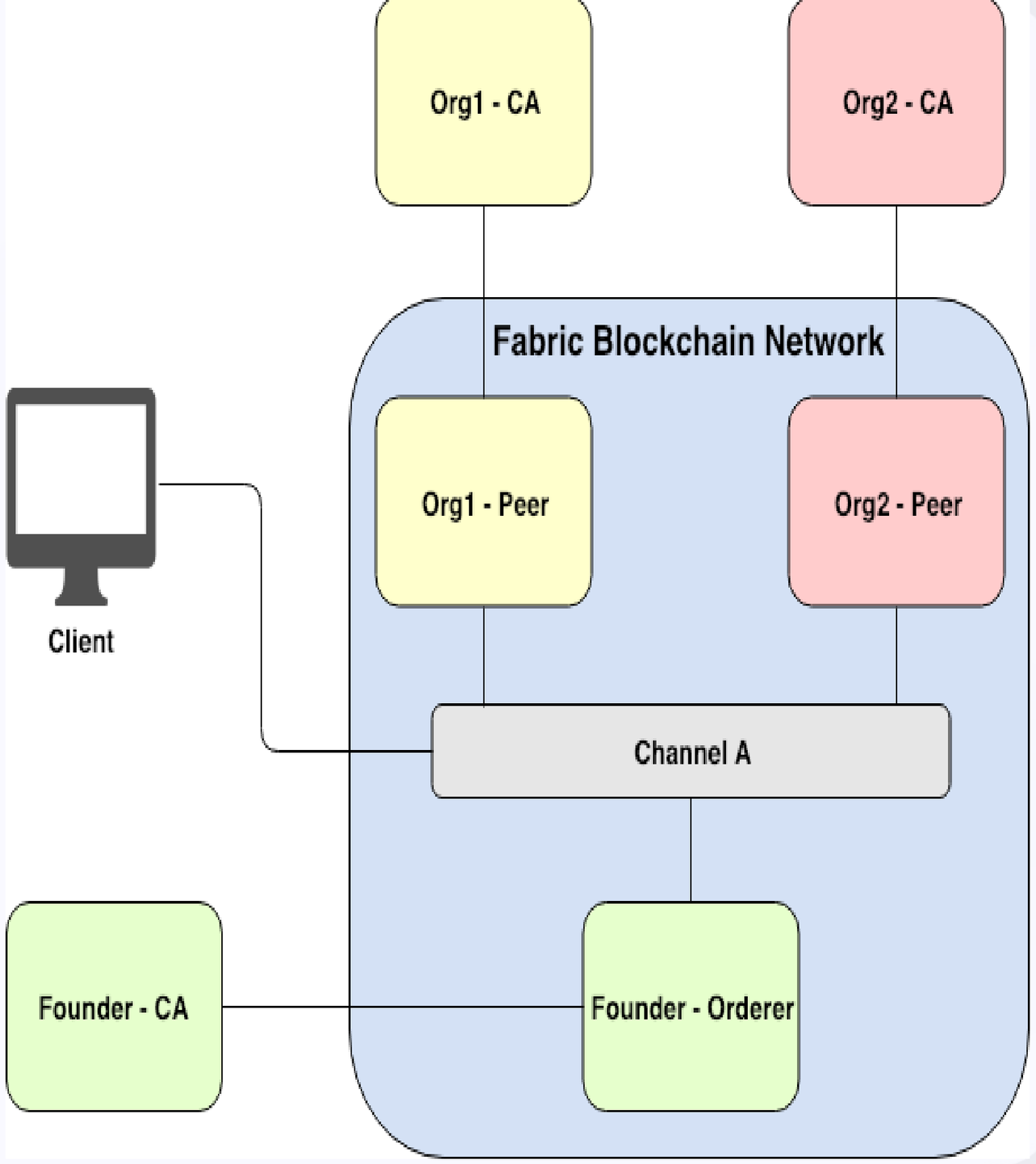
Hyperledger Reference Architecture



What is Hyperledger?

Hyperledger is not a blockchain but a project launched by **The Linux Foundation** in **2015** to enhance blockchain technology. It is an **open-source initiative** where organizations collaborate to build **distributed ledger frameworks** for business applications. The goal is to create **reliable, high-performance blockchain platforms** that support global business transactions.

