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LinuxONE

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Secure your data
and spark innovation

Leverage a large
partner ecosystem

Dynamically scale to meet
your business needs



Judith Hurwitz

Daniel Kirsch

Fred Dalrymple

IBM Limited Edition



LinuxONE

IBM Limited Edition

**by Judith Hurwitz, Daniel Kirsch,
and Fred Dalrymple**

**for
dummies®**
A Wiley Brand

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Introduction

As more companies transform their infrastructures with hybrid cloud services, they require environments that protect the safety of their intellectual property, such as data and business rules. In addition, businesses need a set of hybrid cloud services that provides the best of both worlds: the elasticity and automatic provisioning of the public cloud with the economic viability of the private cloud. Welcome to IBM LinuxONE.

LinuxONE is a hardware system designed to support and exploit the Linux operating system based on the value of its unique underlying architecture. We are in an era where openness is paramount to support the needs of corporations. At the same time, in the era of cloud computing, businesses need scalability and security to support increasingly complex workloads. The business value of LinuxONE is that it can be used within a multi-cloud environment to support a range of workloads and a variety of customer scalability requirements.

LinuxONE supports open APIs and Kubernetes. The openness of the platform means your business can create a hybrid environment that can include both on premises environments and public cloud services.

About This Book

LinuxONE For Dummies, IBM Limited Edition, is designed to help you understand LinuxONE as an integrated hardware and software environment that supports a hybrid cloud environment. This book provides you with an overview of the value of LinuxONE when compared to other platforms.

Foolish Assumptions

The information in this book is useful to many people, but we have to admit that we did make a few assumptions about who we think you are:

- » You're already familiar with enterprise and cloud computing and need to understand how to enable your company to scale in the era of the hybrid cloud.
- » You're planning a long-term cloud strategy and want to understand the value of the private cloud and how it can be used to support your business goals.
- » You need to ensure that data is managed in a secure manner.
- » You're a business leader who wants to ensure that you have a predictable, secure, and resilient computing infrastructure.

Icons Used in This Book

The following icons are used throughout the book.



REMEMBER

This icon highlights important information that you should remember.



TIP

Tips help identify information that needs special attention. You may save money, time, or resources.



WARNING

This icon points out content that you should pay attention to in order to avoid problems.



TECHNICAL
STUFF

This icon is reserved for more technical information.

IN THIS CHAPTER

- » Examining the history and evolution of LinuxONE
- » Understanding the hardware and characteristics of LinuxONE
- » Grasping the LinuxONE ecosystem
- » Seeing LinuxONE in action: workload performance
- » Cashing in on the business benefits of LinuxONE

Chapter 1

Explaining LinuxONE

Linux adoption has grown dramatically over recent years, expanding from initial use by startups for web servers, into its use today for a vast range of enterprise computing workloads. These mission-critical applications have in turn placed greater requirements on the underlying server hardware for security, scalability, and resilience.

LinuxONE is an enterprise-grade Linux server with a unique architecture designed to meet these needs. It brings together IBM's experience in building secure, resilient, and scalable systems with the openness of the Linux operating system. LinuxONE is a Linux-only platform intended to support customers interested in leveraging the open source ecosystem combined with highly secure and highly scalable servers.

Linux has been available on supercomputers for more than a decade, so it's no novice at being the operating system for powerful machines. However, LinuxONE is focused squarely at enterprise computing in the era of the cloud. After you understand the hardware and software platform of LinuxONE, you can understand the business opportunities and benefits of LinuxONE.

In this chapter, we provide an overview of what LinuxONE is and how it can be used to support growing requirements in the enterprise.

The Evolution of LinuxONE

Over the years, centralized enterprise computers and their workloads have taken on many new roles, such as hosting servers in client-server applications or hosting a World Wide Web server. In the late 1990s, IBM made the strategic decision to support the Linux operating system on its enterprise server architecture.

In 2014 IBM saw a shift in how clients were deploying Linux and open source. This was driven by the use and maturity of open source software for enterprise application deployments. Clients were increasingly looking for scale, performance, availability and security in their Linux servers. Observing this shift IBM decided to build a system to address these requirements.

IBM decided to take existing components from across its Systems portfolio and fashion a platform that is uniquely designed to deliver on these new expectations for enterprise Linux servers. The LinuxONE system was launched in August, 2015.

The result is a platform that scales like a cloud, provides class-leading security, has traditional enterprise server reliability, and can consolidate workloads from many smaller servers onto a single integrated LinuxONE machine.

Looking at the LinuxONE Hardware and Its Characteristics

The first two LinuxONE products were named Emperor and Rockhopper (named after penguins as a nod to the Linux mascot). Emperor II and Rockhopper II, the second iteration of LinuxONE, were launched in 2017 and early 2018:

» **Emperor II** features up to 170 processor cores, running at 5.2 gigahertz (GHz), up to 32 terabytes (TB) of RAM, and

640 dedicated I/O processors, housed in a dual-frame. It supports tens of thousands of sessions and millions of containers. It can run 8,000 virtual servers and over 30 billion RESTful web interactions per day.

- » Designed as an entry point into LinuxONE, **Rockhopper II** is the newest member of the product portfolio, built on the same technology but at a lower price point and housed in an industry-standard 19-inch rack. Rockhopper II is available with up to 8TB of memory and 30 processor cores, running at 4.5 GHz, supporting hundreds of production and development virtual machines (VMs) in a single footprint.



REMEMBER

LinuxONE cores are more powerful than x86 cores, through a combination of processor architecture, clock-speed, cache, optimization, and I/O offloading. While security and scalability are the key differentiators of these platforms, the hardware also provides reliability and performance benefits for many important workloads. We cover the key characteristics of the platform in this section.

Security

Security is architected into LinuxONE for both the hardware and software. For example, pervasive encryption can encrypt all data associated with an application, database, or cloud service — whether at rest or in flight. This level of protection is achieved through hardware accelerated encryption of data, delivered with near-zero overhead by the on-chip Central Processor Assist for Cryptographic Function (CPACF) and the new dedicated Crypto Express6S adapter. The availability of this level of encryption makes it easier for applications to meet regulations such as HIPAA and PCI DSS.

Security is further promoted by protecting cryptographic keys by using a Hardware Security Module (HSM). Protected key encryption is processed in the CPACF for high speed and stored in an HSM. This key encryption enables fast encrypting and decrypting of complete disks (volumes) or selected partitions. Logical partition (LPAR) isolation, standard on all LinuxONE processors for generations, virtually eliminates east-west, north-south security breaches and their damaging impact both financially and to an organization's credibility.

IBM Secure Service Container adds further security capabilities for Docker and other container environments. IBM Secure Service Container technology provides workload isolation, restricted administrator access, and tamper protection against internal threats, including from systems administrators.

Linux itself provides a comprehensive set of security technologies, including firewalls, VPNs, auditing tools to support regulatory compliance, and SELinux, a kernel-based security system. For more details on security of LinuxONE, check out Chapter 2.

Scalability and performance

LinuxONE is designed to be a high-performance machine. With its impressive number of processors, clock-speed, I/O bandwidth, and more, LinuxONE is designed to operate at near 100 percent utilization. In contrast, x86 machines need to operate at relatively low utilization levels (typically near 50 percent, although case studies show that number is often lower in practice). In addition, because security is built in at the core, security requirements don't impact performance like they commonly would with systems that require the customer to add third-party encryption tools.

