Server Consolidation using IBM BladeCenter™
and VMware® Infrastructure
Table of Contents

1. Executive Summary ...........................................................................................................3
2. Solution Overview ..............................................................................................................3
3. Solution Component – IBM BladeCenter .................................................................4
4. Solution Component – VMware Infrastructure ..................................................5
5. The Synergy of Virtualization on Blades ...............................................................9
6. Solution Proof Points ......................................................................................................10
7. How to Get Started ........................................................................................................11
Server Consolidation using IBM BladeCenter™ and VMware® Infrastructure

1. Executive Summary

IT managers are under constant pressure to increase operational efficiency and responsiveness. Ever increasing requirements to support more applications and a larger user base while improving uptime are rarely matched with increased IT budgets, higher headcount and larger facilities. To contain costs while growing their data centers, IT managers are consolidating computing resources into a smaller number of physical and logical components and working to automate resource allocation, application deployment and server management.

Enterprise computing is now returning to its roots as it evolves into the 21st century. Having started out with a small number of centralized mainframes in the 1970s and early 1980s, enterprises decentralized in the mid-80s and through the 1990s resulting in a proliferation of low cost but challenging to manage servers. Today’s technology and best practice efforts are now re-centralizing computing power to leverage the best of both worlds, resulting in manageable, highly scalable servers assembled using modular, low cost components. Consolidation started with the move from tower servers to rack servers, and it is being taken to a new level of manageability today by using blade servers to increase efficiency and leverage virtualization to increase server utilization.

This Solution Blueprint addresses the high-level architecture and opportunities created by combining IBM BladeCenter and VMware Infrastructure as complementary technologies to deliver maximum server consolidation. Consolidating servers from tower and rack servers onto blade servers yields solid results when an IT organization is looking to reduce costs, improve manageability and optimize operational parameters such as server provisioning, cabling complexity, power and cooling expenses, and floor space utilization. Virtualizing servers using VMware Infrastructure maximizes server utilization while providing many other unique server provisioning, availability and manageability benefits.

Server consolidation leverages blades and virtual infrastructure to change the economics of IT by delivering measurable savings in both capital and operating costs. Those savings come in the form of:

- Increased server utilization and reduced new hardware requirements with server consolidation ratios commonly exceeding eight virtual machines per physical processor
- Reduced operating costs of rack space and power based on the consolidation ratio achieved
- Improved IT staff productivity by simplifying and automating provisioning and management

VMware Infrastructure improves responsiveness, availability and flexibility of IT infrastructure by allowing organizations to quickly respond to changing business needs by instantly deploying new virtual machines to any server using hardware independent templates. Using VMware Infrastructure, IT organizations can:

- Increase capacity for all virtual machines by simply adding a new server blade to a VMware resource pool
- Perform zero-downtime maintenance and real-time load balancing by migrating live, running workloads between servers using VMware DRS and VMotion technology
- Improve service levels for critical applications by implementing cost-effective virtualization-based solutions for high availability, disaster recovery and business continuity

As virtualized computing on blade servers creates a highly scalable, manageable and fault tolerant infrastructure with a small footprint, it is ideal for both centralized corporate data centers and distributed regional offices and store branches.

2. Solution Overview

IT departments around the world all share common business drivers and challenges: How do you provide a flexible and responsive computing infrastructure that can grow to meet future needs while containing costs today?

Fortunately, server virtualization answers to this challenge with efficient hardware utilization and automated management capabilities. Looking at the historical problem, each instance of an operating system and each software application have traditionally needed to run on a dedicated server for manageability, performance and reliability. The relatively low cost of industry-standard x86 servers has made this model possible, but the proliferation of software applications and the resulting server sprawl have brought on new challenges.
VMware Solution Blueprint

- **Inability to take full advantage of advancing computing power** – Server infrastructure is designed to accommodate peak load requirements, resulting in significant under-utilization of hardware resources. In most cases server capacity is utilized at only 5-15%, and these utilization rates are only falling as computing power advances.

