NATIONAL INSTITUTE OF TRANSPORT

Blockchain Technology Short Training

Introduction to Hyperledger Fabric

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Introduction to Hyperledger | Overview

- The Hyperledger
- Hyperledger frameworks, libraries and tools
  - Frameworks (Besu, ~~Burrow~~, Fabric, Indy, Iroha, Sawtooth, Grid)
  - Libraries (Aries, ~~Quilt~~, Transact, Ursa, AnonCreds)
  - Tools (~~Avalon~~, Caliper, Cello, ~~Explorer~~, Bevel, FireFly, Solang)
- Principles of Hyperledger Fabric design

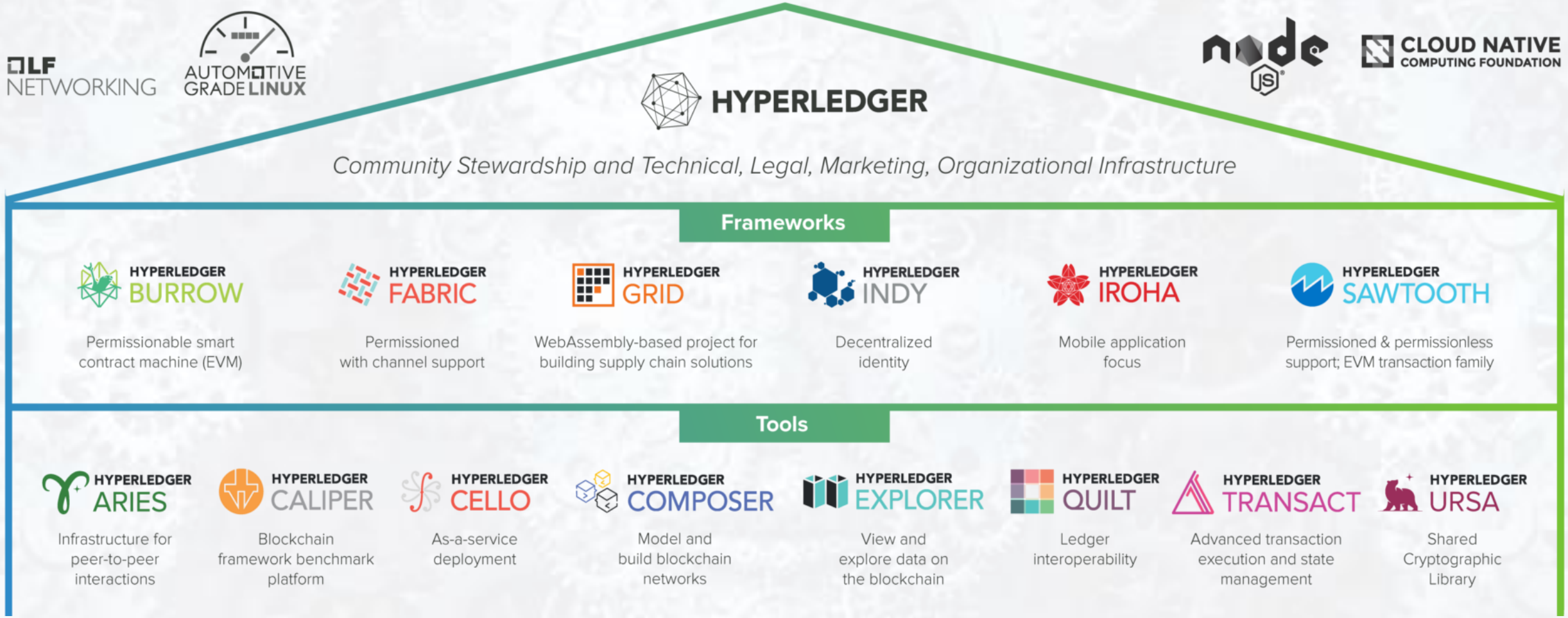
Hyperledger | Definition

- **Hyperledger** is an umbrella project of open-source blockchain technologies hosted by the Linux Foundation.

- It was launched in 2015 to advance cross-industry blockchain technologies and provide a collaborative space for building enterprise-grade blockchain frameworks and applications.

- Hyperledger consists of a collection of blockchain frameworks, libraries, and tools, each with different use cases.

