

Virtual Appliances: A New Paradigm for Software Delivery

vmware

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Introduction

With the advent of virtualization, the industry was in need of a new software delivery system that leveraged all the benefits of virtual infrastructures. The current approach to software delivery is costly and complex, especially when it comes to enterprise software and hardware-based appliances. Virtual appliances offer a new paradigm for software delivery that improves the experience for developers and customers alike by packaging pre-configured, virtualization-ready solutions in a single software package that is secure, easy to distribute, and easy to manage.

The growing use of virtualization, along with standardization efforts, new appliance-optimized operating systems, and the emergence of cloud computing, are all driving rapid adoption of virtual appliances. However, for virtual appliances to gain permanent traction, a healthy and diverse ecosystem must evolve to provide a rich and seamless experience for both developers and customers across the entire appliance life cycle.

This white paper discusses the value of virtual appliances and outlines the ways in which VMware is building a rich and diverse ecosystem around the virtual appliance model based on four key elements:

- A VMware Ready Virtual Appliance Program which is an ecosystem initiative that enables customers to identify virtual appliances that follow best practices and are optimized for VMware Infrastructure.
- A robust authoring tool for configuring, packaging and updating production-ready virtual appliances.
- A large and diverse marketplace where vendors can list their virtual appliances online for customers to discover, download, evaluate and purchase.
- A reliable, robust and proven virtualization platform for deploying and managing virtual appliances.

This white paper will also discuss how virtual appliances are helping to make cloud computing a reality, and how VMware is building a common set of cloud computing services, based on broad and diverse partner ecosystems, that will support a large set of applications and enable easy migration of virtual appliances and other solutions in and out of the cloud.

Industry Trends

“Moving from concept to a new service paradigm, and challenging the existing operating system-based paradigm of service management, virtual appliances will be mainstream by 2010.”

– Gartner Research, October 2007

Virtual appliances are entering the mainstream at a rapid pace. A large ecosystem of virtual appliances has emerged in a short amount of time, and many customers are beginning to recognize the advantages of using virtual appliances to evaluate, deploy and manage enterprise software. With the adoption of open standards, the growing demand for slimmer, purpose-built operating systems, and the emergence of cloud computing, virtual appliances are now poised to transform the software delivery experience for both developers and customers.

The Open Virtualization Format (OVF)

Open standards are a cornerstone of the virtual appliance paradigm. The Open Virtualization Format (OVF) specification, co-authored by VMware and other industry leaders, describes an open, secure, portable, efficient and extensible format for the packaging and distribution of software to be run in virtual machines. The OVF specification is backed by the Distributed Management Task Force (DMTF) and almost every major virtualization vendor, including Dell, HP, IBM, and Microsoft, as an industry-standard format of choice for virtual appliances.

By using the OVF format, developers gain a simpler way to package and distribute their appliances while making it easier for customers to evaluate, deploy, manage and update complex solutions. Table 1 provides a brief look at some of the benefits of using OVF to distribute virtual appliances.

Table 1. Benefits of the Open Virtualization Format (OVF)

Benefit	Description
Secure Distribution	OVF supports content verification and integrity checking based on industry-standard public key infrastructure, and it provides a basic scheme for the management of software licensing.
Optimal Customer Experience	OVF supports validation of the entire package and each virtual machine or metadata component of OVF during the installation phase of the virtual machine life cycle management process.
Vendor/Platform Independence	OVF supports the full range of virtual hard disk formats used for hypervisors today and does not rely on the use of a specific host platform, virtualization platform, or guest operating system.
Extensibility	OVF is designed to be extended as the industry moves forward with virtual appliance technology. It also supports and permits encoding of vendor-specific metadata for vertical markets.
Localization Support	OVF supports user-visible descriptions in multiple locales, and it supports localization of the interactive processes during installation of an appliance. This capability allows a single packaged appliance to serve multiple market opportunities.

VMware fully supports the OVF standard, and virtual appliances that are distributed as OVF packages can be directly imported into VMware Infrastructure. To learn more about the Open Virtualization Format, read the OVF Specification¹ white paper.

¹ http://www.dmtf.org/standards/published_documents/DSP0243_1.0.0.pdf

Just Enough Operating System (JeOS)

The growing use of virtual appliances has spawned demand for slimmer, purpose-built operating systems that are optimized for running virtual appliances. Ubuntu and other Linux vendors have responded with JeOS solutions and appliance operating systems that include only the base elements needed to support the application load. Table 2 provides a brief look at some of the major OS vendors that offer appliance-optimized operating systems.