Frameworks

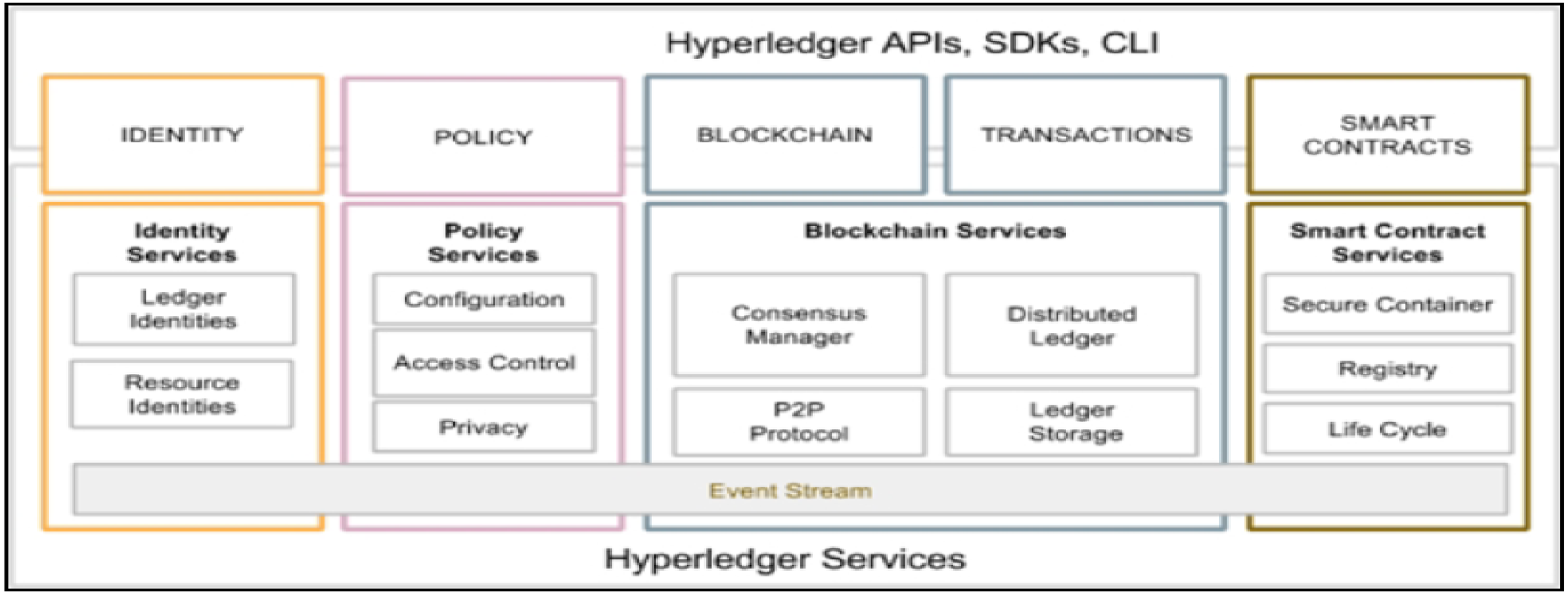
- Fabric
- Burrow
- Sawtooth Lake
- Iroha
- Indy
- Cello

Goals

- Modular and Interoperable Platforms
- Permissioned Blockchain Networks
- Collaboration and Open-Source Development
- Interoperability with Existing Systems
- Enhanced Security and Privacy
- Reducing Costs and Improving Efficiency

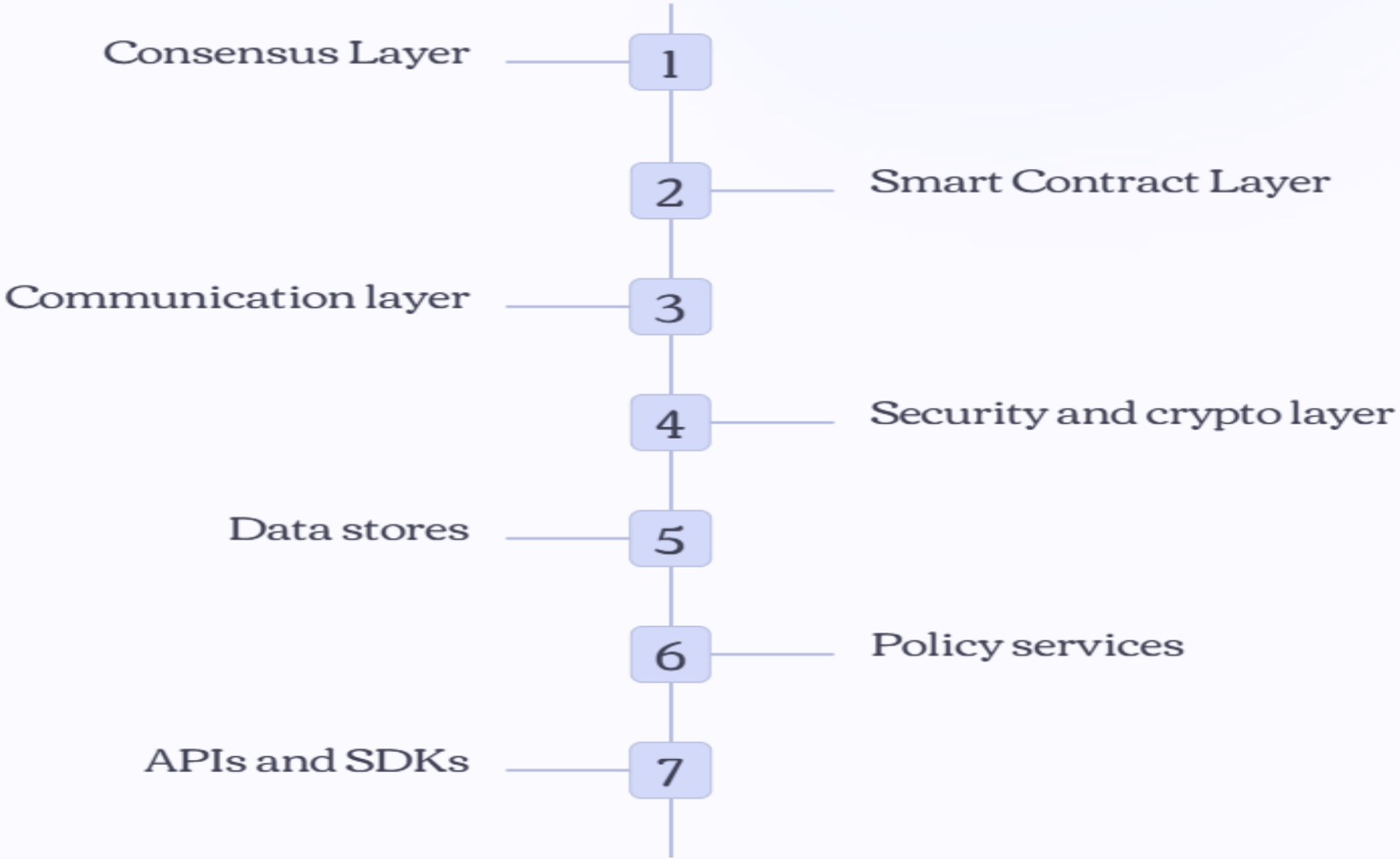
Hyperledger Reference Architecture Components

