IBM Systems

# Building blockchain solutions

## with IBM Storage and IBM LinuxONE

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**Highlights**

- Accelerate blockchain performance, security, and availability with IBM LinuxONE Rockhopper II servers
- Reduce risk and cost with pre-tested and validated IBM Storage solutions blueprints
- Deploy multicloud blockchain solutions that leverage the advantages of on-premises private cloud foundations

## Blockchain solutions using IBM Storage and IBM LinuxONE servers can help lower risk, reduce costs, and increase blockchain performance.

Use existing resources while extending leading-edge functionality across your entire infrastructure with NVMe-enhanced, IBM® Storage solutions powered by IBM Spectrum® Virtualize. Blockchain technologies represent a fundamentally new way to transact business. They may profoundly change the way we organize our economic, social, political, and scientific activities. Blockchain has been described as having "revolutionary potential" to reinvent how entire industry ecosystems operate.[1]

But its presence in the exploding blockchain marketplace goes beyond providing solutions based on the IBM Blockchain Platform itself. IBM is also deeply involved in developing and offering IT infrastructure solutions designed to enable enterprises of all types and sizes to implement individualized blockchains that leverage both your existing data center systems and new technologies, as well as your multicloud architectures.

These new blockchain infrastructure solutions from IBM incorporate many offerings from the IBM Storage portfolio, plus IBM LinuxONE Rockhopper II servers. The end-to-end, pretested, and validated infrastructure solutions provide a number of important benefits, including multiple high-performance storage and server options, reduced deployment times, and increased data and application security. Blockchain solutions, leveraging the combined power and proven capabilities of IBM Storage systems and IBM LinuxONE servers, can help your business more safely and cost-efficiently make blockchain technology your competitive advantage in a security-rich environment.

## Blockchain basics

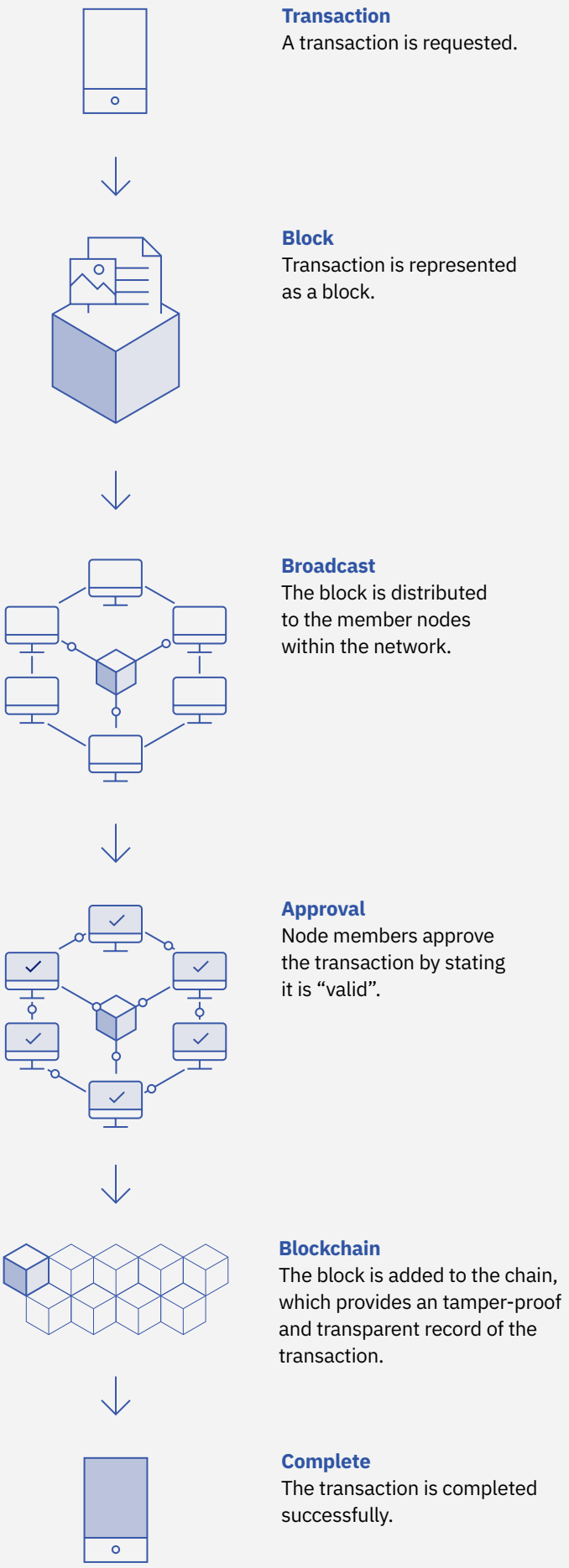
A blockchain is a tamper-proof, shared digital ledger that records transactions in a public or private peer-to-peer network that is often called a “ledger.” Distributed to all participants or member nodes in the network, the ledger permanently records, in blocks of information, the history of asset exchanges that take place between the peers in the network. All the confirmed and validated transaction blocks are linked and chained from the beginning of the chain to the most current block, hence the name blockchain. This architecture makes the blockchain immutable. It thus acts as a single source of truth.

