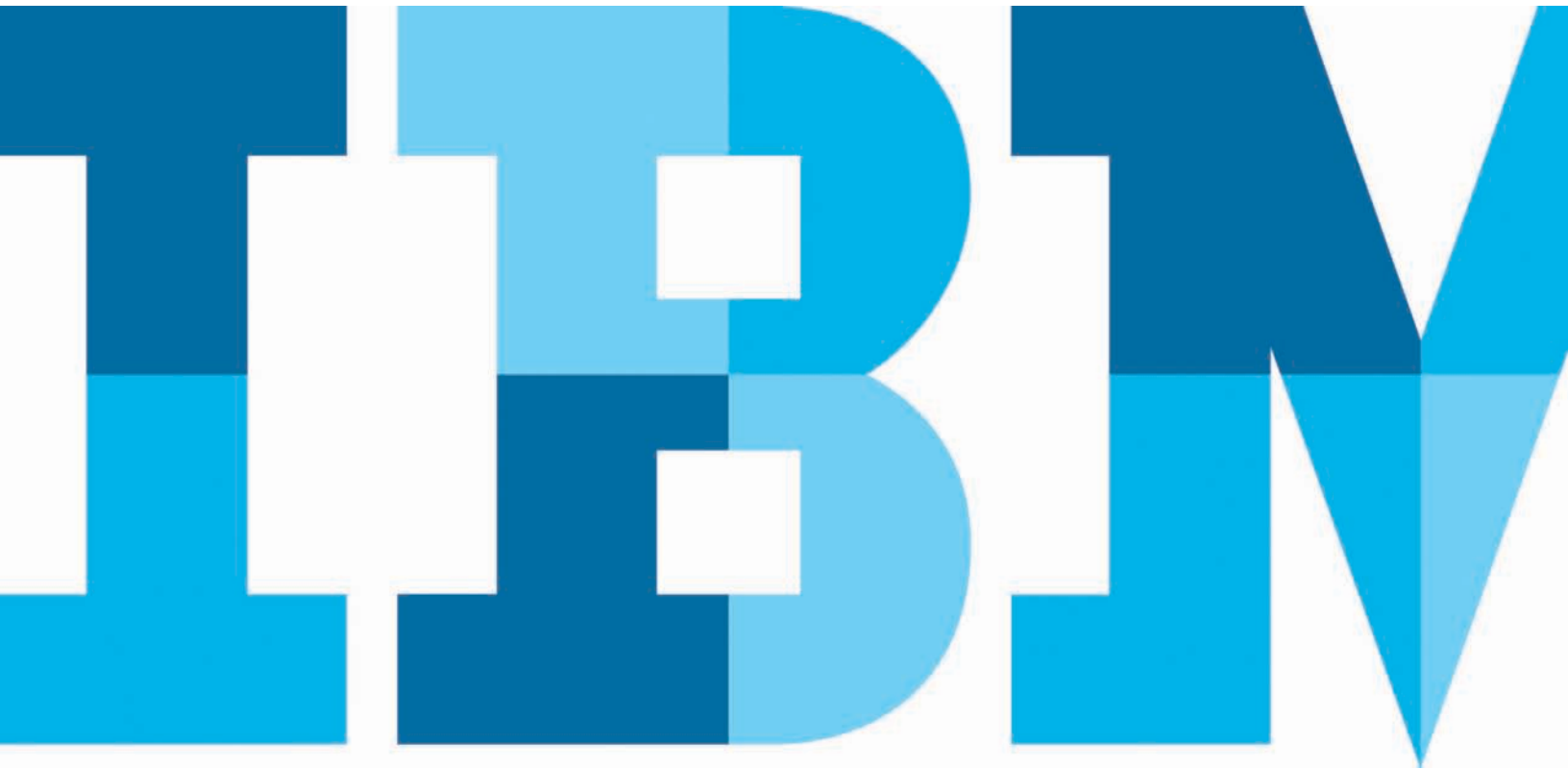# IBM solutions for cloud and virtualization in enterprise environments

Service delivery and management solutions help ensure high availability, tighten security and reduce costs

Executive summary

The benefits of virtualization, from accelerated service delivery and resource optimization to reduced costs for IT resources, have spurred many organizations to move toward a virtual infrastructure. However, the nature of the virtual environment, which calls for a vast network of shared resources, has created a new set of management complexities that can impede business service delivery—and that are best handled by adding cloud-computing capabilities to the virtualized infrastructure.

