Enterprise Blockchain Solutions for Financial Services: Techniques and Challenges

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About Us

Using digital technology to enable businesses and industries beyond traditional boundaries

Digital Research Innovation Capability Platform

Outline

- Part I: Blockchain & core techniques
- Part II: Enterprise Applications & Blockchain Platforms
- Part III: Key lessons we learnt in practice

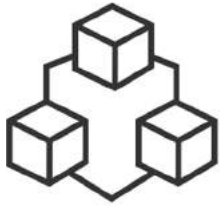
Blockchain Impact

10% of Global

GDP will be stored on blockchains or blockchain related technology by 2025.

$360 Billion

The business value added by blockchain by 2026, then to exceed $3.1 trillion by 2030.



$20 Billion

Estimated revenue of the blockchain technology market by 2024.

30% of Banks

Blockchain can offer a reduction in banks' costs by up to 30%, or $12 Billion.

Source: World Economic Forum; ITWeb; Cision; IBM; Gartner; MarketandMarkets

Why Blockchain

- Enable exchange of value without trusting intermediaries.
- Maintain a single source of truth and a shared set of rules across entities without anyone being able to alter them and control the system.

- Anything that is capable of being owned or controlled to produce value, is an asset

Two fundamental types of asset

- Tangible, e.g. a house
- Intangible, e.g. a mortgage

Intangible assets subdivide

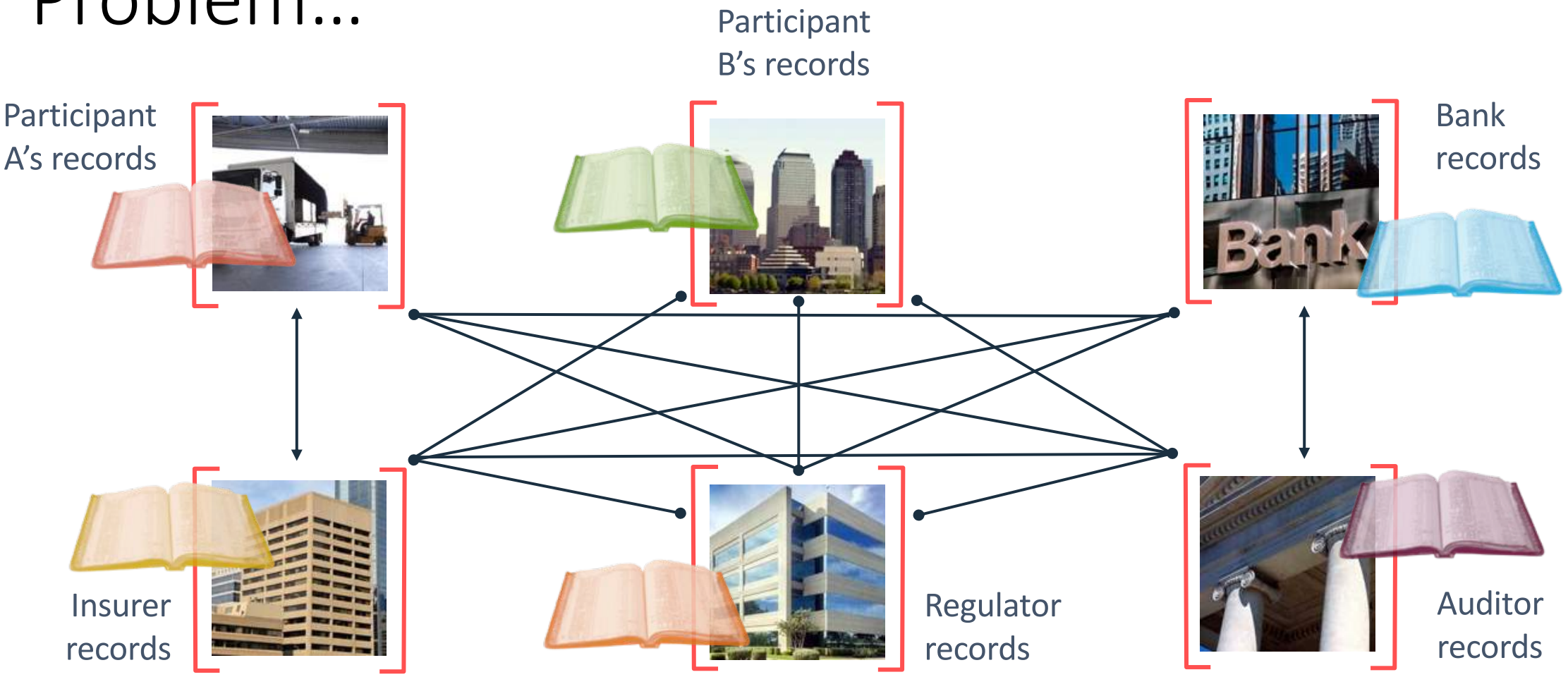
- Financial, e.g. bond
- Intellectual, e.g. patents
- Digital, e.g. music

