

Advantages of Building Virtual Appliances on SUSE[®] Linux Enterprise Server

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Executive Summary

Squeezing JeOS from a Bloated OS

Major OS distributions are notorious for their bulk and complexity. This is because these OSs must support every software function and option. However, most applications require only a fraction of the functionality of these overgrown OS environments. The extra, unused packages become a liability from a security and management perspective.

Pronounced “juice,” JeOS (just enough operating system) is a slimmed down version of a normal OS that is designed to fit the needs of a particular application. JeOS provides exactly the OS functionality, resources and third-party components that an application requires—and nothing else. The result is a lightweight operating system that is more efficient, higher performing and better secured.

Over the past year, Software as a Service (SaaS) and software appliances have become two of the most frequently cited terms in IT articles and surveys. Since SaaS has been around for quite some time, growing out of the original ASP model, its benefits are well known. However, because software appliances are just emerging, their advantages are only now becoming evident.

Software appliances are a natural evolution in the drive to simplify software development, distribution, management and maintenance. Industry analysts predict that software appliances will play an important role in the future of application deployment. Indeed, independent software vendors (ISVs) that today maintain applications on Linux* and Windows* have been looking at this latest software-distribution model as a way to deliver their solutions to new markets. While most ISVs have held back because of the inability to build software appliances, recent announcements by Novell®, Red Hat* and Canonical* demonstrate that major vendors have embraced the model and that mainstream tools for enabling software appliances are now available.

In this white paper, aimed at enterprises and ISVs alike, we will examine the drawbacks of multi-tenant SaaS, the rise of software appliances and the optimization of “JeOS” (just enough operating system). Next, we will describe virtual appliances and their benefits. This discussion leads into why Linux—and, in particular, SUSE® Linux Enterprise Server—is the best choice for virtual appliances. We will then consider why developers should use the Kiwi image-building toolkit to create virtual appliances. Finally, we will list best practices for building virtual appliances.

The Drawbacks of Software As a Service

SaaS is a software delivery model that is well understood by the software industry. Applications are hosted offsite, typically on the software vendor’s server or SaaS cloud servers, and delivered over the Internet to subscribers. Licensing fees to use the software can vary greatly, with subscribers paying per seat, per hour, per transaction or according to another payment model.

The SaaS delivery model first gained popularity after the turn of the millennium, and has evolved since then. Today, many companies subscribe to the SaaS model because it provides a simpler and lower-cost alternative to traditional onsite software delivery. It is particularly attractive to small and medium businesses. However, SaaS does have its drawbacks for customers:

- **The SaaS model is multi-tenant.** *This means there are multiple customers for any given application instance. Each customer is vocalizing his own wants and needs, and these likely do not match. This situation makes it difficult for the vendor to address any individual customer’s needs.*
- **Updates are forced.** *Because updates happen for all customers on the software vendor’s schedule, they may not fit with a company’s individual schedule or that of its end users.*
- **Updates may affect integrations and customizations.** *Because no rollback is possible, customers are often required to patch over a problem to remain functional after an update. This action can make future updates even more problematic.*

SaaS has its share of drawbacks for software vendors, too:

- *SaaS is expensive. It requires a large upfront investment by ISVs in infrastructure, backup, business continuity and much more. Or, if an ISV chooses to use a SaaS cloud instead, the upfront barriers are lower, but long-term costs are higher.*
- *SaaS is a product that can meet the general needs of many customers, while meeting all of the specific needs of few or none.*
- *Customers considering SaaS for mission-critical systems rightfully have security concerns, as multi-tenant applications can host sensitive data. While the potential for stealing or bleeding session data is small, it is still a major concern. While service level agreements (SLAs) provide strong data safety guarantees, they don't actually help protect the data.*

The Rise of Software Appliances

In concept, a software appliance is a tightly integrated package of enterprise application software and an operating system, designed to run on a standard industry platform. If the appliance is designed to run on a standard server, it is a software appliance; if it is designed to run on a hypervisor, it is a special kind of software appliance called a *virtual appliance*. In implementation, a software appliance can function much like a black box, providing a business function to end users with the complexity hidden from view. The appliance is portable and easy to move, as long as it runs on the hardware or hypervisor for which it is designed. In these ways, SaaS and software appliances are very similar.