Industry analysts predict that the blockchain market is already growing at an astounding 82 percent and will reach nearly USD 10 billion by 2021.[3] Using blockchain-based ledgers, businesses can save time and costs while reducing risks. Blockchain technologies promise improved transparency among willing participants, new business models and sources of revenue, greater speed and simplicity, and improved trust in record keeping.

But implementing blockchain solutions brings certain challenges. For example, it’s not necessary or appropriate to store all the information related to a particular transaction in the blockchain ledger itself. Instead supporting files and certain types of sensitive information are kept in what is called “off-chain” storage, which can be located on-premises or in the public cloud. Because of the extreme growth rates in these environments and the challenges of coordinating off-chain and on-chain systems, the underlying IT infrastructure supporting blockchain implementations must provide extraordinary security, availability, system performance, and scalability:

- **Security:** Each participant or node in a blockchain implementation must employ effective data encryption and user authentication to ensure the integrity of their contributions to the blockchain.
- **Availability:** Blockchain solutions are only as useful as they are available. To maintain user confidence and value, each node must utilize infrastructure that ensures very high availability.
- **Performance:** As blockchains grow, low-latency high-performance servers, and storage becomes more and more necessary in order to handle the increasing data traffic generated by hundreds, perhaps thousands, of concurrent users accessing transaction records and utilizing smart contracts.
- **Scalability:** Both capacity and performance requirements increase as blockchains naturally grow; therefore, IT infrastructure must be able to scale as needed.

To meet such challenging requirements, many enterprises around the globe are building their new blockchain solutions by leveraging the power and capabilities of IBM Storage and IBM LinuxONE.



## Key members of the IBM Storage and LinuxONE portfolios

**IBM Cloud Private**
- Software-defined infrastructure (SDI)
- Enables on-premises blockchain
- Multicloud blockchain environments

**IBM LinuxONE Rockhopper II**
- Pervasive encryption servers
- High-performance processors
- Nearly unlimited scalability
- Additional security features

**IBM FlashSystem® and IBM Storwize® family**
- Non-Volatile Memory Express (NVMe)-accelerated storage arrays powered by award-winning IBM Spectrum® Virtualize

**IBM Spectrum Scale**
- high-performance data management software
- On-chain and off-chain structured, unstructured, and object data management

**IBM Cloud Object Storage**
- Cost-efficient storage capacity
- Data archiving

**IBM Spectrum Protect Plus**
- Snapshot backup and recovery
- Continuous data synchronization
- IBM Storage integration
- IBM LinuxONE systems integration

IBM Storage solutions are driven by pretested and validated blueprints designed to make deployment of these leading-edge solutions easier, faster, and less risky to implement.

## IBM Storage and IBM LinuxONE solutions for blockchain

IBM Storage solutions are a line of all-in-one offerings recently introduced by IBM Storage. IBM has been rapidly adding new solutions designed to address the most pressing real-world business challenges. IBM Storage solutions are driven by pretested and validated blueprints designed to make deployment of these leading-edge solutions easier, faster, and less risky to implement. They include storage capacity, hardware, software infrastructure, and servers, plus, deployment support, detailed configuration documentation, and best practices advice.

