

IBM Blockchain Platform

Build. Operate. Govern. Grow.



Technical Overview

June 2019

Introduction

This paper provides an overview of the capabilities of the IBM Blockchain Platform built around the Linux Foundation's Hyperledger Fabric. The IBM Blockchain Platform provides a managed, full stack blockchain-as-a-service (BaaS) offering delivered in an environment of your choice, including the IBM Cloud, on-premises, and third-party clouds. It allows members to develop, operate, govern and grow a network with the performance and security necessary for even the most demanding use cases in regulated industries.

The IBM Blockchain Platform enables you to create a blockchain network with a few clicks and provides an easy-to-use interface for managing networks, channels, and smart contracts. When you are ready to grow your network, the IBM Blockchain Platform makes it easy to invite new members, create channels, customize governance policies, manage the identity credentials of network participants, and much more. Leveraging Hyperledger Fabric, the IBM Blockchain Platform enables a new kind of distributed business network founded on the principles of finality, trust, and privacy.

1. Data finality matters

When transactions are committed to the ledger they should not be removed or altered. Because Hyperledger Fabric does not fork, information appended to the blockchain will not change. The only way the ledger can be updated is via a new transaction. Since data finality is important, the system leverages a checks and balances protocol that ensures transactions are valid, accurate, and verified. For example, a transaction process includes: initiation by an authorized client, verification and signing by endorsers, inspection and validation of endorser responses, then validation of the transaction by all peers on the network. All of this must perform successfully before a new block can be appended to the blockchain. For enterprise use, distributed ledger technology must be capable of ensuring data is secure, transparent and final.

2. Trust through transparency, not through anonymity

Unlike permission-less networks, the IBM Blockchain Platform is not based on trust through anonymity. Participants to business networks must be known to the network, enabling distributed trust amongst a known business network. Regulatory requirements often dictate certain information on participants and transactions in a network be known. It is also important to note that working in an onymous nature removes the need for mining, and inherently makes transaction processing speeds much faster.

