



How to migrate from Red Hat Linux to Red Hat Enterprise Linux: A Technical Paper

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Abstract

In recent years, Linux has been validated as an enterprise-worthy operating system, capable of managing the robust components of major production environments. IT professionals acknowledging the cost savings, scalability, and stability of Linux are deploying open source technologies at every opportunity. Most IT professionals are familiar with the Red Hat Linux retail product line and have been using Linux systems in business environments for some time. This paper outlines the Red Hat Enterprise Linux family of products and explains Red Hat's goal to become the complete open source technology provider. The intent is to help the customer understand how Red Hat's corporate strategy has evolved around the Red Hat Enterprise Linux technology and why customers familiar with prior Red Hat releases should migrate to Red Hat Enterprise Linux. The paper concludes with an engineering overview of Red Hat Enterprise Linux version 3 and offers migration strategies for those considering moving to this platform.

Table of Contents

Introduction	4
Red Hat Platforms--An Overview.....	4
Red Hat Linux.....	4
Fedora Project.....	5
Red Hat Professional Workstation.....	6
Red Hat Enterprise Linux.....	6
Why Red Hat Enterprise Linux?.....	6
Overview.....	6
Performance.....	8
Stability.....	9
Scalability.....	10
Security.....	10
Manageability.....	12
Update Module.....	12
Management Module.....	13
Monitoring Module.....	14
Red Hat Enterprise Linux Family.....	15
Red Hat Enterprise Linux 2.1.....	15
Red Hat Enterprise Linux 3.....	15
Red Hat Enterprise Linux 3 Kernel.....	17
4GB-4GB Split.....	17
I/O Subsystem Improvements.....	18
Native Posix Threading Library.....	19
Development Enhancements.....	19
Logical Volume Manager.....	20
Networking and Security Improvements.....	20
Desktop Environment.....	21
Diskless System Support.....	21
Miscellaneous Enhancements.....	21
Partner Support ISV Certifications.....	22
Red Hat Ready Applications.....	22
Red Hat Applications.....	23
Red Hat Cluster Suite.....	23
Red Hat Developer Suite.....	23
Red Hat Enterprise Linux Migration Strategies.....	23
Linux Migration Fundamentals.....	24
1.Linux Integration and Migration Assessment.....	24
2.Linux Migration Planning & Design.....	24
3.Implementation and Integration.....	24
4.Establishing Operations Services.....	24
Migrating From Red Hat Linux to Red Hat Enterprise Linux	24
Migrating from Red Hat Enterprise Linux 2.1 to Red Hat Enterprise Linux 3..	25
Upgrading from Red Hat Enterprise Linux 2.1 to Red Hat Enterprise Linux 3..	27
Conclusion.....	27

Introduction

Red Hat has played a critical role in escalating the status of Linux as a viable enterprise operating system. Red Hat initially excelled as a Linux vendor because the company recognized the value of code management and maintenance to its customers. Red Hat's approach to distributing Linux was unique because the code was packaged to make it more manageable. Through this technical packaging methodology, Red Hat facilitated enhancements in functionality, performance, reliability, and security that take many years to achieve in the proprietary operating system world. Since its inception, Red Hat has become the industry's leading Linux solution for enterprise and commercial deployments. As a company Red Hat continues to maintain its position as the Linux industry leader because it continues to offer value and innovative engineering to customers. Red Hat has helped accelerate the adoption of Linux in the enterprise by offering corporate accountability, manageability, and engineering expertise to companies deploying Red Hat products. Red Hat has also committed to building relationships with OEM software vendors so that hardware and established applications can be used on Red Hat systems.

It is apparent to the technology sector that Red Hat technology has become an integral component of enterprise domains. It is important for our customers to understand Red Hat's corporate direction as the adoption of Red Hat technologies continues to evolve in enterprise environments. This paper will clarify Red Hat's position and direction with regard to the enterprise, and help existing Red Hat Linux customers understand why and how to migrate to Red Hat's next generation--Red Hat Enterprise Linux.

Red Hat Platforms--An Overview

Red Hat has several options available for customers that want to use Linux as an operating system. Currently, there are four options:

Red Hat Linux

Red Hat Linux has historically been Red Hat's retail release. The first release of this line of products appeared with the Halloween beta in October 1994 and eventually became Red Hat Linux 1. The Red Hat Linux Operating System was Red Hat's flagship product for many years, and after 33 revisions, is discontinued as a managed release. The last product in this series, Red Hat Linux 9, will no longer be maintained by Red Hat after April 31, 2004. Red Hat Global Support Services will also be unavailable for the Red Hat Linux product line after this date. The

supported and maintained Red Hat distribution going forward Red Hat Enterprise Linux, and Red Hat encourages its customers to migrate to this platform.

The open source development model has historically been driven at a rapid pace. For example, in just 18 months Red Hat released Red Hat Linux 7.2, 7.3, and 8.0. The typical Red Hat Linux release cycle lasted about four to six months and was maintained by Red Hat for no longer than two years. This model was vastly different from the much longer release cycles prevalent in the proprietary operating system space and was not consistent with the development models many enterprise application vendors were accustomed to.

Red Hat Linux was developed to meet the needs of the Open Source movement and early technology adopters. Because the Red Hat Linux platform used bleeding-edge open source technologies, it was not appropriate for customers that needed stability in production environments. Red Hat Linux products were usually schedule driven, which made features of secondary importance. These products could also be freely replicated and deployed on many systems which is no longer in line with the subscription-based Red Hat Enterprise Linux products. Red Hat Linux hobbyists looking to test or develop new Linux features are encouraged to participate in the Fedora Project.

Fedora Project

The Fedora Project is an open source community project sponsored by Red Hat. Through this project, Red Hat works with the open source development community to build, test and eventually integrate packages into Red Hat Enterprise Linux. The idea is to promote a collaborative effort for development with other open source projects around the globe.

The Fedora Project is intended to be a proving ground for new technologies. There is no focus on binary compatibility within the Fedora project. Critical fixes are available to users a few months after a release, but there are no explicit errata or security patches regularly available. Additionally, there are no official Quality Assurance programs or integration testing procedures for the Fedora Core releases. Red Hat does not recommend deploying any Fedora Core releases in production environments. For more information on the Fedora Project please see:

<http://fedora.redhat.com/>

Red Hat Professional Workstation

The Red Hat Professional Workstation will replace the Red Hat Linux product line and will be available to customers from retail outlets after the Red Hat Linux product line has been discontinued. This product offers a suite of tools for the power desktop user but is limited to 30 days of basic installation and configuration support. There are no annual subscription support options, or Service Level Agreements available for this release, and it is therefore not intended or recommended for corporate IT environments. Red Hat Professional Workstation additionally is not a platform for ISV certification and is not recommended for customers that need technical support for the product or from Red Hat ISV partners. Red Hat Professional Workstation does include RHN channel access for errata updates and security advisories, but maintenance is limited to one year. There will also be no upgrade path to successive versions of this product.