- **Increasing number of servers to monitor and manage** – Hardware infrastructure at most companies represents a disparate collection of servers from different vendors with widely varied CPUs and form factors, resulting in complex heterogeneous environments that are difficult to monitor and manage.

- **Increasing management costs** – Provisioning and managing servers represents a series of labor-intensive, one-of-a-kind tasks. Because of the complexity of managing servers in heterogeneous environments, one system administrator can only support about 10 servers on average, resulting in high operating cost. These challenges also make it hard for IT departments to guarantee service levels to the business at acceptable cost.

- **Increasing data center costs** – The real estate and power and cooling bills associated with a large number of servers, particularly in large or information-intensive enterprises have become significant capital and operating costs.

For the vast majority of data center computing needs, the most efficient path to improved utilization and simplified management lies in virtualizing and consolidating these applications from underutilized dedicated hardware onto high-density blade servers. Applications will still be running securely and reliably on dedicated operating systems, but they will be virtualized onto shared hardware to reduce costs and simplify management. Future growth in server capacity is more manageable as consolidating servers into virtual machines reduces hardware requirements and server capacity can be easily provided by adding more blades to the server resource pool.

Virtual infrastructure, delivered by the VMware Infrastructure software suite and IBM BladeCenter, provides a solid foundation for building dynamic, automated and self-optimizing data centers. When combined, they furnish the highest levels of performance, scalability, robustness and security required for mission critical IT environments.

3. **Solution Component – IBM BladeCenter**

The IBM BladeCenter unit is a high-density, high-performance rack-mounted server system first introduced in 2002 to provide the consolidation benefits of 1U and 2U rack systems while eliminating the cabling and management complications associated with these standard rack systems. BladeCenter supports up to 14 two-way or 7 four-way blade servers, making it ideally suited for networking environments that require a large number of high-performance servers in a small amount of space.

Each server blade is an independent server containing one or more processors and memory. Each server blade is inserted into a slot at the front of the BladeCenter unit and connects to the midplane. The midplane provides a connection to shared infrastructure components that includes power, cooling, the management module and I/O (media drives, USB ports, keyboard, video, mouse, and integrated Ethernet and Fibre Channel switches). Unlike 1U and 2U rack systems which each require their own infrastructure, the use of common resources in the BladeCenter enables small blade server size, reduced power consumption and minimal cabling in the racks.

The BladeCenter architecture is an efficient solution for adding scalability and capacity in a data center. Capabilities and benefits of the blade server architecture include:

- **Modular scalability** – Unlike traditional 8-way or 16-way servers, blade servers are designed to scale out rather than up. Adding a new server typically involves simply sliding a new single, dual or quad-processor blade into an open bay in a BladeCenter unit. There is no need to physically install and cable individual servers. BladeCenters also integrate easily into Network Attached Storage (NAS), iSCSI and Storage Area Networks (SAN) to leverage scalable storage solutions with enhanced manageability features.

"The cost savings, flexibility and redundancy from the combination of VMware virtualization and IBM BladeCenter made running virtual machines on server blades the clear choice for us. Certainly we are purchasing less hardware, but more importantly, we are cutting expenses on maintenance, energy and real estate. We are getting more out of the money we spend, so our infrastructure will last longer and perform better. These are the cost savings that, over time, help make an organization truly efficient."

Benjamin Thompson
Senior Network Engineer/Manager
Community College of Baltimore County
• **Versatility** – Unlike conventional server designs, blade design does not impose a limit of only one type of processor per server. Advanced chassis designs with sophisticated cooling and power technologies can support a mix of blades containing different types and speeds of 64-bit and 32-bit processors from IBM, AMD and Intel.

• **Performance** – Get the same processing power found in 1U servers, but obtain up to twice the rack density at a potentially lower cost.