For organizations that have migrated business-critical workloads to the virtual environment, current market offerings may provide a robust hypervisor layer, but they do not provide adequate support for managing service availability, performance, security, and quality. In addition, virtualization breeds a variety of issues stemming from a lack of visibility into business services and the components on which they reside. Consequently, what many organizations face today is an opaque infrastructure that hinders their ability to manage service performance and delivery, to optimize resource usage and to isolate and resolve problems. Furthermore, lack of visibility and control hinders organizations' ability to confidently maximize their investment in virtual resources, such as VMware, by mixing different workload types in a single cluster.

Managing the virtual environment with an eye toward business services requires integrated capabilities within an integrated architecture. This white paper details the IBM open standards-based offerings for VMware and other virtual environments, focusing on key capabilities for discovery, monitoring, capacity planning, provisioning, storage, security and financial management.

The journey to the cloud with IBM SmartCloud Foundation

Virtualization is a necessary step in the journey to cloud computing and to its cost savings and operational efficiency benefits. And the technologies known collectively as IBM SmartCloud™ Foundation provide a holistic and proven set of virtualization and cloud service delivery and management capabilities in private, hybrid and public cloud environments. IBM SmartCloud Foundation capabilities, in fact, underpin IBM's own public cloud offerings, serving more than 19 million users each day.

SmartCloud Foundation capabilities provide the fundamental building blocks for smarter cloud solutions, enabling organizations to virtualize, automate and transform service delivery across virtualized infrastructures and achieve agile and cost-effective cloud environments. Organizations of virtually any size can leverage foundation capabilities to easily build and rapidly scale private, public and hybrid cloud environments with practically unparalleled time to market, integration and management.

There are several key aspects of SmartCloud Foundation that set it apart from competitive solutions:

- Helps organizations avoid costs associated with single-vendor solutions by supporting heterogeneous platforms and hypervisors, enabling the flexibility to choose the most cost-effective virtualization solution
- Provides real virtual machine sprawl management with a central enterprise image repository that works across hypervisors and supports the versioning of templates and images, which enables tracking
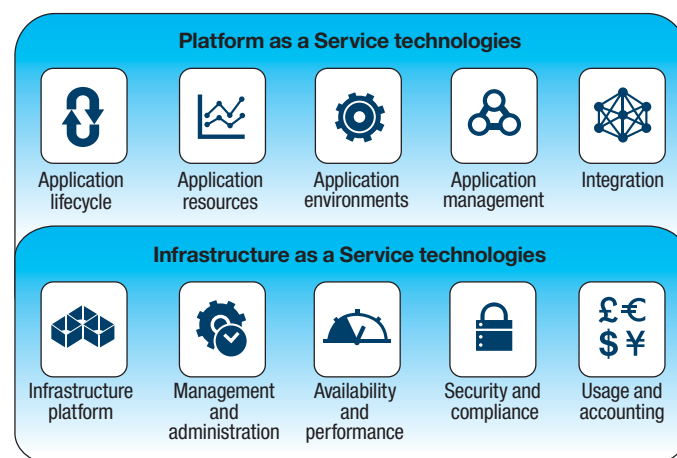
- Drives automated remediation based on in-depth application management by providing an integrated view of application performance across the virtual and physical infrastructure, tracking applications between virtual machines
- Offers workload placement recommendations to improve resource utilization and save costs
- Provides management capabilities across heterogeneous hybrid cloud environments to optimize deployment flexibility and lower costs
- Manages rapid workload changes with distributed administration of virtual machines to enable fast provisioning of tens of thousands of virtual machines
- Provides high availability at the application level with advanced system automation capabilities that are application aware, which greatly reduces downtime
- Enables users to view utilization across resources and applications for virtually unlimited chargeback options
- Eliminates backup windows, reduces the load on physical resources, automatically discovers and protects new virtual machines, and restores files, volumes and entire virtual machines within minutes
- Integrates security event management and intrusion detection across the data center, including virtualized environments

