HYPERLEDGER FOUNDATION

An Overview of Hyperledger Foundation

Purpose of This Paper

This paper provides a high-level overview of Hyperledger as an organization, including why it exists, what it does, and who is involved. Next it covers Hyperledger technologies and their impact on existing and new markets. Finally, this paper looks at the roadmap to widespread adoption of Hyperledger platforms, tools, and libraries to power a new generation of multiparty systems.

This is not intended as a deep technical white paper, but an introduction to Hyperledger for a general business reader.

Intended Audience

We expect this paper will be read by people from different backgrounds, including entrepreneurs, executives, IT managers, and software developers. Since Hyperledger is a worldwide project, we expect this paper will be read by people around the world, many of whom do not have English as their first language, so we have tried to make this paper as clear and readable as possible.

ABOUT HYPERLEDGER FOUNDATION

Hyperledger Foundation was founded in 2015 to bring transparency and efficiency to the enterprise market by fostering a thriving ecosystem around open source blockchain software technologies. As a project of the Linux Foundation, Hyperledger Foundation coordinates a community of member and non-member organizations, individual contributors, and software developers building enterprise-grade platforms, libraries, tools, and solutions for multiparty systems using blockchain, distributed ledger, and related technologies. Organizations join Hyperledger Foundation to demonstrate technical leadership, collaborate and network with others, and raise awareness around their efforts in the enterprise blockchain community. Members include industry-leading organizations in finance, banking, healthcare, supply chains, manufacturing, technology and beyond. All Hyperledger code is built publicly and available under the Apache license. To learn more, visit hyperledger.org

V1 published October 2021.

Acknowledgments

Hyperledger Foundation would like to thank the members of the Whitepaper and Greenhouse Graphic Update Taskforce (Anthony Lusard, Arnaud Le Hors, Arun SM, Bobbi Muscara, Csilla Zsigri, David Bowswell, Hart Montgomery, Helen Garneau, Tracy Kuhrt and Travin Keith) for contributing to this paper.

1 Executive Summary

Blockchains and their underlying distributed ledger technologies (DLTs) change the way business is conducted.

All businesses participating in a commercial ecosystem need a ledger to record transactions. Any business network that records transactions—and does not want to depend on a central proxy that everyone must trust—can be remade through blockchain technology.

DLTs can be used to record promises, trades, transactions, or any items we never want to disappear. Mirrored exactly across all nodes in a given network, the distributed ledger gives everyone in an ecosystem an identical copy of the common system of record.

When used as an enterprise software solution, blockchain enables trust where it did not exist and removes layers of inefficiency. And when built as open source software, blockchain serves as a common and open platform that enterprises can build collectively and use confidently as shared infrastructure for multiparty systems.

The Hyperledger Foundation exists to foster community development of enterprise-grade open source blockchain, distributed ledger, and related technologies, and to drive broad adoption of these technologies. It hosts a wide array of software projects and the communities that develop and deploy them.

Hyperledger technologies are transforming a wide range of existing markets and driving a growing list of new business models in emerging markets. According to **research** from Blockdata, Hyperledger technologies are used by more of the top 100 public companies in the world than any other blockchain platform.

2 Hyperledger Foundation Basics

This section provides a high-level overview of the Hyperledger Foundation, including why it exists, what it does, and who is involved.

2.1 Why Hyperledger Foundation Exists

The **Hyperledger Foundation** is the open, global ecosystem for enterprise blockchain technologies. As part of the Linux Foundation, it is a neutral home for developers to collaborate, contribute, and maintain open source software.

Hyperledger was founded in 2015 to bring the transparency and efficiency of DLT technologies to the enterprise market, leveraging the well-proven open source software model. The high-level aim is to enable solutions that connect industries, organizations, and even individuals more directly, recreating how information is shared and business is conducted.

The Hyperledger Foundation hosts a number of open source software projects that serve as the building blocks for enterprise blockchain deployments. These projects are conceived and built by the Hyperledger developer community as freely available, enterprise-grade software that vendors, end user organizations, service providers, start-ups, academics, and others can use to build and deploy blockchain networks and even commercial solutions.