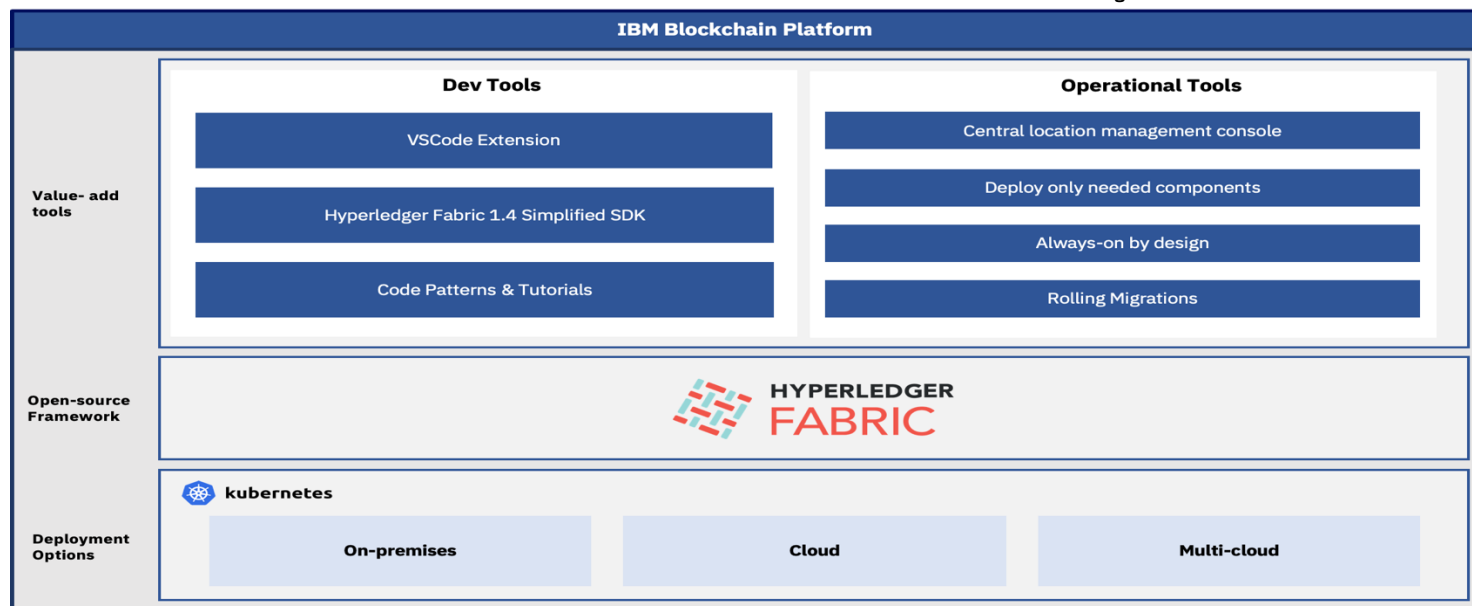
3. Privacy on the network

Businesses require full confidence that both their transaction data and the transactions themselves are confidential. The IBM Blockchain Platform enables privacy via three key mechanisms: channels, private data database, and zero-knowledge proof technologies. Channels are used when information is not desired to be shared with the entire network. The private data database is operated alongside the ledger to store private data that may be referenced, ensuring private information remains private. Lastly, zero-knowledge proof technologies enable a party who possesses private information to prove to another party that the information satisfies a certain set of properties without revealing the information.

Architecture overview

The IBM Blockchain Platform builds on top of key open-source and openly-governed technologies resulting in no vendor lock-in. Utilizing the modularity, performance, privacy and scalability of Hyperledger Fabric, the IBM Blockchain Platform provides the necessary components for developing, operating, governing, and growing enterprise blockchain solutions. Figure 1 outlines the high-level overview of the IBM Blockchain Platform components and capabilities. This captures the experience from hundreds of client engagements to provide a production-ready platform for enterprise blockchain networks.

Figure 1: IBM Blockchain Platform Overview

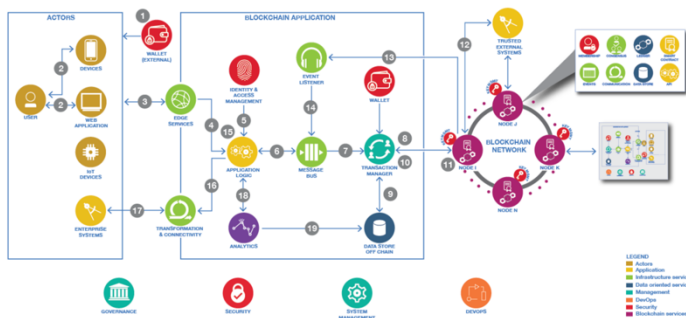


Reference Architecture

The IBM Blockchain Platform is a fully integrated enterprise-ready blockchain platform designed to help you accelerate the development, governance, and operation of a multi-institution business network. It provides a complete set of blockchain software, services, tools and sample code – everything you need to create, test, govern, and manage a working blockchain network, so that you can accelerate creation of blockchain applications in a variety of cloud environments.

With this blockchain reference architecture, you can learn how to design a blockchain application and experience the benefits that blockchain can bring to your enterprise. Record a history of transactions in a shared immutable ledger for transactional applications. Transactions are trusted, accountable, and transparent.

Figure 2: Blockchain Reference Architecture (link for downloadable PDF below)



This blockchain architecture shows how actors such as users and IoT devices interact with a typical blockchain application, which in turn interacts with a blockchain network. Before this flow starts, the blockchain network and governance, including peers, membership services, and endorsement policies, have already been designed, implemented, deployed and in operation.