Through the use of IBM SmartCloud Foundation capabilities, organizations gain the visibility, control and automation needed for effective cloud service delivery and management:

- Visibility to see and understand the business in real time
- Control to transform and adapt while managing risk
- Automation to support greater efficiency and quality by standardizing best practices

IT organizations can use IBM SmartCloud Foundation solutions to create or enhance Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) cloud models. IaaS capabilities are the foundation on which cloud service delivery models are built.

IBM SmartCloud Foundation

Platform as a Service technologies

| Application lifecycle | Application resources | Application environments | Application management | Integration |

Infrastructure as a Service technologies

| Infrastructure platform | Management and administration | Availability and performance | Security and compliance | Usage and accounting |

IBM SmartCloud represents a leading portfolio of software, hardware and services, from cloud-enabling technologies to PaaS and IaaS.

IBM SmartCloud Foundation solutions provide multiple entry points, ranging from simple, entry-level capabilities to advanced offerings needed to manage a virtualized infrastructure and evolve it into highly automated IaaS capabilities. They allow cloud-enabled data centers to drive higher return on investment

(ROI) and to support the evolution to an on-demand, cost-effective IT service delivery environment by providing the following:

- Infrastructure platform: Supporting improved utilization, availability, cost and performance of server, storage and networking assets
- Management and administration: Delivering a flexible and automated management command center
- Availability and performance: Holistically identifying and supporting an understanding of quality-of-service metrics to continually improve performance
- Security and compliance: Helping protect cloud services and data from malicious threats and addressing compliance mandates
- Usage and accounting: Enabling an understanding of cloud service and resource usage, effectively managing against financial metrics and supporting pay-as-you-go services billing

The following sections examine each of the above areas in more detail.

Infrastructure platform: Supporting utilization, cost and performance

The journey to the cloud starts with building a virtualization foundation. Organizations put secure, scalable and efficient systems into place, leveraging a range of hardware platforms to meet workload needs. They reduce complexity and risk with a pre-integrated IBM BladeCenter® foundation for cloud, consolidate multiple workloads onto fewer servers with IBM PowerVM® or take advantage of virtualization on IBM System z®, which offers industry-leading, large-scale,

proven IT optimization capabilities to reduce the cost of managing and maintaining the tremendous proliferation of servers in today's technology infrastructures.

Management and administration: The cloud command center

Many IT organizations that have virtualized their environments are not achieving the anticipated cost savings due to the rising expense of managing the virtualized environment. A key contributor to rising costs is the management of virtual images, which is hampered by a lack of automated tools and vendor lock-in to a single environment. There are three main areas to consider when looking for costs savings:

- **Reducing image sprawl:** When the numbers of virtual machine instances and templates grow quickly, it can be difficult to remember each template's contents and configurations. When users can't easily find the template they need, they create new templates and the problem worsens. Without automated tooling, image sprawl grows and costs rise.
- **Simplifying image maintenance:** Finding and maintaining the images across a large virtualized environment can quickly become a daunting task. Keeping systems in compliance and up to date can be greatly simplified with an advanced virtual image library and change-management tools.
- **Maintaining flexibility in hypervisor and platform support:** Relying on a single hypervisor and platform for all virtualized systems can lead to rising software cost and sub-optimal platform usage. Selecting the best hypervisor and platform for a particular workload can accelerate cost savings.

The core problem has been that administrators lacked the ability to manage virtualized production environments effectively because they could not see what's inside their virtual machines or view a centralized virtual image library to manage vulnerabilities, image consolidation opportunities, configuration drifts, software compliance, version control and other issues. This can be an expensive task to perform manually as new images emerge, golden masters change and older images are archived. As with any data that is collected or maintained manually, the mappings become inaccurate and unreliable the minute something changes in the environment. It's not uncommon for administrators to maintain terabytes of unnecessary images because no one knows why they're there, who created them, or who needs them.