The Hyperledger Reference Architecture provides a modular structure. This enables developers to select components. These components suit their specific blockchain solutions. Key components include consensus, smart contracts, and identity management.



Understanding the Layers

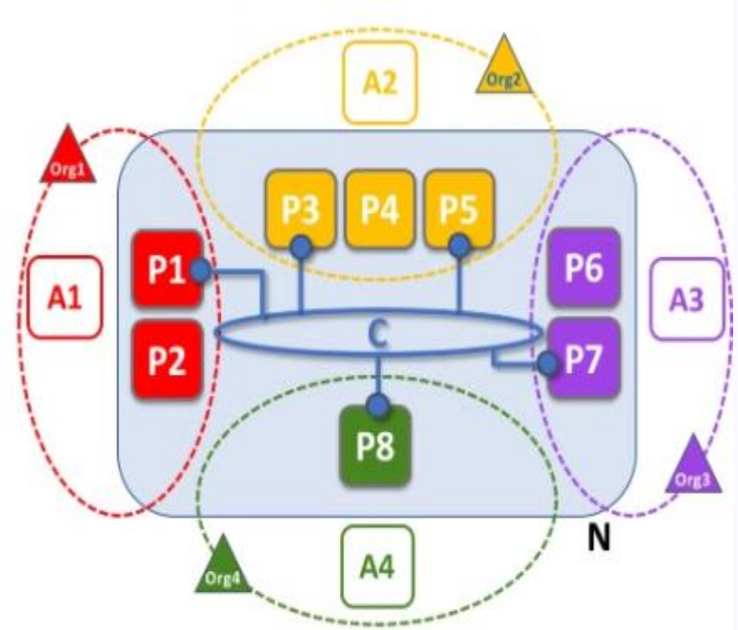
Hyperledger architectures are layered. Each layer performs specific functions. The layers include the data, network, consensus, and smart contract layers. This layered approach promotes modularity and flexibility.

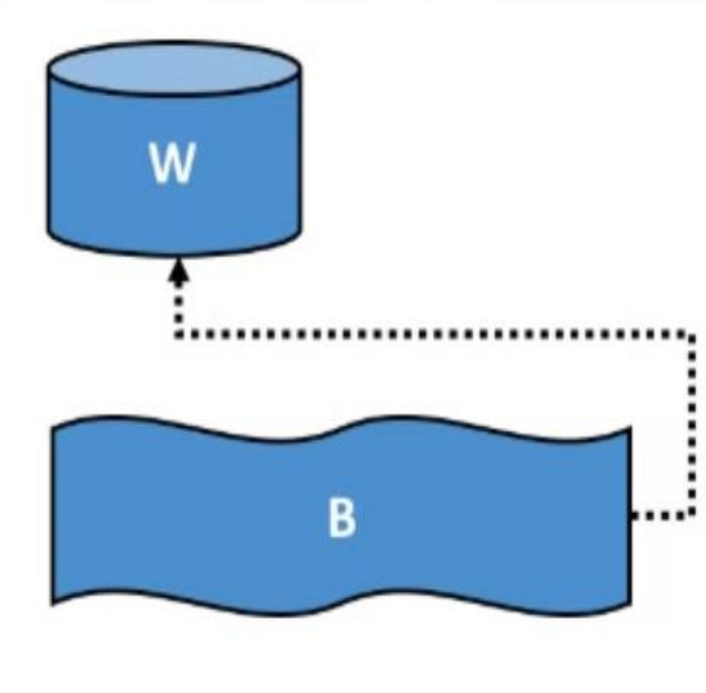


Deep Dive into Layers

Consensus layer: These services are responsible for facilitating the **agreement process between the participants** on the blockchain network. The consensus is required to make sure that the order and state of transactions is validated and agreed upon in the blockchain network.

