AlmaLinux for Beginners

A Practical Introduction to Enterprise Linux Administration

Preface

Welcome to the World of AlmaLinux

In the rapidly evolving landscape of enterprise computing, AlmaLinux has emerged as a cornerstone of reliable, secure, and cost-effective server infrastructure. Born from the community's need for a stable, enterprise-grade Linux distribution following the changes to CentOS, AlmaLinux represents more than just an operating system—it embodies the spirit of open-source collaboration and enterprise reliability.

AlmaLinux for Beginners: A Practical Introduction to Enterprise Linux Administration is designed specifically for newcomers who want to master this powerful platform. Whether you're a system administrator taking your first steps into enterprise Linux, a developer seeking to understand the infrastructure that powers modern applications, or an IT professional looking to expand your skill set with AlmaLinux, this book provides the foundation you need to succeed.

Why AlmaLinux Matters

AlmaLinux stands as a testament to the resilience and innovation of the open-source community. As a 1:1 binary compatible fork of Red Hat Enterprise Linux (RHEL), AlmaLinux offers enterprise-level stability and security without the associat-

ed licensing costs. This makes it an ideal choice for organizations of all sizes seeking robust, production-ready infrastructure solutions.

Throughout this book, you'll discover why AlmaLinux has quickly gained adoption across diverse industries—from startups building their first server infrastructure to large enterprises migrating from other platforms. The distribution's commitment to long-term support, security updates, and community-driven development makes it an excellent foundation for learning enterprise Linux administration.

What You'll Learn

This book takes a hands-on, practical approach to AlmaLinux administration. Starting with the fundamental question of what AlmaLinux is and why it exists, you'll progress through essential topics including system installation, command-line mastery, user management, and network configuration. Each chapter builds upon the previous one, ensuring you develop a comprehensive understanding of AlmaLinux administration.

Key areas covered include:

- **AlmaLinux fundamentals** and its place in the enterprise Linux ecosystem
- **System installation and initial configuration** tailored specifically for AlmaLinux
- **Command-line proficiency** using AlmaLinux's bash environment
- **Package management** with dnf, AlmaLinux's primary package manager
- **Service management** through systemd on AlmaLinux systems
- **Security practices** including user management and file permissions
- **Network administration** and remote access via SSH

- **Troubleshooting techniques** specific to AlmaLinux environments

How This Book Works

Each chapter combines theoretical knowledge with practical exercises, ensuring you can immediately apply what you learn in real AlmaLinux environments. The book includes comprehensive appendices featuring command references, troubleshooting guides, and a learning roadmap to help you continue your AlmaLinux journey beyond the basics.

The structure progresses logically from foundational concepts to advanced administrative tasks, making it suitable for both self-study and classroom use. Whether you prefer to read cover-to-cover or focus on specific topics, the clear chapter organization and cross-references will guide your learning path.

Acknowledgments

This book exists thanks to the vibrant AlmaLinux community, whose dedication to maintaining a free, enterprise-grade Linux distribution makes this learning opportunity possible. Special recognition goes to the AlmaLinux OS Foundation and the countless contributors who ensure AlmaLinux remains a reliable, secure platform for enterprise use.

Your Journey Begins

As you embark on this AlmaLinux learning adventure, remember that mastering enterprise Linux administration is both a technical skill and an art. AlmaLinux provides an excellent platform for this journey, combining enterprise-grade capabilities with the accessibility and community support that make learning enjoyable and effective.

Welcome to AlmaLinux—your gateway to enterprise Linux mastery awaits.

Ready to transform your understanding of enterprise Linux? Let's begin with AlmaLinux.

Thomas Ellison

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Chapter 1: What AlmaLinux Is and Why It Exists

Introduction to AlmaLinux

In the ever-evolving landscape of enterprise Linux distributions, AlmaLinux stands as a beacon of stability, reliability, and community-driven development. Born from necessity and nurtured by dedication, AlmaLinux represents more than just another Linux distribution—it embodies the principles of open-source collaboration and enterprise-grade computing that have made Linux the backbone of modern digital infrastructure.