The IBM advanced image analytics capability can reduce image sprawl by providing insight into the templates used to create virtual machines. The IBM virtual Image Library capabilities include the ability to index virtual templates in order to understand their operating system, complete software contents, as well as other properties such as disk size and free disk space. All this information is gathered into a knowledge base for easy searching so that the user can find the virtual template that has the desired configuration.

To simplify image maintenance the IBM Virtual Image Library can help in a number of ways:

- **Vulnerability management:** There are two fundamental problems with using standard patch management tools with gold images. First, it's difficult to determine which "master images" or image templates need to be updated along with the running instances. Second, where users have deployed virtual machines but have turned them off or they are in a dormant state, it's difficult to determine which machines need to be patched. IBM Virtual Image Library search capability allows users to search for images that contain or don't contain particular software, ensuring vulnerability exposures are closed.

- **Configuration drift detection:** Over time, systems diverge from their original configuration. IBM Virtual Image Library analyzes the bits on disk to detect changes without interfering with the guest operating systems. No agents are required inside your images.
- **Image versioning:** The inability to determine what has changed between the current image and its predecessor can cause unintended problems that are difficult to diagnose. IBM provisioning has the ability to version control images prior to promoting images to production, thereby minimizing disruptions in service. This simple concept applied to your images lets you take control over current and future virtual deployments.
- **Software license management:** Software audits resulting in expensive compliance settlements are too often caused by over deploying software in virtualized environments. Many data centers lack the ability to accurately measure the software that is deployed in virtualized environments because virtual machines could be turned off or lie in a dormant state. IBM provisioning provides insight into software that is installed on all instances (running or not) including master images, enabling you to reduce your licensing exposure.
- **Software version control:** Software that is installed on virtual machines that are dormant or have been turned off can be overlooked when upgrading or patching vulnerabilities. IBM provisioning ensures you're updating all instances that are used in your virtual environment.

To provide flexibility in hypervisor and platform support, the IBM capabilities support a wide range of hypervisors and platforms from x86 to the mainframe. The IBM management tools provide the flexibility to manage your choice of hypervisor on the platform best suited to the workload and manage it all through common user interfaces so that as workloads move, your management context remains the same.

Automate provisioning and application delivery

Provisioning business services can be time consuming and costly without the correct tools. While the time it takes to create a logical partition and to provision an operating system may be minimal, provisioning across hardware and software, networks, storage and security can easily slow application deployment cycles to multiple weeks. IBM provisioning solutions help to manage the provisioning process end-to-end, enabling organizations to automate the deployment of virtual images and application stacks to improve service delivery while decreasing the time and costs required to deliver a new application. IBM provisioning enables organizations to:

- Automate best practices for data center provisioning activities in support of change and release management processes, helping to optimize efficiency, accuracy and service delivery
- Discover and track data center resources to enable highly accurate server provisioning, software deployments and storage
- Support in-place adding, removing and upgrading of physical servers—without configuration changes
- Perform near-instant deployment of a few to hundreds of virtual machines to respond quickly to dynamic user resource demands and business growth
- Support heterogeneous hypervisors with hardware agnosticism to simplify administration while reducing operations costs
- Spend less time (in many cases, more than a 90 percent reduction) building and tearing down systems and more time innovating

In addition, with IBM provisioning solutions, the time to provision virtual machines typically is reduced by more than 90 percent and the administrative workload typically is decreased by 70 percent—because administrators can easily manage more resources through the automation of previously manual provisioning processes through automation.

Availability and performance: Supporting quality of service metrics

Without end-to-end visibility, pinpointing and resolving problems in the virtual environment is impossible. This is because in the shared virtual environment, problems usually result from the complex interaction of application servers, database servers and other shared server, storage and network resources. For this reason, organizations must be able to collectively monitor applications, servers, storage and networks, while having access to a historical performance baseline. They must be able to stay abreast of processor utilization and capacity, to understand whether a configuration change has downgraded performance and to anticipate the best way to distribute workloads for optimal performance and energy usage—while avoiding virtual sprawl.