Red Hat Enterprise Linux

Red Hat Enterprise Linux is the enterprise-class product line and is recommended for production environments. The Red Hat Enterprise Linux offers stability and quality with an extended release cycle for certified ISVs and OEM hardware vendors. This is the only offering from Red Hat that includes comprehensive professional services support from Red Hat and its partners. Red Hat Enterprise Linux is an established, capable enterprise OS and is the cornerstone of Red Hat's future corporate strategy. The majority of this paper focuses on Red Hat Enterprise Linux and why it is important for Red Hat customers to migrate their systems to this platform.

Why Red Hat Enterprise Linux?

Overview

Prior to the release of Red Hat Enterprise Linux AS 2.1 the Linux marketplace was challenging for Independent Software Vendors (ISVs) and OEMs. Red Hat developed Red Hat Enterprise Linux as the single target platform for all major ISVs and their enterprise-level server applications to alleviate the burden the previous development cycle imposed on software development companies. With Red Hat Enterprise Linux, Red Hat provides a platform that ISVs, hardware manufacturers and system administrators support. Red Hat Enterprise Linux AS 2.1 was released in May 2002. Red Hat also released Red Hat Enterprise ES and Red Hat Enterprise Linux WS shortly after to complete the product line with products appropriate for edge-of-network server applications and

technical workstations. Red Hat Enterprise Linux is released every 12-18 months, giving ISVs more time to certify and deliver their products. The next version of the Enterprise product line, Red Hat Enterprise Linux version 3, is available in October 2003. All versions of Red Hat Enterprise Linux are maintained by Red Hat for five years after the initial release date. Red Hat Enterprise Linux products are available to customers through annual subscriptions which include maintenance and technical support services.

Red Hat Enterprise Linux is a more mature environment than the retail Red Hat Linux products or the community driven Fedora Project. The Red Hat Linux retail releases were appropriate for smaller businesses, open source developers, and hobbyists. Both the Red Hat Linux product line and the Fedora Project contain a variety of technologies and applications that are either not business related, or are still in the early stages of development. In contrast, the packages that comprise Red Hat Enterprise Linux have been included for their stability and applicability to a production enterprise environment.

The longer release cycle for Red Hat Enterprise Linux does not mean that system administrators must sacrifice the timely release of security and bug fix updates they have come to expect from Red Hat. Bug fixes and security updates are released on an as-needed basis to ensure that customers have the most reliable, stable, and secure systems possible. Quarterly updates in the form of ISO images are available and include driver updates and feature enhancements relevant for enterprise customers. All updates are made available through Red Hat Network (see Manageability later in this paper), which enables the easy deployment of updated software to a large number of systems. Red Hat Network reduces administrative overhead for corporate system administrators by simplifying and centralizing package management and system maintenance at an affordable cost.

As of this writing, two versions of Red Hat Enterprise Linux are currently available to customers: Red Hat Enterprise Linux 2.1 and Red Hat Enterprise Linux version 3 (available October 2003). Both versions of Red Hat Enterprise Linux share the release model outlined below:

Red Hat Enterprise Linux Release Model

12-18 Month Release Cycle

5 Year Product Lifecycle

Red Hat Network Updates/Errata

Bug Fixes

Partners and Customer Beta Testing

Extended QA Cycle

Both versions of Red Hat Enterprise Linux were engineered with the following priorities:

Performance

Red Hat Linux was only consistently available for x86 systems and was not modified for any particular purpose. Fedora project development only focuses on 32 bit architectures as well. In contrast, Red Hat Enterprise Linux is highly optimized to provide exceptional performance across seven architectures. Red Hat Enterprise Linux was tuned for enterprise IT operations and is currently demonstrating world class performance in critical environments. Benchmarking statistics are not available for the Red Hat Linux products or Fedora because these products are not intended for production environments. Additionally, most benchmarks come from third party OEM or software vendors who have only certified their products for the Red Hat Enterprise Linux product line.

Red Hat Enterprise Linux is achieving outstanding industry-standard benchmark results that can be used to assess capabilities across the entire product line. The results cover a range of configurations, architectures, and performance metrics. Red Hat Enterprise Linux has been a core part of configurations that offer significant performance and cost advantages over traditional, proprietary OS environments. Many noteworthy benchmarking statistics are available for Red Hat Enterprise Linux 2.1 and preliminary testing suggests that Red Hat Enterprise Linux v.3 demonstrates more impressive performance benchmarks than its predecessor.

ECperf is an industry-standard benchmark for J2EE application server and database systems. The world-record price/performance ECperf benchmark available today (at \$5/BBop) was achieved using Red Hat Enterprise Linux AS and Oracle 9i running on HP ProLiant DL360 systems.

The Transaction Processing Performance Council Benchmark C (TPC-C) has become a highly regarded industry reference that measures online transaction processing and database benchmarks. World-record benchmarks have been achieved with Red Hat Enterprise Linux 2.1 for x86 architectures and a cluster of eight, quad-CPU HP ProLiant DL580s. The database size was 17Tb, and the total hardware cost for this benchmark was approximately \$2 million. Red Hat Enterprise Linux AS in this configuration was able to attain 138,362 transactions per minute at a cost of only \$17.87. These results show outstanding business throughput at a minimal cost confirming total cost of ownership with Red Hat Enterprise Linux is considerably less than many other OS alternatives.

Other recently archived and upcoming Red Hat Enterprise Linux performance benchmarks are available online at:

<http://www.redhat.com/software/rhel/benchmarks/>

Stability

Red Hat Enterprise Linux is known for its stability. Much of this is due to the robust architecture of the system itself. The Linux kernel minimizes the affect that application components have on each other and the kernel with regard to resource allocation. This means that if a single application fails, it fails in isolation, and leaves the rest of the operating system functional.

Red Hat applies significant quality assurance measures including testing of high stress operational conditions prior to the official Red Hat Enterprise Linux release. While quality assurance testing was a component of the Red Hat Linux development cycle, it has been significantly increased and expanded for the Red Hat Enterprise Linux product line. Red Hat considers failures at this level to be unacceptable in a production operating system and makes every effort not to distribute unstable code. Red Hat is relying on the Fedora community project and the Red Hat Linux releases to function as a proving ground for code to incorporate into the Red Hat Enterprise Linux product line. Code that is proven stable in Red Hat Linux or Fedora will become part of the Red Hat Enterprise Linux family.