LinuxONE systems scale vertically or horizontally without interruptions to running applications. The scalability of LinuxONE is efficient because you can scale up within the same machine. This scalability is ideal for “systems of record” workloads, such as databases and transaction processing, and reduces the costs of scaling workloads. In comparison, to scale out with an x86 system, you're required to add more servers and dedicate more floor space, management tools, and networking — anything associated with adding new systems to your environment.

Reliability

Reliability is a well-known capability of IBM's unique enterprise server architecture — for example, the fact that it has no single points of failure. LinuxONE inherits these capabilities, including component redundancy to allow the machine to continue when a single component fails. This feat is possible because maintenance and repairs can be performed while the machine is still running workloads.

The LinuxONE Ecosystem

The LinuxONE environment is designed as a unified system based on the Linux operating system combined with the most important open source services ranging from databases to management tools. Therefore, IBM has marshaled key open source and industry software for LinuxONE systems including Python, Go, Swift, Java, and other languages; MongoDB, PostgreSQL, Apache Spark, Node.js, Hadoop, and other tools including Kubernetes, Docker, Chef, and Puppet.

These technologies work seamlessly on LinuxONE, just as they do on other hardware platforms, requiring no special skills. Because of its open source heritage, LinuxONE can operate both in the traditional data center or as a private cloud platform. LinuxONE runs the enterprise Linux distributions — Red Hat, SUSE and Ubuntu — as well as community editions, including CentOS, Debian, Fedora, and OpenSUSE.

Workload Performance of LinuxONE

The unified platform of LinuxONE is designed to support demanding performance requirements in the enterprise. While we could give you countless examples of the benefits of this level of performance, in this section we describe four use cases where customers benefit from the workload performance.

Support for large high-performance databases

Many databases use sharding or other scale-out mechanisms because the data is too large to fit on a single machine. Because of the scalability and performance of LinuxONE, a massive database can often fit on a single LinuxONE machine. Performance is improved because everything is in the same server — avoiding the overhead of additional communications and coordination, the latency from gathering results, and the application changes required with a scale-out approach.

Support for large number of containers

LinuxONE systems have been enabled for Docker containers and Kubernetes with integrated management and scale tested to support up to two million containers. Supporting high numbers of containers is key for businesses that support a large number of enterprise customers in areas such as telecommunications, cloud service providers (CSPs), and financial institutions.

Support for blockchain



REMEMBER

Blockchain is a technology for creating distributed, secure ledgers that represent the history of transactions and life cycle of things (Bitcoin is the best known application of blockchain). Blockchain is an ideal technology to run on LinuxONE. It relies on data encryption and decryption, and LinuxONE's hardware cryptography delivers superior performance to a software solution. When the size of a blockchain network or the size of the ledger gets huge, LinuxONE's massive available RAM still allows verification of the ledger to occur in memory for maximum performance.

Support for DevOps

LinuxONE is an important platform to support the DevOps process. Because LinuxONE is based on open source Linux, developers can use the same tools they're familiar with in any on premises or cloud environment and can safely run development alongside production workloads.

The Customer Benefit of LinuxONE

One of the consequences of the movement to the hybrid cloud is the need to have performance, resilience, scalability, security, and manageability as the foundation. The cloud has brought the imperative of elasticity and security to the forefront of how businesses are supporting their customers, suppliers, and partners. You can no longer assume that you can estimate the capacity you'll need a year in the future. While you can continue to add individual servers, management and security concerns are holding businesses from achieving their goals. Ironically, LinuxONE — based on one of the longest lasting architectures in the industry — has emerged as one of the most forward-focused platforms to support change.

IN THIS CHAPTER

- » Knowing why you need a secure platform to protect your data
- » Seeing the LinuxONE approach to security
- » Understanding the ability to encrypt all your data
- » Securing a cloud on LinuxONE

Chapter 2

LinuxONE as a Secure Platform

Security must be at the center of any IT platform. If critical business data is compromised or customer data is leaked, your business's reputation may be damaged, and you may face regulatory and legal consequences. Likewise, if corporate data is exposed, you risk the chance of losing significant intellectual property.

When you're considering an infrastructure platform, you need to understand the security features inherent in the platform, both in the cloud and on premises. In this chapter, we discuss how the LinuxONE system incorporates a high level of security.

Why You Need a Secure Platform

Initially, corporate management assumed that regulatory compliance and audits would be enough to protect your company's data. However, many security risks come from third-party malicious attacks. Management now understands that with the advent of cloud computing, many of the risks may be out of their direct control.

Businesses are concerned about cybersecurity threats to the information that is the lifeblood of their relationships with their customers and partners. More and more data resides in a multi-cloud environment, and applications are designed to manage data and provide collaboration between customers and partners.



REMEMBER

We are not just talking about data stores here. Rather data is embedded in spreadsheets, documents, applications, and data-bases on premises and in the cloud. At one point, the chief security officer had direct control over how security was handled. However, increasingly distributed data and applications make it difficult for the security officer to control this complex set of services. At the same time, security is now a major concern of business management. Management needs to report to shareholders that security is being managed at the highest level.

What Does It Mean to Have a Secure Platform?

A common misconception exists that when a business entrusts its data and applications to a cloud provider it is no longer responsible for security. But in fact, the business remains responsible for keeping track of this highly distributed data, including who's allowed to access the data and whether regulations are adhered to. While many cloud vendors tout the sophistication of their security capabilities, they rely on third-party partners to ensure that their clouds are secure and protected from attack. To be successful at protecting your assets, there needs to be a partnership between the cloud vendor and the security management team.

IBM's Approach to Security with LinuxONE

In Chapter 1, we discuss how LinuxONE is designed to support industry standard Linux. LinuxONE provides customers with a combination of a highly scalable standards-based platform with the highest level of security at the core. Security is built in at the lowest levels of the platform for LinuxONE. Security is at the heart of helping businesses to protect their assets at the most sophisticated

level possible. The most important technologies for ensuring this level of protection are pervasive encryption, Hardware Security Module (HSM), and IBM Secure Service Container.

Pervasive encryption

The idea of encrypting all your data is new. Because of the overhead of software encryption, businesses in the past have been forced to choose which data to encrypt, leaving the remaining data at risk. In nearly every online interaction, data is left unencrypted at some point in the process. This point, when data is left unencrypted, gives wrongdoers the opportunity to steal data.

Pervasive encryption can encrypt data both at rest and in flight, and this type of encryption doesn't require application changes. This approach enables companies to encrypt all their data by default with little compute overhead.



TIP

One of the benefits of the LinuxONE system is the extent of the security services. Because of the architecture of LinuxONE, security is pre-integrated at every level of the hardware and software stack. LinuxONE-based security is designed to encrypt data in bulk. Therefore, it is possible to encrypt all the data associated with an application or a database at one time.

Providing encryption of everything and at every level is in stark contrast to the way encryption is typically approached. Most companies only encrypt a small amount of data, leaving the vast majority of data completely unencrypted. All the unencrypted data is at risk of being leaked by mistake or stolen by a criminal. On the other hand, when all the data is encrypted, even if it's exposed to people outside of your organization, it will be meaningless without the encryption key.

