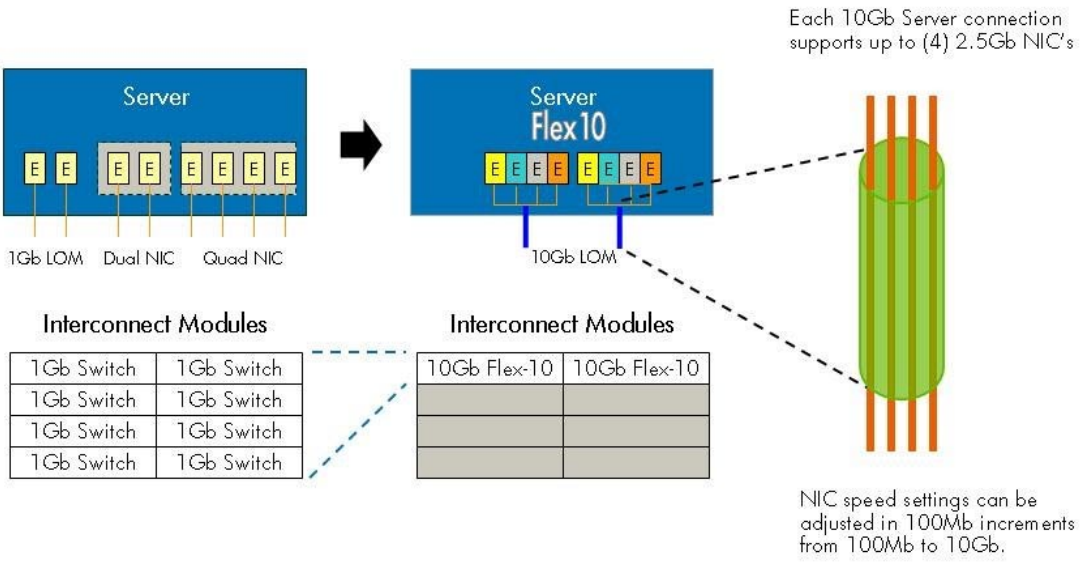
Further, this level of network consolidation is achieved using industry-standard Ethernet protocols that work with an organization's current Ethernet and Fibre Channel infrastructure. A rip-and-replace approach is not required.

Divide and Fine-Tune I/O

HP Virtual Connect Flex-10 also provides customers with the ability to fine-tune their bandwidth settings. The bandwidth of each FlexNIC can be set from 100Mb to 10Gb, in increments of 100Mb. This adds flexibility and control, enabling each virtual machine to get the right amount of bandwidth without having to resort to overprovisioning or underprovisioning the network. The bandwidth of each virtual machine network channel can be prioritized, dynamically adjusted, and adapted as workload requirements change. For a graphical depiction of HP Virtual Connect Flex-10 technology, see Figure 3.

FIGURE 3

Server Evolution: Before and After Flex-10



Source: HP, 2009

Virtual Connect Flex-10 Complements Other HP BladeSystem Technologies

In addition to HP Virtual Connect for virtual I/O networking, HP BladeSystem supports two fundamental technologies: HP Insight Software for infrastructure management and HP Thermal Logic for power and cooling. Together, these technologies play a central role in HP's approach to reducing overall datacenter operating expenses while differentiating HP BladeSystem from competitive blade offerings and rack-mounted servers:

- **HP Insight Software.** The HP Insight Software portfolio is designed to allow companies to continuously control and optimize their HP infrastructure across a variety of platforms, including BladeSystem, ProLiant, Integrity, and even storage. The foundation of HP Insight Software is HP Systems Insight Manager, which provides a single, integrated view of all infrastructure resources and delivers core event management services for discovery, monitoring, and control. On top of that are HP Insight Control Environment, a full-featured management tool that provides provisioning, imaging, deployment, and monitoring, and Insight Dynamics – VSE, an integrated management platform that enables physical and virtual resources to be managed in exactly the same way. By delivering automation for key management processes, HP Insight Software can help companies to perform more work in less time and ensure that IT talent is focused on proactive, strategic business needs.
- **HP Thermal Logic.** HP Thermal Logic combines innovations in monitoring, reporting, and adaptive management functionality designed to provide a holistic approach to power and cooling issues, from processor to enclosure design and from architecture to management. Thermal Logic is designed to pool and share power resources and, through management and thermal design, efficiently deliver those resources based on the performance level required. It ensures optimal power efficiency by incorporating server advances that enable adaptive power draw based on demand. It enables managers to quantify power consumption needs across the datacenter at the level of individual servers, racks, or groups of systems, and it optimizes the delivery of cooling resources within the datacenter. By raising the ceiling on cooling as a limiting factor for the number of servers that can fit into a datacenter, and by optimizing the power and cooling required per server, HP Thermal Logic allows IT to better scale computing resources while reducing overall TCO.