Table 2. Commonly Used JeOS Solutions

OS Vendor	JeOS Solution
LiveTime	LiveTime JeOS
Novell	SUSE Linux Enterprise JeOS
Red Hat	Red Hat Appliance Operating System
Ubuntu	Ubuntu Linux Server Edition JeOS

JeOS solutions occupy a much smaller footprint than general-purpose operating systems and are often more stable and secure because they contain fewer lines of code, which reduces the statistical probability of a vulnerability exploit or configuration conflict. Linux's open source licensing also makes it a natural fit for developers who want to distribute their software as an appliance without worrying about OS licensing costs and constrictions.

Cloud Computing and Software-as-a-Service (SaaS)

Cloud computing and the SaaS model are rapidly transforming the IT landscape. Quantum improvements in Internet bandwidth, computing power and memory, coupled with enabling technologies like virtualization, parallel processing and multicore chips, make it feasible to run large computing tasks on a centralized "cloud" infrastructure.

Cloud computing is driving demand for virtual appliances because they offer a simple, cost-effective way to distribute appliance solutions as hosted services. Many hosting service providers are expanding their businesses to accommodate the growing demand for cloud computing services. IT organizations are also leveraging compute clouds to deliver services to business units as "just-in-time" utilities with usage-based chargeback models.

Virtual Appliance Basics

A virtual appliance is a preconfigured software solution that makes it possible to package, maintain, update and manage one or more virtual machines together as a single unit.

As the name suggests, virtual appliances are not so different from the home appliances that many of us use in our kitchens and laundry rooms. Just as a dishwasher integrates water sprayers, heating coils, sensors and timers as a prepackaged solution for washing and drying dishware, virtual appliances allow virtual machines to work together as an integrated, preconfigured solution that provides an end-to-end service such as email spam protection.

As illustrated in Figure 1, a virtual appliance consists of application software running on a pre-configured virtual machine with "just enough operating system" (JeOS) needed to support the functions of the application.



Figure 1. The Virtual Appliance Stack

Virtual Appliances vs. Virtual Machines

A virtual machine is a software-based computer that provides operating systems and applications with "virtual" access to hardware resources such as CPU, RAM, networking and storage. Virtual machines offer many advantages over physical PCs and can encapsulate an entire PC environment—including the OS, applications and all data—inside a single file. However, users must still configure the virtual hardware, guest operating system and guest application before putting a virtual machine into operation.

Virtual appliances, like virtual machines, incorporate an application, OS and virtual hardware. However, virtual appliances differ from virtual machines in that they are delivered to customers as preconfigured "turnkey" solutions that simplify deployment for customers by eliminating the need for manual configuration of the virtual machines and operating systems used to run the appliance.

Transforming Software Delivery with Virtual Appliances

Service-oriented architectures and the 1:1 mapping of applications to operating systems and hardware have resulted in a massive proliferation of server equipment, all of which must be configured properly in order to ensure adequate levels of service and availability across the software stack. Deployment often takes weeks or even months, and patches and updates must be painstakingly tested across multiple versions of databases, application servers, directories and other components to avoid potential conflicts.

Delivering software as an appliance can solve some of these issues, but hardware-based appliances are difficult to scale and pose challenges in terms of inventory control, shipping and logistics, demos and evaluations, and negative perceptions that customers may have about purchasing "non-standard" equipment. These and other issues are driving up costs, lengthening sales cycles and creating obstacles to success for many appliance vendors.

Virtual appliances address many of the challenges associated with traditional application delivery for developers, appliance vendors and customers alike. Table 3 outlines some of the key benefits that developers, appliance vendors and customers can achieve with virtual appliances.

Table 3. Virtual Appliance Benefits at a Glance

Group	Benefits
Developers and Appliance Vendors	□ Reduce development and distribution costs. □ Accelerate time to market and expand customer reach. □ Strengthen security and improve the customer experience.
Customers	□ Reduce the cost of owning and operating software. □ Accelerate evaluations, deployment and time to value. □ Leverage integration with virtualization platforms.

Benefits for Software Developers and Appliance Vendors

"ISVs (Independent Software Vendors) have a new and better way of delivering their software through virtual appliances."