In many ways, though, software appliances offer benefits that SaaS alone cannot address. For example, software appliances are typically hosted onsite. The appliance can also be purpose built to meet the needs of a specific customer, solving the multi-tenancy challenges introduced by SaaS. Unlike SaaS, the appliance can handle updates on an

individual appliance basis, enabling better timing of updates and rollbacks. Finally, appliances are easier to manage and more secure because they only contain the components of the OS that are required for a specific application. This reduces the footprint of the OS, the number of relevant attack vectors and the number of patches needed by the appliance.

Comparing to a Virtual Machine

Now you may ask, "What is the difference between a virtual appliance and a virtual machine?" The difference is that a virtual appliance is a preconfigured image with an application stack and JeOS, while a virtual machine is simply a hypervisor capable of running a standard OS, and it contains no application software. With a virtual machine, a customer still needs to choose, install, configure and manage an OS and application stack.

The Benefits of Virtual Appliances

The benefits of virtual appliances over the SaaS model, or even the corporate-hosted application model for that matter, run the gamut—from simpler distribution to bolstered security:

- **Simplified distribution.** *Because a virtual appliance is a self-contained, preconfigured application packaged with a JeOS, distribution is greatly simplified. A single file with a small footprint is easy to download via the Internet. A preconfigured, self-contained package with no external dependencies is also easy to transfer through testing and into the production environment. In addition, encapsulated virtual appliances are highly portable between virtual platforms and from server to server, which is especially beneficial in the case of disaster recovery.*
- **Easier deployment.** *Deploying a compact, self-contained virtual appliance entails a single straightforward installation.*



“SUSE Linux Enterprise Server helps us lower the barrier to entry with our customers. Instead of telling customers which hardware to use, we can hand them a preconfigured virtual machine. Xen virtualization makes it easy for us to test our solutions in house and give customers something they can use without having to purchase expensive new hardware.”

Branden Black
Hosted Solutions Architect
Messaging Architects

Read the whole story:
www.novell.com/success/messaging_architects.html

Linux is supported by a large community of developers and users, ensuring a wide range of support for hardware and software environments.



“Linux gives us a reliable platform for business software. As a data center provider, customers depend on us to deliver high-performance solutions. We can implement solutions faster and at a lower cost with SUSE Linux Enterprise Server than we could with UNIX.”

Michael Gebauer
Solution Architect
Siemens IT Solutions and Services

Read the whole story:
www.novell.com/success/siemens.html

Configuring a virtual appliance is simple and is accomplished through a command-line interface or a Web browser. These attributes reduce the installation and configuration costs associated with running complex stacks of software.

- **High performance.** *Virtual appliances tend to offer better performance when compared to a standard virtual machine for a given application. A small, finely tuned JeOS environment allows an application to run more efficiently, and all the components of a virtual appliance are tested and optimized to run together and without any unnecessary bloat.*
- **Greater reliability.** *Extensive interoperability testing and tuning of components makes virtual appliances more robust. What’s more, the self-contained nature of virtual appliances insulates them from the surrounding system, also improving reliability.*
- **Lower hardware costs.** *Because they are self-contained, virtual appliances can be installed on any commodity hardware, with no need for underlying OS or third-party components. In addition, many virtual appliances can run simultaneously on a single virtual server, further reducing hardware costs and increasing overall hardware utilization.*
- **Improved security.** *Virtual appliances tend to be more secure than comparable applications running on normal OSs. Much of that is because of the compactness of a JeOS, which contains fewer packages and thus fewer vulnerabilities to exploit. In comparison to the SaaS delivery model, virtual appliances are more secure because applications with sensitive data remain on a company’s premises and safely behind its firewall. Data is not transmitted over the Internet and stored offsite at a vendor’s*

location, where the company has no control.