AlmaLinux, officially known as AlmaLinux OS, is a free and open-source Linux distribution that emerged in 2021 as a direct response to significant changes in the Red Hat Enterprise Linux ecosystem. The name "Alma" derives from the Latin word meaning "nourishing" or "kind," which perfectly encapsulates the distribution's mission to provide a nurturing environment for enterprise applications while maintaining the robust characteristics that system administrators and developers have come to expect from enterprise-class Linux systems.

At its core, AlmaLinux is a 1:1 binary compatible fork of Red Hat Enterprise Linux (RHEL), designed to fill the void left by CentOS's transition to CentOS Stream. This binary compatibility ensures that applications, scripts, and configurations that work on RHEL will function identically on AlmaLinux, making it an ideal drop-in re-

placement for organizations seeking stability without the licensing costs associated with commercial enterprise distributions.

The distribution is built upon the rock-solid foundation of the Linux kernel, incorporating enterprise-grade features such as Security-Enhanced Linux (SELinux), advanced file systems like XFS and ext4, and comprehensive package management through the DNF package manager. AlmaLinux inherits the stability and security features that have made RHEL a trusted choice for mission-critical applications across industries ranging from finance and healthcare to telecommunications and government sectors.

The Historical Context and Need for AlmaLinux

To understand why AlmaLinux exists, we must first examine the historical context that led to its creation. For nearly two decades, CentOS served as the de facto free alternative to Red Hat Enterprise Linux, providing organizations with access to enterprise-grade Linux capabilities without the associated subscription costs. CentOS was particularly popular among small to medium-sized businesses, educational institutions, and development environments where budget constraints made commercial Linux distributions prohibitive.

The relationship between Red Hat and CentOS was complex and evolved significantly over time. Initially, CentOS was an independent project that rebuilt RHEL packages from source code, removing Red Hat's trademarks and branding. This process, while legal under open-source licenses, required significant effort and expertise from the CentOS community to maintain compatibility and provide timely security updates.

In 2014, Red Hat acquired the CentOS project, bringing the key CentOS developers into the company and providing official support for the distribution. This acquisition was generally well-received by the community, as it promised better integration, faster updates, and more resources for CentOS development. For several years, this arrangement worked well, with CentOS continuing to serve as a stable, free alternative to RHEL.

However, in December 2020, Red Hat announced a fundamental shift in CentOS's direction. The company declared that CentOS Linux 8 would reach end-of-life by December 31, 2021, significantly earlier than its originally planned support timeline through 2029. Furthermore, Red Hat announced that future development efforts would focus on CentOS Stream, a rolling-release distribution that serves as the upstream development branch for RHEL rather than a downstream rebuild.

This announcement sent shockwaves through the Linux community. Organizations that had built their infrastructure around CentOS suddenly faced the prospect of migrating to alternative solutions or purchasing RHEL subscriptions. The change was particularly challenging for smaller organizations and educational institutions that relied on CentOS's stability and long-term support without the budget for commercial licenses.

CentOS Stream, while valuable for development and testing purposes, represented a fundamental departure from what many users expected from CentOS. Instead of providing a stable, point-release distribution that tracked RHEL's proven codebase, CentOS Stream became a rolling-release distribution where changes are continuously integrated. This model, while beneficial for developers contributing to RHEL's development, introduced a level of instability that many production environments could not accept.

The Birth of AlmaLinux

In response to this crisis, several community-driven initiatives emerged to fill the gap left by CentOS's transition. Among these, AlmaLinux quickly distinguished itself through its professional approach, strong community backing, and commitment to long-term stability.

AlmaLinux was founded by Igor Seletskiy, the CEO of CloudLinux, a company with extensive experience in Linux distribution development and enterprise hosting solutions. CloudLinux had previously developed CloudLinux OS, a commercial Linux distribution designed specifically for shared hosting environments, giving the team deep expertise in Linux distribution management, security hardening, and enterprise deployment.

The AlmaLinux project officially launched on January 20, 2021, with the ambitious goal of providing a free, community-driven alternative to RHEL that would maintain full binary compatibility. The project's founding principles emphasized transparency, community governance, and long-term sustainability, addressing many of the concerns that arose from CentOS's corporate ownership and subsequent strategic changes.