Recently, IBM announced new IBM Storage solutions designed specifically to satisfy blockchain infrastructure requirements. Many of these solutions incorporate LinuxONE Rockhopper II servers. IBM Storage solutions for blockchain incorporate elements from across the IBM Storage and IBM LinuxONE portfolios with pretested blueprints that tie each solution together with a set of instructions defining each component and providing configuration details.

Full stack, multicloud IBM Storage solutions for blockchain contain server and storage options; connectivity to distributed, remote, or IBM Cloud™ platforms; networking components; comprehensive support from IBM and IBM Business Partners; a range of expansion choices; and even various advantageous payment options—but certain members of the IBM Storage and LinuxONE portfolios play key roles:

- **IBM Cloud Private** software-defined infrastructure (SDI) to enable both on-premises and multicloud blockchain environments
- **IBM LinuxONE Rockhopper II** servers with pervasive encryption and many other security features, plus high-performance processors and nearly unlimited scalability
- **IBM FlashSystem® and IBM Storwize® family** Non-Volatile Memory Express (NVMe)-accelerated storage arrays powered by award-winning IBM Spectrum® Virtualize
- **IBM Spectrum Scale** high-performance data management software to manage both on-chain and off-chain structured, unstructured, and object data
- **IBM Cloud Object Storage** that provides essentially unlimited cost-efficient storage capacity and data archiving
- **IBM Spectrum Protect Plus** for backup and recovery via snapshot or continuous data synchronization and deep integration with other IBM Storage and IBM LinuxONE systems

**IBM Cloud Private**

Addressing key factors, such as security-richness, scalability, and flexibility are top considerations when building blockchain solutions. Increasingly organizations are seeking to deploy their blockchains, or components of them, within their own data centers. Well-constructed, on-premises or private cloud environments are becoming attractive because they offer the benefits of a public cloud, including rapid deployment and scalability, plus ease of use and elasticity. Private clouds also offer greater control, increased performance over traditional infrastructure, predictable costs, tighter security, and flexible management options. Perhaps most importantly, private clouds can be customized to your unique needs and security requirements.

IBM Cloud Private offers a leading-edge private cloud platform for developing and running blockchain workloads locally. It is an integrated environment that enables you to design, develop, deploy, and manage on-premises, containerized cloud applications behind your firewall. It can accelerate the work of developers by providing access to valuable data and applications behind the firewall through a flexible container-based architecture and application programming interface (API)-based catalog of services, and includes a private image repository, a management console, and monitoring frameworks.

IBM Cloud Private can enable faster and easier blockchain deployments thanks to its container-based technologies. It includes tools that enable administrators to manage, monitor, and govern their blockchain network servers or nodes across virtually any blockchain architecture. It allows flexible deployment patterns, with options for full blockchain deployment on-premises, or hybrid solution architectures with both local and remote public cloud elements. This deployment flexibility can enable greater blockchain scalability; every member of the blockchain network has choice and control on where to deploy solution elements.

**IBM LinuxONE**

To provide the processing power, security, and scalability required in blockchain implementations, IBM Storage solutions for blockchain can incorporate the IBM LinuxONE Rockhopper II. It's the next evolution of the IBM LinuxONE Rockhopper family, combining pervasive encryption, unprecedented speed, agile scalability, and exceptional cost-efficiency in a single blockchain application host platform.


The 10-core LinuxONE Rockhopper II processor chip leverages the density and efficiency of 14 nm silicon-on-insulator technology to deliver increased performance and capacity for blockchain workloads. Much of that increase results from innovations in the microprocessor design, driven by tight collaboration across hardware, firmware, and software development. These innovations include:

- A redesigned cache architecture with four levels of processor cache. Bigger and faster caches help maximize the throughput of blockchain workloads.
- A new set of instructions in the single instruction, multiple data (SIMD) facility that helps improve the efficiency of complex mathematical models and vector processing for blockchain workloads.
- Optimized simultaneous multithreading (SMT) for superior Linux performance with many new efficiency enhancements.

Security is designed into every LinuxONE server core. Much of the computing time in blockchain operations is taken by cryptographic computations, where both symmetric and asymmetric algorithms are used. Because each server core has hardware accelerated encryption, the LinuxONE Rockhopper II offers a distinct performance advantage.