Hyperledger

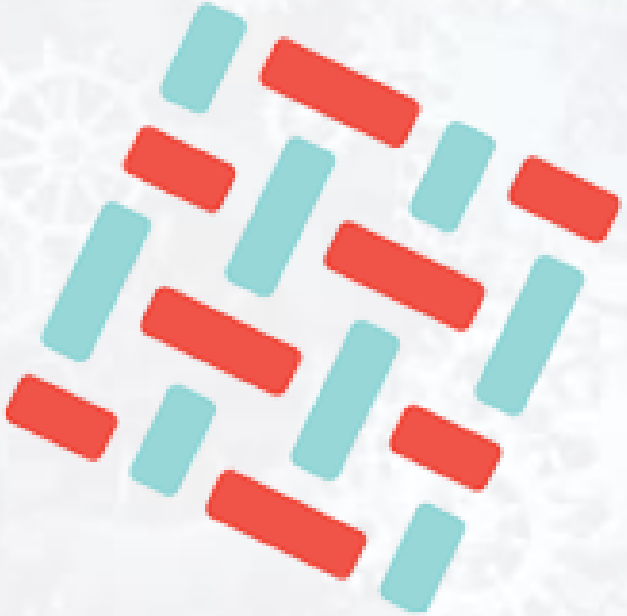


Hyperledger - Frameworks | Definition

- Hyperledger frameworks are open-source projects that aim to create enterprise-grade blockchain solutions for various industries. Each Hyperledger framework has its own unique features and is designed to address specific business requirements.
- The frameworks include Hyperledger Fabric, Besu, Burrow, Indy, Iroha, Sawtooth, and Grid.
- They provide high scalability, interoperability, security, and privacy, and support various consensus mechanisms, programming languages, and use cases.

Hyperledger - Frameworks | Hyperledger Fabric

- Hyperledger Fabric is a modular, general-purpose blockchain platform that supports various consensus mechanisms and allows for the creation of consortium networks.
- It is designed to be highly scalable, permissioned, and flexible, making it suitable for enterprise blockchain solutions.
- Fabric supports smart contracts written in Go, Java, and other languages and provides privacy features such as private channels, which allow for secure communication between specific parties on the network.



Hyperledger - Frameworks | Hyperledger Besu

- Hyperledger Besu is a Java-based Ethereum client that supports the Ethereum Virtual Machine (EVM) and various consensus mechanisms, including Proof of Work (PoW), Proof of Authority (PoA), and Istanbul Byzantine Fault Tolerance (IBFT).
- It is a lightweight client that can be easily integrated with other Hyperledger projects and supports privacy features such as private transactions and private contracts.
- Besu also supports web3 JSON-RPC API, which allows developers to use familiar Ethereum tools to interact with the Besu network.

Hyperledger - Frameworks | ~~Hyperledger Burrow~~

- Hyperledger Burrow is a smart-contract blockchain implementation that supports Solidity, Ethereum Virtual Machine (EVM), and WebAssembly (WASM).
- It is designed to be modular, scalable, and efficient and supports both permissioned and permissionless blockchain networks.
- Burrow also supports various consensus mechanisms, including Proof of Work (PoW), Tendermint, and Byzantine Fault Tolerance (BFT).

Hyperledger - Frameworks | Hyperledger Indy

- Hyperledger Indy is a decentralized identity management platform designed for self-sovereign identity.
- It is a permissioned network that allows individuals to create and manage their digital identities independently of any central authority.
- Indy supports the creation of verifiable claims, which allow users to prove their identity without revealing any unnecessary personal information.

Hyperledger - Frameworks | Hyperledger Iroha

- Hyperledger Iroha is a platform for developing blockchain-based solutions for digital identity management and asset transfer.
- It is designed to be simple, easy to use, and scalable, making it suitable for both small-scale and large-scale projects.
- Iroha supports a variety of consensus mechanisms, including Byzantine Fault Tolerance (BFT) and YAC (Yet Another Consensus).

Hyperledger - Frameworks | Hyperledger Sawtooth

- Hyperledger Sawtooth is a modular platform for building, deploying, and running distributed ledgers.
- It is designed to be flexible and scalable and supports both permissioned and permissionless networks.
- Sawtooth supports a variety of consensus mechanisms, including Proof of Work (PoW), Proof of Stake (PoS), and Practical Byzantine Fault Tolerance (PBFT).
- Sawtooth also supports smart contracts written in Rust, Python, and other languages.

Hyperledger - Frameworks | Hyperledger Grid

- Hyperledger Grid is a set of tools and libraries for building supply chain solutions on top of Hyperledger Fabric.
- It provides a set of pre-built components for common supply chain use cases, including asset tracking, provenance, and trade finance.
- Grid allows developers to build customized solutions for their specific supply chain needs and integrates with other Hyperledger frameworks for enhanced functionality.