Smart Contracts: The smart contract layer is responsible for implementing **business logic** and ensuring transactions adhere to predefined policies and contracts. Transactions are processed based on the logic defined in **smart contracts**, and any invalid transactions are denied or removed from consideration for inclusion in a block.





Communication Layer:

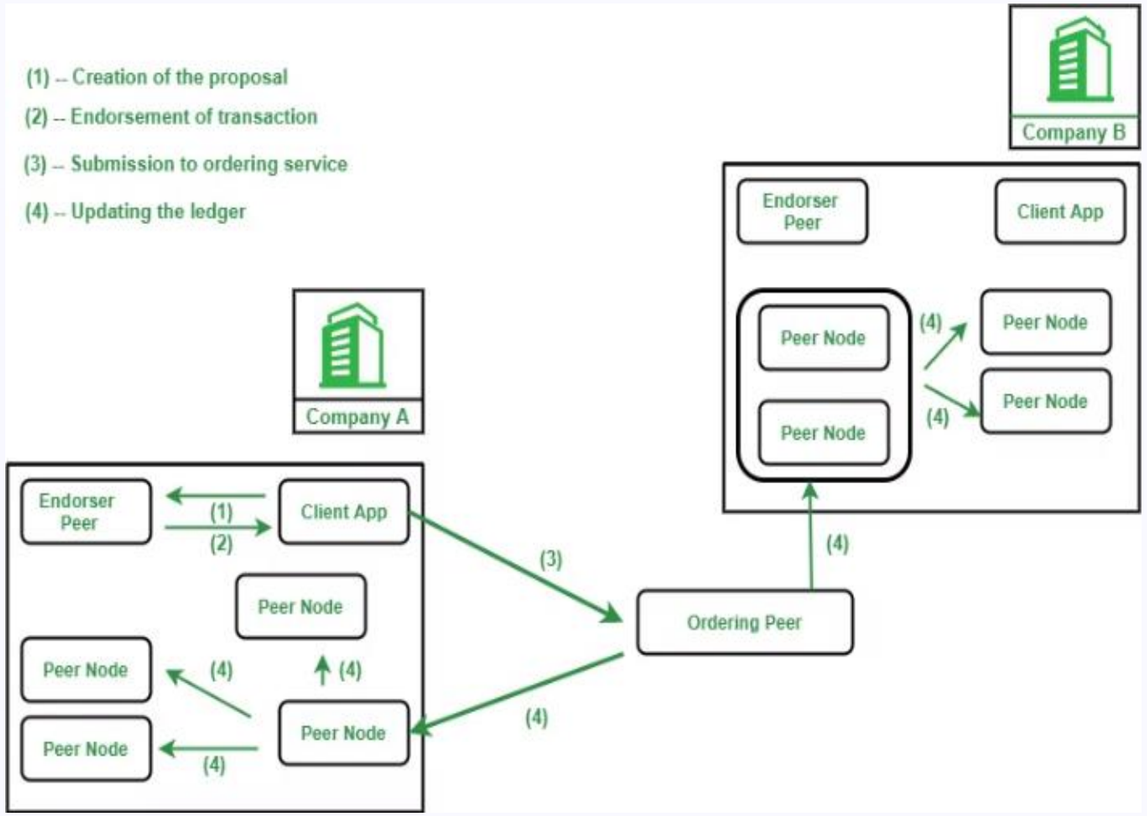
Communication Layer is in charge of peer-to-peer message transfer between nodes in a shared ledger instance.The communication layer is used by the consensus layer to communicate with the client and other network peers.

Security and crypto layer:

These services are responsible for providing a capability to allow various cryptographic algorithms or modules to provide privacy, confidentiality and non-repudiations services.