Traditionally encrypting all your data required a large amount of compute and time overhead; however, the LinuxONE platform has dedicated hardware specifically tuned for encryption. The on-chip encryption co-processor is on every compute chip next to the main processor and can encrypt up to 13 gigabytes (GB) of data per second per core.

HSM

LinuxONE can also include CryptoExpress adapters, which support high-speed encryption as well as provide an HSM for securely storing and protecting encryption keys. These cryptographic

co-processors are protected within a tamper-responsive environment that will destroy encryption keys if it senses an attack.

IBM Secure Service Container

The IBM Secure Service Container for IBM Cloud Private (ICP) is a solution that hosts container-based applications for hybrid and private cloud workloads on IBM LinuxONE and Z servers. This secure computing environment for microservices-based applications can be deployed without code changes to exploit the security capabilities and provides the following:

- » Tamper protection during installation and boot time to protect against malware attacks
- » Restricted administrator access to help prevent the misuse of privileged user credentials, for both cloud and on premises environments
- » Automatic pervasive encryption of data both in flight and at rest

IBM Secure Service Container technology builds on the workload isolation of the firmware based Logical Partitions (LPARs) and is unique to IBM LinuxONE. It has been used in the IBM Cloud on LinuxONE to provide the advanced security of IBM Blockchain Platform and has now been extended for generic container-based applications through IBM Secure Service Container for ICP.

Leveraging LinuxONE Security to Create a Secure Cloud

There are different ways that organizations can apply LinuxONE security services to their computing environments. These services can be used as part of a private cloud or as cloud services hosted in ICP. For example, a client can implement an on premises LinuxONE machine to build a private cloud, or it can gain access to the secure services by provisioning a LinuxONE instance on the cloud.

LinuxONE servers can be configured to host the ICP software, a platform that integrates DevOps capabilities with cloud optimized

software. ICP on LinuxONE servers allows teams to take advantage of the IBM and open source portfolios of software via containers and microservices in a secure cloud environment. Deploying an ICP environment on the LinuxONE platform allows customers to take advantage of the security capabilities of IBM's unique enterprise server architecture. For example, customers can decide to encrypt all their data, whether in flight or at rest, by using pervasive encryption, and additionally isolate containerized applications further using IBM Secure Service Container for ICP (which automatically includes pervasive encryption) to create a highly secure environment. This automatic encryption protects applications and data from attacks that attempt to gain access through privileged administrator credentials. Leveraging these security capabilities allows clients to securely build and host their own hybrid and private cloud deployments on premises.

IBM Hyper Protect Services

There are a variety of security services that are hosted in the IBM Cloud. IBM offers the IBM Hyper Protect Services built with enterprise-grade data protection, made possible by bringing IBM LinuxONE into IBM's global public cloud data centers. Now, developers and clients can build, deploy, and host applications with an industry-leading data protection that encrypts information at rest and in flight. This technology is designed to help protect against threats, both inside and outside of an organization.



REMEMBER

The IBM Cloud Hyper Protect family provides two services and intends to expand to include others that are crucial for providing protected cloud capabilities. Two services are available, initially as beta releases:

- » IBM Cloud Hyper Protect Crypto Services
- » IBM Cloud Hyper Protect DBaaS

See Chapter 5 for a more detailed discussion of IBM Cloud Hyper Protect Services.

- » **Scaling approaches for LinuxONE and databases**
- » **Choosing LinuxONE for running databases**
- » **Looking at IBM Cloud Hyper Protect DBaaS**

Chapter 3

Scalable Databases for LinuxONE

The key difference between LinuxONE and other Linux systems is that LinuxONE's hardware offers dramatic improvements in performance, security, and reliability. In particular, LinuxONE can scale up to handle much larger databases than other Linux systems. The platform also enables the consolidation of multiple database servers onto a single system. The hardware advantages create the opportunity to run databases on a single scale-up LinuxONE machine rather than multiple scale-out servers. Transitioning from a scale-out to a scale-up strategy helps organizations increase performance, achieve higher utilization, and reduce costs.

In this chapter, we provide an overview of IBM's LinuxONE and why it's well suited to running large databases. We also discuss an IBM product designed to deploy and monitor secure databases in the cloud.

Scaling LinuxONE and Databases

While organizations have been coping with large volumes of data for many decades, the challenge has been exacerbated by the ever-increasing volume of big data that is being applied to advanced

analytics problems at a massive scale. This rapidly increasing data requires powerful processing power and computing resources that can scale performance quickly as demands change.

Scalable processing power can be achieved in various ways. The cloud has demonstrated the ability to scale massively by scaling out — using many independent, cooperating virtual machines (VMs), running on commodity servers. While this scale-out approach can work for systems of insight and systems of collaboration, there are challenges for systems of record because of the need to achieve immediate consistency in data across multiple VMs — and managing a sprawling network of distributed servers can quickly become difficult. In addition, as you continue to scale out, you'll likely introduce latency and increase costs.

Scale up, not out

Besides scaling out, you can scale up. Scaling up allows you to get more compute and storage resources from a single machine. With the scale-up model, you begin with a small VM and add processors and memory to the VM as your workloads expand.

LinuxONE uses the fastest commercially available processor so its performance level is significantly higher than x86-based servers (the standard server running in most clouds and many databases). I/O is offloaded to up to 640 dedicated co-processors, speeding access to data. And LinuxONE can run many workloads that would otherwise require multiple x86 machines. For example, a single IBM LinuxONE Rockhopper II system can scale up to 377 billion transactions per day, support up to 8 terabyte (TB) of main memory, contain 30 CPUs, and provide extreme I/O bandwidth with a 16 gigabit (Gb) Channel — all while providing 99.999 percent availability. However, you can start by provisioning and paying for a much smaller workload and scale up as your requirements expand.

Database scalability

There is not a shortage of databases in the world. Each platform has its strengths and weaknesses depending on its use and constraints. For example, some databases are designed to run as clusters of cooperating servers in the cloud. This scaled-out configuration can manage larger quantities of data than a single machine and can continue to scale out with even more servers to meet additional demands.

Other on premises databases are designed to operate on a single machine. If a business needs to deploy a workload larger than the machine's capacity, it may need to use a strategy like *sharding* — another form of scaling out.



Sharding is a technique where one large database is partitioned into independent smaller databases that do not overlap — and can therefore be placed onto separate machines. For example, a database for customers and their phone numbers could be partitioned based on the first letter of the customers' last names. One might end up with 26 databases for the English character set.

When the data is complex or has many interconnections, sharding will also introduce latency to data access when it is retrieved and reassembled from multiple partitions. Add in the extra communication required between the scaled-out servers as well as the management overhead of a cluster of servers, and the performance cost of the scaled-out solution becomes significant. Therefore, as a general solution, sharding can cause as many (or more) problems as it solves.

In contrast, a single LinuxONE machine, with its high capacity and performance, can handle large databases in a single system without requiring sharding.

Consolidating databases

One common use case for LinuxONE is to host the consolidation of commercial databases onto a single system. The benefits include increased performance, better throughput of data, and more efficient sharing of resources.