Hyperledger – Libraries | Definition

- Hyperledger Libraries are a set of reusable code components that provide foundational capabilities for developing distributed ledger applications.
- These libraries are designed to help developers quickly build and deploy blockchain-based solutions by providing standardized building blocks that can be easily integrated into their applications.
- The libraries include components such as cryptographic libraries, smart contract libraries, and consensus algorithms.
- Hyperledger Fabric, a popular blockchain platform, uses these libraries as its foundation.

Hyperledger - Libraries | Hyperledger Aries

- Hyperledger Aries is a toolkit for building blockchain-based identity solutions. It provides a set of tools and libraries that enable developers to create, exchange, and verify digital identities on a decentralized network.
- Aries uses a decentralized public key infrastructure (PKI) to create verifiable credentials and allows users to control their own identity data.
- Aries is interoperable with other Hyperledger projects, including Hyperledger Fabric and Hyperledger Indy, and can be used to build a wide range of applications, including digital wallets, authentication systems, and supply chain tracking solutions.

Hyperledger - Libraries | ~~Hyperledger Quilt~~

- Hyperledger Quilt is a Java implementation of the Interledger protocol (ILP), which is a protocol for sending payments across different ledgers. It allows users to make cross-ledger transactions, such as sending payments between different blockchain networks or between a blockchain network and a traditional payment system.
- Quilt provides a set of libraries that implement the ILP and enable developers to build applications that can interact with different payment networks.
- Quilt supports a variety of payment protocols, including Bitcoin, Ethereum, and Ripple.

Hyperledger - Libraries | Hyperledger Transact

- Hyperledger Transact is a platform-agnostic transaction execution platform that supports various blockchain frameworks. It provides a standard interface for executing smart contracts and supports multiple programming languages, including Python, Rust, and JavaScript.
- Transact allows developers to write smart contracts once and deploy them on different blockchain networks.
- It also provides a pluggable architecture that enables developers to customize the execution environment for their specific use case.

Hyperledger - Libraries | Hyperledger Ursa

- Hyperledger Ursa is a cryptographic library that supports the implementation of various cryptographic algorithms. It provides a set of reusable cryptographic components that can be used by other Hyperledger projects, such as Fabric and Indy.
- Ursa includes implementations of commonly used algorithms, such as digital signatures, hash functions, and symmetric encryption.
- By providing a standardized set of cryptographic primitives, Ursa helps to ensure the security and interoperability of different Hyperledger projects.

Hyperledger - Libraries | Hyperledger AnonCreds

- Hyperledger AnonCreds provides a set of protocols, libraries, and toolkits for creating and verifying anonymous credentials on distributed ledgers. It enables users to share credentials without revealing their real identity or any personally identifiable information.
- The AnonCreds protocol uses zero-knowledge proofs to allow the verification of credentials without revealing any sensitive information.
- It is designed to integrate with frameworks, such as Hyperledger Fabric and Indy, to manage digital identities and privacy on distributed ledgers.

Hyperledger – Tools | Definition

- Hyperledger Tools are a set of software applications that help developers and users manage and interact with blockchain networks built using Hyperledger technologies.
- These tools include blockchain explorers, network management tools, and development frameworks.
- Blockchain explorers help users visualize and analyze data on a blockchain network.
- Network management tools allow administrators to manage and monitor the performance of the network, while development frameworks provide tools for building and testing blockchain applications.

Hyperledger - Tools | ~~Hyperledger Avalon~~

- Hyperledger Avalon is a platform for off-chain computing that enables blockchain networks to perform complex operations. It provides a standard interface for off-chain computing tasks, which can be carried out by trusted computing environments (TCEs).
- By moving computationally intensive tasks off the blockchain network, Avalon can improve the efficiency and scalability of blockchain-based applications.
- Avalon is designed to support a variety of TCEs, including Intel SGX, ARM TrustZone, and others.

Hyperledger - Tools | Hyperledger Caliper

- Hyperledger Caliper is a blockchain performance benchmarking tool. It allows users to test the performance of various blockchain networks under different workloads and scenarios.
- Caliper supports several blockchain platforms, including Hyperledger Fabric, Sawtooth, and Iroha, as well as Ethereum and others.
- Caliper can help developers and network operators optimize their blockchain networks by identifying potential bottlenecks and areas for improvement.

Hyperledger - Tools | Hyperledger Cello

- Hyperledger Cello is a platform for deploying and managing blockchain networks. It automates the process of setting up blockchain networks, from provisioning hardware and software to configuring nodes and deploying smart contracts.
- Cello also provides a dashboard for monitoring and managing the blockchain network, as well as tools for scaling the network up or down as needed.
- Cello is designed to make it easier for developers and network operators to deploy and manage blockchain networks.