• **High availability and ease of serviceability** – Blade server designs include high-availability features such as redundant and hot-swap components (even the hot swapping of the blade servers themselves). Removing a server for maintenance involves simply sliding a blade out of the BladeCenter unit, which makes a policy of hot-spare servers effective to implement.

• **Systems management and deployment** – BladeCenter uses integrated systems management processors to monitor the status of blades and modules at all once. In the event of an alert, the processors can signal the systems management software, which can then notify the administrator by e-mail or pager at any hour of the day or night.

Performance, ease of use, reliability and expansion capabilities were key considerations during the design of BladeCenter. The result is a highly available, high-density and cost-effective computing platform with shared power, cooling, storage, networking and input/output devices that provides an ideal resource pool for virtualization. Scaling out to expand computing capacity is as easy as adding additional blades to the resource pool.

4. Solution Component – VMware Infrastructure

VMware Infrastructure is the most widely deployed software for optimizing and managing IT environments through virtualization—from the desktop to the data center. VMware first introduced virtualization technology to the x86 computing platform in 1999, and since then has saved its 20,000 enterprise customers and more than four million users billions of dollars in capital and operating costs. Virtualization abstracts the operating system from the hardware it’s running on, providing standardized virtual hardware for operating systems and their applications that enables the virtual machines to run simultaneously and independently on one or more shared processors. With virtualization, customers can easily consolidate many disparate servers onto a single more reliable and higher performance physical server such as a server blade within an IBM BladeCenter.

The VMware Infrastructure software suite transforms a mix of industry standard x86 servers and their existing processors, memory, disk and networking into a pool of logical computing resources. Operating systems and their applications are isolated into secure and portable virtual machines. System resources are then dynamically allocated to each virtual machine based on need and prioritization, providing mainframe-class capacity utilization and control of server resources. Resources from many server blades and BladeCenter chassis can be combined into resource pools and virtual machines can be shifted between the servers in the pool seamlessly with zero downtime. As a result, virtual machines can be dynamically and automatically allocated to the most appropriate host in the resource pool to guarantee service levels to software applications. By aggregating hardware resources into resource pools, IT environments can be optimized to dynamically support changing business needs while ensuring flexibility and efficient utilization of hardware resources.

In order to better understand how virtual infrastructure works, let’s examine the definition and capabilities of virtual machines. A virtual machine is like a physical server, only instead of being a box of electronics, it is a set of software files. Each virtual machine represents a complete system—with processors, memory, networking, storage and BIOS—so that unmodified operating systems and software applications can run in virtual machines exactly as they do in physical servers. The figure to the right shows the standard virtual components presented to every virtual machine, regardless of variations in the hardware present in the physical server.

![Virtual Machine Diagram](image-url)
Based on their inherent partitioning, isolation and encapsulation, virtual machines offer many advantages over physical servers. Virtual machines:

- Run on industry standard x86 physical servers (VMware Infrastructure is certified with most server systems from IBM and other vendors)
- Have full access to all physical server resources such as CPU, memory, disk, networking, and peripherals, allowing them to run any software application in a virtual machine
- Are completely isolated, providing secure processing, networking and data storage
- Can run concurrently with other virtual machines for optimal hardware utilization
- Are encapsulated in software files so that they can be provisioned, backed up or restored with the ease of a file copy or a reference to a shared storage location
- Are portable, so full systems including virtual hardware, operating systems and fully configured applications can be easily moved from one physical server to another, even while running
- Can incorporate distributed resource management and high availability capabilities that provide better service levels to software applications than static physical infrastructure
- Can be built and distributed as plug-and-play virtual appliances that contain the entire stack of virtual hardware, operating system, and fully configured software applications for rapid deployment

Virtual infrastructure for data center server consolidation is provided by the VMware Infrastructure 3 product suite deployed on certified x86 hardware. VMware Infrastructure includes the ESX Server 3 virtualization platform and a VirtualCenter 2 management agent. A single ESX Server can host up to 128 running virtual machines, typically running about 8 running virtual machines per host processor. Each virtual machine can be configured with access to 16GB of memory and up to 4 processors when using the VMware Virtual SMP™ (Symmetric Multi-Processing) option.