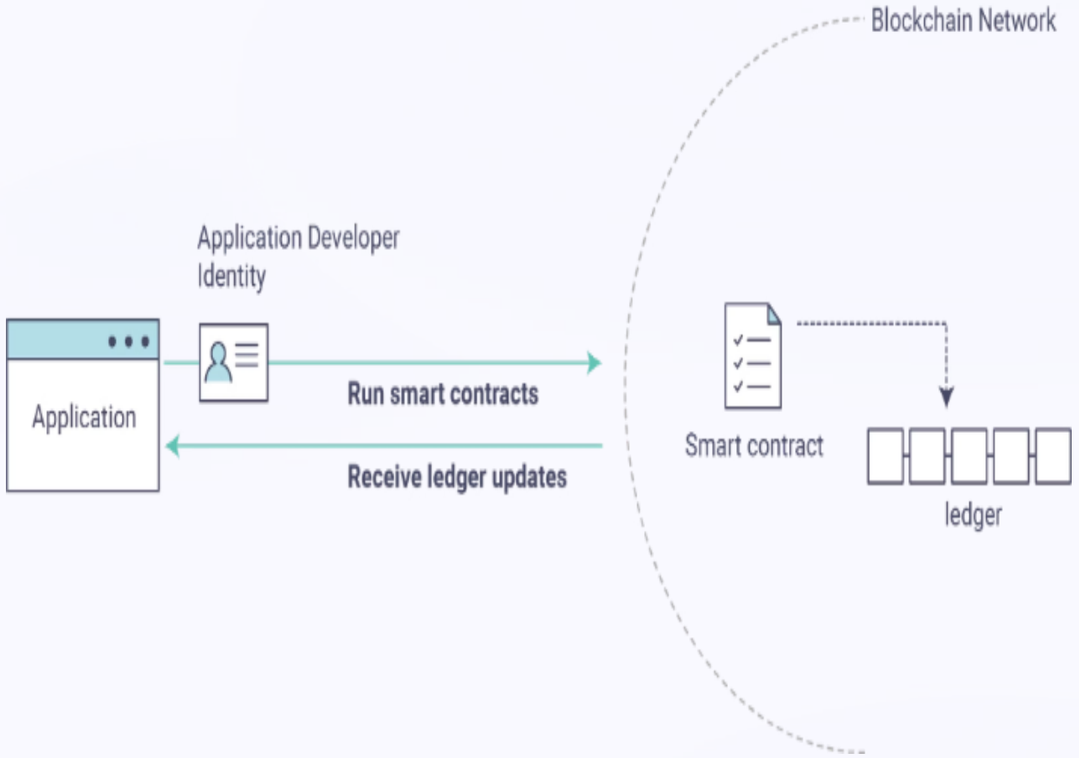
Data stores:

This layer provides an ability to use different data stores for storing state of the ledger. This means that data stores are also pluggable and allows usage of any database backend.



Policy Services:

This layer manages various **policies** essential for the blockchain network, including **endorsement policies** (defining who can validate transactions) and **consensus policies** (ensuring agreement on transaction order). It helps enforce **security, access control, and governance rules** across the network.

