

Advantages of Building Virtual Appliances on SUSE® Linux Enterprise Server



Table of Contents:

2	Executive Summary	7	Building Virtual Appliances with Kiwi
2	The Drawbacks of Software As a Service	8	The Benefits of Building with Kiwi
3	The Rise of Software Appliances	8	SUSE Studio
3	Comparing to a Virtual Machine	8	Best Practices for Building Virtual Appliances
3	The Benefits of Virtual Appliances	9	Yes Certification
4	Why Build Virtual Appliances on Linux?	9	SUSE: The Clear Choice for Virtual Appliances
4	SUSE Linux Enterprise Server: The Linux of Choice for Virtual Appliances		

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. 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

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

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 SUSE 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 SUSE 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. SUSE 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.

- **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. SUSE 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*.*
- **Take advantage of built-in virtualization capabilities.** *Increased performance and efficiency doesn't have to empty your wallet or burden your IT team with administration nightmares. Each SUSE Linux Enterprise Server subscription includes support for all the leading open source hypervisor technologies. It ships with Xen, the most widely used open source virtualization hypervisor, and Kernel Virtual Machine (KVM), an emerging open source technology. To make life easier on your IT staff, SUSE Linux Enterprise Server includes graphical and command-line tools that dramatically simplify installing, configuring and managing your virtualized environments. Benefits 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



“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

- 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.*

■ **Save time with powerful administration and development tools.** *SUSE Linux Enterprise Server also comes with administration and development tools that make it simpler for your staff to install, configure and support Linux in your data center. Easy to use, and with the power to handle large numbers of systems, these tools cut maintenance costs and save time, freeing your staff to focus on adding more value to your business. These tools include:*

- **ZYpp.** Quickly manage package installations and resolve dependencies with the fastest update stack available on any enterprise Linux distribution.
- **YaST®, AutoYaST and WebYaST.** YaST offers a user-friendly environment for server installation, configuration and management. AutoYaST extends these capabilities by enabling automated remote systems configuration and mass deployment, while WebYaST offers the functionality of YaST through a web browser.
- **Subscription Management Tool (SMT).** Centrally manage software updates on a per-system basis and track your entitlements across large deployments—all within your firewall.
- **Software development kit (SDK).** The comprehensive SDK included with SUSE Linux Enterprise Server enables

you to create applications quickly and effectively. It provides developers with powerful open source programming languages, integrated development environments, libraries, compilers, debuggers and simulators.

■ **Manage SUSE Linux Enterprise the Linux way.** *Whether your data center is large or small, manually updating, patching and configuring servers can be a time-consuming, error-prone task. SUSE Manager can help. Built for Linux, SUSE Manager automates Linux server management, allowing you to provision and maintain your servers faster and more accurately. SUSE Manager lets you monitor the health of each Linux server in your data center from a single console so you can identify server performance issues before they impact your business. With SUSE Manager you can comprehensively manage your Linux servers across physical, virtual and cloud environments while improving the efficiency of your data center. Key benefits include:*

- **Slashes total cost of ownership** by automating server management and provisioning tasks. This improves your IT staff’s productivity and enables you to grow your Linux estate without adding IT personnel. Plus, SUSE Manager delivers the capabilities you need to effectively manage your Linux systems, more affordably than proprietary third-party systems management products.
- **Reduces the complexity of managing Linux systems** by providing organizations with a single solution for managing SUSE Linux Enterprise Server and related extensions, as well as Red Hat* Enterprise Linux.
- **Simplifies compliance** by letting you audit software patch status and deploy required security patches remotely. Your IT staff can use SUSE Manager to develop and maintain standard configurations that conform to security specifications and

increase the consistency of provisioning new servers.

- **Improves service quality** by helping IT administrators perform management and provisioning tasks faster and with fewer errors, SUSE Manager reduces server downtime. Your IT staff can also identify server performance issues earlier, reducing service disruption and limiting any adverse business impacts.

- **Protecting Your Enterprise with Advanced Security.** *SUSE Linux Enterprise Server is not only perfect for processing mission-critical workloads and delivering business services. It also protects your intellectual property—the lifeblood of your business—with advanced, built-in security capabilities.*

SUSE Linux Enterprise Server ships with AppArmor®, an effective and easy-to-use security system. AppArmor proactively protects the operating system and applications from external or internal threats—even zero-day attacks—by enforcing secure behavior and preventing unknown application flaws from being exploited.

AppArmor security policies completely define what system resources individual applications can access, and with what privileges. Such oversight is critical today, as more people access your resources via the Internet and more workloads run in virtual environments and the cloud. AppArmor includes default policies so you can successfully deploy security policies for complex applications in just a few hours.

When it comes to enterprise Linux security, AppArmor is just the beginning. SUSE Linux Enterprise Server also provides a true firewall that protects your resources from internal and external attacks. This “stateful” firewall technology lets you separate networks and control which packets pass through any network interface.

SUSE Linux Enterprise Server also supports the Trusted Platform Module (TPM) standard for authenticating common hardware devices. Our comprehensive,

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

enterprise-class security capabilities include certificate creation and management, VPN, encryption, authentication, access control lists and intrusion detection.

- **Common-sense subscriptions.** *SUSE Linux Enterprise Server changes the way you think about buying software. No longer tied to complex licensing programs, you can buy what matters: a subscription for the services, updates and patches that help you run your business.*

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.

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 fastest and easiest way to create, test, configure software application images or appliances in several formats, making it easy to deploy them on physical hardware, in virtualized environments, or to cloud environments. You can even deploy from SUSE Studio to Amazon EC2 with one click. 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. SUSE 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.

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

“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

www.suse.com

When it comes to building virtual appliances, SUSE 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 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 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—SUSE is the clear choice for virtual appliances.

For more information, visit: www.suse.com/products/susestudio/



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