For the downloadable PDF of the reference architecture diagram above, please go to the following link:
<http://ibm.biz/BlockchainArchitecturePDF>

To view the interactive version of the architecture, please visit our blockchain reference architecture page:
<http://ibm.biz/BlockchainArchitecture>

Hyperledger Fabric

The core open source component of the IBM Blockchain Platform is Hyperledger Fabric. Hyperledger announced the production-ready version of Hyperledger Fabric 1.0 in July of 2017. Hyperledger Fabric v1.0 benefited from the contribution of 159 developers from 28 organizations – built by the enterprise community, for the enterprise community. Hyperledger’s Technical Steering Committee drove community involvement and contribution in line with the needs of enterprise adoption, enabling modularity, scalability, and consensus for production networks. As of May 2019, Hyperledger now consists of over 250 contributing

organizations that continue to advance the capabilities of Fabric, which is currently in version 1.4 LTS.

Hyperledger Fabric provides core features to address specific needs of a permissioned blockchain network with organizational membership from businesses large and small. Hyperledger Fabric is built with modularity throughout the architecture to allow a variety of implementations on cryptography, identity, consensus protocols, smart contract languages and other aspects to be easily interchangeable based on the needs of the consortium. Hyperledger Fabric provides a strong foundation for building decentralized business networks without having to integrate disparate solutions.

Modularity

Blockchain networks must be able to incorporate a wide range of new and existing “pluggable” features depending on the enterprise and industry. As a result, Hyperledger Fabric was developed to be modular in order to support networks as new features emerge.

Modularity in Hyperledger Fabric allows the IBM Blockchain Platform to leverage industry leading security practices to serve production-ready networks, including GDPR and HIPAA best practices.

Scalability

Organizations across sectors demand solutions that scale as they move past initial explorations and proof-of-concepts. Hyperledger Fabric was built to support growing business networks which need to dynamically add participants and support increasing transaction processing. Many aspects of scalability depend on network configuration of consensus, membership, and security. The IBM Blockchain Platform leverages Hyperledger Fabric to provide a modular platform that supports the ability to configure a network to support needed throughput numbers and network growth.

Consensus

An important feature to the security, scalability, and maturity of any blockchain framework is a clearly-defined and implemented consensus protocol. As mentioned above, consensus in Hyperledger Fabric is designed to be pluggable and fit specific enterprise use-cases. Therefore, Fabric allows you to choose the best consensus protocol to fit your specific business networks’ needs.

Hyperledger Fabric’s success to date is driven by the massive amount of community support it has received through Hyperledger. Open governance of the code base with a clear purpose has allowed it to emerge as the industry leading protocol and framework for enterprise production networks.

IBM Blockchain Platform builds on Fabric

Hyperledger Fabric is the premier blockchain framework for enterprise use. There are many benefits, as mentioned above, to working with Fabric; however, Fabric combined with the IBM Blockchain Platform brings the capabilities and value necessary for enterprises to innovate with the security, speed, and scale required in industry today. The IBM Blockchain Platform builds on Fabric by providing a fully managed and supported, full stack blockchain- as-a-service (BaaS) offering delivered with flexible deployment options to meet your business requirements.

The IBM Blockchain Platform, built around Hyperledger Fabric, offers an array of capabilities that expand and enhance the value of Fabric. It allows members to model, create and operate networks with the performance and security necessary for a multitude of use cases in regulated industries. Check out some of the key features below.

- Built on Hyperledger Fabric 1.4 LTS (Open-source)
- Simplified Hyperledger Fabric SDK
- Development and operational dashboards and toolsets
- Visual Studio Code extension for developers
- Add new members/participants in seconds not minutes
- Create secure, private channels with a couple clicks
- Multi-industry use case sample code
- Support for multiple smart contract languages, including: Node.js, Go, Java, Solidity and more
- Rolling migrations of updates with zero network downtime
- Multi-cloud deployment models: IBM Cloud and multi-cloud
- Thriving blockchain marketplace including existing IBM and third-party blockchain solutions
- 24x7x365 support
- And much, much more

Development

The first step in recognizing the value of transactional business networks is enabling developers to materialize innovative business ideas. The IBM Blockchain Platform allows developers to leverage core tools and common languages to model, build, test, and deploy business applications to a distributed business network.