Unlike the Red Hat Linux product model which was based on a 4-6 month release cycle, Red Hat Enterprise Linux has a 12-18 month release cycle giving partners, developers and quality assurance teams ample time to make sure the code is stable for their technologies. Software vendors have a six month beta cycle to test Red Hat Enterprise Linux code and provide technology input. Historically, Red Hat Linux beta cycles were fit into a 10 week time frame that did not allow time for thorough testing. The extension of the beta program has had the biggest impact on stability for the Red Hat Enterprise Linux product line.

Red Hat is committed to ABI compatibility and stability for the life time of the Red Hat Enterprise Linux products. All relevant errata and kernel updates are provided to partners and software vendors prior to being made publicly available. This was not the case with the Red Hat Linux releases, and will not be the case with the Fedora core releases. as stability was not the outstanding engineering goal for these products. Preserving stability in the ABI is a priority reserved exclusively for Red Hat Enterprise Linux.

Scalability

Linux has proven itself in enterprise environments and scalability has been a priority focal point for Red Hat engineering. Red Hat continues to improve scalability in Red Hat Enterprise Linux v.3 by creating an OS twice as scalable as its predecessor (2.1).

The practical limits on Linux scalability have significantly improved and continue to evolve. Red Hat Linux products were mostly limited to x86 architectures which inhibited this product line from taking off as a horizontal enterprise solution. Red Hat Enterprise Linux on the contrary is available for seven different architectures and can be deployed on platforms ranging from an administrator's laptop to a corporate mainframe. Red Hat Linux was also limited as a vertically scalable solution because of the lack of application support. Most Red Hat Linux deployments were stand alone systems that managed standard network services. Red Hat's ISV partnerships and OEM relationships are much more tightly integrated with Red Hat Enterprise Linux, giving customers the ability to build a completely Linux based enterprise infrastructure capable .

There were two target areas for improvement with regard to scalability in Red Hat Enterprise Linux version 2.1. The Max RAM count per process thread in Red Hat Enterprise Linux version 2.1 is limited to 3GB and Max CPU count is certified to 8 (the theoretical limit is 32). Customers working with very large data sets with significant processing on single systems should keep these limitations in mind when deploying Red Hat Enterprise Linux version 2.1. The low cost of additional Intel hardware means that it is easy to sidestep these issues and continue to grow Linux in data centers. If these limitations are of consequence for a customer, they should deploy Red Hat Enterprise Linux version 3, which supports up to 64GB of memory.

Security

The Red Hat Linux product line is not recommended for customers with real world security requirements. Administrators should not run Red Hat Linux on public facing systems because the product line is retiring and security errata will no longer be available from Red Hat. The Red Hat Linux errata that address potential vulnerabilities in the kernel or networked services do not have the same priority or undergo the same amount of testing as the security errata provided for Red Hat Enterprise Linux.

Fedora is also inappropriate for security conscious customers as Red Hat is not committed to directly providing security patches for the Fedora

releases. Red Hat sponsors the Fedora project, however, it will not be maintaining or distributing security patches or other errata in a timely manner.

The most secure platform Red Hat makes available is the Red Hat Enterprise Linux family of products. Red Hat Enterprise Linux has fewer serious security vulnerability reports than either UNIX or Windows, despite the fact that Red Hat Enterprise Linux contains many applications not included in other operating systems. While this is not scientific proof of Linux security, it is a good indication of real world experience for Linux. Red Hat Enterprise Linux gives the administrator complete control over network ports and services and many security and authentication applications are fully supported, including Kerberos, SSL, NIS, and PAM. Red Hat Enterprise Linux security errata are available to customers via the Red Hat Network. Red Hat packages are signed with the Red Hat GNU Privacy Guard (GPG) keys so customers are certain errata updates are distributed securely from Red Hat.

Third party firewall applications such as Checkpoint and monitoring solutions like BMC Patrol are supported and have proved very stable on Linux. Customers should note that security related products available from ISVs are only certified for Red Hat Enterprise Linux line of products. Security applications modified to run on the Red Hat Linux or Fedora code bases are not supported by Red Hat or the application vendor.

Red Hat Enterprise Linux, unlike Red Hat Linux or Fedora, has achieved the US Defense Information Systems Agency (DISA) Common Operating Environment (COE) certification. The COE certification means that Red Hat Enterprise Linux is approved for deployment at the US Department of Defense and has passed this agency's strict requirements for interoperability, performance, and standards compliance, a true testament to the federal governments' confidence in Red Hat Enterprise Linux as a secure solution. Customers interested in learning more about the COE certification should refer to the the Red Hat Enterprise Linux COE whitepaper online at:

https://www.redhat.com/apps/webform.html?event_type=whitepaper&eid=100

In addition to the applications , management tools and certifications associated with providing security on Linux, it is important to understand the role of the open source development model in making Red Hat Enterprise Linux secure. Open source means that all of the code that Red Hat runs has been through a large amount of peer review. Open source development also means that new bugs are resolved accurately and made available in a timely manner with documentation for the next round

of peer review or future development.

Red Hat Enterprise Linux customers with an interest in optimizing their systems securely should refer to the Red Hat Enterprise Linux Security Guide online at:

<http://www.redhat.com/docs/manuals/enterprise/RHEL-3-Manual/security-guide/>

Manageability

Red Hat offers Red Hat Linux and Red Hat Enterprise Linux customers manageability through Red Hat Network. The Red Hat Network is a fully integrated Red Hat systems management solution which is easily integrated into enterprise environments. Built with distributed systems in mind, Red Hat Network was created to reduce the overall burden and cost of administering, maintaining and managing production systems. There are no Red Hat Network channels for Fedora packages, and this technology is not available for Fedora users. Red Hat Network is available as a limited management solution for single instance Red Hat Linux deployments until these products are retired. Red Hat Network channels will not be maintained for retired Red Hat Linux releases. For Red Hat Enterprise Linux customers, Red Hat Network is the centralized system that makes errata updates, security advisories, feature enhancements, bug fixes, ISO images, and quarterly updates readily available to client machines in networked environments.

For Red Hat Enterprise Linux, there are three Red Hat Network modules currently available:

Update Module

The Update Module uses Red Hat Package Management (RPM) to apply updates to single instance Red Hat systems. RPM is a Red Hat designed Linux Standard Base (LSB) package installation tool that is utilized by all Red Hat Network clients. Security is top priority at Red Hat and the Red Hat Network infrastructure is no exception. All connections are based on SSL and package verifications are performed using GPG Keys and MD5 CheckSums. RHN Update Module capability is a complementary entitlement included with all Red Hat Enterprise Linux products. The Update Module provides the basic RHN services including errata updates via a point and click Graphic User Interface or the standard command line utility, email errata notification, RPM dependency resolution and optional auto update manageability for a single system via a central Web interface.