Customers have reported consolidation ratios of 10:1 cores or more, which leads to the opportunity for significant savings in software license fees where these are calculated on a per-core basis. See Chapter 6 for a more detailed discussion of LinuxONE and total cost of ownership (TCO).

LinuxONE as a Database Platform

The Linux operating system has enjoyed great success in the enterprise and has a broad and deep ecosystem for databases and applications. One of the benefits of LinuxONE is that it supports many of the popular SQL and NoSQL databases. Remember

that there are many databases available on LinuxONE. Two of the commercial databases, Oracle and IBM's Db2, are among the most popular. Two others, PostgreSQL and MongoDB, are prominent open source databases, which can also benefit from LinuxONE's scalability.

The Linux operating system can be tuned to optimize performance of applications and databases. For example, administrators can configure swapping conditions, RAM page size, choice of filesystem to use (ext4, XFS, ZFS), filesystem parameters, as well as many other system features. The scale-up capacity and performance allows many large database workloads to be handled by a single LinuxONE server. Also, multiple databases and applications can be consolidated on a single LinuxONE server for cost savings without a performance penalty. In addition, a database running on LinuxONE can exploit the large memory to hold data.

IBM Cloud Hyper Protect DBaaS

IBM Cloud Hyper Protect Database as a Service (DBaaS) is a new IBM cloud-based platform for provisioning and managing cloud databases with strong security features. Where databases used to be installed and configured by hand, IBM Cloud Hyper Protect DBaaS presents a visual, graphical user interface where you can select a database type (currently, MongoDB or PostgreSQL), a processor class, and security features to apply. One click then creates a cluster of three databases for you, in a master/slave/slave configuration.

From the moment your databases are created, they're protected by security features like LinuxONE pervasive encryption, hardware protected encryption keys (via a Hardware Security Module [HSM]), and IBM Secure Service Container technology.

The cluster of three databases provides not only scale-out performance but also redundancy for extra protection of data. Users can monitor their running databases from the IBM Cloud Hyper Protect DBaaS Graphical User Interface (GUI) or use their favorite database-specific management tools. With IBM Cloud Hyper Protect DBaaS, you don't have to be a Database Administrator (DBA) or database expert to provision highly secure databases quickly and easily.

- » Understanding the fundamentals of blockchain
- » Using blockchain within the enterprise
- » Looking at the industry initiatives and technologies behind blockchain
- » Choosing IBM LinuxONE for blockchain applications

Chapter 4

LinuxONE as the Blockchain Platform

Businesses leaders are beginning to understand that blockchain is much more than just the technology that underlies Bitcoin and other cyber currencies. The core architecture of blockchain allows a means of conducting secure transactions among many participants. The blockchain architecture ensures that the transactions are secure, are auditable, and have transparency to all stakeholders.

The IBM LinuxONE platform is designed to make applications using blockchain perform faster and more efficiently with the highest levels of security. This chapter explains what blockchain is, how visionary enterprises are saving money and increasing their security with blockchain, and how LinuxONE and blockchain work together in the data center and in the cloud. We also explain the benefit of the LinuxONE platform to support the extensive requirements of the blockchain.

Understanding Blockchain

Forward-looking enterprises have realized that blockchain technology is a more cost-effective way to manage their secure business interactions with customers, partners, and others. More

trustworthy business interactions lead to increased satisfaction for the business and those it interacts with.

Blockchain is a response to situations and challenges created by the cost, complexity, and vulnerabilities of business transactions between two or more parties who do not necessarily trust each other. Before blockchain, a central clearing house was responsible for verifying the identity of participants, managing inventory of the product (for example, currency), conducting transactions (purchases), and providing security and transparency. Each party kept its own records of transactions, which took time and expense to reconcile. A security breach of the central authority could be catastrophic, risking the financial underpinning of the marketplace and possibly destroying trust in the business.

The breakthrough for blockchain was to replace a central authority with a distributed, “peer-to-peer” model where the previous centralized database becomes a “distributed, secure ledger” available to all members of a community.

Figure 4-1 shows how a traditional transactional network works and how a blockchain systems works. As you can see, the traditional network is reliant on a central clearing house. All transactions must go through the clearing house. The clearing house possesses one master transactional ledger. In essence, the centralized clearing house is a potential choke point and a single point of failure likely to be targeted by cybercriminals.

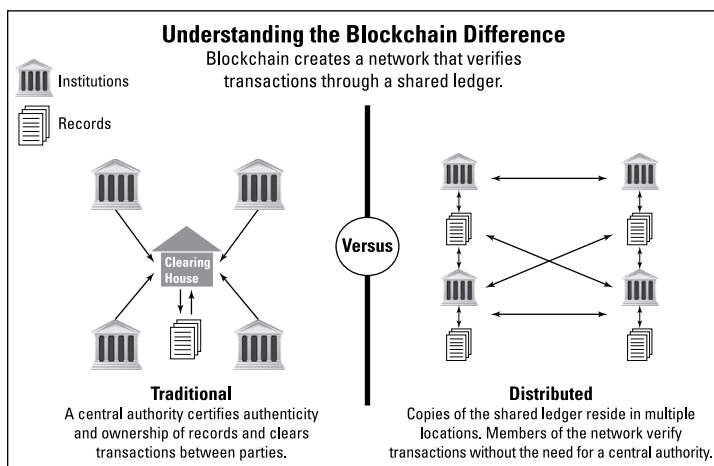


FIGURE 4-1: Traditional transactions versus blockchain transactions.

SUPPLY CHAIN AND ASSET MANAGEMENT

Blockchain's architecture is general enough to manage transactions of non-financial information, and many businesses seek the same security and transparency for their own complex and distributed environments.

Take a look at an example from Everledger, a supply chain management company located in the United Kingdom. The company's blockchain pilot project is used to track the ownership of diamonds across the precious gems supply chain, from mining through processing to dealers. By having a secure record of the history of each diamond, the company is able to help other companies create a secure supply chain of diamonds that are authentic, not stolen, and free from conflict-zones. Additionally, dealers and ultimately consumers can see the complete and transparent provenance of the diamond — from coal to the diamond in their hands. Everledger is running the IBM Blockchain Platform on LinuxONE in the IBM Cloud.

Another example of blockchain being used for supply chain management can be seen in a joint venture between the global shipping company Maersk and IBM. The two companies jointly created the company TradeLens to apply blockchain to the global shipping industry. The joint venture has more than 90 partnering organizations that are participating in the blockchain transactional system.

By using the IBM Blockchain Platform on LinuxONE in the IBM Cloud, every member of the shipping supply chain, from shippers and shipping lines to ports, inland transportation, and customs authorities, can access a trusted document showing the complete history of a shipping container. Approximately one million events are captured in the system per day.

The alternative to this blockchain-based system is sharing information via outdated Electronic Data Interchange (EDI) systems that are inflexible and do not operate in real time. Often, even with an EDI system, companies must share shipping documents via email, fax, and courier. The goal of the joint venture is to create an open, industry standard platform to securely transmit global shipping supply chain information.