Cash is also an asset

- Has property of anonymity

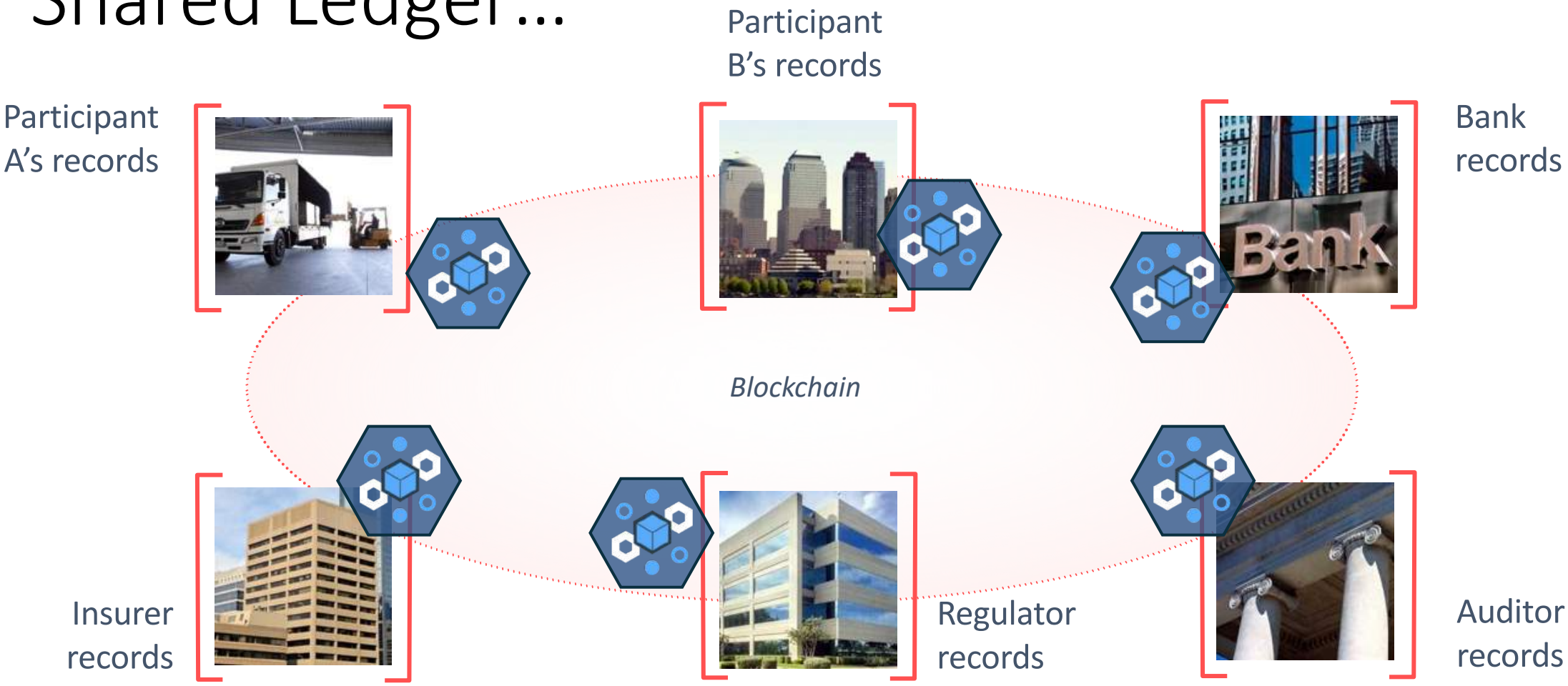
Blockchain shift the cost of trust

Problem…



… inefficient, expensive, vulnerable

Shared Ledger…



… with consensus, provenance, and immutability

Blockchain Benefits