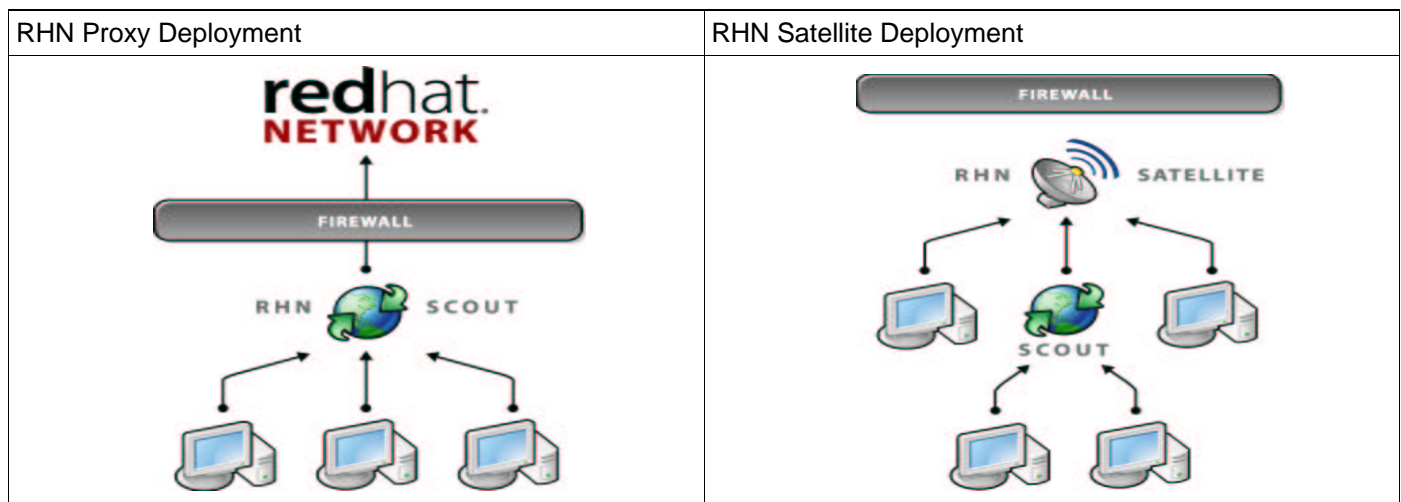
Management Module

The RHN Management Module is the middle tier RHN component. The Management Module includes all the features of the Update Module and scalability enhancements for enterprise operations. The Management Module includes the ability to do systems grouping, systems permissions, scheduled actions, package searches, reporting and profile comparisons. Management module scalability solutions for established networks include the RHN Proxy Server and the RHN Satellite Server. When used in conjunction with RHN Satellite Server, this module can scale to thousands of systems.

The RHN Proxy Server offers the customer all of the above hosted functionality plus local package caching to conserve bandwidth, and the ability to create custom channels for third party or custom RPMs. The RHN Proxy Server typically sits behind the customer firewall and is available to distribute packages to numerous systems via a secure connection.

The RHN Satellite Server offers customers hosted functionality, all the features described for the RHN Proxy Server with the ability to clone, manage, and apply permissions to channels as well as create Activation Keys for mass kickstart installations and updates. RHN Satellite is a two server system behind a corporate firewall that does not have a dedicated SSL connection to Red Hat's central RHN servers. Customer packages are stored in an onsite Oracle database and errata updates are provided by Red Hat on a quarterly basis. RHN Satellite Server is the focus for future RHN functionality and is appropriate for enterprise operations looking to deploy an efficient and secure management solution.

The following diagram outlines the RHN Proxy and RHN Satellite architectures for further clarification:



Monitoring Module

The RHN Monitoring Module is a completely web based all-inclusive monitoring system developed by Red Hat. RHN Monitoring Module is capable of many levels of monitoring. At the System Level administrators can monitor CPU, Disk, Ping, Memory, Load, Users, Procs, Swap, etc. The Port Level can monitor services such as HTTP, HTTPS, FTP, POP, IMAP, SMTP, SNMP, IRCD, NNTP, DNS, Oracle, Postgres, REAL, etc. Application server monitoring includes BEA Weblogic, IBM Websphere, ATG Dynamo, Sun ONE, and several others. Database monitoring for Oracle, SQLServer, MySQL, etc. Network device monitoring can also be implemented for Cisco, Alteon/Nortel, Foundry, F5, and other devices. RHN Monitoring module uses standards based code so custom monitoring can be easily integrated for particular ports, protocols, or APIs.

RHN Monitoring Module features helpful to administrators include threshold alerts, inventory management, URL/Transaction Monitoring, auto discovery, Multi-Tenant and historical or trend reporting. All of the Monitoring features are available in real time and notifications can be customized to meet the needs of the organization. Red Hat Network is an area of strategic investment for Red Hat, and the services, with over 1.2 million registered client nodes, are already proving invaluable to many large customers. For complete information on Red Hat Network, please refer to:

www.redhat.com/software/rhn/

Red Hat Enterprise Linux Family

Choosing the appropriate member of the Red Hat Enterprise Linux family can be daunting for customers migrating from Red Hat Linux. Migrating customers will find there is a variant of Red Hat Enterprise Linux for just about any application or specialized network service. Customers can choose from a range of service level agreements for architectures ranging from x86 systems to IBM mainframes. The Red Hat Enterprise Linux Family of products is comprised of three different offerings, Red Hat Enterprise Linux AS, Red Hat Enterprise Linux ES, and Red Hat Enterprise Linux WS. Red Hat Enterprise Linux products are available as annual subscriptions that include technical support and RHN maintenance. The following chart is provided to assist customers in selecting the right version of Red Hat Enterprise Linux:

I am using Linux (or Unix or Windows) for:	<ul style="list-style-type: none"> Large databases Enterprise applications 	<ul style="list-style-type: none"> Edge of network applications Small office or departmental servers 	<ul style="list-style-type: none"> Technical Workstation applications Desktop productivity High Performance Computing (multinode clusters) applications
<i>Recommended product</i>	<i>Red Hat Enterprise Linux AS</i>	<i>Red Hat Enterprise Linux ES</i>	<i>Red Hat Enterprise Linux WS</i>
Common usages	Databases, ERP, CRM, Applications	Small-medium Web, file, and print configurations	CAD/CAM, Rendering, Trading, Manufacturing, S/W development, mail, document processing, browsing, instant messaging, Beowulf; Oscar; MPI
Includes desktop applications	Yes	Yes	Yes
Supported by leading ISV applications	Yes	Yes	Yes
Includes Apache, Samba, NFS		asdf	d
Includes: amanda-server, arptables_jf, bind, caching-nameserver, dhcp, freeradius, inews, inn, krb5-server, netdump-server, openldap-servers, quagga, radvd, rarpd, tftp-server, tux, vsftpd, ypserv	Yes	Yes	No