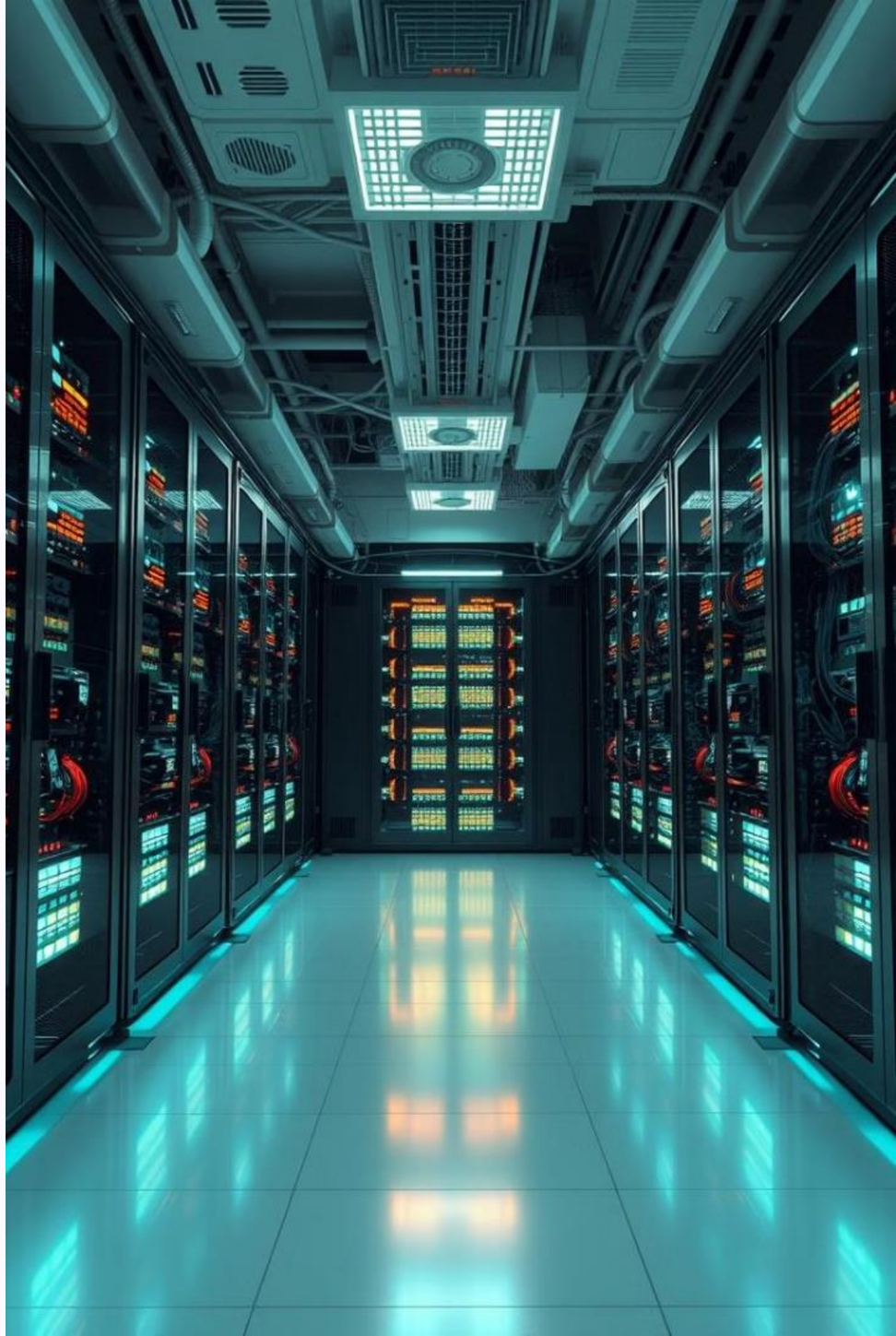


APIs and SDKs:

This layer enables **clients and applications** to interact with the blockchain through **APIs and SDKs**. It facilitates **deploying and executing chaincode, querying blocks, monitoring events**, and ensuring seamless communication between applications and the blockchain network. SDKs support multiple programming languages for easy integration.

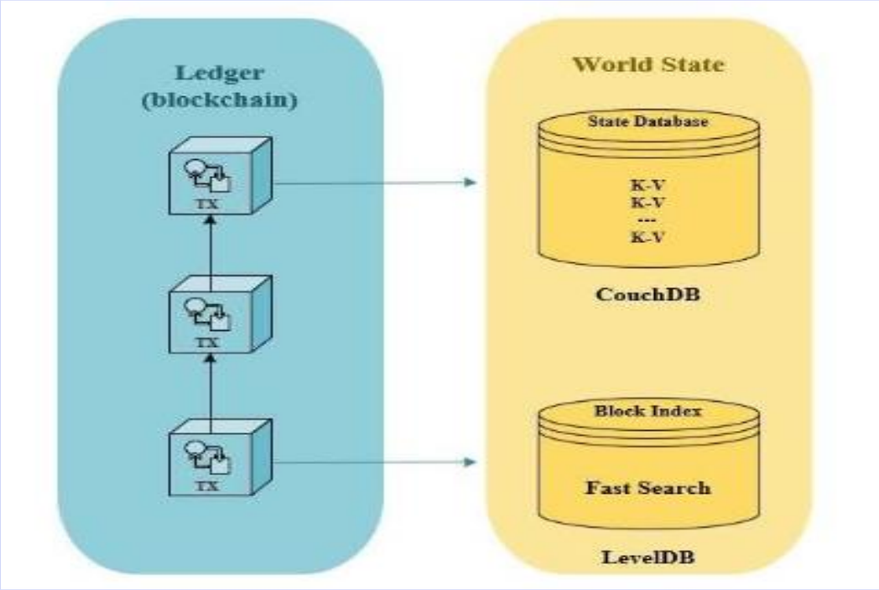
Requirements and Design Goals of Hyperledger Fabric

Hyperledger Fabric is a **permissioned blockchain framework** designed for enterprise use. It is part of the **Hyperledger** project hosted by the **Linux Foundation** and is used for building **private, scalable, and secure blockchain networks**.There are certain requirements of a blockchain service. The reference architecture is driven by the needs and requirements raised by the participants of the Hyperledger project and after studying the industry use cases.



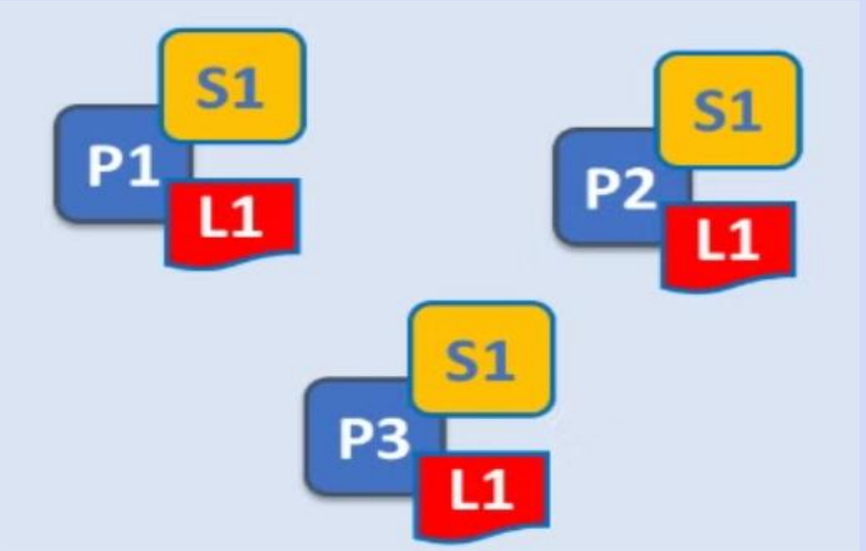
Modular approach:

The **modular approach** in Hyperledger ensures flexibility by making key blockchain components like **storage, policy, chaincode, access control, and consensus pluggable**. This allows businesses to **customize and replace modules** as needed, enabling **plug-and-play functionality** to suit different industry requirements.