Because they are developed and governed as open source technologies, Hyperledger projects are all community led. This means that the code is written collaboratively and available for review and use by anyone. Decisions about development roadmaps and priorities are made openly and cooperatively.

Open source software development is a transparent process, which is particularly fitting for blockchain technologies. It brings together organizations and individuals with different requirements and drives them to work together to develop common solutions that can be the foundation for mutual success—another good parallel with blockchain.

The role of Hyperledger Foundation is to ensure the health and transparency of the community and all its projects, including managing the development cycle, software licensing, security audits, and provenance tracking for every line of code.

In short, Hyperledger Foundation provides the backbone of services that open source projects require to ensure community growth. This increases the willingness of enterprise software companies, start-ups, and independent developers to commit resources to open source projects.

The Hyperledger staff is part of the larger Linux Foundation team that has years of experience in providing program management services for open source projects.

2.2 What Hyperledger Does

Distributed ledger technologies enable decentralized, transparent networks that require no central authority to validate data. In these networks, transactions are authenticated and recorded as a series of encrypted blocks, or a blockchain, creating a live, open, and immutable audit trail.

The first application of blockchain was Bitcoin, which used the decentralized architecture and immutable records of the technology to introduce cryptocurrencies to the world. Blockchain technology and digital currencies have been linked together in the public imagination ever since.

But there is a difference. Cryptocurrencies like Bitcoin and Ethereum enable transactions on large-scale, public networks with permissionless models. There are no limits on who can buy, sell, trade, and transact over the network. Anyone can see the whole history of what has transpired as it is written, block by block. Users operate freely and quite often anonymously.

Yet cryptocurrencies are not the only use case for blockchain.

The Hyperledger Foundation is focused on consortium networks that link a group of stakeholders to streamline critical, often proprietary business processes and transactions. There is no one Hyperledger blockchain network. Instead, businesses, consortia, and other organizations deploy Hyperledger technologies to build networks that support their needs.

With this approach, these networks, or multiparty systems, are modular and flexible enough to support different industries and use cases. The diverse and growing Hyperledger ecosystem means enterprises can mix and match technologies to balance privacy and performance; create permissioned, permissionless, or hybrid networks; integrate with legacy systems; or even tap into a cryptocurrency "mainnet."

The Hyperledger Foundation does not sell any of these technologies as products or services. Hyperledger projects are vendor neutral, meaning that they can be deployed in products and solutions by any company, anywhere in the world.

As a result, Hyperledger technologies are used in everything from powering global trade networks and supply chains to fighting counterfeit drugs, banking "unbanked" populations, and ensuring sustainable manufacturing.

Hyperledger-based networks are used by some of the largest corporations around the world, including more than half of the companies on the **Forbes Blockchain 50**, a list of companies with revenue or a valuation of at least $1 billion that lead in employing distributed ledger technology.

2.3 Who Is Involved

The Hyperledger Foundation is a member-driven, not-for-profit organization. **Industry-leading organizations** join Hyperledger to help build and shape the ecosystem for blockchain technologies, use cases, and applications. Member organizations help set the agenda for Hyperledger, with many serving in governance roles for the community. They also have access to a range of resources and services that help them plan, develop, deploy, and even market Hyperledger-based solutions.

Membership is not a requirement to use, build a business upon, contribute, or even lead development of Hyperledger technologies. The community is filled with active contributors from both member and non-member organizations.

The developer community is governed by the **Technical Steering Committee**, which approves projects and guides them through their development lifecycle. Individual projects each have their own communities, with maintainers serving in the leadership roles.

There are also various **Special Interest and Working Groups** that take on work relating to specific industries or technical challenges.

Hyperledger has a truly global community with hundreds of **Meetup groups** hosting events across numerous countries. There are also many **regional chapters** that facilitate collaboration among people in their local languages and geographies.

3 Hyperledger Technologies and Their Impact

This section covers the benefits of Hyperledger technologies for enterprises, provides an overview of Hyperledger projects, describes three markets Hyperledger is already transforming (supply chain, trade and finance, and healthcare) and lists emerging markets and business models where Hyperledger is making an impact.