– Yankee Group, December 2007

For software developers and appliance vendors, virtual appliances provide a simpler, more cost-effective and more secure way to deliver their solutions to market, helping to reduce development and distribution costs, accelerate time to market, expand customer reach, and tighten control over the security and quality of their products.

Reducing Development and Distribution Costs

Virtual appliances help vendors lower the cost of developing and distributing enterprise software by abstracting applications and operating systems from underlying hardware, reducing the need for hardware testing and decreasing the number of platforms that developers must support.

Patching becomes easier because developers can ensure compatibility between application, OS and virtual machine components while distributing updates to customers as a single pre-configured package. Support becomes less costly because the vendor gets more control over the OS and virtual hardware configuration, while at the same time reducing problems introduced by customer-installed device drivers or patches with unknown compatibility implications.

For appliance vendors, the virtual appliance paradigm offers a viable alternative to selling, shipping and supporting hardware-based solutions. With virtual appliances, the burden of managing physical inventory and supporting hardware components is replaced by the convenience and simplicity of packaging the application OS and virtual hardware together as an integrated, prefabricated product that is ready to run in a virtualized IT environment.

Accelerating Time to Market and Expanding Customer Reach

Virtual appliances reduce the amount of time it takes to configure, package and distribute appliance solutions, and accelerate sales cycles by eliminating the time and complexity that customers face in evaluating software. Unlike hardware-based appliances, virtual appliances can be distributed online, helping vendors to increase market awareness, target new accounts, and engage small-business markets and customers that would not normally evaluate or purchase hardware-based appliances.

Increasing Security and Control

Virtual appliances allow developers and appliance vendors to maintain tighter control over the quality and security of their products while giving customers the freedom and flexibility to use the hardware of their choice. Support for content verification and integrity checking based on industry-standard public key infrastructure, along with a built-in scheme for management of software licensing, all make it easier to deliver complex solutions in a more secure and controlled manner while relieving developers and appliance vendors from the burden of configuring and securing hardware components that they often can't access on site.

"Virtual appliances let our product sell itself. We have seen our product turnover double...and the rate of growth of our virtual appliance customers is twice that of our hardware appliance customers."

– Ronan Kavanagh, Director of Sales, SpamTitan

Benefits for Customers

"Forrester has spoken with many enterprise IT infrastructure and application administration professionals and found that most are very comfortable with the appliance model -- and, in most cases, prefer it. Virtual appliances fulfill IT objectives of standardization, commoditization, and simplification."

– Forrester, November 2007

For customers, virtual appliances reduce the cost of owning and operating software. By using preconfigured software-based solutions, customers can deploy services more quickly, streamline management and administration tasks, and leverage their virtual infrastructure as a strategic, standardized computing platform for application delivery.

Accelerating Time to Value

Virtual appliances are faster and easier for customers to evaluate, purchase and deploy than traditional enterprise software because they come packaged as an integrated unit of pre-configured application, OS and virtual machine components, reducing the complex, expensive, lengthy, and potentially error-prone tasks associated with OS and hardware configuration.

Simplifying Software Management

Virtual appliances also simplify IT management by allowing customers to manage and maintain a single encapsulated solution rather than a disparate set of applications, operating systems and server hardware. In addition, the virtual appliance approach allows customers to work with a single vendor for support of all components in their appliance solution.

"We found that deploying ZEUS ZXTM as a virtual appliance meant that we could cut as much as 95 percent of the time from the typical installation process."

– Karsten Thygesen, Systems Architect & Technical Director, Netic A/S

Enabling the VMware Ready Virtual Appliance Ecosystem

"We believe the market conditions are right for virtual appliances to gain permanent, positive traction and establish themselves as a new and durable long-term solution."

– IDC, February 2008

For virtual appliances to become a new standard for delivering software, a diverse and open ecosystem must evolve around the virtual appliance paradigm to provide a rich and seamless experience for both developers and customers across the entire appliance life cycle. Central to that ecosystem is a standards-based program designed to ensure the quality of virtual appliances.

As illustrated in Figure 2, VMware is leading the way in enabling this new virtual appliance ecosystem with a comprehensive strategy that includes:

- A VMware Ready Virtual Appliance Program which is an ecosystem initiative that enables customers to identify virtual appliances that follow best practices and are optimized for VMware Infrastructure.
- A robust and intuitive authoring tool for building high-quality appliance solutions that are ready for use in virtualized IT environments.
- A large and diverse marketplace where vendors can distribute and promote their appliances, and where customers can find solutions that are ready to run in a virtual infrastructure.
- A robust virtualization platform that customers and hosting providers can use to deliver virtual appliances as secure and highly available cloud-based services with the mobility to support a dynamic mix of on- and off-site computing.