Saves
time

Transaction time from days to near instantaneous

Removes
cost

Overheads and cost intermediaries

Reduces
risk

Tampering, fraud & cyber crime

Increases
trust

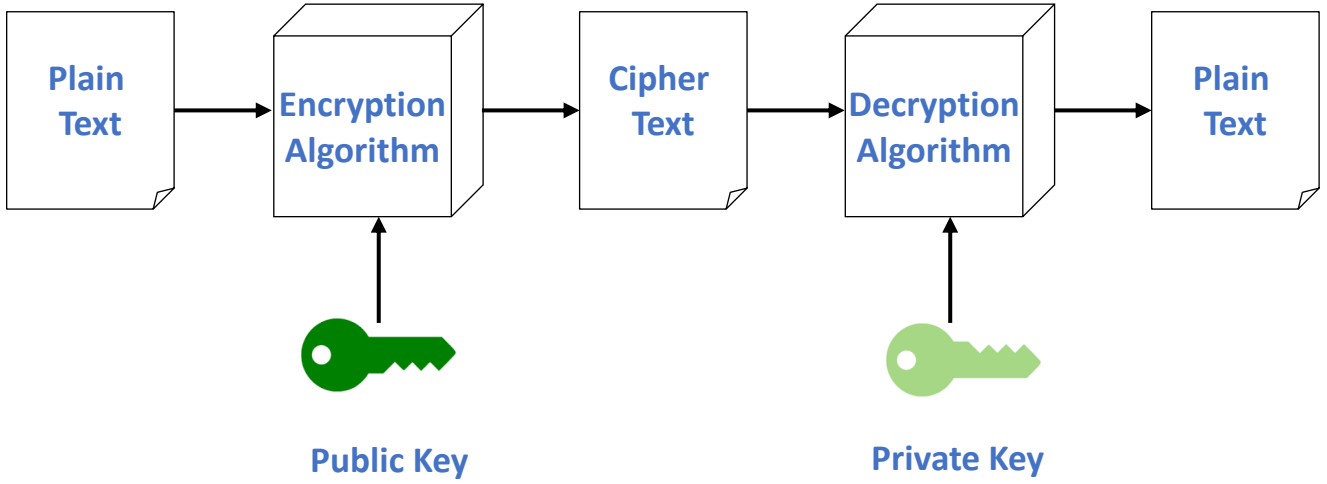
Through shared processes and recordkeeping