The VMware Infrastructure software suite is the building block for virtual infrastructure on server blades.

Without Virtualization

With Virtualization

VMware ESX Server installs directly on the hardware to insert a transparent and robust virtualization layer that allows multiple virtual machines to run side-by-side on the same server. Virtual machines are completely encapsulated in software files that can be stored locally or preferably on a SAN, iSCSI or NAS storage network using the VMware VMFS clustered file system. The use of storage networks is very powerful in an enterprise data center environment as it allows a resource pool of multiple ESX Servers to concurrently access the same self-contained virtual machine files, effectively virtualizing the virtual machine storage. This allows virtual machines contained in a storage network to be instantiated on any ESX Server that has access to the shared storage, enabling:
• Workload balancing by migrating a running virtual machine to a different ESX Server host using the VMotion and VMware DRS (Distributed Resource Scheduler) options,
• High availability by automated restart of failed virtual machines on other hosts in the pool with the VMware HA option, and
• Rapid server provisioning using a shared virtual machine template repository.

To clarify, VMware VMotion™ enables hot migration of running virtual machines from one blade to another while maintaining continuous service availability and transaction integrity. VMotion can work between blades in different BladeCenter chassis and between blades and conventional servers as long as those servers use the same family of processors and virtual machines reside on shared network storage. Hot migration of virtual machines allows resource pools to be continuously and automatically optimized with the VMware DRS feature for maximum hardware utilization, flexibility and availability. With VMotion, companies can perform hardware maintenance without scheduling downtime and disrupting business operations. VMotion is a key enabling component of the dynamic, automated and self-optimizing data center.

ESX Server provides very granular resource management, allowing it to share the resources of the physical server across the running virtual machines to maximize server utilization while ensuring virtual machine isolation. Virtualization acts as a resource multiplier, allowing a diskless 4-way server blade with 16GB of memory to boot from a storage area network 20 virtual machines that collectively think they have 32 GB of memory, 20 virtual disks and 40 virtual network cards.

IT managers can take advantage of the fact that workloads are sometimes idle and that different applications are constrained by different hardware resources (i.e., some applications are memory bound, some are CPU bound) and that peak usage occurs at different times for different workloads. Virtual machine resource allocations can be established with minimum, maximum, and proportional share amounts for CPU, memory and network bandwidth, allowing applications to safely use greater resources periodically without requiring a constant allocation.

In the event that allocation demand from virtual machines exceeds the physical resources of the server blade, lower priority applications will simply run at less than full speed temporarily as they receive fewer than the requested CPU cycles and memory is paged to disk. To prevent unexpected capacity constraints from slowing operational systems, VMware DRS can actively monitor computing loads and intelligently and transparently relocate virtual machines using VMotion to other VMware Infrastructure hosts in a resource pool to balance the load and ensure service level agreements are maintained.

In the event of physical server blade failure, VMware HA provides easy to use, cost effective high availability for applications running in virtual machines. VMware HA detects server failures and automatically re-starts affected virtual machines on other production server blades with spare capacity. Downtime and IT service disruption are minimized without the need for dedicated standby hardware and integration with additional software. VMware HA enables higher availability of IT environments without the cost and complexity of operating system or application-specific failover solutions.

A virtual infrastructure consisting of one or hundreds of VMware Infrastructure hosts is managed by VMware VirtualCenter. VirtualCenter enables the organization of VMware Infrastructure hosts and their virtual machines into clusters and resource pools to simplify their monitoring and management. Access to virtual machines and their configurations can be securely restricted with permissions delegated to authorized administrators and users. Virtual machines can be provisioned, configured, started, stopped, deleted, relocated and remotely accessed with keyboard and mouse control. VirtualCenter enables large server pools with thousands of servers to be managed from a central, secure point of control with monitoring, alerting and scripting automatically handling exceptions.
Central management of virtual machines enables automation and simplification of provisioning resulting in lower operating costs. Virtual machine templates and an easy to use deployment wizard reduce the time and effort for creating and deploying a virtual machine to a few mouse clicks.