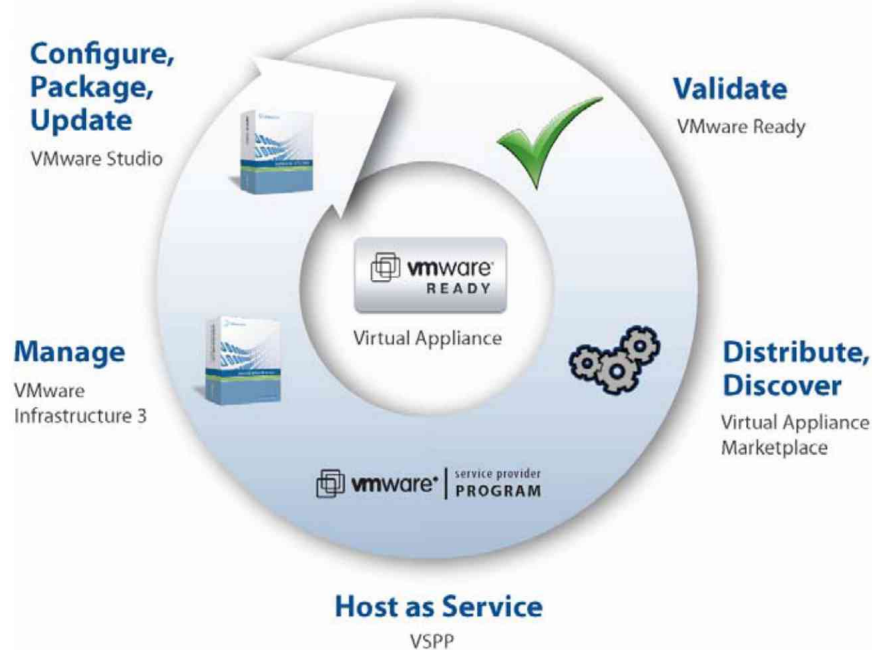


Figure 2. The VMware Virtual Appliance Ecosystem

Validating Virtual Appliances through the VMware Ready Program

The VMware Ready Virtual Appliance Program helps to ensure the best possible experience for consumers by promoting virtual appliance solutions that have been validated by VMware as "ready to run" in VMware Infrastructure. VMware Ready virtual appliances are commercial, production-ready solutions that follow best practices and have passed a comprehensive validation test in the VMware Virtual Appliance Lab.

To qualify for the VMware Ready Virtual Appliance program, virtual appliances pass a series of comprehensive tests conducted by the VMware Validation Lab. In addition, solution providers must agree to conform to VMware support requirements, comply with marketing and branding guidelines, and join the VMware Technology Alliance Program (TAP). Read the VMware Guidelines for Virtual Appliances² or visit the VMware Web site to view detailed instructions on listing and validating virtual appliances.

² http://www.vmware.com/files/pdf/vam_virtual_appliance_guidelines.pdf

Benefits for Virtual Appliance Vendors

VMware actively promotes VMware Ready virtual appliances, helping developers to broaden their reach and engage organizations with a high level of interest in virtualization-ready solutions. VMware Ready virtual appliances are distinguished from other virtual appliances in the VMware Virtual Appliance Marketplace, and developers who participate in the VMware Ready program gain the ability to offer virtual appliances that seamlessly integrate with VMware Infrastructure.

Vendors who offer VMware Ready virtual appliances can leverage the VMware brand by adding the "VMware Ready" logo to sales and marketing collateral. Prospects and customers who see the VMware Ready logo will immediately recognize that the virtual appliance has been through a battery of tests and is safe to run in production-level virtual IT environments.



Benefits for Virtual Appliance Customers

VMware Ready appliances offer the greatest value to customers in terms of quality and operational readiness. All appliances undergo a comprehensive set of tests to ensure consistency and completeness of the virtual appliance. All appliances will be tested to verify that they work with VMware Infrastructure and have all of the necessary documentation to assist new users in either evaluating the virtual appliance or setting that appliance up for production use. Vendors that offer VMware Ready virtual appliances will also provide support for their appliances to ensure that the solution they offer has all of the latest security patches and is maintained according to VMware best practices. The companies that provide these virtual appliances will ensure that they have tested and optimized the entire solution stack on VMware Infrastructure.