Hyperledger - Tools | ~~Hyperledger~~ Explorer

- Hyperledger Explorer is a blockchain explorer that provides information about blocks, transactions, and other network information. It allows users to view the details of individual transactions, including transaction ID, timestamp, and transaction inputs and outputs.
- Explorer also provides a graphical representation of the blockchain network, showing the connections between nodes and the flow of transactions.
- Explorer can help developers and network operators troubleshoot issues and gain insights into the operation of the blockchain network.

Hyperledger - Tools | Hyperledger Cacti

- Hyperledger Cacti is a platform for integrating multiple blockchain networks. It provides a framework for connecting different blockchains, enabling interoperability and communication between them.
- Cacti supports a range of blockchain platforms, including Hyperledger Fabric, Corda, Quorum, and Ethereum, among others. With Cacti, developers can create cross-chain smart contracts and execute transactions across multiple blockchains.
- Cacti can help organizations to leverage the strengths of different blockchain networks and create more powerful and flexible blockchain applications.

Hyperledger - Tools | Hyperledger Bevel

- Hyperledger Bevel is a tool that simplifies the process of creating and deploying smart contracts on a Hyperledger Fabric network.
- It provides a command-line interface that enables developers to write, test, and deploy smart contracts without requiring extensive knowledge of the underlying blockchain infrastructure.
- Bevel abstracts away the complexity of the Hyperledger Fabric network and provides an intuitive interface for developers to interact with the blockchain. It supports smart contracts written in popular programming languages such as Java, JavaScript, and GoLang.

Hyperledger - Tools | Hyperledger FireFly

- Hyperledger FireFly is a pluggable API orchestration and data layer that integrates multiple blockchain ecosystems, decentralized technologies, and token economies.
- FireFly acts as a Supernode, sitting between the application and underlying infrastructure nodes, providing additional functions and reducing the complexity and fragility of the application layer.
- Without FireFly, integrating Web3 infrastructure into an application requires tens of thousands of lines of low-level code, which can be expensive and time-consuming to maintain.

Hyperledger - Tools | Hyperledger Solang

- Hyperledger Solang is a Solidity-to-WebAssembly compiler designed to enable the execution of smart contracts on a blockchain. It provides a way to write smart contracts using the Solidity language and compiles them into WebAssembly bytecode, which can then be executed on a blockchain.
- Solang is compatible with Ethereum Virtual Machine (EVM) and can be used to run Solidity smart contracts on different blockchain platforms, including Hyperledger Sawtooth and Substrate.

Hyperledger Fabric

- Hyperledger Fabric is an open source enterprise-grade permissioned distributed ledger technology (DLT) platform, designed for use in enterprise contexts, that delivers some key differentiating capabilities over other popular distributed ledger or blockchain platforms.
- Fabric has a highly modular and configurable architecture, enabling innovation, versatility and optimization for a broad range of industry use cases including banking, finance, insurance, healthcare, human resources, supply chain and even digital music delivery.

Hyperledger Fabric

- Fabric is the first distributed ledger platform to support smart contracts authored in general-purpose programming languages such as Java, Go and Node.js, rather than constrained domain-specific languages (DSL).

- The **design philosophy** of a Hyperledger Fabric blockchain service is based on the needs and requirements of the participants in the Hyperledger project, which have been deduced from studying industrial use cases and can be categorized into several principles.

Hyperledger Fabric | Design Principles

- **Modularity**: Hyperledger Fabric is modular and allows for plug-and-play of consensus algorithms, membership services, and other components, enabling the network to be customized for specific use cases.

- **Privacy and Confidentiality**: Hyperledger Fabric provides channels and private data collections, which allows for transactions and data to be kept private between specific network participants.

Hyperledger Fabric | Design Principles

- **Scalability and Performance**: Hyperledger Fabric uses a flexible consensus mechanism and parallel transaction execution, which allows for high throughput and low latency. This makes it suitable for enterprise use cases.

- **Interoperability**: Hyperledger Fabric is designed to work with other Hyperledger frameworks, tools and Libraries, and other blockchain networks, enabling interoperability and collaboration between different blockchain networks.

Hyperledger Fabric | Design Principles

- **Security**: Hyperledger Fabric provides security features such as role-based access control, digital signatures, and end-to-end encryption, making it suitable for enterprise use cases.
- **Flexibility**: Hyperledger Fabric is flexible, with the ability to support multiple consensus algorithms, smart contract languages, data storage options, and can be deployed in different network configurations.

Introduction to Blockchain | Summary

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