On the other hand, the distributed blockchain system allows members to transact directly with each other. The shared ledger (record of transactions) is held by each node in the blockchain

network. Every instance of the shared ledger is updated whenever a new transaction is completed. As you can see, unlike the traditional system, there isn't a central clearing house, and the master ledger of all the transactions is held by every member of the system.

The distributed shared ledger is a record of all inventory, transactions, and interactions related to the product. Instead of having a central authority protect its database from outsiders to keep it secure, blockchain allows its ledger to be publicly available (with governance for certain types of products) where security is provided by encryption of its content and algorithms that control access and validation.

Of course, problems and disputes among buyers and sellers may still come up, but because of the comprehensive and transparent ledger, many fewer issues arise, and those that do are more easily resolved. In other words, blockchain solves security problems in its design, not with additional technology. The design of the blockchain approach makes the system simpler, more resilient, and more efficient — and ultimately much less expensive — than traditional centralized transactional networks.

The IBM Blockchain Platform

IBM has invested a tremendous amount of resources to create its blockchain platform. The platform is available as a managed, full stack blockchain-as-a-service (BaaS) offering delivered on the IBM Cloud, on premises with IBM Cloud Private when data regulations insist on local storage or where corporate preference is for on premises deployment, and on other public clouds.

In 2015, IBM approached the Linux Foundation to propose kick-starting a new open source project focused on blockchain. IBM donated the original code to start a project called Hyperledger. The project's mission is to advance cross-industry blockchain initiatives. Hyperledger now includes more than 250 member companies from finance, banking, the Internet of Things, supply chain, manufacturing, technology, and more. Hyperledger is now the fastest growing project in the Linux Foundation's history, showing the depth of interest in blockchain.

THE OPEN SOURCE CONNECTION

Open source software has dramatically changed the IT landscape. Where software was previously created by companies and kept proprietary, now developers and organizations often combine to form communities that build open source software. The software may be a major platform such as Linux, or applications such as the PostgreSQL database or LibreOffice Suite of office productivity tools.

The creation of the Hyperledger as an open source project is important for the following reasons:

- Bringing developers together from many companies to build Hyperledger provides many more perspectives, leading to more general and powerful solutions.
- More developers and organization are now working together on Hyperledger than if just one company created the platform.

IBM's Blockchain Platform is built on the open source framework of Hyperledger, which allows customers to develop and operate a blockchain network with the performance and security necessary for even the most demanding use cases in regulated industries.

LinuxONE Security Enables Blockchain

Both IBM LinuxONE and blockchain emphasize the importance of security to ensure that the business solutions built or running on their platforms are robust and secure from security threats. While LinuxONE's hardware and software have security benefits for all applications, there are features that particularly benefit blockchain. In this section, we discuss the primary benefits.

Built-in encryption

Encryption and decryption can decrease performance, and LinuxONE has dedicated on-chip co-processors for hardware encryption and decryption of data without the typical processing overhead associated with software encryption. The low overhead of LinuxONE hardware encryption enables pervasive encryption to be practical, automatically protecting all data.

Key management

LinuxONE has hardware support for storage of private keys (HSMs) required for cryptographic signing in a tamper-resistant module — another feature that improves performance and security.

Workload isolation

Workloads are also isolated on LinuxONE, using the firm-ware virtualization of logical partitions (LPARs). These ensure near air-gap separation between workloads and have enabled LinuxONE to be certified at EAL5+, one of the highest commercially available certifications.

IBM Secure Service Container

Building on logical partitions is the IBM Secure Service Container technology, which takes workload isolation to the next level by providing a secure computing environment for container-based applications. We discuss IBM Secure Service Containers in more detail in Chapter 2.

Performance

The algorithms used by blockchain to verify the state of the ledger are complex and require a lot of processing power. LinuxONE offers hardware to process these algorithms much more quickly and efficiently than a software-only approach.

IBM LinuxONE also provides a high-capacity scale-up environment, with very large memory, a dedicated I/O subsystem, and the largest cache available. In internal tests, blockchain transactions were up to two times faster on LinuxONE than on a compared x86 system.

Customized Go language

To make these hardware solutions available to the blockchain software, the Go language used to implement the blockchain Hyperledger Fabric has been ported and optimized for use on LinuxONE hardware.

Blockchain on LinuxONE

Because of its distributed architecture, blockchain is best suited for the hybrid cloud model and can be deployed both in the public cloud and on premises. The decision on where to deploy blockchain could, for example, depend on if a managed service is preferred for ease of use, or whether government, industry, or corporate regulations mean that data needs to be held locally.

For both cases, Blockchain running on LinuxONE benefits from the LinuxONE security capabilities, including pervasive encryption, workload isolation, and the additional protection of IBM Secure Service Container technology.

Blockchain on LinuxONE in the cloud

Because a blockchain network can be a large set of distributed servers, the cloud may be the easiest option to be able to set up and run blockchain. Cloud service providers can easily support a variety of customer use cases and make it easy to get started quickly. If you select a new virtual machine residing on a LinuxONE server for your blockchain node, it can instantly scale up to handle billions of transactions per day. This ability to scale-up happens without interrupting applications running on the server, making it a powerful platform for running blockchain in the face of volatile demands.



TIP

Another benefit of a LinuxONE server in the cloud is the ability to consolidate multiple applications and processing that might otherwise have to be placed on separate machines. Consolidation leads directly to cost savings, better security, and higher performance.

Blockchain on LinuxONE on premises

Blockchain can also be deployed on premises — either as a remote peer or as the full blockchain stack. This deployment could be done in order to comply with government, industry, or corporate regulations on where data is stored. An added benefit to organizations is that they own the resources and can offer customized services to their own customers. Data centers respect the role that extremely robust and powerful servers play. They are built to perform reliably, take less floor space, require fewer interconnections, consume less power, and generate less heat than an equivalent set of commodity machines.

- » Understanding IBM Cloud Private (ICP)
- » Seeing the benefits of LinuxONE for CSPs

Chapter 5

LinuxONE as a Cloud Platform

Increasingly businesses are turning to the hybrid cloud as a way to pragmatically manage their workloads to support customers and partners. There simply isn't one solution to support all workloads and all business situations. Both corporations and cloud service providers (CSPs) are evaluating a new generation of private cloud offerings as a solution. In this chapter, we explore the IBM Cloud Private (ICP) platform in combination with LinuxONE, along with public cloud services. LinuxONE can be deployed in a variety of cloud use cases, including in the IBM Cloud as the foundation for IBM Blockchain Platform and IBM Cloud Hyper Protect offerings, as well as the platform for CSPs to build their own public cloud offerings on IBM LinuxONE.

Explaining ICP

ICP is not a single unified environment typical of the data center. Rather, ICP is architected with a software-defined layer that removes the dependencies connected with a single hardware or virtualization infrastructure. This software layer can sit on top of any public or private cloud. The benefit of this software

abstraction layer is that LinuxONE can become the high-end platform for ICP. There are four primary components of the ICP platform.

Kubernetes-based container platform

Containerization is the foundation of the design of the private cloud. Now code becomes a service. By placing code into a container, the service is designed to be independent of the underlying system. Containerization enables code to include any necessary dependencies needed to operate that service. A standardized application programming interface (API) supports each container. In this way, a container may be used to manage newly built microservices or to refactor an existing application or service in new ways through encapsulation into a service.