Available in Premium Edition - Web and phone-based comprehensive support - 24x7 - 1-hour response - Unlimited incidents - 1-year Red Hat Network**	Yes	Yes	Yes
Available in Standard Edition - Web and phone-based comprehensive support - 5x12* - 4-hour response - Unlimited incidents - 1-year Red Hat Network**	Yes	Yes	Yes
Available in Basic Edition - Web and phone-based installation and basic configuration support - 1-year Red Hat Network**	No	Yes	Yes
Supports x86 compatible systems	Yes	Yes	Yes
Support Itanium and AMD64 systems	Yes	No	Yes
Supports IBM z,i,p and S/390 series systems	Yes	No	No
Supports systems with >2 CPUs ¹	Yes	No	No
Supports >8GB memory (x86)	Yes	No	Yes

*USA: Mon-Fri, 9 a.m.-9p.m., Rest of World: Mon-Fri, 9am-5pm

** Red Hat Network includes priority errata notification, errata information, RPM dependency checking and auto update

Red Hat Enterprise Linux version 2.1

Red Hat Enterprise Linux version 2.1 is Red Hat's first OS offering capable of supporting resource intensive applications in enterprise environments. Red Hat Enterprise Linux version 2.1 is an outstanding product and is still available from Red Hat. This is the recommended platform for customers seeking a proven OS. Customers considering deploying Red Hat Enterprise Linux version 2.1 should be aware that it is architecturally limited to Intel x86 and Itanium2 chip sets.

Red Hat Enterprise Linux version 2.1 supported architectures

Platform	X86	Itanium2
Red Hat Enterprise Linux AS v.2.1	Yes	Yes
Red Hat Enterprise Linux ES v.2.1	Yes	No
Red Hat Enterprise Linux WS v.2.1	Yes	Yes

More information on the current Red Hat Enterprise Linux 2.1 product line is available online at:

www.redhat.com/software/rhel/

Red Hat Enterprise Linux version 3

While Red Hat Enterprise Linux 2.1 demonstrated outstanding performance and benchmarking in production environments, the product had room for improvement. Red Hat learned a great deal from its first attempt at an enterprise OS solution. One of the primary goals for Red Hat Enterprise Linux version 3 is to improve high end functionality while making the OS more scalable. This was not an easy challenge as Red Hat is absolutely committed to preserving stability across the Red Hat Enterprise Linux product family. By ensuring that engineering enhancements were feature driven efforts Red Hat was able to attain this goal. Red Hat Enterprise Linux v.3 contains over 100 priority 1 features and over 350 general enhancements included in response to requests from customers, OEM vendors, and ISV partners.

Another Red Hat Enterprise Linux v.3 engineering goal was to consolidate the product family to provide consistent products and support across seven total architectures including x86, Itanium 2, AMD64 and IBM z,i,p series systems. This too was accomplished because of Red Hat's established relationships with technology partners.

The following table is provided to help customers interested in deploying Red Hat Enterprise Linux v.3 choose the right product for their architecture:

Red Hat Enterprise Linux v.3 supported architectures

Platform	X86	Itanium 2	AMD64	IBM zSeries	IBM iSeries	IBM pSeries
Red Hat Enterprise Linux AS 3	Yes	Yes	Yes	Yes	Yes	Yes
Red Hat Enterprise Linux ES 3	Yes	Yes	Yes	No	No	No

Red Hat Enterprise Linux WS 3	Yes	Yes	Yes	No	No	No
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For the first time with Red Hat Enterprise Linux v.3, a single source code base is now used for all architectures. This consolidation enhancement significantly improves stability and maintainability and simplifies ISV application support. The single source code makes application development much easier for customers. Red Hat also recognized the maturity of Linux as a practical desktop environment and has determined that Red Hat Enterprise Linux v.3 is the first Linux desktop suitable for widespread deployment.

The Red Hat Enterprise Linux product family has also been organized for target hardware and target markets. The following table in addition to the architecture table above should help the customer determine which Red Hat Enterprise Linux v.3 product is right for their deployment:

Red Hat Enterprise Linux v.3 segmentation

Platform	Hardware	Target market
Red Hat Enterprise Linux AS	>2 CPUs, >8GB RAM >16GB RAM (Itanium2, AMD64)	Large servers: Database, Application servers, etc.
Red Hat Enterprise Linux ES	1-2 CPUs, <8GB, RAM	Mid-level servers, web, file/print servers, nameservers, etc.
Red Hat Enterprise Linux WS	1-2 CPUs, 4GB RAM	Workstations: Corporate desktops, technical workstations, HPC, etc.

Red Hat Enterprise Linux v.3 was released October 22, 2003 and is available to existing Red Hat Enterprise Linux v.2.1 customers via Red Hat Network. Red Hat continues to offer a feature driven product family and by doing so encourages customers to download ISO images, binary, and source RPM packages for Red Hat Enterprise Linux v.3 releases at <https://rhn.redhat.com>

The following is a summary of the feature enhancements that have been included with Red Hat Enterprise Linux v.3:

Red Hat Enterprise Linux v.3 Kernel

The kernel distributed with Red Hat Enterprise Linux 3 is based on a 2.4.21 kernel, but includes numerous backported 2.5/2.6 features. Customers should understand that a stable 2.6 kernel will not be available until sometime in 2004 and that some features are too

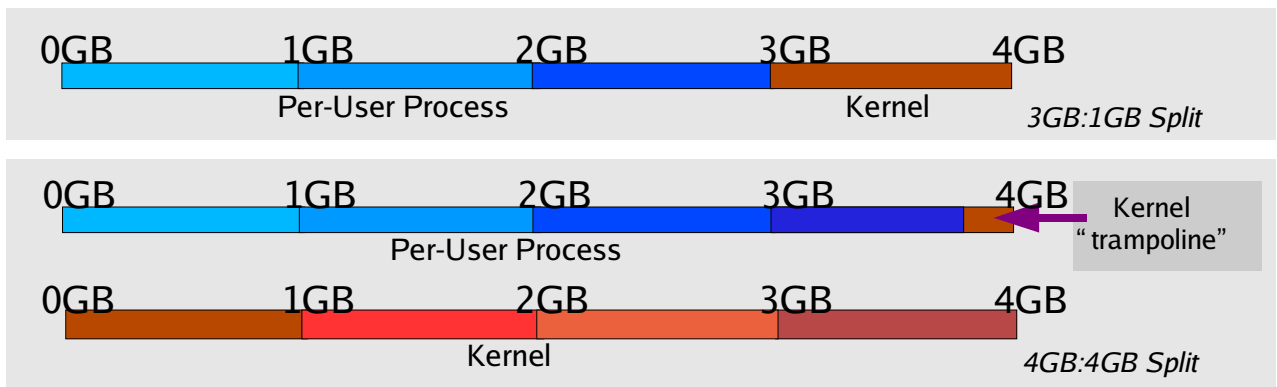
intrusive to backport at this time. Red Hat is committed to stability with its Enterprise product line and has not finalized plans for 2.6 based Enterprise products at this time.