Proactively detect performance problems

IBM monitoring solutions deliver a holistic view of application components across the IT infrastructure, enabling organizations to visualize application environments from end-to-end, to pinpoint the location of problems and to anticipate potential problems wherever they occur. They can also collect metrics to uncover problems within a specific component, enabling administrators to take necessary actions before services are disrupted. IBM monitoring tools also enable IT to monitor performance over time and understand when they are approaching thresholds

and performance indicators, such as a maximum database work-load, so that administrators can proactively reassign resources before the problem occurs.

IBM monitoring solutions help organizations to:

- Visualize virtual server utilization against historical trends
- Collect key performance and availability metrics, including application, virtual machine, virtual network and virtual storage I/O
- Monitor both the virtualized and non-virtualized environment through a common user interface
- Set proactive and predictive alerts
- View real-time and historical data simultaneously
- Separate intermittent problems from recurring problems within peak workloads
- Warehouse data and report on current and future trends to identify resource bottlenecks and plan for future capacity needs
- Monitor across heterogeneous environments, including IBM z/VM®, IBM Power Systems™, VMware, Kernel-based Virtual Machine, Hyper-V, Solaris and Citrix.

Plan to meet your capacity needs
To effectively manage capacity that enables high availability and maximizes resource utilization, capacity planning needs to occur at the resource and workload level. Capacity planning at the resource level includes:

- **Virtual machine right-sizing:** By understanding real usage of computing resources over time, organizations can adjust the allocated computing resources to levels actually needed for the virtual machine

- **Predicting physical and virtual resource capacity bottle-necks:** Preventing performance problems related to capacity constraints requires the ability to understand actual usage, allocated capacity, and available capacity for CPU, memory, network and storage resources for clusters, hosts, virtual machines, datastores, volumes, host bus adapters and network adapters
- **Workload balancing:** Comparing usage and available capacity across clusters and hosts allows you to determine over- or underutilized clusters and hosts

Capacity planning at the workload level requires determining how many more customers or transactions can be serviced with existing resources, as well as performing "what if" analysis to determine whether adequate capacity exists and what capacity is available for additional virtual machines

Analyze workload placement to minimize costs
In addition to capacity planning reports, IBM solutions provide recommendations on where to place workloads, based on business and technical policies, to balance workloads across clusters or to minimize server resources needed. Key features include:

- **Benchmarking data for analysis:** Systems Performance Evaluation Cooperative (SPEC) benchmarking data is included for "what-if" analysis on various hardware platforms.
- **Custom fields for analysis:** Customers can associate virtual machines with other data sources such as application association data from a configuration management database or line-of-business data from a self-service provisioning tool.
- **Workload modeling:** This feature assesses workload patterns (for example, stable or bursty) and provides reservation recommendations based on historical data and growth projections.

- **Technical and business policies:** The policy-based framework enables customers to apply policies in areas such as growth rates or location of virtual machines to the analysis.
- **Results simulation: Simulation capabilities provide reports to answer the question:** "If I place workloads in this way, what is the benefit in terms of numbers of servers saved?"
- **Optimization recommendation report:** This capability provides specific recommendations on reservations and where to place workloads in the environment to achieve the greatest benefit

Using capacity optimization algorithms and workload placement analytics, IBM customers have achieved a 60 percent increase in server utilization and a 20 percent reduction in total cloud delivery costs.

Ensure high availability for applications

As more users switch from running mission-critical applications on physical computer systems to running on virtual machines, the demand for high availability on an application level increases. Leading competitors have the ability to manage on a virtual machine basis but have no awareness of applications running within virtual machines, and can therefore neither monitor on an application basis nor restart applications.

IBM system automation capabilities provide a continuous high-availability clustering solution with advanced automation capabilities, which monitors and automates the starting, stopping, and recovery of applications and application components anywhere in the cluster.