ICP has also containerized middleware, data, and analytics services. It also includes a unified installer to rapidly set up a Kubernetes-based cluster with master, worker, and proxy nodes by using an Ansible-based installer. With containers at its core, IBM provides the same open source application runtime services across the IBM public and private clouds.

Cloud-optimized software and services

Because ICP is based on a container architecture, a number of optimized services are part of the platform. For example, you can set up a multi-tenant version of your cloud service. This is especially useful for a CSP. Therefore, each stakeholder gets a customized set of services within the private cloud based on a designed business process that sits behind the firewall. Isolated tenant networks leverage Calico (a network policy service for Kubernetes clusters) to improve performance and network isolation inside clusters.

ICP provides you with a common catalog of services that helps developer productivity. The catalog helps to manage microservices so they can scale both horizontally and vertically. The structure of the catalog makes it easier to govern, deploy, and maintain software and services to support rapid development, test, and deployment. Services that are managed in the catalog include Helm charts, Terraform templates, and Cloud Foundry buildpacks.

Within ICP, a brand range of managed middleware, data, and analytics services support both cloud native and existing applications. New Kubernetes services included are Microservices Builder, Watson Studio, security services, and API connect. Developers can leverage existing application development skills such as Java, Spring, and Open Liberty. API connectivity and management services make it possible to integrate services across public, private, and existing enterprise environments. ICP is intended to provide an end-to-end solution for applications including popular open source frameworks and languages, built-in DevOps, integrated monitoring services, as well as middleware, and data and analytics services.

Integrated DevOps and management tools

A goal of ICP is to provide integration and management services to create a hybrid cloud environment that behaves as though it were a unified computing environment. ICP includes security at the core including authentication, authorization, and identity services. There are services to support the security of containers, including scanning of Docker images and containers. One of the key capabilities of ICP is a set of overall multi-cloud management tools.

Flexibility in choice of infrastructure

The ICP environment can operate on any existing hardware environment, including IBM LinuxONE, IBM Z, IBM Power Systems, and x86-based systems. It can also support OpenStack, VMware, IBM Storage, IBM Hyperconverged Systems, and third-party cloud providers. Where a higher level of scalability, resiliency, or security is needed, LinuxONE's unique architecture makes it a pragmatic enterprise choice for deploying ICP.

IBM Cloud Hyper Protect Services

IBM Cloud Hyper Protect Services is a range of services deployed on IBM LinuxONE and hosted in the IBM Cloud. These services provide advanced security, database, and container offerings that use the enterprise-grade capabilities of IBM LinuxONE but are

available to everyone through the IBM Cloud catalog, initially as beta releases.

IBM Cloud Hyper Protect Services uses the IBM Secure Service Container technology available with IBM LinuxONE. This provides a protected environment to run containerized applications. This secure computing environment for microservices-based applications can be used without requiring application code changes. See Chapter 2 for a discussion of IBM Secure Service Container.

IBM Cloud Hyper Protect Crypto Services

IBM Cloud Hyper Protect Crypto Services is a cryptography service designed to provide LinuxONE based security capabilities to the cloud with a complete set of encryption and key management services. IBM Cloud Hyper Protect Crypto Services helps to secure cloud native solutions for highly regulated industries through the highest level of security in a Hardware Security Module (HSM) ecosystem, allowing only the data owner to control access to the data. This service has the industry's highest FIPS 140-2 Level 4 crypto certification. The system provides high density and unique transaction in flight and at rest protection accessible in the cloud on IBM Cloud Hyper Protect Crypto Services. This capability, typically used by banks and financial services companies, brings the security services of LinuxONE to the IBM Cloud. IBM Cloud Hyper Protect Crypto Services integrates with multiple IBM Cloud data services such as IBM Key Protect, an IBM Cloud service that helps clients protect their keys on LinuxONE. These services can be accessed with several popular programming languages, including Java, JavaScript, and Swift.

IBM Cloud Hyper Protect DBaaS

IBM Cloud Hyper Protect DBaaS is a cloud service designed to provide highly secure databases on demand, such as PostgreSQL and MongoDB Enterprise Edition database clusters. It enables clients to quickly provision, manage, and protect sensitive data workloads. The service leverages the LinuxONE pervasive encryption service, allowing clients to retain their data in a fully encrypted client database without needing specialized skills. In addition, it supports the IBM Secure Service Container providing workload isolation, restricted administrator access, and tamper-protection against internal threats. The Docker-based stack inherits security

without any code changes. With IBM Cloud Hyper Protect DBaaS, clients can deploy integrated database clusters in the IBM Cloud, manage database instances using APIs, Command Line Interfaces (CLIs) or User Interfaces (UIs), administer database content, and monitor their database environments.

The Benefits of LinuxONE for CSPs

CSPs find themselves competing in a crowded market. To be successful, CSPs must have a way to differentiate themselves from competitors. LinuxONE provides CSPs with an alternative platform that can be more effective than the use of commodity servers. The LinuxONE platform provides built-in scalability, flexibility, security, and manageability. In this way, the cloud service provider can offer differentiated services with a range of cloud environments to meet increased SLAs, while also offering a good business opportunity.

Because LinuxONE supports the most popular Linux operating system distributions, there is an ecosystem of tools, services, and applications that can be added into the environment as customer requirements change. CSPs can also more effectively manage risk and optimize performance through LinuxONE, by leveraging the integrated security that helps protect against both external and internal threats, especially in a multi-tenant environment.

- » Consolidating workloads onto LinuxONE
- » Examining higher utilization
- » Reducing cost by using open source software
- » Saving money in additional areas

Chapter 6

The Economics of LinuxONE

You might assume that the total cost of ownership (TCO) of the enterprise-grade LinuxONE platform would be much higher than commodity servers. However, on careful examination, customers have been surprised at the economic advantage of the LinuxONE platform compared to a similarly complex set of applications running in an x86 environment. The economics of LinuxONE become clear when you begin to compare the total costs to operate a LinuxONE machine versus other servers. x86-based infrastructures tend to have workloads distributed over many individual servers while LinuxONE-based infrastructures consolidate workloads onto fewer LinuxONE cores. The system software of LinuxONE servers can be lower cost because it is open source. Secondary and indirect costs also have a significant impact on TCO.

In this chapter, we explain how LinuxONE provides cost savings by consolidating workloads, supporting higher utilization, using open source software, and more. We also discuss two business cases where organizations replaced x86-based environments with LinuxONE servers.

Consolidating Workloads

Workload consolidation is the practice of gathering workloads from multiple servers and running them on a single larger server. LinuxONE servers are designed to run many workloads simultaneously and can consolidate many workloads from x86 servers. The result is many fewer LinuxONE servers than the number of x86 servers they replace.



TIP

Consolidation has many advantages. Removing the servers whose workloads are consolidated onto a larger server reduces hardware costs. Having fewer physical machines to run and maintain reduces operations costs. Additional savings are gained by the reduction in data center infrastructure resources required, including less networking (because of fewer servers to connect), freed-up floor space, reduced power requirements, and redeployment of staff from administration to innovation. The largest savings comes from fewer software licenses due to dramatically fewer processor cores required to run the same work.