The 2.5/2.6 features that were backported include IPv6, IPsec, Rmap VM, the 0(1) hyperthreading scheduler, per device locks for block IO, and the Native Posix Threading Library (NPTL). These technical implications of these technologies are elaborated on in the following summary.

4GB-4GB Split

The 4-4 Split is a major feature enhancement for large memory x86 systems that need more kernel/user Virtual Memory. This capability was integrated into the Red Hat Enterprise Linux AS product so that larger user applications can take advantage of more memory. This enhancement provides support for up to 64GB RAM.

Diagram of 4-4GB Split included in Red Hat Enterprise Linux v.3



Prior to the release of Red Hat Enterprise Linux v.3, the 32-bit 4GB virtual address space was divided into 3GB for user processes and 1GB for the kernel. The Red Hat Enterprise Linux v.3 *hugemem* kernel increases virtual address space to 4GB for user processes and 4GB for the kernel. This feature is only applicable to x86, 32-bit systems. The *hugemem* kernel is an enhancement available in the Red Hat Enterprise Linux AS product. The 4-4 split is not necessary for 64 bit architectures because they do not have the same virtual address space limitations as x86 systems. Transferring from user to kernel space initiated, for example, by system calls and interrupts. Users may see some performance degradation when using the *hugemem* kernel, however, the level of degradation is difficult to determine as each application behaves differently. It is also important to know that modules behave differently when using the 4-4 Split and there is a validated subset of drivers for this configuration. Customers with questions about hardware compatibility should verify that their device module supports this functionality with Red Hat technical support.

I/O Subsystem Improvements

Red Hat Enterprise Linux v.3 supports up to 256 SCSI devices, compared to the 128 SCSI device limitation in Red Hat Enterprise Linux v.2.1. This improvement permits larger systems to utilize many drives. New architectures such as Intel's PIIX/ICH Serial ATA are supported. Performance with regard to the 64 bit SCSI/Fibre channel DMA support is improved for systems with over 4GB of memory. Also, VaryIO support is available in Red Hat Enterprise Linux v.3 so databases can take advantage of coalesced reads and writes.

The Hyperthreading Scheduler in Red Hat Enterprise Linux v.3 recognizes the differences between logical and physical processors

and has been expanded to support up to 8 hyperthreaded CPU pairs, which translates to support for 16 logical CPUs. Hyperthreading in Red Hat Enterprise Linux v.2.1 used one run queue per processor on each system, while the O(1) Hyperthreading Scheduler in Red Hat Enterprise Linux v.3 handles only one run queue per actual physical processor. This Hyperthreading Scheduler optimizes process scheduling to take advantage of cache on the physical CPU.

Native Posix Threading Library

The Native Posix Threading Library included in Red Hat Enterprise Linux v.3 is a replacement for Linux Threads. Linux Threads are familiar to Linux users as the threading model used by the Linux operating system since 1996. NPTL is a major scalability enhancement required for high performance multi-threaded applications like Java. NPTL is a full implementation of POSIX threads which is used in most modern file systems. NPTL is much faster because it allows the simultaneous creation and deletion of threads independent of the number of threads running. Red Hat informal testing has demonstrated greater than 50,000 simultaneous thread creations/deletions per second with this technology. For more information on NPTL please refer to the following document online at:

www.redhat.com/partners/pdf/POSIX_Linux_Threading.pdf

Development Enhancements

For some time the development community has been requesting improvements to the compiler environment in Red Hat Enterprise Linux. Red Hat has responded by including the GCC 3.2 cross platform tool chain in Red Hat Enterprise Linux v.3. The GCC 3.2 tool chain has full ANSI C++ , ISO C99 and memory debugging support. Specific architecture optimizations include Pentium IV software pipelining, an IA64 instruction scheduler and compiler intrinsics for MMX, and SSE for multimedia instructions.

Other development related upgrades include configurable core dump paths which allow the developer to customize the way core files are named. This makes troubleshooting much easier because core dump paths can be specified and core dump names can be customized to include PIDs, UIDs, signals that caused the dump, etc.

Red Hat Enterprise Linux v.3 includes the system-wide profiler OProfile to assist programmer locating performance problems in code. OProfile does not require instrumentation of code and collects data on all

code running on the system, including daemons and the kernel. On processors with supported performance monitoring hardware, OProfile collects data on specific processor events such as caches misses and pipeline stalls. The OProfile analysis tools map the profiling data back source code, allowing programmers to focus on the sections of code that affect performance. For more information refer to the following document online at:

<http://people.redhat.com/wcohen/wwc2003/wwc2003a.ps>

Logical Volume Manager

LVM is included in Red Hat Enterprise Linux v.3, eliminating the need for Red Hat customers to utilize third party vendors for this technology. LVM separates physical and logical drives and allows ext2 and ext3 file systems to be resized for flexible storage management. Red Hat Enterprise Linux v.3 ships with the LVM 1 implementation from Sistina, and is compatible with software RAID.

Networking and Security Improvements

Channel bonding improvements in Red Hat Enterprise Linux v.3 enable NIC failover and bandwidth aggregation. Implementing VPNs has been simplified as a result of the integration of kernel IPsec for securing IPv4 traffic. Kernel IPsec is capable of communicating with other IPsec devices and operating systems through secure tunnels built between subnets. IPsec encrypted packets are authenticated and anti-replay protected for secure communication between systems. Red Hat Enterprise Linux v.3 also includes a more complete IPv6 implementation.

NFS has been the target of many client side performance enhancements in Red Hat Enterprise Linux v.3. The NFS client has been completely rewritten with scalability and stability in mind. NFS now supports caching directory information and supports TCP. File system operations are also much faster because of the addition of O_Direct support in Red Hat Enterprise Linux v.3. These enhancements dramatically improve NFS performance across the board.

Red Hat implemented file system Access Control Lists in response to customers with stringent security requirements. Standard Unix file permissions are not always adequate for security conscious customers. ACLs were designed with customization in mind and can be added to files, directories, devices, or any other file system object. The ACLs in Red Hat Enterprise Linux v.3 are highly configurable and give administrators the ability to fine tune access. NFS mounted file

systems that support ACLs can also be protected.