- **Digital signing.** *Virtual appliances also simplify adding security aspects such as digital signing to ensure the trustworthiness of solutions. An authoring organization can digitally sign a virtual appliance at every step, including the image description, repository packages and the image file itself.*
- **Reduced management workload.** *With a typical software stack, there are individual vendors for the application, the OS and each third-party component. These vendors all have their own update schedules, which makes keeping track of versions, patch levels and compatibility a logistical nightmare for IT organizations, and makes conflicts inevitable. Because the virtual appliance author is responsible for configuring the software stack, JeOS and third-party components, there’s just a single path for updates. By replacing OS- and application-specific management tasks with a single efficient, standardized set of processes, IT staffs gain a simplified software management lifecycle while reducing associated costs.*

Why Build Virtual Appliances on Linux?

Linux is the operating system of choice for virtual appliances for several reasons. First, its flexible subscription model provides users with a stable, cost-effective enterprise-grade platform that includes free, modifiable source code—and maintenance and support options. Second, Linux’s modular architecture is ideal for creating JeOSs for virtual appliances because it can easily be stripped and modified as needed. Finally, Linux is supported by a large community of developers and users, ensuring a wide range of support for hardware and software environments.

SUSE Linux Enterprise Server: The Linux of Choice for Virtual Appliances

While Linux is an optimal operating system for virtual appliances, not just any Linux will

do in the enterprise environment. Companies creating or deploying a virtual appliance require a trusted and supported distribution. That's where Novell and SUSE Linux Enterprise Server come in.

SUSE Linux Enterprise Server is a trusted, enterprise-quality operating system designed to handle mission-critical workloads. It offers an open, scalable, high-performance solution that features integrated virtualization technology, application security and systems management across a full range of hardware architectures. Supported and certified by the world's leading hardware and software vendors, SUSE Linux Enterprise Server is backed by award-winning Novell technical support and a global ecosystem of partners and services.

SUSE Linux Enterprise Server is deployable as a general-purpose or real-time operating system, or it can be tailored to run a variety of specialized workloads, including virtual appliances. It offers industry-leading interoperability with your existing data center infrastructure, including Windows*. With SUSE Linux Enterprise Server, your business can dramatically reduce costs while deploying the most secure and reliable server on the market.

Open source technologies—including Linux—are constantly evolving. Novell is a Linux vendor that will be ahead of the curve when it comes to product quality and open source innovation.

SUSE Linux Enterprise Server is the perfect operating system for virtual appliances for several reasons:

- **Reduced hardware costs.** *SUSE Linux Enterprise Server runs on all leading architectures including x86, AMD64, Intel* 64, Intel* Itanium* 2 (IA-64), IBM* PowerPC* and IBM mainframes, giving your organization complete deployment flexibility. Its proven compatibility with*
- a range of commodity hardware—from blades to clusters and mainframes—simplifies integration and reduces costs. By switching to SUSE Linux Enterprise Server on commodity hardware, some organizations have reduced their infrastructure costs by up to 70 percent.*
- **Scalability.** *Never an issue with SUSE Linux Enterprise Server, scalability is proven to 128 processors on most standard architectures and up to 4,096 processors on specific Itanium systems.*
- **Reliability for your data center.** *The performance and reliability of SUSE Linux Enterprise Server have been demonstrated in some of the world's largest deployments. For example, it currently powers six of the world's top ten supercomputers.*
- **Interoperability.** *Almost all data centers have some combination of Linux, UNIX* and Windows operating systems. Each year about 20 percent of the UNIX installed base migrates to Linux, another UNIX platform or Windows, and more than 80 percent of the migrated UNIX systems end up on Linux and Windows. Novell focuses on interoperability, so you aren't limited to only Xen* virtual machines. You can also run and manage VMware* virtual machines or Hyper-V virtual machines from Microsoft*.*
- **Integrated Xen virtualization.** *Many of today's servers run at less than 20 percent utilization. With the integrated Xen virtualization in SUSE Linux Enterprise Server, you can typically increase utilization levels from 50 to 60 percent—and up to 80 percent in some instances. You get far more value from your IT investments without the need to purchase an expensive, proprietary virtualization solution. The benefits of consolidating multiple disparate workloads onto Xen-based virtual machines include:*
 - Improved server utilization resulting in lower hardware, maintenance and electrical costs
 - Simplified provisioning of new servers in the form of virtual machines



“SUSE Linux Enterprise gives us complete independence in our choice of hardware vendor, so we can always buy the best-value machines at any given time. What's more, Linux offers very high performance on standard x86 processor technology, so we do not need to invest in more expensive proprietary chipsets.”