TCO Savings with Virtual Connect Flex-10 Technology

To assess these TCO savings, IDC interviewed two companies that have implemented early deployments of HP Virtual Connect Flex-10 technology: Nth Generation Computing, an IT solutions provider, and Vägverket, the Swedish Road Administration. Through interviews with these two companies, IDC identified specific areas where companies are realizing savings by implementing HP Virtual Connect Flex-10 technology, including:

- Reduced hardware costs, including reductions in NICs, switches, and cables
- IT operations associated with management
- Infrastructure costs associated with reduced facilities, power, and HVAC costs

Hardware Costs

In the discussions, one of the most noted areas of cost savings was the reduction in the hardware infrastructure required to support a given number of VMs in the datacenter. By enabling an Ethernet adapter to support the I/O requirements of multiple VMs, the customers could reduce the costs associated with the NICs, interconnect modules, and cabling for physical machines required to support their virtual infrastructure by up to 66%. As I/O bottlenecks can be the limiting factor in determining the number of VMs that can be supported by a single server, Nth Generation and Vägverket were able to break down this barrier with Flex-10. This enabled them to reduce the number of physical servers they required, saving expenses on acquisition costs for servers and software.

By deploying Flex-10 at customer sites, Nth Generation noted that it was able to use one PDI Adaptor for up to eight FlexNICs with two Virtual Connect Flex-10 modules on each one. On average, Nth Generation believes it could save customers $5,000 in hardware by opting for Flex-10. Vägverket described hardware savings of 50% as a result of fewer network connections and cabling expenses for the virtualized portion of its infrastructure.

IT Operations

Server management and administration personnel costs can represent over 80% of the costs of a typical IT organization today, eclipsing the costs associated with purchasing servers and other hardware. Technologies that can drive efficiencies in operations can therefore play a significant role in reducing this major IT cost center.

A significant percentage of datacenter IT administrators' time is taken up with the setup and management of server I/O. Configuring and updating network connections with today's technologies is a labor-intensive task, requiring the coordination of server and network administrators.

Both Vägverket and Nth Generation indicated that Flex-10 greatly benefited their organizations in terms of alleviating staff time. Vägverket believes it would need "some four to five more full-time employees" to manage the environment without Virtual Connect and Flex-10. Nth Generation said that its customers do not need to add new staff to manage the system and that system administrators benefit by "getting back control" through a single interface that is able to see the systems and network. By virtualizing the I/O associated with blade deployments for virtual servers, Virtual Connect Flex-10 can alleviate the burden associated with maintenance and provisioning tasks. Configuration and changes can now be done in software and don't require changing addresses in physical NICs. Vägverket described the benefits of the predefined WWN/MAC:

> The predefine concept is very handy. It gives a geographical freedom. Also, from a competence level, all activities that need specific competence can be done beforehand. Also, the ability to support test and development is much better and disaster recovery using different sites is enhanced, as is the HA concept from VMware that these sites use.

Facilities Costs

Facilities costs — the costs associated with power and cooling the IT systems — are another major and growing component of datacenter costs. With fewer NICs and switches, there is less hardware to power and cool and in cases where a company can increase the ratio of virtual machines to physical by eliminating the I/O bottleneck, fewer servers as well. The energy expense associated with IT systems has become a significant cost factor for companies. Reducing this cost has become a focal point for many IT organizations. According to Vägverket, "This was one of the big drivers for installing c-Class blade servers and virtualization. Savings could be around $400–500 per server each year."

Since cooling is the main limiting factor determining the number of servers that can be deployed in most datacenters today, reducing the number of servers required to handle a given number of VMs could greatly improve the server capacity of the datacenter, delaying or eliminating the need for expensive datacenter buildouts.

CHALLENGES AND MEETING THE CHALLENGES

While the virtualization market has witnessed rapid market growth over the past several years, a number of factors could potentially stall the growth of server virtualization. One factor is that adding additional virtual machines on a single physical server increases the requirements on system memory and I/O. HP is addressing this issue through the release of new servers targeted at addressing the needs of virtualized workloads. In terms of virtualized network I/O, HP will have to educate its customers on how Flex-10 can enable them to take full advantage of the benefits of virtualization without the addition of extra NICs, switches, and cables.

Other issues that IDC sees with I/O virtualization and HP Virtual Connect include the need for customers to choose appropriate networking technologies, as well as the perception that HP Virtual Connect Flex-10 will introduce new complexity, best practices, or networking standards into companies' datacenters. The challenge for HP will be to communicate how Virtual Connect Flex-10 uses industry-standard Ethernet and Fibre Channel protocols and can actually reduce complexity and simplify the job of IT administrators.

HP Virtual Connect Flex-10 represents a different approach to server I/O from traditional pass-through modules or switches, and as a result, companies are likely to approach the technology cautiously. To alleviate this concern, HP will need to clearly illustrate the value of the technology and showcase best practices gathered through actual customer implementations.

CONCLUSION

Companies are struggling under the burdens imposed by the explosion of servers in the datacenter. While many are adopting virtualization as a way to reduce their server sprawl and thereby reduce management costs and complexity, the introduction of widespread virtualization brings problems of its own, including the introduction of I/O bottlenecks. While these bottlenecks can sometimes be alleviated by overprovisioning I/O, this is an expensive and inefficient option.

HP Virtual Connect Flex-10 was designed specifically to serve the needs of I/O in virtualized blade deployments and eliminate these bottlenecks. By enabling up to four FlexNICs per physical NIC port, Flex-10 can effectively quadruple the number of virtual machines that can be supported per physical server without the need to add more networking hardware or bandwidth. By enabling the bandwidth to be throttled at increments of 100Mb, Flex-10 can ensure a more efficient use of networking resources. As testified to by customers who have implemented Flex-10, this can lead to reduced management complexity, improved use of IT resources, and lower TCO.