IBM solutions can automatically recover from both hardware and software failures:

- **Hardware failures:** IBM system automation will restart the application on a different virtual machine that is part of the cluster, and therefore decrease the unplanned downtime
- **Software failures:** IBM system automation constantly monitors defined application components and reacts individually on various error scenarios. It can stop, start and restart components in a defined order.

A powerful addition to a VMware HA environment, IBM system automation provides sophisticated, application-based high availability and tightly integrates with the VMware VMotion solution. The combination of VMware and IBM system automation reduces unplanned downtimes of mission-critical applications significantly and can reduce planned downtime for events, such as maintenance, to zero.

Effectively manage virtual storage

Managing storage capacity, maintaining near-instant backups and restores and controlling storage growth and costs are critical to an effective virtualization management strategy—and can be just as important in maintaining high-performance service delivery. Unlike other solutions, IBM solutions provide deep storage monitoring and management capabilities, helping organizations to optimize storage usage by:

- Viewing capacity utilization by computer, virtual machine or heterogeneous storage system
- Revealing file system and database storage utilization details
- Identifying underutilized space on volumes based on age, file type or any other user-defined filter

In VMware environments, IBM storage management provides integration to:

- Utilize VMware's vStorage Application Program Interface for data protection, including block-level incremental backups based on VMware's Changed Block Tracking
- Offload the backup workload from virtual machines and production VMware ESX hosts to vStorage backup servers
- Automatically detect and protect new virtual machines
- Provides flexible recovery options—file, volume or image— from a single-pass backup
- Fully integrated with VMware vCenter in vSphere 4 and later environments, including integration within the vCenter client user interface

Other IBM solutions for managing the virtual server environment enable organizations to:

- Virtualize across heterogeneous storage for more efficient use of resources, simplify storage management and provision and enable nondisruptive data migration
- Manage replication technologies to automatically move copies of data into different locations to support disaster recovery and business continuity
- Reduce the amount of data at risk of loss to nearly zero and reduce the time to restore any amount of data to just a few minutes
- Manage data throughout its life-cycle, including data placement, migration, retention and expiration
- Reduce the data storage footprint through efficient, block-level incremental backups and built-in data deduplication
- Perform fast off-guest backups that conserve processor resources, while simplifying licensing and administration
- Conduct easy-to-use laptop data protection and recovery

Security and compliance: Protecting cloud services and data

IBM solutions for virtual security help organizations eliminate security threats that are inherent in shared environments, enabling them to leverage:

- Authentication and role-based access control
- Isolation management for servers, storage and networks
- Integrity management
- Risk and compliance tools for auditing, configuration management and regulatory compliance
- Threat and malware management

Know the security challenges of virtualization

Because of the nature of the virtual environment, in which multiple resources are shared across components and users, a breach of one physical server can potentially become a breach across a multitude of virtualized servers. In addition, virtualization enables mobility of systems and flexible deployment and redeployment of systems that is impossible to achieve with physical resources.

The benefit is flexibility, but the risk is a lack of control. Whereas a purely physical environment once allowed administrators to manage a one-to-one ratio of operating systems and applications per server, that ratio is now one-to-many, creating an additional layer that must be managed and secured in the infrastructure. What's more, as network and server administration begins to converge, physical security devices and other security tools become less effective, and manually tracking software stacks and configurations of virtual machines and images becomes increasingly impractical. Subsequently, virtual environments are vulnerable to hazards such as virtual

machine-to-virtual machine attacks, malicious hypervisors that attack hosted virtual machines and decentralized management due to virtual sprawl. The reality is that traditional security tools are not equipped to address virtualization.