A blockchain network consists of various independent blockchain members hosted in a multitenant configuration. The first level of security required is the protection of members from each other. Most blockchain solutions implement separation between tenants via software, but IBM LinuxONE takes isolation a step further, enforcing separation through firmware and hardware, delivering one of the highest commercially available security levels. Also, the IBM Rockhopper II introduces pervasive encryption, which provides extensive encryption of data inflight and at rest to substantially simplify and reduce the costs associated with protecting data and meeting compliance requirements.

**170 Processor Engines**

**32 TB of Memory**

**832 Gbps (I/O) Bandwidth**

LinuxONE provides unmatched scale-up capabilities that allow growth of applications with virtually limitless scale. The Emperor II server in the LinuxONE family can handle the most demanding workloads, exploiting up to 170 processor engines, 32 TB of memory, and dedicated system input/output (I/O) bandwidth of 832 GB per second (Gbps) in a single server.

Blockchain applications rely on a shared ledger that allows distributed workloads on multiple nodes, so a node outage may impact the entire network. Because of this, in blockchain implementations it's far more preferable to ensure high availability than to rely on recovery. LinuxONE is the most available servers on the market. Its unmatched design enables:

- Error prevention of through built-in redundancy for all the critical system components
- Exhaustive error detection and correction capabilities that isolate problems
- Non-disruptive installation, upgrades, and maintenance of hardware and firmware
- Automated failover capabilities that speed recovery and minimize system impact.

**IBM FlashSystem and Storwize systems**

Every blockchain implementation must have high-performance, highly scalable, secure, and easily accessible on-chain data storage. Off-chain storage will almost certainly be required as well. IBM Storage solutions for blockchain allow you to leverage your existing storage assets, but you can also incorporate powerful IBM storage systems that can perform as the sole storage solution or easily integrate with existing systems. IBM FlashSystem and Storwize storage arrays can offer powerful and cost-efficient choices for this key role.

IBM FlashSystem and IBM Storwize combine the performance of flash and NVMe with the reliability and innovation of IBM FlashCore® technology, and the rich feature set of IBM Spectrum Virtualize. The systems provide ultra-low latency, industry-leading encryption, and high-availability features, powerful data reduction technologies to lower capacity requirements and storage costs, and easy scalability into the multi-petabyte range. Most importantly for blockchain projects, all these systems leverage the data management, multicloud connectivity, and virtualization capabilities of IBM Spectrum Virtualize software to enable consolidation of both existing and newly deployed storage assets into one storage domain managed from one pane of glass.

**IBM Spectrum Virtualize**

Storage virtualization is a powerful technology that can consolidate and simplify complex blockchain storage environments. It's a proven, award-winning member of the IBM Spectrum Storage™ family of software-defined storage solutions that can extend its wide range of data management features to over 440 heterogeneous systems, creating a single blockchain storage resource for both on-chain and off-chain requirements. With IBM Spectrum Virtualize, existing storage assets, various public cloud resources, and new systems can be added, retired, revitalized with new functionality, or repurposed to meet evolving business and infrastructure objectives. Data can be automatically tiered to optimize performance or cost priorities, transparently moved from system to system, encrypted and replicated—even if this functionality was not native to the original systems—and all designed to be easily managed as a single, highly flexible resource.

**IBM Spectrum Scale**
The majority of the information contained in blockchain implementations will be unstructured data in the form of files, contracts, documents, emails, and even images. The various participants in any particular blockchain solution may be distributed around the globe, but all require immediate, low-latency access to shared data. And data growth will almost certainly be explosive. A complex mix of technologies and products might be integrated through much trial and error into a high-risk but workable solution to these requirements—or you can simply deploy IBM Spectrum Scale.

IBM Spectrum Scale is a full-featured set of file data management tools, including advanced storage virtualization, integrated high availability, automated tiered storage management, and high-performance configurations to effectively manage large quantities of file data. It is designed to support a wide range of application workloads using a variety of access protocols and has been proven extremely effective in large, demanding environments. IBM Spectrum Scale brings powerful solutions to many of the unstructured data challenges found in blockchain implementations.