From its inception, AlmaLinux was designed to be more than just a CentOS replacement. The project established the AlmaLinux OS Foundation, a non-profit organization dedicated to ensuring the distribution's independence and long-term viability. This governance structure was specifically designed to prevent the kind of unilateral strategic changes that had affected CentOS users.

The first stable release of AlmaLinux, version 8.3, was released on March 30, 2021, just three months after the project's announcement. This rapid development cycle demonstrated the team's expertise and commitment to providing users with a viable migration path from CentOS. The release included full binary compatibility

with RHEL 8.3, comprehensive documentation, and migration tools to help users transition from CentOS with minimal disruption.

Core Philosophy and Design Principles

AlmaLinux's development philosophy centers on several key principles that distinguish it from other Linux distributions and ensure its suitability for enterprise environments.

Binary Compatibility: The most fundamental principle of AlmaLinux is maintaining 1:1 binary compatibility with Red Hat Enterprise Linux. This means that applications compiled for RHEL will run without modification on AlmaLinux, and vice versa. This compatibility extends to system libraries, kernel interfaces, and package dependencies, ensuring that migration from RHEL or CentOS to AlmaLinux can be accomplished with minimal risk and disruption.

Community Governance: Unlike CentOS, which ultimately fell under corporate control, AlmaLinux operates under a community-driven governance model through the AlmaLinux OS Foundation. This structure ensures that the distribution's direction is guided by user needs rather than corporate strategic interests. The foundation model provides transparency in decision-making and protects against unilateral changes that could disrupt user environments.

Long-term Stability: AlmaLinux follows the same release and support lifecycle as RHEL, providing predictable, long-term support for each major version. This approach gives organizations the confidence to build long-term infrastructure plans around AlmaLinux, knowing that security updates and bug fixes will be available for the full lifecycle of each release.

Enterprise Focus: Every aspect of AlmaLinux is designed with enterprise requirements in mind. This includes robust security features, comprehensive logging

and auditing capabilities, support for enterprise storage systems, and integration with enterprise management tools. The distribution includes the same enterprise-grade features found in RHEL, such as SELinux mandatory access controls, advanced networking capabilities, and support for high-availability clustering.

Security First: Security is paramount in AlmaLinux's design philosophy. The distribution includes the same security frameworks and tools as RHEL, with timely security updates provided through the AlmaLinux security team. The project maintains close coordination with Red Hat's security advisories to ensure that AlmaLinux users receive security patches as quickly as possible.

Technical Architecture and Components

AlmaLinux's technical architecture is built upon proven enterprise Linux components, ensuring reliability and compatibility across diverse computing environments.

Kernel and System Foundation: AlmaLinux utilizes the same kernel versions and configurations as RHEL, providing identical hardware support, performance characteristics, and security features. The kernel includes enterprise-focused features such as kernel-based virtual machine (KVM) support, advanced memory management, and support for large-scale symmetric multiprocessing (SMP) systems.

Package Management: The distribution uses the DNF (Dandified YUM) package manager, which provides robust dependency resolution, transaction rollback capabilities, and modular package streams. DNF represents a significant improvement over the older YUM package manager, offering better performance, cleaner code architecture, and enhanced plugin support.

Here's a practical example of DNF usage in AlmaLinux:

```
# Update the package database
sudo dnf update

# Search for packages
sudo dnf search apache

# Install a package with dependencies
sudo dnf install httpd

# View package information
sudo dnf info httpd

# List installed packages
sudo dnf list installed

# Remove a package
sudo dnf remove httpd
```

Security Framework: AlmaLinux incorporates Security-Enhanced Linux (SELinux) as a mandatory access control system, providing fine-grained security policies that go beyond traditional Unix permissions. SELinux policies in AlmaLinux are identical to those in RHEL, ensuring consistent security behavior across environments.

File Systems: The distribution supports advanced file systems including XFS (the default for most installations), ext4, Btrfs, and specialized file systems for specific use cases. XFS provides excellent performance for large files and high-throughput applications, while ext4 offers broad compatibility and proven reliability.