Supporting Higher Utilization

Because LinuxONE servers have higher processing, storage, and I/O capacities than x86 servers, a LinuxONE server will generally support many more active applications than an x86 server. However, that's not the whole story. LinuxONE and x86 machines support fundamentally different levels of CPU utilization.

Understanding the utilization capacities of servers is critical when comparing hardware platforms. Utilization is the percentage of overall processor performance consumed by a computer when running workloads. After a processor reaches 100 percent of processor utilization, no additional processing power is available. Remember that you must plan for application spikes. For example, an application's load might average just 20 percent of the server's utilization, but during brief high-demand periods that 20 percent could spike to nearly 100 percent.



WARNING

When workloads exceed 100 percent of processor capacity, even if from temporary spikes, overall performance decreases as the machine struggles to manage the workloads it can't service. x86 servers rarely sustain high levels of utilization, further limiting

available performance. Because exceeding the available processing capacity is counterproductive, organizations usually over-provision compute resources and limit the number of workloads on machines to avoid bottlenecks.

THE COST BENEFIT OF MIGRATING TO LINUXONE

A mid-sized financial services organization was at a crossroads. As it grew, it was required to add more and more servers to its data center to support its database workload. The company had forty-two x86 servers with 1,512 cores. Expenses were beginning to exponentially increase. For example, its software licensing costs were increasing because the licenses were based on the number of cores. Likewise, networking costs between all the machines were high. The company knew it had to look at alternatives. It considered the cloud but determined that the costs would be similar if not more than the current environment.

The company began to learn more about the LinuxONE platform and discovered that it could begin consolidating database workloads. To run the database workload, the company needed two IBM LinuxONE Emperor II's with 135 cores — close to 1,400 fewer cores than was needed with their forty-two x86 servers. After implementing the LinuxONE the company realized the following savings:

- Migration: 50 percent savings
- Energy: 86 percent savings
- Networking: 98 percent savings
- Staffing: 28 percent savings
- Software: 89 percent savings

Although the company spent more on hardware and system software, switching to LinuxONE resulted in a TCO savings of 41 percent, or \$12 million over five years. The company realized savings within the first year, and the difference in annual run rate was approximately \$2.5 million.

LinuxONE cores run at higher speeds and have other performance features that allow them to handle more demanding workloads than x86 cores. LinuxONE cores are also designed to provide sustained high utilization, whereas commodity server cores are not. Therefore, LinuxONE machines have the capacity to handle spikes that near 100 percent utilization without over-provisioning. Further, LinuxONE machines can reach higher average utilization levels, while x86 machines often have to reserve more than half their capacity simply to handle spikes.

Using Open Source Software

The accelerating growth of data from mobile devices, social media, and big data activities is exerting pressure on data storage, communications bandwidth, and processor power resources. LinuxONE's open source operating system and tools can be lower priced than proprietary offerings and offer a more manageable path to handle the continuing rapid growth of data that organizations handle. There is also a large ecosystem of open source partners and tools. LinuxONE customers are able to take advantage of a wide variety of free open source tools or lower priced tools, many of which aren't available on proprietary platforms.

Looking at Additional Savings

LinuxONE's robustness, resiliency, and security have potential to save customers money in other ways, such as costs associated with downtime, repairs, and security breaches. LinuxONE customers can realize savings in these two areas as well:

- » **Achieving high availability (HA):** Enterprise applications require constant up-time and use HA to achieve it. HA is provided by maintaining redundant hardware and software environments, with constant data mirroring. Providing HA can be a costly and difficult process. However, fault tolerance is built into the LinuxONE server, and redundant parts take over seamlessly without staff intervention. Mean time between failures (MTBF) of the underlying technology is measured in decades.

LINUXONE DEPLOYMENT AT A BANK

A banking enterprise was experiencing 30 percent year-to-year growth in new accounts and also for transactions from different applications, credit cards, core bank accounts, and peripheral accounts. The company faced frequent server upgrades and additions, which led to a sprawling infrastructure. The easiest approach was to keep doing what it had always been doing, but that created a complex environment that required more people and more processes. DR was another growing concern. If a move to DR was needed, could the business do it confidently? Would all data be accessible at the right speed and within the right amount of time?

After learning about the LinuxONE platform, the company contacted IBM for help. The CIO explained that the company needed a platform that could scale to avoid frequent upgrades. Key objectives and issues for the client were

- **Achieving scalability:** The company needed an environment that would scale-up as demand increased.
- **Increased security:** Data protection was one of the key requirements for everything the company did.
- **Reducing database costs:** With the company's existing scale-out strategy, software licenses for the increasing numbers of cores were becoming expensive.

The client decided to use a phased LinuxONE approach. It started small, moving a few workloads at a time and increased capacity over time to minimize costs. Unlike other architectures, LinuxONE growth can happen nondisruptively so moving the workloads was simple. The phase one migration of 20 applications was complete in less than 90 days.

The business was convinced of the technical merits of the LinuxONE solution, but the financial benefits convinced its board. In phase one, the company saw reduced TCO of 40 percent, or \$10 million over five years. The largest savings came from reduced application and database license pricing due to a core reduction of ten times for the workloads.

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The business case also showed that fewer staff members were required, freeing up resources to work on new projects. In the data center, floor space, networking, and cabling were also areas for savings, and those savings were realized in the first year.

Today, the business sees LinuxONE as a future-proof solution. It is prepared for any growth rate and can respond quickly to changing plans. Additional capacity can be added in one day's time. This change has provided significant capital and operations savings for the business.

» **Planning for disaster recovery:** In a traditional scale-out environment with potentially dozens of servers, each server must be replicated in another physical region with constant data mirroring from the active servers to achieve a reliable disaster recovery (DR) plan. DR is easier in a LinuxONE environment because of the greatly reduced numbers of servers and associated infrastructure that must be replicated to handle failovers. In fact, with LinuxONE there may be only one or two physical servers that must be maintained offsite.

- » Introducing LinuxONE's open source background
- » Delivering innovation and agility
- » Recognizing the breadth of software available with LinuxONE
- » Using LinuxONE for software development and DevOps

Chapter 7

The LinuxONE Open Ecosystem

Linux is a dominant operating system in the overall computing landscape for both on premises and cloud environments. The LinuxONE open ecosystem includes the broader set of Linux software developed and used by the Linux community. Although many different Linux distributions exist, the vast majority of Linux software can run on any Linux distribution.

In this chapter, you focus on the LinuxONE ecosystem for partners and customers. You explore how open models foster innovative software and how software stability is maintained in the context of constant innovation. You also see how these traits have attracted innovative developers who are creating new offerings on top of the LinuxONE platform.

Open Source

Linux is an established platform for business. Many software developers build applications and tools on top of Linux because the operating system is open source and ubiquitous. By using the open source model, developers from many different companies

around the world have formed a community to continue the evolution and innovation of Linux. For example, Google's Android operating system, used in many smartphones, is based on a modified version of Linux.

Communities work at their own schedules to build open source code. These experts work in collaboration to innovate whenever they can to produce new features and capabilities. Keeping up with the rapid pace of open source software development needs to be balanced with the enterprise need for reliable and stable software that is fully tested and secured.