Authoring Virtual Appliances

A number of authoring tools are currently available to help create virtual appliances including VMware Studio. A select list of tools is available under the "how to build³" section of the VMware Virtual Appliance Marketplace.

Building Custom Virtual Appliances with VMware Studio

VMware Studio is a robust authoring tool that enables developers to package and distribute their software solutions as virtual appliances that are not tied to any particular hardware platform. Using VMware Studio, developers can build and customize virtual appliances to suit the needs of their applications. Developers can also use VMware Studio to create an update repository for their appliance and publish updates for deployed appliances on a regular basis.

VMware Studio provides both a Web-based GUI and a command line interface for building virtual appliances. The Web interface offers ease of use while the command-line interface provides integration of existing 3rd-party software for fully automated virtual appliance builds. As illustrated in Figure 3, each virtual appliance created in VMware Studio contains an application, along with an operating system disc image (in ISO format) and virtual machine, which are configured and packaged together as defined by a "build profile."

³ <http://www.vmware.com/appliances/build/how.html>

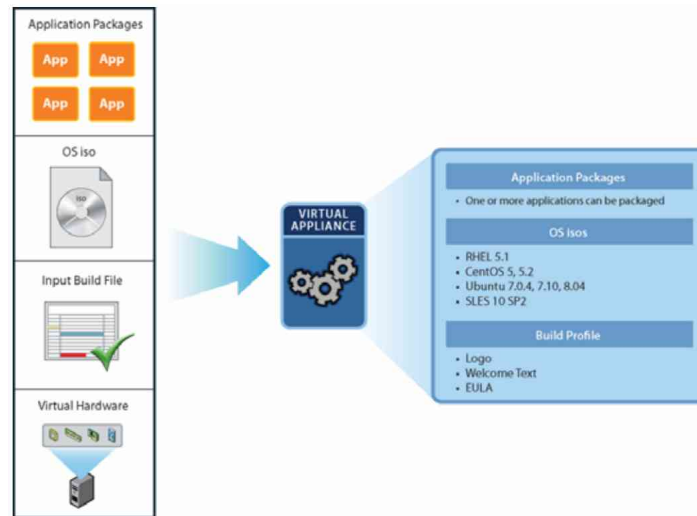


Figure 3. Virtual Appliance Packaging with VMware Studio

The build profile serves as a recipe for building a virtual appliance, specifying the application, OS, and virtual hardware configuration, along with vendor and product descriptors, custom GUI elements, and other attributes. Users can work with the VMware Studio Web Console, or manually edit the XML to create a build profile for their virtual appliance; VMware Studio provides some templates to enable a quick start.

VMware is authorized by Novell to deliver the JeOS version of SUSE Linux Enterprise Server (SLES) to virtual appliance developers through VMware Studio. This certification gives developers who use VMware Studio to build SLES-based appliances the assurance of knowing they are obtaining a genuine SLES build, and all of the software certifications associated with SUSE Linux Enterprise will continue to apply to developers who build their appliances using VMware Studio.



Deploying VMware Ready Virtual Appliances

VMware Ready virtual appliances created using VMware Studio run seamlessly on VMware products such as VMware Infrastructure, VMware ESXi, VMware Workstation, VMware Fusion™ and VMware Server, as well as on third-party virtualization products that support the OVF specification. In addition, virtual appliances built with VMware Studio carry an in-guest management framework that provides management capabilities for end users to perform administrative tasks such as configuring and updating the appliance.

Distributing Appliances on the VMware Virtual Appliance Marketplace

The VMware Virtual Appliance Marketplace⁴ is the industry's largest online directory of virtual appliances. With more than 900 virtual appliances, the Virtual Appliance Marketplace represents a continuously growing ecosystem of virtual appliances for security, content and collaboration, infrastructure management, database management, network monitoring and other solutions. With its growing popularity, the marketplace is expanding to become a place where customers can share their experiences through online reviews and discussion forums, as well as identify hosting providers who can deliver virtual appliances as cloud-based services.