Networking: AlmaLinux includes advanced networking capabilities through NetworkManager and systemd-networkd, supporting complex network configurations, VPN connections, bonding, bridging, and software-defined networking features required in modern enterprise environments.

Virtualization: Full support for KVM virtualization, container technologies including Podman and Docker, and integration with cloud platforms makes AlmaLinux suitable for modern virtualized and containerized workloads.

Comparison with Other Enterprise Linux Distributions

Understanding how AlmaLinux compares to other enterprise Linux distributions helps clarify its unique position in the ecosystem and its suitability for different use cases.

Feature	AlmaLinux	RHEL	CentOS Stream	Rocky Linux	Ubuntu LTS
Cost	Free	Subscription Required	Free	Free	Free
Support Lifecycle	10 years	10 years	Rolling	10 years	5 years
Binary Compatibility with RHEL	1:1 Compatible	Native	Upstream	1:1 Compatible	Different
Governance Model	Non-profit Foundation	Corporate	Corporate	Community	Corporate
Release Model	Point Releases	Point Releases	Rolling	Point Releases	Point Releases
Enterprise Features	Full	Full	Full	Full	Partial
Security Updates	Community-driven	Commercial Support	Red Hat	Community-driven	Canonical
Package Manager	DNF	DNF	DNF	DNF	APT
Default File System	XFS	XFS	XFS	XFS	ext4
Container Support	Podman/Docker	Podman/Docker	Podman/Docker	Podman/Docker	Docker

AlmaLinux vs RHEL: The primary difference lies in cost and support structure. RHEL requires paid subscriptions but provides commercial support, while AlmaLinux offers the same technical capabilities with community support at no cost. For organizations that don't require commercial support, AlmaLinux provides identical functionality.

AlmaLinux vs CentOS Stream: CentOS Stream operates as a rolling-release distribution that serves as RHEL's upstream, while AlmaLinux follows the traditional point-release model with long-term stability. Organizations requiring predictable, stable environments typically prefer AlmaLinux's approach.

AlmaLinux vs Rocky Linux: Both distributions emerged to fill the CentOS void and offer similar technical capabilities. The main differences lie in governance structure and founding organizations, with AlmaLinux backed by CloudLinux's enterprise experience and Rocky Linux founded by CentOS's original creator.

AlmaLinux vs Ubuntu LTS: Ubuntu uses a different package management system (APT vs DNF) and follows Debian-based conventions. While Ubuntu LTS offers long-term support, it lacks the RHEL binary compatibility that makes AlmaLinux attractive for organizations migrating from Red Hat ecosystems.

Use Cases and Target Audiences

AlmaLinux serves diverse use cases across various industries and organizational types, each benefiting from its unique combination of enterprise features and cost-effectiveness.

Small to Medium Businesses: Organizations that previously relied on CentOS find AlmaLinux an ideal replacement, providing enterprise-grade capabilities without licensing costs. These businesses often lack dedicated Linux administrators but

need reliable, secure systems for file servers, web applications, and database systems.

Educational Institutions: Universities and schools benefit from AlmaLinux's free licensing and enterprise features for computer labs, research computing, and administrative systems. The distribution's stability and security features make it suitable for environments with limited IT support staff.

Development and Testing Environments: Software development teams use AlmaLinux to create development environments that closely mirror production RHEL systems. This compatibility ensures that applications developed on AlmaLinux will deploy seamlessly to RHEL production environments.

Web Hosting Providers: Hosting companies leverage AlmaLinux's stability and security features to provide reliable hosting platforms. The distribution's compatibility with standard web server software and its robust security framework make it ideal for multi-tenant hosting environments.

Government and Public Sector: Government agencies often prefer open-source solutions for security, cost, and transparency reasons. AlmaLinux's enterprise security features, including SELinux and comprehensive auditing capabilities, meet the stringent requirements of government computing environments.

Financial Services: Banks and financial institutions require extremely stable and secure computing platforms. AlmaLinux's enterprise-grade security features, long-term support lifecycle, and proven stability make it suitable for financial applications and regulatory compliance requirements.