Kernel level cryptography has been included as a general purpose cryptographic API. Kernel-level cryptography allows various types of cryptographic transforms to be used by IPsec and allows encryption to be done within the kernel, eliminating the need for an external patch.

Secure web services have also been dramatically expanded in Red Hat Enterprise Linux v.3. The Stronghold secure web server product that was formally a layered product offered by Red Hat is now included with the OS. Stronghold is made up of several open source projects including OpenSSL, PHP, mod_perl and Apache 2.0. All Stronghold capabilities are part of Red Hat Enterprise Linux v.3 except the Java related applications such as Tomcat.

Desktop Environment

Red Hat Enterprise Linux v.3 ships with XFree86 4.3.x and includes the Bluecurve graphical interface. All members of the Red Hat Enterprise Linux v.3 family have bundled productivity applications like OpenOffice.org (which supports Microsoft formats) and Ximian Evolution. Numerous graphical service configuration tools have also been added for users from Windows backgrounds.

Diskless System Support

One of the shortcomings in Red Hat Enterprise Linux v.2.1 was that it did not have a thin client solution. In response to customers with these requirements, the integration of diskless system support is available in Red Hat Enterprise Linux v.3. Red Hat Enterprise Linux v.3 is suitable for High Performance Computing and thin client configurations because it allows a Red Hat Enterprise Linux server to host other Red Hat Enterprise Linux images bootable by networked clients. This also improves security and reduces administrative overhead because only the host system needs to be maintained and monitored.

Miscellaneous Enhancements

Large Translation Buffer pages (hugetlbfs) have been included that improve performance by conserving TLB slots. This enhancement for large hardware pagesizes significantly reduces the overhead of pagetables for each process.

A much needed memory management enhancement included in Red Hat Enterprise Linux v.3 is support for Reverse Mapping (RMAP) VM.

RMAP VM alleviates the problem of kswapd over-utilizing the CPU when physical memory is used up on large RAM systems.

Support for Large Pages has also been included in Red Hat Enterprise Linux v.3. This enhancement allows processes to request a chunk of large page memory or create shared memory regions using the new `get_large_pages` or `share_large_pages` system calls. Large Pages are handled completely outside of the normal memory management mechanisms to avoid the difficulty of supporting Large Pages in the VM. It works by setting aside a percentage of memory to satisfy large page requests when the system boots. The pages are not swapped, but are handed out when processes request them.

Power management improvements such as support for ACPI have been collaboratively developed with hardware partners for Itanium2 and AMD64 systems.

Samba 3.0 is distributed with Red Hat Enterprise Linux v.3. Active Directory support included in Samba 3.0 means Samba is now able to join as a member server and authenticate users using LDAP or Kerberos. Unicode support, a new authentication system and better Windows printing support of some of the many enhancements including in Samba 3.0.

The Summit kernel has been improved and integrated into the standard Red Hat Enterprise Linux v.3 kernel.

The BEA, IBM, and Sun Java 1.4.x implementations as well as GCJ, the Java GCC compiler and associated libraries are included with the Red Hat Enterprise Linux v.3 distributions as well.

Partner Support: ISV Certifications

Red Hat Ready Applications

As noted previously in the Red Hat Enterprise Linux overview, Red Hat Enterprise Linux is the primary, often exclusive, Linux platform supported by major enterprise application vendors. Companies including Oracle, IBM Software, VERITAS, BEA, Reuters, BMC and SAP port to, and certify their enterprise application software on Red Hat Enterprise Linux (and don't certify their solutions on other Red Hat platforms like Red Hat Linux, Red Hat Professional Workstation and/or Fedora).

By selecting Red Hat Enterprise Linux as your production operation

system for IT systems, you have the assurance of broad application availability from the world's leading enterprise software vendors. For a complete list of certified applications for Red Hat Enterprise Linux, please see http://www.redhat.com/solutions/migration/applist_chart.html.

Red Hat Applications

With the introduction of Red Hat Enterprise Linux v.3, Red Hat created an open source solution stack called Red Hat Applications. Red Hat created layered products for Red Hat Enterprise Linux that are delivered in the same manner as the operating system family. Each of the Red Hat Application suites are sold as annual subscriptions that include support and maintenance via Red Hat Network. Several other products are under active development and are available to customers in 2004.

Red Hat Cluster Suite

Red Hat previously included the clustering tools as part of Red Hat Enterprise Linux AS. Many customers had a need for clustering or load balancing tools but wanted to deploy on the smaller Enterprise platforms. In order to accommodate these requirements Red Hat is bundling the clustering packages as a layered product. After the introduction of Red Hat Enterprise Linux v.3, clustering and load balancing packages can be deployed on any of the Red Hat Enterprise Linux platforms.

High Availability clustering in Red Hat Enterprise Linux v.3 has been enhanced to support n-node failover clusters (up to 8 nodes). The Cluster Manager solution requires shared SCSI or Fibre Channel data and allows scalability to a large number of applications. A GUI configuration and monitoring management tool has also been added. The bundled Cluster Suite includes LVS/Piranha for IP Load Balancing.

Red Hat Developer Suite

The Red Hat Developer Suite provides a complete development environment for Enterprise application developers. It includes the Eclipse IDE framework, C/C++, Java, RPM and profiling plugins. Other plugins are available to customers on an ongoing basis.

Red Hat Enterprise Linux Migration Strategies

Linux Migration Fundamentals

Any successful migration depends on calculated design and careful integration. There are important details and scenarios that administrators should consider before embarking on a migration or upgrade of any kind. The basic outline for a migration to Red Hat Enterprise Linux from any prior platform includes the following steps:

1. Linux Integration and Migration Assessment

Information gathering, analyzing findings, defining deliverables that address the existing infrastructure.

2. Linux Migration Planning & Design

Planning, designing and defining deliverables that address the desired infrastructure.

3. Implementation and Integration

Doing the work and executing previously defined deliverables.

4. Establishing Operations Services

Setting up an accountable internal technical operation or using Red Hat Global Technical Support or Professional Consulting Services to maintain and manage the new technology.

Attempting to detail the above steps is beyond the scope of this document, however, the recommendations below should be incorporated into any upgrade methodology. Customers that require assistance or have large-scale migrations to complete should contact Red Hat's Global Professional Services (GPS) team as they are unmatched in architecting and executing migrations to the Linux platform and additionally integrating Red Hat Enterprise Linux into heterogeneous domains.