**IBM Cloud Object Storage**
In most blockchain implementations, the vast majority of data will be supporting information stored off-chain. This will be unstructured data rarely accessed–the perfect use case for cloud-based object storage. IBM Cloud Object Storage provides flexible, cost effective, and scalable cloud storage for unstructured data.

IBM Cloud Object Storage makes it possible to store practically limitless amounts of data, simply and cost effectively. It is commonly used for data archiving and backup, web and mobile applications, and as scalable, persistent storage for analytics. Flexible storage class tiers with a policy based archive let you effectively manage costs while meeting data access needs. Immutable object storage technology helps blockchain participants preserve records and maintain data integrity in a Write-Once-Read-Many (WORM), nonerasable and nonrewritable manner to protect against deletion or modification. And IBM Cloud Object Storage offers unmatched flexibility of deployment-on-premises, hybrid cloud, dedicated cloud, or public cloud.

**IBM Spectrum Protect Plus**
Data protection is a key concern in blockchain environments, especially in off-chain storage systems. As the data centers where off-chain systems reside leverage the latest virtualization technologies, like containers, and shift away from manual tasks and toward automation, simplicity, and agility, IBM Spectrum Protect Plus becomes a key element in the overall data protection strategy. IBM Spectrum Protect Plus takes a modern approach to data protection by focusing on operational recovery and reuse of data rather than being only a backup solution.

IBM Spectrum Protect Plus helps protect virtual environments, specifically VMware ESXi and Microsoft Hyper-V. It also supports file and database recovery, as well as multisite data replication for disaster recovery. IBM Spectrum Protect Plus data copies can be repurposed for multiple data copy use cases, such as provisioning application development and test environments, supporting analytics, and reporting. The software can be up and running in less than an hour compared to some alternatives that may take weeks to deploy and require costly professional services.

## Benefits from a market leader

Blockchain solutions built with IBM Storage and IBM LinuxONE servers offer many benefits to enterprises looking to set up or enhance their blockchain infrastructure. These pre-tested and validated storage solutions help you:

- Improve both on-chain and off-chain data resiliency with enterprise proven NVMe-based IBM FlashSystem 9100 and powerful host-side options, such as new LinuxONE Rockhopper II servers
- Reduce on-chain and off-chain testing and development, and deployment times while improving time to new profits from days to hours
- Increase blockchain security with pervasive encryption and many additional layers of data protection
- Meet and exceed blockchain peer-to-peer network performance requirements with industry-leading processor speeds and up to ten million input/output operations per second (IOPS) and 136 GB per second of NVMe-accelerated on-chain and off-chain storage

Key Solution benefits include:

- **Rapid deployment:** IBM Storage solutions deliver a complete compute to storage stack that is open and flexible to meet your most demanding blockchain requirements. The solutions are ledger fabric-ready and incorporate pre-tested and validated blueprints to simplify and accelerate solution deployment. They are optimized for the entire on-chain and off-chain environment, with NVMe-based technology and services.
- **Hybrid multicloud capabilities:** IBM Storage solutions provide secure access to multiple public cloud services. They are open, Kubernetes-based container platforms.
- **Peace of mind:** IBM Storage solutions provide leading-edge data security from creation to archive. They reduce blockchain infrastructure complexity to help you commercialize a network, unlock new value, and scale up to create competitive advantages. They also lower business risk through the IBM FlashWatch and data reduction guarantee, Controller Upgrade Program, high availability guarantee, and built-in data migration.
- **CapEx to OpEx advantages:** IBM Storage solutions help you move from capital to operational cost models by offering multiple pay-as-you-go options, including the popular IBM Storage Utility Offering.

## Business success

Blockchain is coming. The only question is—how will you take advantage of this remarkable new technology? Will your company be the disruptor by bringing new technologies such as blockchain into the marketplace and thus gaining a competitive advantage? Or will you be one of those disrupted by change?[4] IBM Storage and IBM LinuxONE offer proven infrastructure solutions that lower deployment risks and costs while simplifying operations and expansion. These proven technologies from IBM may offer the advantages and benefits you need to turn a brand-new technology into good old-fashioned business success.



IBM Systems

IBM Corporation
New Orchard Road
Armonk, NY 10504

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