The platform enables developers to

- Ensure alignment across business and technical requirements to significantly reduce blockchain application develop time.
- Quickly build blockchain skills by leveraging popular tools and languages such as JavaScript, Java, Go, and more.
- Flexibly learn and develop in preferred environments with

an open and modern toolset, including VS Code integration and simplified Hyperledger Fabric SDK.

IBM Blockchain Platform developer tools

Since IBM's initial investment in blockchain in 2015, one thing has become really clear: developers need innovative tools to support development, as the demand of enterprise blockchain solutions continues to grow. That's why we've continued to invest in building with platforms developers already use, leverage the open-source, and make tools and education accessible to everyone. The comprehensive blockchain developer tools for the IBM Blockchain Platform include simplified SDKs within Hyperledger Fabric 1.4 LTS, samples that include smart contracts and applications, tutorials to make every step of building applications easy, and a powerful end-to-end extension for Visual Studio Code.

We're excited to have released v1.0.2 version of the IBM Blockchain Platform extension for Visual Studio Code. Since October 2018, we've been building it in the open, regularly delivering new features based on feedback from our developer community. The extension has been downloaded over 23,000 times, and during the last 6 months we've released new features every two weeks. The v1.0.2 release will continue to deliver the most essential tools every blockchain developer needs, along with tutorials and samples to equip developers with blockchain fundamentals.

Introducing the v1.0.2 version of the IBM Blockchain Platform extension for Visual Studio Code

Developers who are new to the IBM Blockchain Platform will find it simple to get started with developing blockchain applications. The extension includes a set of integrated tutorials that guide a developer through developing their first smart contract and deploying that smart contract to a cloud hosted network, as well as samples that demonstrate real world use-cases and best practices.

The extension also provides developers with an extensive set of capabilities that assist them throughout the process of developing their blockchain solutions.

Developers can quickly create new smart contract projects, with best practices around linting and unit testing baked in from the start. Standing up a local Fabric peer for development purposes is as simple as clicking a button, and developers can rapidly package and deploy their smart contracts to this peer. Developers can interactively test their deployed smart contracts by submitting transactions, and they can generate a set of functional tests that can be automated into their CI/CD pipelines. When things go wrong, developers can debug their smart contracts as they would any other application – stepping through the code line by line as transactions are executed. And

when development moves from local to cloud, developers can add gateway connections to any peer, running anywhere with the IBM Blockchain Platform.

Developers can achieve all of that, and more, without ever leaving their IDE.

The extension is built around Hyperledger Fabric 1.4, and any smart contracts and applications that developers build with the extension can be deployed to any Hyperledger Fabric 1.4 network using the standard SDKs and CLIs.

We're continuing to develop the extension, and we aim to publish a new version of the extension every couple of weeks. Developers can view the changelog in the marketplace for information on the latest enhancements – and they'll also get access to our blockchain themed comics!

Grow with us and get in touch

With this investment in the development lifecycle, and the flexibility and control our new version of the IBM Blockchain Platform for production networks, developers can be assured that they have everything they need to be able to build, grow, scale, and receive support with the IBM Blockchain Platform. Developers can start by downloading the extension from the Visual Studio Marketplace for free and begin development with our beginner tutorials. We invite developers to ask question through Stack Overflow and contribute through GitHub.

IBM Blockchain Platform VS Code Extension:

<http://ibm.biz/IBP-VSCode>

IBM Blockchain Platform Stack Overflow Questions:

<http://ibm.biz/BlockchainStackOverflow>

IBM Blockchain VS Code GitHub:

<http://ibm.biz/IBP-VSCode-GitHub>

Operation and Governance

Perhaps the most important feature of decentralized business networks is clear and effective governance definitions, models, and tools. The IBM Blockchain Platform provides key features and dashboards to ensure networks are created with a well-defined model and are governed based on consensus protocols.