⁴ <http://www.vmware.com/appliances/>



Figure 4. The VMware Virtual Appliance Marketplace

Listing Software on the VMware Virtual Appliance Marketplace

Listing a virtual appliance on the VMware Virtual Appliance Marketplace gives developers immediate access to a large and growing audience of organizations and virtualization enthusiasts. Any vendor can submit their virtual appliance for inclusion in the marketplace; developers and appliance vendors can also differentiate their offerings from other virtual appliances by validating their appliances through the VMware Ready Virtual Appliance program.

Finding Software on the VMware Virtual Appliance Marketplace

"For each IT solution I want to evaluate, I download about three virtual appliance candidates at a time, test them in our virtual environment, and select the one that works best -- often in just a couple of hours. Virtual appliances are so easy to deploy and maintain that we've decided to examine traditional software solutions only if virtual appliances are unavailable"

– Jason Langone, NetStar Systems

(IT provider for the US Census Bureau and other government agencies)

The VMware Virtual Appliance Marketplace is the trusted source for the latest and greatest commercial and open-source virtual appliances. As the most widely used directory of virtual appliances in the world, the Virtual Appliance Marketplace lists nearly 1,000 appliances, from security appliances to infrastructure, administration and collaboration tools. Features such as search tools, most-popular lists and top-rated lists help customers find the right virtual appliance for their specific business needs. Table 4 displays a few of the many VMware Ready virtual appliances listed on the VMware Virtual Appliance Marketplace.

Table 4. Examples of VMware Ready Virtual Appliances on the VMware Virtual Appliance Marketplace

Vendor	Virtual Appliance Solution
IBM	Proventia Network Mail Security System
LeftHand Networks	Virtual SAN Appliance for VMware ESX
Mindtouch	Mindtouch Deki Collaboration Appliance
Stonesoft	StoneGate Firewall/VPN
Symantec	Mail Security 8300 Series – Virtual Edition
Zeus Technology	Zeus Extensible Traffic Manager (Load Balancer)

The VMware Virtual Marketplace is also the best place for customers to find VMware Ready virtual appliances that have been tested and validated by VMware, giving customers the assurance of knowing they are obtaining a solution that is reliable, secure, and ready to run in a virtualized environment.

Managing VMware Ready Virtual Appliances with VMware Infrastructure

As shown in Figure 5, VMware Ready virtual appliances offer seamless integration with VMware Infrastructure, the industry's most widely deployed virtualization platform, enabling customers to leverage their virtual infrastructure as a strategic datacenter platform while optimizing the availability, security and stability of their virtual appliances with essential features such as automated patch and update management, failover and load balancing, and sitewide disaster recovery.

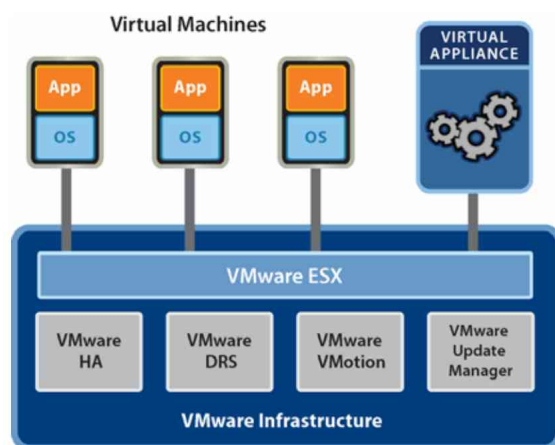


Figure 5. A Virtual Appliance Running on VMware Infrastructure

Hypervisor Integration

As the industry's only true "bare-metal" hypervisors, VMware ESX™ and VMware ESXi provide reliable, robust and secure platforms for running virtual appliances, and can directly import appliances that are distributed as OVF packages. Customers can also use the VMware OVFTool⁵ to convert OVF bundles into the virtual machine format used by "hosted" virtualization software such as VMware Server, VMware Workstation, VMware Player and VMware Fusion.

In addition, hypervisor integration makes VMware Ready virtual appliances compatible with a broad range of server, storage, networking and I/O hardware, helping appliance vendors to remove sales obstacles while minimizing the compatibility issues associated with "non-standard" hardware and operating systems.

Automated Patch and Update Management

VMware Ready virtual appliances help to ease the management burden and security risks associated with patches and updates through seamless integration with VMware Update Manager, a component of VMware Infrastructure that automates patch and update management for VMware ESX and VMware ESXi hosts, as well as for select OS and application software.