Core Techniques

- Asymmetric Cryptography
- Digital Signature
- Hash Functions

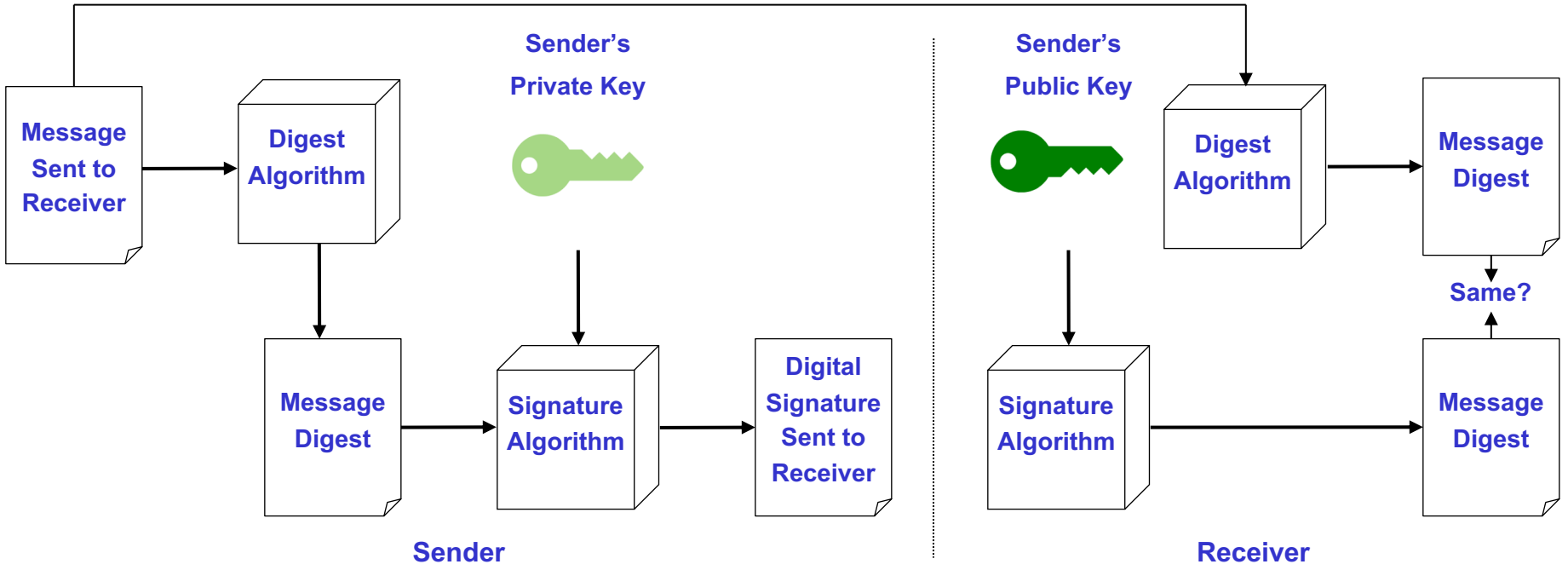
Asymmetric Cryptography

- Uses a pair of keys for encryption
  - Public key for encryption
  - Private key for decryption
- Messages encoded using public key can only be decoded by the private key
  - Secret transmission of key for decryption is not required
  - Every entity can generate a key pair and release its public key



Digital Signature: Authentication

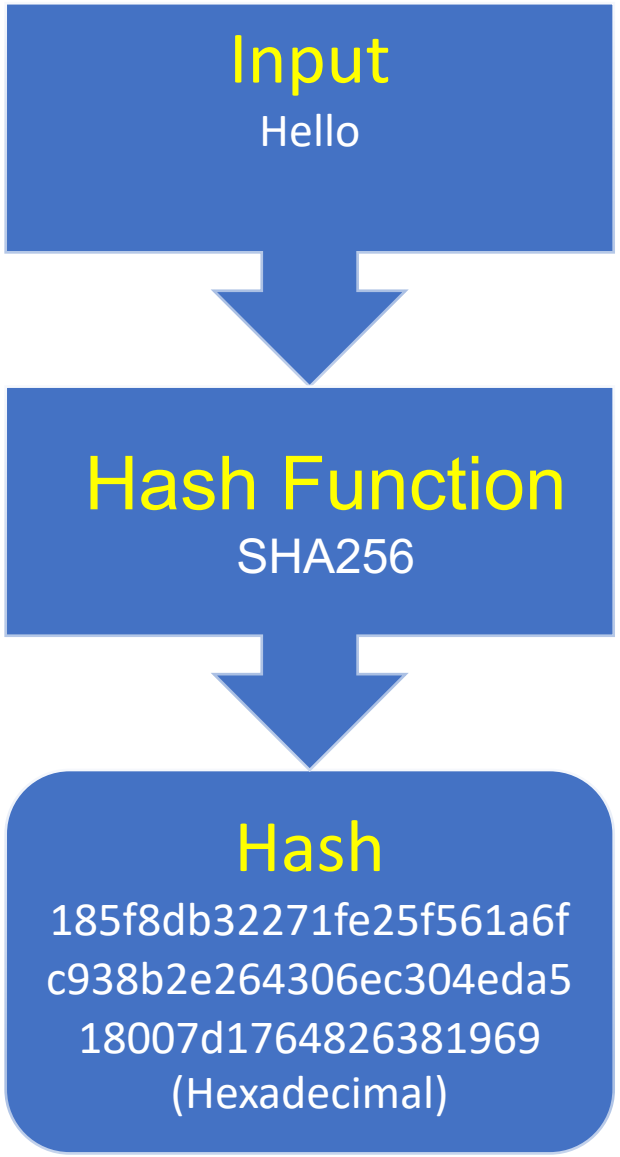
- A digital signature is a way to prove that a message originates from a specific person and no one else.
  - A guarantee of the source of the data
  - Proof that the data has not been tampered with
- Your public key is how others are able to identify you. Your private key gives you the power to digitally sign and authorize different actions on behalf of this digital identity when used with your public key.