Initiating and governing a blockchain network across a group of members once it is operational can take significant amounts of coordination, time and effort. The ability to properly govern a blockchain network is often overlooked and underestimated; however, the IBM Blockchain Platform was built with this in mind, enabling users to easily and seamlessly govern and operate their network.

Proper governance ultimately ensures the network is in compliance, removes uncertainty and risk of your business obligations (embodied within smart contracts), ensures privacy and confidentiality of different classes of transactions (embodied in channels) and affords a vetting process to introduce new members.

Key governance capabilities provided with the IBM Blockchain Platform:

- Democratic management tools allow members of a network to collectively manage the rules and policies governing the decentralized business network
- Dynamic management environment provides the capability to add members to a network as it grows, and new smart contracts become available
- Pre-built tools for faster on-boarding customization and activation

The IBM Blockchain Platform introduces a variety of governing and operating capabilities to maintain and optimize their blockchain networks.

Activation Tools

Decentralized business networks constantly change as new participants and transactions are created. Available activation tools allow members to easily invite new members, set up new smart contracts, and create secure channels within a broader business network.

Policy Editor

Core components of a blockchain network such as endorsement policies, membership policy, smart contracts, and transaction channels must be supported in a flexible and democratic manner. The IBM Blockchain Platform allows permissioned members of a decentralized business network to collaboratively update the policies that govern the network.

Multi-party Workflow Simulation

When taking the first steps to creating a blockchain network or understanding what it is like to participate in a blockchain network, it is a good idea to create a test network to simulate how members and organizations will interact. The IBM Blockchain Platform allows you to create as many Members and Organizations necessary to simulate your business network. This will give you visibility and insight into how parties might interact on the network. You may also invite members within your business network to join, making the simulation even more realistic.

Network Operations

The IBM Blockchain Platform enables network members to initiate, invite, and configure a network with a simple user interface. Founders can then invite additional

members/participants to the network using any number of peers. Participants will receive email notifications of their invite so that they can easily join the network.

Based on agreement from the network members, the configuration enables members to configure core network components such as identity verification and channel creation. This helps to ensure that only permissioned users access the network, and confidential transactions are enabled via channels.

Business Operations

The IBM Blockchain Platform provides a central console (user interface) to support business operations in an active blockchain network. Updates are made with zero network downtime and continuous operations.

Smart contracts represent a core feature of a blockchain network by automating the exchange of information and assets. Users of the IBM Blockchain Platform are easily able to deploy and upgrade smart contracts across the network through a single user interface. Additionally, users are able to edit the policies of a channel which govern consensus. These features ensure business operations are visible, operational, and adaptable for a growing network.

Flexible Deployment

Businesses and business networks require flexibility in deployment models, with options regarding where and how blockchain networks and applications are deployed. In addition to the IBM Cloud (public, dedicated and private), IBM Blockchain Platform can now be deployed on-premises, in a third-party cloud, or multi-cloud.

Deployment Options

To participate as a member in a network each member must operate one or more peers which enables them to transact and represents their copy of the distributed ledger. The IBM Blockchain Platform allows members to manage their peers and other Hyperledger Fabric components by selecting from a variety of deployment options based on the ecosystem's needs for compute performance and isolation:

1. **IBM Blockchain Platform for IBM Cloud:** The next generation of the IBM Blockchain Platform, based on a Kubernetes architecture, includes more control, flexibility, scalability and enhanced developer tools.
2. **IBM Blockchain Platform for Mutlicloud:** Take advantage of the full IBM Blockchain Platform solution behind your firewall in your private cloud or in third-party clouds of your choice.