Migrating From Red Hat Linux to Red Hat Enterprise Linux

Red Hat Linux and Red Hat Enterprise Linux are intended for different markets and are two very different operating systems. Red Hat Enterprise

Linux is a completely different code base than the Red Hat Linux retail products. Customers moving from Red Hat Linux to Red Hat Enterprise Linux will find that the installer does not offer an option to upgrade. This is because automated upgrades have historically been unsuccessful due to the vastly added community, proprietary, custom, or otherwise non Red Hat code on top of the standard Red Hat distribution. That being said, migrating from Red Hat Linux retail products to Red Hat Enterprise Linux products should be a fairly simple undertaking as the releases have similar tools and capabilities. System Administrators should be clear that the recommended way to migrate between Red Hat Linux and Red Hat Enterprise Linux is to backup data on the existing system and run a clean installation of Red Hat Enterprise Linux. Red Hat technical support can provide assistance to customers that need to configure services and restore data on the new Red Hat Enterprise Linux installation.

Users migrating Applications from Red Hat Linux to Red Hat Enterprise Linux version v.3 should consider the possibility of complications arising from changes in runtime libraries, compilers, and other fundamental OS components. Where possible, it is wise to deploy Red Hat Ready or Red Hat Certified Applications that have been tested and are officially supported.

Compatibility with Red Hat Enterprise Linux v.3 should not be a problem provided the application adheres to the POSIX and Linux Standards Base criteria. Applications that were not developed with these standards will make the migration challenging. Please refer to the following table for a complete list of Red Hat Enterprise Linux v.2.1 supported applications:

http://www.redhat.com/solutions/migration/applist_chart.html

For more information the Linux Standards Base certification please refer to the following article online at:

http://www.redhat.com/partners/press_partner_fsg.html

Developers should be aware that C++ version 3 runtime libraries are not API compatible with the previous C++ version 2 runtime libraries. Administrators with questions about backwards source compatibility should refer to the GCC documentation posted online at:
<http://gnu.gcc.org>

Application Binary Interface compatibility should also be evaluated when migrating from Red Hat Linux or Red Hat Enterprise Linux version 2.1 to Red Hat Enterprise Linux v.3 because the GCC compiler that ships with Red Hat Enterprise Linux v.3 uses a new C++ ABI standard.

Migrating from Red Hat Enterprise Linux version 2.1 to Red Hat Enterprise Linux version 3

Customers migrating from Red Hat Enterprise Linux version 2.1 to Red Hat Enterprise Linux version 3 should find the upgrade path straightforward and familiar. As previously mentioned, Red Hat suggests that the best approach when migrating to a new operating system is backing up data and performing a clean installation, particularly when third party applications or non Red Hat RPMs are involved. This is the recommended way to move from Red Hat Enterprise Linux version 2.1 to Red Hat Enterprise Linux version 3.

Any migration should be carefully planned and scheduled during a time that is not disruptive to users. It is important to verify hardware compatibility prior to initiating the migration. Red Hat hosts a Hardware Compatibility list where device supportability can be verified at:

<http://hardware.redhat.com/hcl>

Data should be backed up using any of numerous open source or proprietary backup applications. Most production networks have automatic back up systems in place. Many proprietary applications are certified on Red Hat Enterprise Linux products such as VERITAS NetBackup for this purpose. In the event that that an automated backup system is not in place, Red Hat Enterprise Linux products include utilities such as tar, mt, dump, and Amanda to assist with data backup and recovery. Red Hat additionally recommends making a *complete* backup of your existing data as it is better to have what you do not need than to need what you do not have. At a minimum, make certain to backup configuration files for active services, databases and spools for active services, custom scripts, and networking subdirectories.

The sizes and locations of partitions created for Red Hat Enterprise Linux version 2.1 do not need to change much when moving to Red Hat Enterprise Linux version 3. When performing the Red Hat Enterprise Linux 3 installation, administrators should format critical partitions such as the root and boot. Partitions that contain user home directories or other operating system exclusive information do not necessarily need to be formatted. Administrators can elect not to format those partitions during the Red Hat Enterprise Linux version 3 installation. Please refer to Chapter 4 in the Red Hat Enterprise Linux Installation Guide for your architecture available online at:

<http://www.redhat.com/docs/manuals/enterprise>

Upgrading from Red Hat Enterprise Linux version 2.1 to Red Hat Enterprise Linux version 3

It is technically feasible, although not recommended as the most stable method, to upgrade to newer versions of the same Red Hat Enterprise Linux product (for example Red Hat Enterprise Linux WS 2.1 to Red Hat Enterprise Linux WS 3). Administrators can specify a boot parameter to upgrade non production or test Red Hat Enterprise Linux systems. When performing an upgrade customers see the familiar installation page just before the installer initializes. At the boot:

prompt at the bottom of the screen, specify:

```
linux upgrade
```

This begins the upgrade process for Red Hat Enterprise Linux. Again, this is not the recommended way to upgrade, however, it is effective for minimal systems that are not running third party applications or do not have a critical role in a production environment. If the above command does not result in the installer beginning to upgrade the system, type:

```
linux upgradeany
```

This minimizes installer checks. Please refer to Chapter 4 of the Red Hat Enterprise Linux Installation Guide for your architecture available online at:

<http://www.redhat.com/docs/manuals/enterprise>

Conclusion

In recent years, Linux has evolved and been validated as a qualified enterprise operating system in many corporate settings. Red Hat and its technology partners have largely contributed to the evolution of Enterprise Linux because they recognized the value of a scalable and stable Linux OS with an extended lifespan. The Red Hat Enterprise Linux product family was created in response to these prerequisites that largely came from enterprise customers and industry partners. Many Red Hat customers have been managing Linux systems in corporate environments for some time and have already completed migrations to Red Hat Enterprise Linux version 2.1. System administrators and IT managers are adopting and deploying Linux at every opportunity in production enterprise environments. The intent of this paper is to clearly define the Red Hat Enterprise Linux product line, Red Hat's corporate strategy and the recommended considerations when migrating to Red Hat Enterprise

Linux. Customers familiar with prior Red Hat releases can migrate to Red Hat Enterprise Linux with minimal effort and should now be familiar with the changes made to the OS as described in this paper.

Resources

1. Solaris to Linux Migration. Nathan Thomas, August 2001.
2. Red Hat Enterprise Linux 3 Technical Overview Presentation. Donald Fisher, September 15, 2003.
3. Migrating to Red Hat Linux Advanced Server from Red Hat Linux--Benefits and Guidelines, Red Hat Inc.
4. Linux Migration/Integration Methodologies, GPS Red Hat Inc.
5. Red Hat Enterprise Linux Installation Guide, Red Hat Inc., 2003.
6. Characteration of GCC 2.96 and GCC 3.1 generated code with Oprofile. William Cohen, April 2003.