VMware VirtualCenter components include a Windows-based Management Server, graphically-rich Virtual Infrastructure Clients available in Windows and browser versions, and a VirtualCenter Agent on each VMware ESX Server host under management. VirtualCenter includes the VMware Infrastructure Software Developer’s Kit (SDK) with Web service interfaces for automating virtual machine management. VirtualCenter also integrates with market leading platform management software such as IBM Director to provide IT managers with the greatest possible control over data center infrastructure.

Finally, how are physical servers captured and converted into virtual machines? VMware offers PV Assistant to automate the migration. PV Assistant takes a snapshot of a physical system and performs all the necessary software substitutions to transform the physical system into a production-ready virtual machine that is ready for deployment on any VMware Infrastructure host.

In summary, VMware Infrastructure:
• Maximizes server blade hardware utilization, often increasing it five or tenfold
• Allows legacy systems to co-exist with new environments
• Accelerates the application development and deployment lifecycle
• Enables non-disruptive maintenance of IT environments with hot migration of live systems
• Enables broad-based, cost-effective application availability and business continuity independent of hardware and operating systems
• Streamlines labor and resource intensive IT operations across disparate hardware, operating system, and software application environments
• Improves responsiveness to business needs with instant provisioning and dynamic optimization of application environments

5. The Synergy of Virtualization on Blades
VMware Infrastructure and IBM BladeCenter together provide a solid foundation for building dynamic, automated and self-optimizing data centers, delivering the highest levels of performance, scalability, robustness and security required for mission critical IT environments.

**Consolidate Servers, Increase Utilization & Lower Operating Costs**

IBM BladeCenter provides a high-density enterprise computing form factor that can reduce floor space requirements by half when legacy servers are physically consolidated onto server blades. Further consolidating servers through virtualization builds on the core benefits of server blades to dramatically improve utilization and make IT infrastructure more robust. Virtualizing server blade resources with VMware Infrastructure promotes use of blades with the highest possible density, meaning that each server blade can support several server workloads rather than only one workload as depicted in the diagram below.

This additional consolidation can reduce data center operational costs by as much as 70% compared to operating the same workloads on non-virtualized server blades. When an organization can deploy a project on a single BladeCenter chassis rather than three, it proportionally cuts capital hardware costs and reduces data center floor space requirements, operating costs for system administration, hardware maintenance and power and cooling.

VMware Infrastructure customers have been able to contain server sprawl by running software applications in virtual machines on fewer, highly scalable, reliable enterprise-class servers, often achieving consolidation ratios of ten or more virtual machines running on a single server blade.
**Increase Flexibility & Improve Availability**

IBM BladeCenter is designed to easily scale by adding more server blades and more BladeCenter chassis to the hardware resource pool. As shared components like power, cooling and networking are redundant and hot-swappable, the resource pool of servers can be available 24x7x365 with individual components pulled for service as needed. Virtualized servers are not tied to any specific server blade, so they can be flexibly provisioned in minutes or transparently migrated to different server blades in the resource pool to support dynamic load balancing or zero downtime maintenance.

Virtualization further improves availability from two perspectives. First, running many workloads with high utilization on fewer, more reliable and scalable servers makes the high-end hardware more cost effective as the cost is distributed across the increased workloads supported. Second, VMware HA provides easy to use, cost effective high availability for applications running in virtual machines in the event of physical server failure. HA detects failures of individual server blades and automatically re-starts affected virtual machines on other server blades with spare capacity.

VMware HA on server blades is much less disruptive to IT operations than typical failover clustering alternatives because there is no need to provide dedicated standby hardware or integrate that hardware with additional software. VMware HA enables higher availability of IT environments without the cost and complexity of operating system or application specific failover solutions.