3.1 Why Enterprise Blockchain? Why Hyperledger?

Blockchain solves a core problem: Many organizations want to share data in a distributed database, but no single owner will be trusted by every user. Blockchain technologies enable direct transactions in a secure, transparent way, baking trust into systems that operate with the efficiency of a peer-to-peer network.

For enterprises, adopting this technology requires a fundamental change in how they conduct business. It is the pathway to digitizing a range of processes and industries.

However, as the Hyperledger community has proven, enterprise blockchain is a team sport. The technologies are building blocks for core, cross-industry systems that will continue to scale in size, complexity, effectiveness, and value. Because Hyperledger technologies are open source code bases built with collaborative design and governance, enterprises embrace them as trusted infrastructure for building blockchain solutions.

In just a few years, the first wave of enterprises adopting Hyperledger technologies moved from early-stage testing to proofs of concept to production systems. These deployments confirmed that strategically developed and implemented blockchain delivers unprecedented gains in speed, security, and transparency.

And now the race is on to put this technology to work. Concerns about public health, climate change, social justice, misinformation, privacy, and other issues are fueling the urgency for multiparty systems that increase trust, boost efficiency, and ensure authenticity. All this is accelerating adoption of enterprise blockchain technologies.

According to PwC's "**Time for Trust**" report, most businesses will be using blockchain by 2025, and the technology is on track to deliver US $1.76 trillion to the global economy by 2030. The economists at PwC predict the use cases with the potential to yield the most economic value are payments, provenance, identity, contract and dispute resolution, and customer engagement.

3.2 Hyperledger Technologies

The Hyperledger Foundation hosts a wide array of community-led, open source projects that are all freely available under the Apache 2.0 license. These projects fall into a number of categories, including:

- **Distributed Ledgers -** A distributed ledger is a multiparty database with no central trusted authority. When transactions are processed in blocks according to the ordering of a blockchain, the result is a distributed ledger. Hyperledger hosts a variety of **distributed ledger technologies** (DLTs) or platforms that serve as the foundation for blockchain networks across a range of industries and use cases.
- **Libraries - Hyperledger libraries** are tested and proven code bases that can be deployed easily to address core requirements or add key functionality for a variety of enterprise blockchain use cases. Hyperledger libraries include toolkits for digital credentials, smart contracts, and cryptographic code.
- **Tools - Hyperledger tools** improve the implementation of enterprise blockchains. They give those deploying Hyperledger—and, in some cases, other DLTs—an edge when tackling complex challenges such as interoperability, performance, and security.
- **Labs -** Dozens of other technologies are being nurtured in the **Hyperledger Labs**. While a full project goes through a formal review and acceptance process with the Technical Steering Committee (TSC), a code base can become a Hyperledger Lab through a simple request to one of the lab stewards. The aim of Hyperledger Labs is to encourage more developers to get involved in the community and to experiment with the technologies.

The mix of Hyperledger projects reflects the different approaches and challenges to building enterprise blockchains and the priorities of those looking to build or reshape different markets with the technology. Because they are community developed, Hyperledger projects create a **landscape** of technologies that are open, trusted, and at work in a fast-growing list of production blockchain networks.

3.3 Hyperledger in Action

As an ever-growing **library of case studies shows**, Hyperledger technologies are already transforming a number of market spaces. As shown in the following table, these include supply chains, trade finance, and healthcare.