Norbert Diehl

Head of IT
MTU Aero Engines

Read the whole story:
www.novell.com/success/mtu.html



“We chose SUSE Linux Enterprise Server because it offered the best overall package of support, a stable distribution of Linux and a long-term relationship with a trusted partner.”

Nick Leake

Director of Operations
and Infrastructure
ITV

Read the whole story:
[www.novell.com/success/
itv.html](http://www.novell.com/success/itv.html)

- Improved business continuity and system uptime
- Application portability and flexibility across hardware platforms
- Improved response times by dynamically balancing virtual computing loads across data center resources during peak times

■ **Support for more guest operating systems.** *SUSE Linux Enterprise Server can enable more guest operating systems than any other commercial operating system. Organizations using this feature will consequently have many more opportunities to consolidate their servers.*

■ **Comprehensive systems management.** *SUSE Linux Enterprise Server ships with a comprehensive set of administration, configuration and deployment tools to ease the burden of systems maintenance and subscription management. These tools include:*

- **YaST.** This unique tool can configure every aspect of SUSE Linux Enterprise Server—from adding users to configuring applications. YaST is the administration, configuration and deployment tool integrated in SUSE Linux Enterprise. If you’re familiar with UNIX management, you’ll be right at home with the excellent usability of YaST—including its graphical tools for single server management as well as its text console interface for remote accessibility.
- **Novell Customer Center.** You can use this convenient online interface to easily manage subscriptions and support entitlements. This tool ensures uninterrupted access to software updates and security patches.
- **Common information management (CIM) support.** This standard provides a vendor-independent framework for systems management and allows other CIM-enabled management solutions to easily run on SUSE Linux Enterprise Server systems.

■ **Optional management tools.** *While not integrated within SUSE Linux Enterprise Server, the Novell ZENworks® suite is optimized for the OS. The suite comprises three components:*

- **Novell ZENworks Linux Management.** Control Linux desktops and servers from the comfort of your office. Novell ZENworks Linux Management makes it easy to extend systems based on Linux within your existing environment and provide centralized control. It uses policy-driven automation to deploy, manage and maintain Linux resources. Advanced functionality can provide desktop lockdown, imaging, remote control, inventory and software management.
- **Novell ZENworks Orchestrator.** Novell ZENworks Orchestrator allows you to more easily manage physical servers as well as virtual machines—and not just those running Novell software—in a heterogeneous data center. Management support for virtual machines includes those based on Xen, VMware and Windows. Orchestrator keeps your physical and virtual resources working together and focused on your business priorities. When a problem arises, Orchestrator automatically takes action. For example, it can find available space on the network, configure a new virtual server and get it up and running to perform whatever business-critical task is needed.
- **Novell ZENworks Virtual Machine Management.** If you are running out of space in your data center, you do not need more machines. You need each machine to do more. Novell ZENworks Virtual Machine Management helps manage the entire lifecycle of your virtual machines, delivering support for VMware, Xen and Microsoft. Novell ZENworks Virtual Machine Management provides for failover of virtual machines

in some scenarios, live migration for paravirtualized guests, saving and restoring of paravirtualized guests, automatic balancing of virtual machines across physical nodes, a well-designed management interface for the entire data center and cross-platform virtual machine management.