VMware Update Manager integrates with the update service in VMware Studio to allow centralized management of virtual appliance updates, both individually and in group sets. Developers can build and maintain update repositories where customers can access patches and updates over a network or the Web, automatically or manually, with the assurance of knowing the application, OS and virtual machine component updates will not conflict with one another. The result is an end-to-end update service that dramatically simplifies the maintenance of a virtual appliance.

Virtual Machine Mobility and Virtual Infrastructure Services

Along with a robust hypervisor and centralized management capabilities, VMware Infrastructure also includes a set of distributed services based on VMware VMotion, the only solution that lets customers move virtual machines from one physical host to another with zero downtime and complete transaction integrity. Table 5 outlines some of the capabilities made possible through the use of VMotion technology.

Table 5. VMware Infrastructure Capabilities Enabled by VMware VMotion

Capability	Description
Automated, Hardware-Independent Failover	VMware High Availability (HA) leverages VMotion to automatically move live virtual machines from one physical host to another in the event of hardware failure.
Dynamic Resource Allocation	VMware Distributed Resource Scheduler (DRS) continuously monitors utilization and intelligently allocates available resources among the virtual machines based on pre-defined rules that reflect business needs and changing priorities, making additional capacity available on demand by migrating live virtual machines to a different physical host.
Zero-Downtime Maintenance	VMware DRS can be configured to move virtual machines to a different physical host at a pre-determined time, facilitating scheduled maintenance while preserving workload availability.
Intelligent Power Management	VMware Distributed Power Management (DPM), a feature of VMware DRS, continuously monitors resource requirements and power consumption; consolidates workloads and puts hosts in standby mode to reduce power consumption; and brings powered-down hosts back online as needed to ensure service levels are met.
Sitewide Disaster Recovery	VMware Site Recovery Manager provides automated, sitewide, hardware-independent disaster recovery for virtualized IT environments, helping customers ensure reliable recovery by eliminating complex manual recovery steps and enabling non-disruptive testing of recovery plans.

⁵ http://www.vmware.com/download/eula/ovf_eula.html

These and other capabilities help customers to ensure the highest levels of service availability for their virtual appliances without the cost and complexity of hardware-based backup, clustering and disaster recovery solutions. Virtual machine mobility also opens the door to flexible cloud computing environments in which virtual appliances can be moved between local and hosted sites in a secure and non-disruptive manner to give customers unparalleled freedom and flexibility in the way they manage IT services.

Cloud Computing and the Future of Virtual Appliances

“Virtual appliances combined with virtual machine clouds enable a powerful one-two punch resulting in a SaaS and on-premises hybrid computing model.”

– Yankee Group

Cloud computing is the next logical stage in the adoption of virtualization and the transformation of IT. As virtualization becomes pervasive, a common infrastructure is being laid across datacenters and bridging corporate boundaries that will enable local and remote resources to be combined securely into a single compute cloud. This infrastructure enables companies to liberate themselves from the constraints imposed by physical datacenters, and run their businesses without the huge costs associated with over-provisioning resources for peak demands, failover, or disaster recovery.

VMware is increasingly recognized as a leader in providing strategic, standardized virtualization platforms that make cloud-based computing a reality. The combination of VMware Infrastructure and virtual appliances form the foundation of a computing environment in which resources are pooled across local datacenters and remote compute clouds interchangeably, fluidly, and safely shared, tracked, and charged-back to the user.

VMware is helping to foster a rich and diverse ecosystem around this transformative computing model with partnerships, programs and solutions that enable software developers, appliance vendors and hosting service providers to deliver virtual appliances and other solutions as virtualization-ready services "in the cloud," to expand the capabilities of the virtual platform, and to further enable cloud computing.

VMware, Inc. 3401 Hillview Ave Palo Alto CA 94304 USA Tel 877-486-9273 Fax 650-427-5001 www.vmware.com
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6,961,941, 6,880,022, 6,397,242, 6,496,847, 6,704,925, 6,496,847, 6,711,672, 6,725,289, 6,735,601,
6,785,886, 6,789,156, 6,795,966, 6,944,699, 7,069,413, 7,082,598, 7,089,377, 7,111,086, 7,111,145,
7,117,481, 7,149,843, 7,155,558, 7,222,221, 7,260,815, 7,260,820, 7,268,683, 7,275,136, 7,277,998,
7,277,999, 7,278,030, 7,281,102, 7,290,253; patents pending.

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