Major security and governance requirements in the virtual environment include:

- Configuration and isolation, supporting understanding of which configuration settings affect virtual machines and using network isolation to continuously monitor the entire infrastructure for changes that might result in data breaches
- Server and image life-cycle management and change control, helping users understand which virtual machines are being deployed, which are currently running, when they were last patched and who owns them
- Well-defined identity and access-management policies, balancing access to allow proper maintenance and security with restrictions to prevent access for unauthorized users
- Control of virtual machine mobility, helping users understand the security zones in which applications are running
- Data encryption capabilities for intercepting critical data—if any of the processes above fail or are not used—so the data cannot be read by the perpetrator of a security breach

Keep threats and compliance violations at bay

IBM provides a range of virtualization security products, services and leading-edge expertise to help organizations maintain security while realizing the benefits of virtualization. The foundational virtual security offering, IBM Security Virtual Server Protection for VMware, is an integrated, threat-mitigation solution designed to help organizations fully exploit the benefits of server virtualization while protecting critical virtualized assets.

It provides the same intrusion prevention capabilities of other network intrusion prevention systems, as well as integration into the hypervisor through VMware's VMsafe interface, so organizations need install only one instance for each virtualization server to protect the virtualized infrastructure. The product also provides firewall technologies for critical network-level access control specifically designed to prevent virtual server sprawl.

Other IBM virtual security offerings and features include:

- Virtual security appliances to reduce operational expenses while increasing flexibility for the security infrastructure by enabling asset reuse
- Transparent inspection of virtual machines to detect rootkit installations
- Automatic virtual machine discovery to increase security awareness and visibility
- Automatic protection against virtual server vulnerabilities, regardless of patch strategy
- Proactive Web application, Web 2.0 and database protection to limit potential business interruptions and exposures
- A central management system for controlling security policy, analysis, alerting and reporting that is supported on VMware ESX
- Virtual infrastructure auditing that ties into regulatory compliance initiatives
- Virtual environment awareness and transparent plug-and-play threat protection to address security concerns associated with virtual machine sprawl, lack of virtual network visibility and mobility

It is important to note that competitive offerings typically contain a limited number of these features and may also require organizations to maintain multiple modules. IBM virtual security solutions are designed to work cohesively for easy deployment and maintenance.

Usage and accounting: Understanding service and resource metrics

To fully realize the benefits of cloud computing implemented via virtualization, organizations must be able to understand the cost of the resources used by the cloud services. This task is much more challenging when services reside on shared virtual servers. Transforming shared assets into shared services requires cost-allocation capabilities. In VMware environments, IBM provides information on utilization both of resources and of the applications that use those resources to improve the granularity of chargeback. Understanding the cost of delivering cloud services helps cloud service providers run a profitable business and maximize their investment in virtualization resources. IBM usage and accounting solutions enable organizations to:

- Provide visibility of costs to determine profitability across lines of business, products and cloud services
- Allocate costs and/or chargeback to the consumers of cloud services or virtualization resources
- Understand virtualization resource costs to help justify expenses and future investments
- Align costs with business objectives

Summary

To achieve full virtualization benefits while maintaining service quality, security and performance, organizations can draw on a modular standards-based platform of service delivery and management solutions to better discover, monitor, provision and secure virtual resources—including storage—and to control virtual environment costs. IBM service management solutions help organizations better manage business services by delivering the visibility, control and automation needed to:

- Discover virtual assets to enhance visibility across the physical and virtual infrastructure
- Rapidly provision virtual resources to accelerate service delivery
- Monitor the virtual environment end-to-end to achieve peak application performance
- Maximize the efficiency and cost-effectiveness of virtual storage
- Enhance security across virtual assets with automated control features
- Control the costs of service delivery in the virtual environment

For more information

For more information about how the IBM service delivery and management platform can help you achieve the full benefits of virtualization while enhancing service delivery, contact your IBM representative or IBM Business Partner, or visit:
ibm.com/cloud

About Tivoli software from IBM

IBM Tivoli® software helps organizations efficiently and effectively manage IT resources, tasks and processes to meet ever-shifting business requirements and deliver flexible and responsive IT service management, while helping to reduce cost. The Tivoli portfolio spans software for security, compliance, storage, performance, availability, configuration, operations and IT lifecycle management, and is backed by world-class IBM services, support and research. For more information on Tivoli software from IBM, visit: **ibm.com**/tivoli

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