- **AppArmor® application security framework.** *While Linux is inherently more secure than other operating systems, the applications that run on it are sometimes the target of attacks. SUSE Linux Enterprise Server eliminates this vulnerability with the powerful application-level security in AppArmor. AppArmor protects your operating system—and all its applications—from the harmful side effects of internal or external attacks, malicious applications and viruses. SUSE Linux Enterprise Server is the only enterprise-class Linux server to:*
 - Provide out-of-the-box application security at no extra cost
 - Provide automated application-profiling and policy-creation tools that simplify application security administration and configuration. With these tools, you can create security policies in minutes, not days.
 - Permit dynamic policy updates without service interruption.
- **Additional security resources.** *In addition to AppArmor, SUSE Linux Enterprise Server features other essential security capabilities: encryption, a firewall, security-certificate creation and management, user authentication and access control. With all these security resources at hand, your business can protect mission-critical data, reduce system administration costs, and prevent downtime and lost revenue.*
- **Common-sense subscriptions.** *SUSE Linux Enterprise Server changes the way you think about buying software. No longer tied to complex licensing programs, you*

With all these security resources at hand, your business can protect mission-critical data, reduce system administration costs, and prevent downtime and lost revenue.

can buy what matters: a subscription for the services, updates and patches that help you run your business. When you purchase a three-year SUSE Linux Enterprise Server subscription from Novell, it costs only about 38 percent of what you would pay for a license and three years of maintenance for Windows Server 2003. Plus, with SUSE Linux Enterprise Server, you do not have to pay a separate fee for each virtual machine you create. You only pay for your original subscription. You can then create and use an unlimited number of virtual machines at no additional cost.*

Building Virtual Appliances with Kiwi

Building a virtual appliance begins with creating an image description, which requires an image-building tool. The image description details the application and OS—and their configuration—including the OS's file system structure and possible additional metadata. Depending on the image type you are considering, disk geometry and partition table data may also be part of the image description. The next step is to create the actual image, which is then deployed to the destination system for activation.

Kiwi is a command line-based image-building toolkit that you can integrate into your existing build system to simplify lifecycle management of virtual appliances. It provides a complete image solution for Linux-supported x86 and x86-64 hardware platforms as well as virtualization systems like Xen, QEMU and VMware. Likewise, Kiwi supports many image types: live CDs, DVDs, USB sticks, virtual disks, Xen paravirtual

images for hypervisors, OEM virtual disks, and network boot via PXE.

You can also use Kiwi to create software appliances for hardware such as thin clients or to preload systems for OEM customers. However, that is outside the scope of this white paper.

Creating and deploying an virtual appliance image using Kiwi is a three-step process:

- 1. Physical extend.** This step defines the image description. During this step, you determine which packages are installed on your image and which configuration files are included. Based on a valid software package source, this creates a so-called physical extend according to the provided image description.
- 2. Logical extend.** This step creates the operating system image based on the first step—the physical extend. The result is called a logical extend.
- 3. Deployment.** The resulting image can then be deployed through different methods. For example, you can install it on a hard disk or send it to a virtualization system such as VMware, QEMU or VirtualBox*.

The Benefits of Building with Kiwi

The advantages of using Kiwi to build your virtual appliance images include:

- *Creating your own live CD/DVD, which contains only the packages that you really need.*
- *Debugging a new distribution by creating all necessary packages.*
- *Building your own installable images to customize available packages, patterns, services and more.*
- *Testing new hardware with a predefined image.*
- *Creating images with customized software included.*

- *Building images that can be directly used by virtualization systems like Xen and VMware.*
- *Generating images for different processor architectures, such as x86 and x86-64, simply by switching repositories.*
- *Creating smaller images than with a usual installation.*
- *Building images for network systems.*

SUSE Studio

SUSE Studio is the Linux appliance construction kit from Novell. It allows you to create customized appliances built on Lime JeOS—the “just enough OS” version of openSUSE. With this free, hosted solution, you simply log in, select a base Linux template, and then customize, build, test and download your appliance. It’s really that easy. Try it out yourself at: <http://studio.suse.com>

With a few clicks in SUSE Studio, you can build a Linux appliance in minutes:

- *Create a tuned server appliance, containing your application and JeOS components*
- *Spin a live CD or DVD with only the packages and software you need*
- *Create a ready-to-run VMware or Xen virtual server appliance*
- *Create a live USB key and carry your Linux system with you wherever you go*
- *Build a hard disk image for preloading onto hardware*
- *Install from your live CD, DVD or USB key to your hard drive*