Community and Ecosystem

The AlmaLinux community represents one of the distribution's greatest strengths, bringing together system administrators, developers, and organizations from

around the world who share a common need for stable, enterprise-grade Linux systems.

AlmaLinux OS Foundation: The non-profit foundation provides governance, ensures project independence, and coordinates community efforts. The foundation's board includes representatives from various stakeholder groups, ensuring diverse perspectives in project direction and decision-making.

Community Contributions: The project welcomes contributions in various forms, including code development, documentation, testing, and community support. Contributors can participate through GitHub repositories, community forums, and special interest groups focused on specific aspects of the distribution.

Commercial Ecosystem: Numerous commercial vendors provide support, consulting, and specialized services for AlmaLinux deployments. This ecosystem ensures that organizations can access professional services when needed while maintaining the freedom to use the distribution without licensing restrictions.

Documentation and Learning Resources: The AlmaLinux community maintains comprehensive documentation, including installation guides, administration tutorials, and migration assistance. These resources help new users adopt the distribution and experienced administrators optimize their deployments.

Migration and Adoption Strategies

Organizations considering AlmaLinux adoption can choose from several migration strategies depending on their current environment and requirements.

Direct Migration from CentOS: The most common migration path involves converting existing CentOS systems to AlmaLinux using automated migration tools. The AlmaLinux project provides scripts and documentation to facilitate this process with minimal downtime.

```
# Example migration command for CentOS to AlmaLinux
curl -O https://raw.githubusercontent.com/AlmaLinux/almalinux-
deploy/master/almalinux-deploy.sh
sudo bash almalinux-deploy.sh
```

Fresh Installation Strategy: Some organizations prefer fresh AlmaLinux installations, particularly for new projects or when significant system updates are needed. This approach provides the cleanest environment but requires more planning for data migration and application reconfiguration.

Hybrid Approach: Large organizations often adopt a phased migration strategy, starting with non-critical systems and gradually moving production workloads as confidence in the new platform grows. This approach minimizes risk while allowing teams to gain experience with AlmaLinux.

Testing and Validation: Regardless of migration strategy, thorough testing in non-production environments is essential. Organizations should validate application compatibility, performance characteristics, and operational procedures before committing to production migrations.

Future Outlook and Development Roadmap

AlmaLinux's future development focuses on maintaining RHEL compatibility while enhancing community features and expanding platform support.

Version Alignment: The project maintains close alignment with RHEL release schedules, ensuring that AlmaLinux users receive new features and security updates in parallel with commercial RHEL deployments.

Cloud Integration: Enhanced support for cloud platforms, including optimized images for AWS, Azure, Google Cloud, and other providers, makes AlmaLinux increasingly attractive for cloud-native deployments.

Container Ecosystem: Continued development of container support, including optimized base images and integration with Kubernetes and other orchestration platforms, positions AlmaLinux for modern application deployment models.

Hardware Support: Ongoing work to support new hardware platforms, including ARM processors and specialized computing hardware, ensures AlmaLinux remains relevant across diverse computing environments.

Conclusion

AlmaLinux represents more than just a technical solution to the CentOS transition; it embodies the principles of community-driven development, enterprise reliability, and open-source sustainability. Born from necessity but nurtured by expertise and community support, AlmaLinux has quickly established itself as a viable, long-term alternative to commercial enterprise Linux distributions.

The distribution's commitment to binary compatibility with RHEL, combined with its community governance model and enterprise-focused feature set, makes it an ideal choice for organizations seeking stable, secure, and cost-effective Linux solutions. Whether you're a small business looking to replace CentOS, a developer needing a reliable testing environment, or an enterprise architect planning large-scale deployments, AlmaLinux provides the foundation for successful Linux implementations.

As we progress through this book, we'll explore the practical aspects of AlmaLinux deployment, administration, and optimization. The solid foundation provided by AlmaLinux's design philosophy and technical architecture will support you as you develop expertise in enterprise Linux administration and build robust, scalable systems that meet the demanding requirements of modern computing environments.

The journey into AlmaLinux administration begins with understanding its origins and philosophy, but the real value lies in practical application. In the following chapters, we'll transform this foundational knowledge into hands-on skills that will serve you well throughout your Linux administration career.