IBM Blockchain Platform for IBM Cloud

The IBM Blockchain Platform for IBM Cloud is the next generation of IBM Blockchain Platform offerings, giving you total control over your deployments and certificates. This next generation version includes the new IBM Blockchain Platform console, a user interface that can simplify and accelerate the process of deploying components into IBM Cloud Kubernetes Service managed and controlled by you. This newest version of the IBM Blockchain Platform features these key capabilities:

- ***Build your network faster and easier within a seamless experience.*** This includes a smooth integration between smart contract development (VS Code) and network management. Simplified DevOps allows you to move from development to test to production in a single environment. Support for writing smart contracts in JavaScript, Java, and Go languages.
- ***Operate and govern networks with total control.*** Deploy only the blockchain components you need (Peer, Ordering Service, Certificate Authority) and upgrade easily through Kubernetes architecture. Redesigned console lets you manage network components in one place, no matter where they are deployed – maintain complete control of your identities, ledger, and smart contracts.
- ***Grow distributed networks with ease with newly enabled multi-cloud flexibility.*** Connect to nodes running in any environment (on-premises, public, hybrid clouds). Easily connect a single peer to multiple industry networks. Start small, pay as you grow for what you use with no upfront investment.

The IBM Blockchain Platform, deployed on the IBM Cloud, meets the highest FIPS 140-2 Level 4 standard for hardware security modules (HSM).

Additionally, the IBM Blockchain Platform, deployed on the IBM Cloud, is “always-on” by design. It supports network updates while operational and has optimized performance on the world's fastest Linux compute. Each of these features are backed by IBM's deep Hyperledger Fabric expertise and 24x7x365 coverage for technical blockchain support.

Specific tools and capabilities are included in the environment to make network operation easier and more secure. These include:

- Monitoring and management of resources on the network
- Lifecycle management for seamless upgrades of the full code stack without pausing the network
- Hardened security stack with no privileged access, malware and tamper resistance
- 100% disk encryption and HSM key protection

With IBM Blockchain Platform for IBM Cloud, you can even manage your other Fabric components with the console, regardless of where they are deployed. This next generation of the platform represents a truly open, interoperable, and anywhere blockchain platform.

IBM Blockchain Platform for Multicloud

Many organizations have data residency requirements that require some workloads to run in their datacenters or private clouds, behind their firewall or in third-party clouds. In many use cases, blockchain deployments will be no exception. Therefore, IBM has introduced IBM Blockchain Platform for Multicloud, enabling you to deploy in the environment that meets your requirements. The IBM Blockchain Platform for Multicloud makes it easy to manage costs, security and data sovereignty in ways that work for you.

IBM Blockchain Platform for Multicloud includes an application platform for developing and managing on-premises, containerized applications. It includes Kubernetes container orchestrator, a private image repository, a management console, and monitoring frameworks.

This offering is ideal for network members/participants who:

- Want to keep a copy of the ledger on their own infrastructure for security and/or risk mitigation reasons
- Want to run workloads on their own infrastructure due to preference and/or compliance
- Have data privacy requirements that require them to store data on their own environment
- Need the ability to deploy blockchain components in multiple clouds to meet consortium needs

Decentralization is a core principle of blockchain technology, and it continues to drive blockchain adoption. Combine this with infrastructure preferences becoming more diverse, and we see a clear demand for blockchain platforms that enable network participants to deploy network components in the infrastructure compute environment of their choice. Within the notion that blockchain is a *peer-to-peer network* the IBM Blockchain Platform with flexible deployment options is IBM's first step in this direction.

Conclusion

The past year has seen an incredible amount of blockchain innovation from a diverse range of organizations. This innovation has been fostered by open-source organizations bringing together institutions and developers to make blockchain ready for enterprise. The IBM Blockchain Platform represents the next step in this innovation by enabling production networks to be developed and operated through an easy to use interface built on an enterprise-ready protocol. It is easy to get started building your use-case, application, or network today using the IBM Blockchain Platform. What will we solve together? Let's find out.

For more information: <https://ibm.com/blockchain/platform>

For developers to get started:

<https://www.ibm.com/cloud/blockchain-platform/developer>

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