Scalability:

Hyperledger must support **high transaction throughput** to handle **large volumes of users and business operations efficiently**. A scalable blockchain ensures smooth performance even as the number of transactions grows, making it suitable for **enterprise-level applications** across various industries.



Deterministic transactions:

Transactions in Hyperledger must always yield **the same result**, regardless of **who executes them or where**. This is essential for ensuring **trust and consensus** across the network. Without determinism, the blockchain would fail to achieve a consistent state, making secure transactions impossible.

Identity:

Hyperledger implements a **flexible Public Key Infrastructure (PKI) model** to manage identities and access control. It allows businesses to choose the strength and type of cryptographic mechanisms based on their needs. In cases where privacy is required, Hyperledger also supports **identity masking** to keep user information confidential.

Auditability:

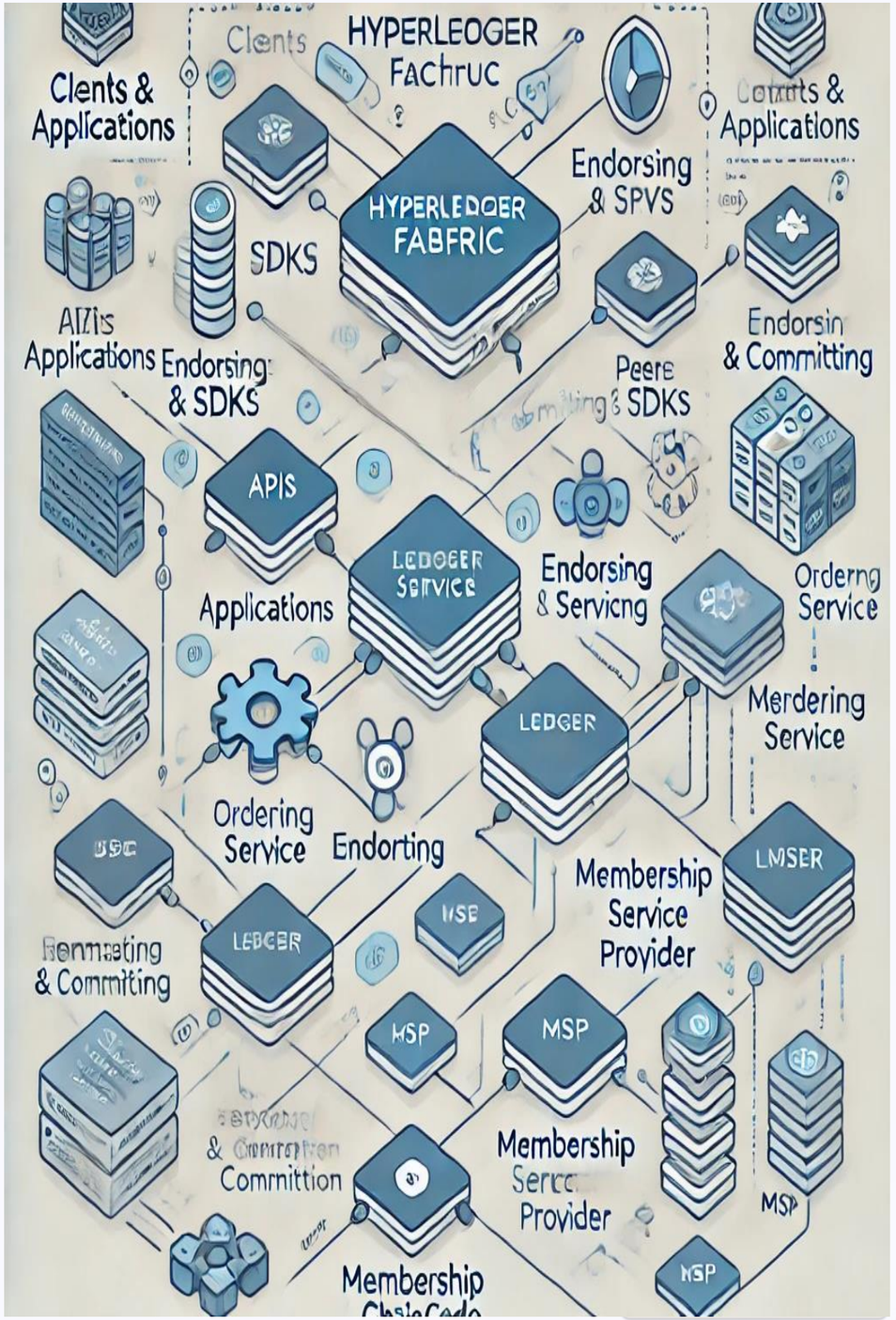
Hyperledger ensures **complete transparency** by maintaining an **immutable audit trail** of all identities, transactions, and system changes. This enables organizations to track operations, meet **compliance requirements**, and enhance **security by preventing fraud or unauthorized modifications** in the network.