MARKET	SUPPLY CHAINS	TRADE FINANCE	HEALTHCARE
KEY HYPERLEDGER PROJECTS	Hyperledger Fabric Hyperledger Sawtooth Hyperledger Grid	Hyperledger Fabric Hyperledger Indy	Hyperledger Fabric Hyperledger Indy Hyperledger Aries
CHALLENGE	Supply chains are the driving force for industries around the world. For products to reach their markets, they flow from farms, mines, forests, and factories through a network of manufacturers, suppliers, shippers, and distributors. Often the journey starts with raw materials or components that are assembled along the route. Multiple parties are each tasked with a segment of a product's journey but all have a stake in its successful delivery.	Auditability and efficiency are vital in the financial market, especially for enabling backend transactions to keep commerce and trade flowing. Institutions are looking to digitize lending and other services to lower operational costs, reduce fraud, cut settlement times, support new asset classes, and streamline cross-border payments.	Technology is a cornerstone of today's complex healthcare market. Despite the increasingly digital infrastructure designed to link providers, payers, patients, and public health officials, gaps remain in how critical data is captured, secured, and shared.
HYPERLEDGER'S IMPACT	Hyperledger technologies are being used to create shared, secure audit trails in a range of supply chain deployments and networks. These solutions make it possible to track and trace products and components in near real-time as they make their way from party to party in the supply chain. Companies such as Walmart, Daimler and Telefonica use Hyperledger in networks focused on traceability for applications such as: • ensuring safe handling of food and other perishables • improving responses for recalls • proving the authenticity of products ranging from diamonds and wine to prescription medicines • documenting sustainable, ethical, and organic sourcing of materials • streamlining shipping-related dispute resolutions and invoicing Find out more from the **Hyperledger Supply Chain Special Interest Group**.	Hyperledger technologies are playing an increasing role in digital trade, supporting new cross-industry networks that reduce reliance on central authorities to authenticate transactions. Hyperledger software is powering critical platforms that ensure: • banks and other trading partners can work cooperatively on a common network that is secure and seamless • transactions are recorded in a fully transparent audit trail open to all approved participants in the network • trading partners can share key documents in public or private channels with smart contracts to trigger trades and other notifications • lenders have a faster and more transparent way to assess risk, which increases the availability of capital for small and medium enterprises Find out more from the **Hyperledger Trade Finance Special Interest Group**.	Hyperledger technologies have been put to work by government agencies, insurance groups, hospitals, and pharmaceutical companies in many ways, including: • managing new challenges relating to COVID-19 testing and credentials • increasing the efficiency of critical, data-intensive workflows like clinical trials or insurance claims • supporting new models that make it easier for patients to access and share critical healthcare information without sacrificing privacy • increasing efficiencies in records management and billing to create a better patient experience Find out more from the **Hyperledger Healthcare Special Interest Group**.

3.4 New Markets and Business Models

In addition, Hyperledger technologies are being applied to a number of new markets and business models. As shown in the following table, these include digital identity; digital payments and Central Bank Digital Currencies (CBDCs); and decentralized finance (DeFi), non-fungible tokens (NFTs) and other new asset classes.

MARKET	DIGITAL IDENTITY	DIGITAL PAYMENTS AND CBDCS	DEFI, NFTS, AND OTHER NEW ASSET CLASSES
KEY HYPERLEDGER PROJECTS	Hyperledger Indy Hyperledger Aries Hyperledger Ursa	Hyperledger Besu Hyperledger Fabric Hyperledger Iroha	Hyperledger Besu Hyperledger Sawtooth Hyperledger Cactus
OPPORTUNITY	People often need to verify their status, whether to prove a birthdate, board a plane, comply with vaccine mandates, prove their education, or access money. Reshaping how digital information is managed and verified can increase online trust and privacy. Digital identity can create verified credentials that are effective, secure, accessible, and privacy preserving.	Blockchain technology has already helped rewrite some of the rules for currencies and payments. **Governments around the world are now moving towards Central Bank Digital Currencies** (CBDCs) or digital forms of their official currency. These will give central banks a more flexible, more secure form of their national currencies and lower the risks from alternative cryptocurrencies. Backed by a central bank, any CBDC, whether developed for wholesale or retail use, will be legal tender with the stability and regulation that confers.	Decentralized transactions open the door to many new financial models and token-based assets. Adding smart contracts paired with assets to define rules and trigger actions creates more opportunity to automate transactions. DeFI, or decentralized finance, covers a host of financial products and services that bypass traditional intermediaries. These include cryptoassets that use blockchain technologies, tokens, digital wallets, and smart contracts to enable trade, investing, payments, and more. Non-Fungible Tokens (NFTs) are digital versions of real-world assets stored and exchanged using blockchains. The blockchain creates proof of ownership and authenticity of the asset, making trades and transactions easier.
HYPERLEDGER'S IMPACT	Hyperledger technologies are being adopted to put individuals in charge of their own identity. The goal is never to put personal information into the public domain, but to create a model where banks, universities, healthcare providers, or government agencies generate a digital certificate of a person's status. The person can present that as needed, with the authenticity of the credential verified using a blockchain.	Governments are moving carefully, but many of the early projects are using Hyperledger platforms. The goals range from modernizing payment processes to removing barriers and costs associated with back-end settlements to boosting financial inclusion.	Much of the consumer-facing DeFi, NFTs, and other token-based financial activity is hosted on the Ethereum public network. This makes the crossover between public and private blockchains important. Hyperledger technologies play a key role in bridging crypto and fiat currencies, making it possible to build decentralized businesses without the volatility of crypto markets. For businesses looking to minimize the environmental cost of their products and services, Hyperledger platforms can be energy-efficient alternatives to Ethereum or other crypto-backed networks.