This need for production-ready, open source software is why many businesses choose open source software with enterprise support. For example, three enterprise Linux distributions that have been certified and tested to run on the LinuxONE platform are Red Hat Enterprise Linux (RHEL), SUSE Linux Enterprise Server (SLES), and Canonical's Ubuntu LTS. In addition, community versions of Linux are available for LinuxONE, including CentOS, Debian, Fedora, and OpenSUSE. By supporting a variety of Linux distributions, the LinuxONE platform gives customers and developers choice.

The Breadth and Depth of Linux

Linux offers the same operating system features one would expect from other platforms, including everything from productivity tools to web and mail servers. Firewalls and other security features are all standard. Because so many organizations are running Linux, the vast majority of software vendors selling significant business applications release versions that run on Linux.

Further, many open source applications and tools are built on and for Linux. These tools include hypervisors, languages, runtimes, management, and analytics platform. The Linux distributions that are certified for LinuxONE include graphical tools that make it easy for administrators to add various development tools and software.



REMEMBER

Open source software is free (although there may be a charge for support and service), so you can try a variety of tools to see which will work best for your business. In addition, like Linux, many of the open source tools have enterprise versions.

LinuxONE as a Development and Deployment Platform

Like all Linux-focused environments, LinuxONE supports a broad ecosystem of third-party tools and languages. Linux has always offered many tools for developers, and the quantity and quality of these tools have grown over the years.

Today, a developer can install Linux with its development options and have everything needed to code, test, and package software. Linux also includes all the other tools needed to design, develop, and deploy software. Organizations that are creating a DevSecOps process will find a wide variety of tools designed to support their practice. LinuxONE also supports a broad set of enterprise programming languages such as Python, Ruby, C and C++, Go, Swift, Java, and Lisp. Scripting and other interpreted languages are also available, including shells, PHP, perl, awk, and others.

Beyond programming languages and IDEs, LinuxONE supports open source relational databases (PostgreSQL, MySQL, and MariaDB) and NoSQL databases (MongoDB, Cassandra, Redis, Apache Hadoop). Databases such as these are able to take advantage of the scalability and performance of LinuxONE and avoid the need for sharding, as discussed in Chapter 3.

Because of LinuxONE's enterprise architecture, some applications may need to be recompiled for LinuxONE. Other applications, such as those written using interpretive languages (for example, Java or Python), should be able to run on LinuxONE without needing to be ported.

Focusing on development processes, Linux also includes source control systems and bug tracking/issue management software.

Finally, many commercial software products are also available for LinuxONE, including Oracle database, Temenos T24 core banking, IBM Financial Transaction Manager, IBM middleware such as Db2 and WebSphere, and Jira, one of the top tools used for agile product management.

LinuxONE as a DevSecOps Platform

With a critical mass of technologies, such as the ones that we mention in this chapter, it's not surprising that Linux has been a top choice of developers as a base for developing and deploying software. The flexibility of Linux gives organizations the ability to quickly develop new applications and features to keep pace with business.

Many organizations are moving to using a DevSecOps approach. Rather than keeping development, operations, and security separate, DevSecOps combines them into a single practice. Many companies have already developed DevOps practices, and DevSecOps is the next step. DevSecOps begins with a change in culture founded in ongoing learning (to raise security awareness with developers who may already be entrenched in DevOps processes), and the empowerment of security experts to determine the best ways to embed security into applications.



TIP

The benefit of DevSecOps is that you have higher quality, fully tested, and secure code in a faster time period. LinuxONE is a good platform for DevSecOps because security is built into the platform, and development and production systems can safely be run on the same server through workload isolation and container support.

Although DevSecOps is largely about changing your corporate culture and processes, a successful implementation does require technology and tools. Because many independent organizations are creating tools for Linux, you are able to take advantage of best of breed tools and software. DevSecOps depends on the ability to quickly and conveniently create new virtual servers for test and staging areas, deploy test instances with secure containers, and scale up production instances to handle changing loads. These are routine tasks for LinuxONE, making it an ideal platform as part of a DevSecOps practice.

- » Meeting your organization's computing requirements
- » Securing all your data and applications
- » Supporting the LinuxONE platform

Chapter 8

Ten Reasons to Consider LinuxONE

Coming up with the right platform that protects your business and customer data and prepares your company to be competitive can be difficult. You need to consider many issues when making a strategic decision. The LinuxONE platform may be a good choice for the following reasons:

- » **Security everywhere:** Having security at the application layer or at the infrastructure level is no longer enough — you need everything protected holistically at every level of your environment. Avoid human error by having a system that builds security in the foundation.
- » **Scalability:** Your size and the complexity of your workloads are expanding with no end in sight, as you gain new customers and offer new services. These workloads change because of the use of emerging technologies such as containers, microservices, blockchain, and artificial intelligence.
- » **Capacity:** You can't always anticipate how much computing power you need. Make sure to consider, for example, the type of applications you'll be using. Are you going to deploy blockchain in the future? Do you have enough horsepower to design and deploy the type of applications that transform you into a market leader?



REMEMBER

» **Manageability:** The environment must be easy to manage so it's transparent to your customers and also requires minimal staff. The centralized approach of LinuxONE makes it easier to manage than distributed systems.

You can experience performance problems if you have too many systems trying to communicate across the network. Management can be impacted if critical operations are not effectively coordinated.

» **Reduced costs:** Your recurring costs, especially software licenses, increase yearly. Your existing IT infrastructure servers are underutilized and your staff costs are high. If you reduce total cost of ownership to meet budget pressures, you can release funds for new products.

» **Blockchain on premises:** You've run a blockchain proof-of-concept in the IBM Cloud and now want to go into production, but government and industry regulations mean that your data needs to reside locally. You need blockchain on premises, but you want to achieve the same security and scalability you experience in the IBM Cloud.

» **Innovation:** Digital transformation impacts your market, and your competitors seem to be nimble on their feet. You want to innovate and leverage new technologies, including containers, analytics, and artificial intelligence. You need a platform that combines the latest innovation in software with secure and scalable systems of record.

» **Container security:** You're implementing a strategy based on containers because of their flexibility. However, you're worried about the security inherent in this model. How can you ensure that you can move forward in a safe and reliable manner? Secure containers are an imperative element of your strategy.

» **Linux and open source:** Linux is the standard operating system for your company. Because Linux is standards-based, you don't have to retrain your staff. Your organization takes advantage of the rich ecosystem of Linux software, especially open source. You want to protect your investment without compromise.

» **Differentiating your cloud services:** As a service provider, you need a platform that's scalable and secure enough to differentiate your services from competitors. Focus on business innovation, not the underlying platform. Have a deployment model that mirrors your organization's changing needs.

IBM LinuxONE: A secure open platform

To be successful, businesses must select a secure, scalable, and reliable computing platform. At the same time, they also demand openness so development teams can select the stack and technologies that they're skilled in using. The LinuxONE system provides security at every layer of the computing stack, while giving developers the flexibility that they demand. In this book, you discover how the IBM LinuxONE platform can play a critical role in your enterprise computing strategy.

Inside...

- Digitally transform with LinuxONE
- DevSecOps on a secure compute platform
- Deploying a cloud on LinuxONE
- The business case for LinuxONE
- LinuxONE as the blockchain platform



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