**Simplify Data Center Management**

IBM BladeCenter and VMware Infrastructure are designed to promote standardization and best practices while collapsing complexity, reducing the number of moving parts where possible. By standardizing the data center on a flexible physical and virtual infrastructure platform, resource intensive IT operations can be streamlined across disparate hardware, operating system, and software application environments. Virtualization also simplifies data center management by enabling legacy systems with outdated hardware and operating system requirements to run on new server blade hardware alongside current applications.

From an operational perspective, IBM and VMware offer a single point of management for the BladeCenter and Virtual Infrastructure resources through IBM Director with the Virtual Machine Manager (VMM) extension. The VMM integrates physical and virtual systems by extending IBM Director to correlate the relationships between physical host blade servers, VirtualCenter, Virtual Farms and their Virtual Machines. The IBM Director systems management console can display the status of physical hosts and virtual machines and provide access to VirtualCenter management tasks such as triggering the migration of virtual machines in response to hardware health events.

This infrastructure can readily scale to support the management of large IT environments consisting of thousands of servers.
6. Solution Proof Points

VMware Infrastructure is the most widely deployed software for optimizing and managing IT environments through virtualization from the desktop to the data center. The only production-ready virtualization suite, VMware Infrastructure is delivering proven results for more than 20,000 enterprise customers of all sizes in the broadest range of use cases. Per IBM primary research from 2005, 22% of enterprises had implemented server virtualization in the first quarter of 2005 and that share is forecast to top 30% by the first quarter of 2006. Virtualization is continuing to gain momentum and in a few more years will be the most common architecture for new server deployments.

Enterprise adoption of server virtualization is accelerating.

IBM and VMware have a long-standing relationship with a history of firsts when it comes to working together to deliver comprehensive, end-to-end, on-demand virtualization solutions. IBM was the:

- 1st VMware system vendor
- 1st Joint Development Partner
- 1st to leverage the VMware SDK
- 1st to offer comprehensive support for Windows, Linux, and IBM Software in a VMware virtual machine
- 1st blade offering to include VMware Infrastructure
- 1st to integrate VMware Infrastructure into a hosted client solution

"VMware virtual infrastructure on IBM BladeCenter allows customers to experience the benefits of virtualization in a scale out environment. Not only can they increase the utilization of their individual server resources, but they can increase the utilization and flexibility of their complete infrastructure."

Jeff Benck, vice president and business line executive of IBM BladeCenter.
7. How to Get Started

IT managers who are evaluating data center infrastructure to improve efficiency and manageability should definitely consider the role that virtualizing servers onto blades can play. The IBM and VMware Sales Teams can help your IT organization determine how IBM BladeCenter and VMware Infrastructure software will provide these benefits in your particular data center environment. Using ROI calculators, best practices guidelines, and our professional services consultants, IBM and VMware will work with you to design and implement specific success criteria so you can effectively evaluate a virtual infrastructure solution on server blades.

Visit VMware on the Web at www.vmware.com, email us at sales@vmware.com, or call us at 877-VMWARE to get started.

Read how the Community College of Baltimore County streamlined their IT operations and improved efficiency with VMware Infrastructure and IBM BladeCenter at http://www.vmware.com/customers/stories/ccbc.html.

Learn more about the VMware IBM Alliance Partnership at http://www.vmware.com/partners/alliances/oem/ibm.html.

Visit the IBM BladeCenter product resources on the Web at http://www.ibm.com/systems/bladecenter/

VMware and IBM are members of Blade.org, an open community dedicated to developing next-generation technologies for blade computing. Read more about Blade.org at http://www.blade.org.

“IBM and VMware share the same vision of increasing efficiency and reducing complexity for our customers. Coupling blades with VMware virtual infrastructure goes a long way towards helping enterprise customers better contain, monitor and manage server workloads.”

Diane Greene, president of VMware, Inc