4 The Roadmap to Widespread Adoption

This section describes the key developments required to support widespread adoption of blockchain technologies. These developments fall into three areas:

- Growing the Hyperledger technology landscape
- Growing the deployment ecosystem
- Growing the Hyperledger community

The enterprise blockchain space is still in its early days. Like the internet, this space will take years to fully mature and become commonplace in our everyday lives.

To drive widespread adoption of enterprise blockchain, Hyperledger Foundation must fuel the development of both the technology and ecosystem of developers, service providers, and users. To support these efforts, the foundation must also foster a growing, global Hyperledger community that is engaged and committed to advancing the development and deployment of the technology.

4.1 Growing the Hyperledger Technology Landscape

The Hyperledger landscape is always changing. Existing projects continue to develop and evolve through community efforts. And new technologies are constantly in the works. Incoming projects are often brought to Hyperledger Labs, the innovation pipeline for the foundation.

The work ahead must ensure that all Hyperledger technologies are built with modularity and interoperability in mind. One important key to accelerating deployments will be open, flexible ledgers, tools, and libraries that can work across a mix of platforms and systems. This will help enterprises to decentralize critical processes and create transparent operations across and between organizations.

4.2 Growing the Deployment Ecosystem

Enterprises need certain resources to help them deploy Hyperledger technologies. The barrier for many organizations is finding people with the expertise to build and manage their solutions.

The **Hyperledger Certified Service Provider** (HCSP) program serves to fill this need with a growing list of pre-qualified, vetted service providers that have deep experience helping enterprises successfully adopt Hyperledger. Hyperledger also maintains an extensive directory of **vendors**, including all the major cloud providers, that provide Blockchain as a Service and offer implementation support. Additionally, Linux Foundation Training offers a robust **Hyperledger training and certification program**.

The active Hyperledger Special Interest Groups (SIGs) are also helping enterprises get up the adoption curve more quickly. They focus on solving specific industry or cross-industry challenges using Hyperledger technologies in segments from accounting to climate action and industries from healthcare to telecom. These SIGs will be increasingly instrumental in identifying new markets and building new business models for blockchain technologies, and in shaping the technical roadmap to support these opportunities.

4.3 Growing the Hyperledger Community

The accelerating growth in the size and range of Hyperledger deployments creates a nearly insatiable need to grow the community. The pace will increase with the growing urgency to digitize key processes and transactions and tackle issues such as climate change, over-stressed supply chains, and new public health requirements.

But this urgency can spark engagement for an open source organization. The trick will be to sideline no resource.

For the Hyperledger Foundation, that means embracing diversity in every sense of the word.

While there is always more work to be done, **Diversity, Civility and Inclusion (DCI)** is a key area of focus for growing and maintaining the community.

With a worldwide calendar of meetups, a growing network of regional chapters, and ongoing translation efforts, Hyperledger Foundation is **engaging international communities on the local level**. However, scaling this effort will be key as the energy and innovation of a global community will drive the Hyperledger technology and ecosystem forward.

5 Conclusion

This paper only scratches the surface of the ways in which blockchain, and especially Hyperledger technologies, will drive change for organizations and industries around the world. As with other foundational technologies, the applications for blockchain and related technologies will continue to expand with time.

By fostering a thriving ecosystem around open source blockchain software development, the Hyperledger Foundation is fueling the creation, adoption, and long-term stability of a portfolio of enterprise technologies and the solutions they power.

Join us. All are welcome!