Best Practices for Building Virtual Appliances

When creating a virtual appliance, there are proven best practices you can implement to ensure an efficient, secure and manageable result:

- **Package your virtual appliance in a run-time format, ready to begin executing the moment it is installed.** Your virtual

appliance should include the following standard components:

- Primary application
 - JeOS
 - Command-line interface
 - SSH daemon
 - Web-management interface
 - External management support (SNMP or XML SOAP interface)
- **Keep the virtual appliance small and secure.** *Include only the absolutely necessary OS components and services, closing any unused ports. For example:*
 - Because you will likely want to enable a Web-management interface, keep port 80, 443 or other specified port open for standard HTTP traffic.
 - You should include an SSH daemon and open the corresponding port for secure remote access to your appliance if you are enabling a command-line interface.
 - For virtual appliances, remove any unnecessary virtual hardware, such as floppies, CDs, USB ports, etc.; even if you want to include virtual CD support, you should configure your appliance with those devices disconnected by default.
 - **Package the virtual appliance for download.** *Here are the basic steps you should take:*
 - Copy the appliance to a clean folder, removing any unneeded files.
 - Add a Getting Started file to the directory.
 - Compress the folder into a single file (.zip or .tar).
 - **Think through your appliance's first boot and initial configuration.** *Allow end users to configure everything that is needed on the first boot. Once your end user sets up the virtual appliance, it should run without further interaction. There are two important things to bear in mind:*
 - Be sure your appliance supports DHCP for obtaining an IP address, and provide for a backup plan in case DHCP is not available, such as letting the end user specify a static IP address.
 - Ensure the virtual appliance informs the end user of the management interface's URL for subsequent configuration, if needed.
 - **Enable a management interface.** *Even though virtual appliances are self-contained, pre-installed and preconfigured, there are likely still a few items that the end user needs to manage, such as exporting and purging log files and database tables. Provide either a console-based command-line interface or, ideally, a Web browser-based interface for configuring; a point-and-click browser-based interface is preferable, as it eliminates any chance of the end user corrupting code within the virtual appliance.*
 - **Provide for painless updates.** *A properly configured virtual appliance should allow end users to apply a patch with minimal disruption.*

Yes Certification

To ensure the functionality of your virtual appliances within certain tolerances, you may choose to run certification tests. Novell issues the YES Certified™ mark for commercial solutions that pass these tests. The YES Certified mark informs customers that a solution is compatible with other YES Certified products.

Novell: The Clear Choice for Virtual Appliances

According to IDC, "It is imperative to look into how software appliances could potentially disrupt existing business models or how end users could leverage them over the next few years instead of purchasing a standard traditional application stack." Virtual appliances are a step up from software appliances,

“Xen virtualization was the best option for us and has saved us tens of thousands of dollars in hardware costs. Using SUSE Linux Enterprise Server and Xen virtualization, along with the paravirtualized drivers in the Driver Pack, we now have greater flexibility, with no degradation in performance.”

Jack McLaine
VP of IT
Leesport Financial

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comprising the application, OS and metadata required to automatically and securely install, configure and run on any virtualization platform.

When it comes to building virtual appliances, Novell is the vendor that best meets the criteria, combining the world's most advanced Linux technology with more than 20 years' experience in enterprise-ready software, support and services.

SUSE Linux Enterprise Server from Novell is a high-powered Linux distribution for enterprise-grade computing. It offers a flexible subscription model, runs on a

wide variety of industry-leading hardware, integrates Xen virtualization technology and provides the foundation for secure, reliable and cost-effective virtual appliances.

Kiwi from Novell is a complete image solution for Linux-supported x86 and x86-64 hardware platforms as well as for virtualization systems like Xen, QEMU and VMware.

For all of these reasons—and an unmatched support ecosystem—Novell is the clear choice for virtual appliances.

For more information, visit: www.novell.com/linux/appliance



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