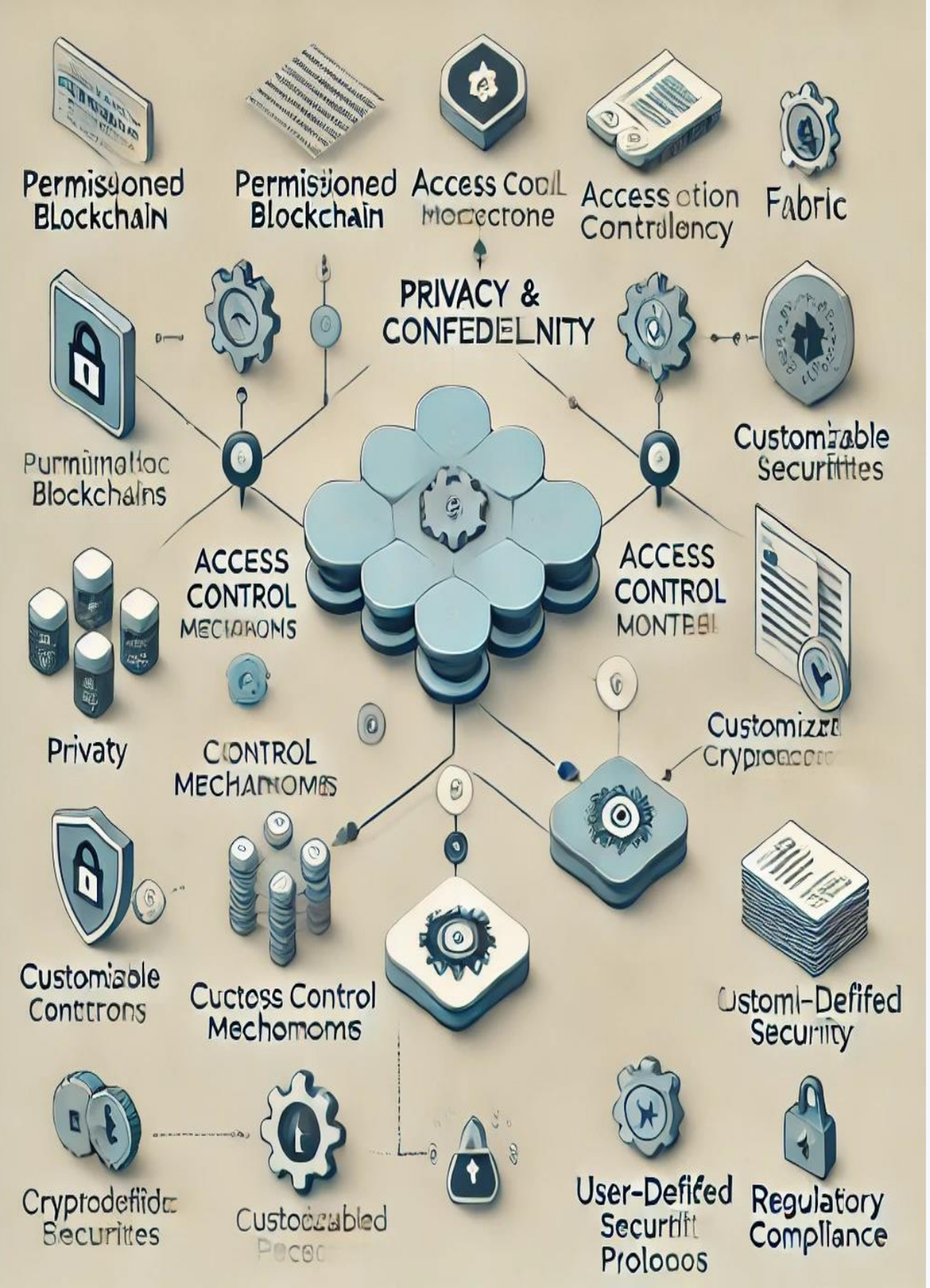
Interoperability

Hyperledger aims to enable **communication between different blockchain networks** by establishing **common standards** for seamless data exchange. This ensures that various blockchain platforms can work together, fostering a **global blockchain-based business ecosystem**.

Portability

Hyperledger Fabric is designed to run across **multiple platforms and environments** without requiring code modifications. It ensures **portability at the infrastructure, code, library, and API levels**, allowing **uniform development** across different implementations.





Privacy and Confidentiality in Hyperledger

Privacy and confidentiality are crucial in permissioned blockchains like Hyperledger Fabric, ensuring transactions are visible only to authorized participants. Hyperledger supports customizable cryptographic protocols and access control mechanisms to meet business needs. Users can select cryptographic modules based on requirements, from basic security for private networks to advanced support, including hardware security modules (HSMs), for cross-industry blockchains. It also ensures compliance with regulatory privacy policies without compromising performance.

Rich Data Queries

The blockchain network should support **complex queries** using **traditional query languages**. This feature enhances usability, enabling users to efficiently access the **current state of the ledger**, leading to **wider adoption and easier integration** into business operations.

Thank You