Hash Functions

- A *hash function*, takes any input, and produces an output of a fixed size.
- The process of applying a hash function to some data, is called *hashing*.
- The output of a hash function is called a *hash*.
- **digital fingerprinting:** It verifies and confirms that the output produced from hashing has not been meddled

- e.g. SHA256 is one example of hash function (Bitcoin uses). It outputs 256 bits of 1s and 0s.



Properties of Hash Function

- **Deterministic**: same input yields same output. This can be used to verify that two documents are the same.
- **One-way**: Given the hash, hard to discover the input.
- **Collision resistant**: it is hard to find two inputs that yield the same hash.

e.g. SHA256 hashes of 'hello' compared to 'Hello'

hello

Hash

2cf24dba5fb0a30e26e83b
2ac5b9e29e1b161e5c1fa7
425e73043362938b9824
(Hexadecimal)

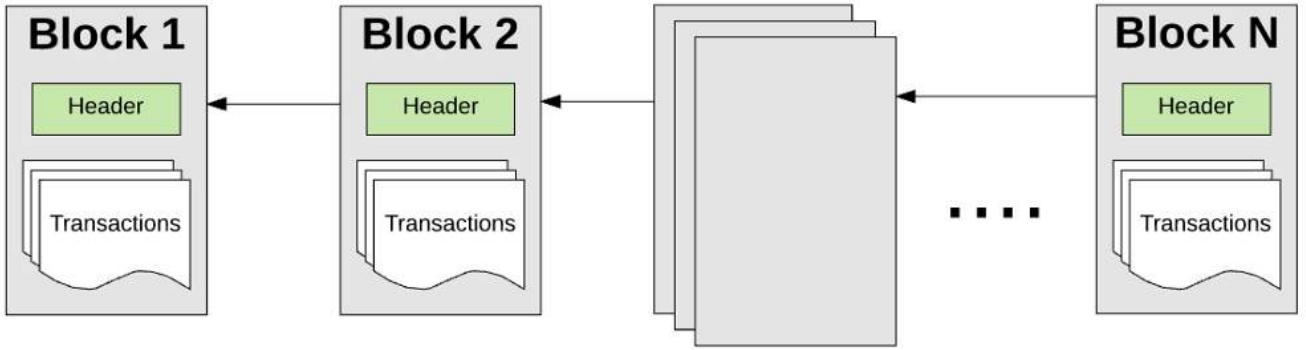
Hello

Hash

185f8db32271fe25f561a6f
c938b2e264306ec304eda5
18007d1764826381969
(Hexadecimal)

What is Blockchain

- Establish **trust** among unfamiliar or unknown partners by **cryptographic** protocols.
- Made up of sequentially grouped, **verified** blocks of transactions. Blocks are chained together, creating a shared record of all transactions.
- Verify and store information in peer-to-peer networks by **consensus** with **no central authority** or intermediary.
- **Immutable** record of transactions dating back to the first transaction.



How does Blockchain Work?

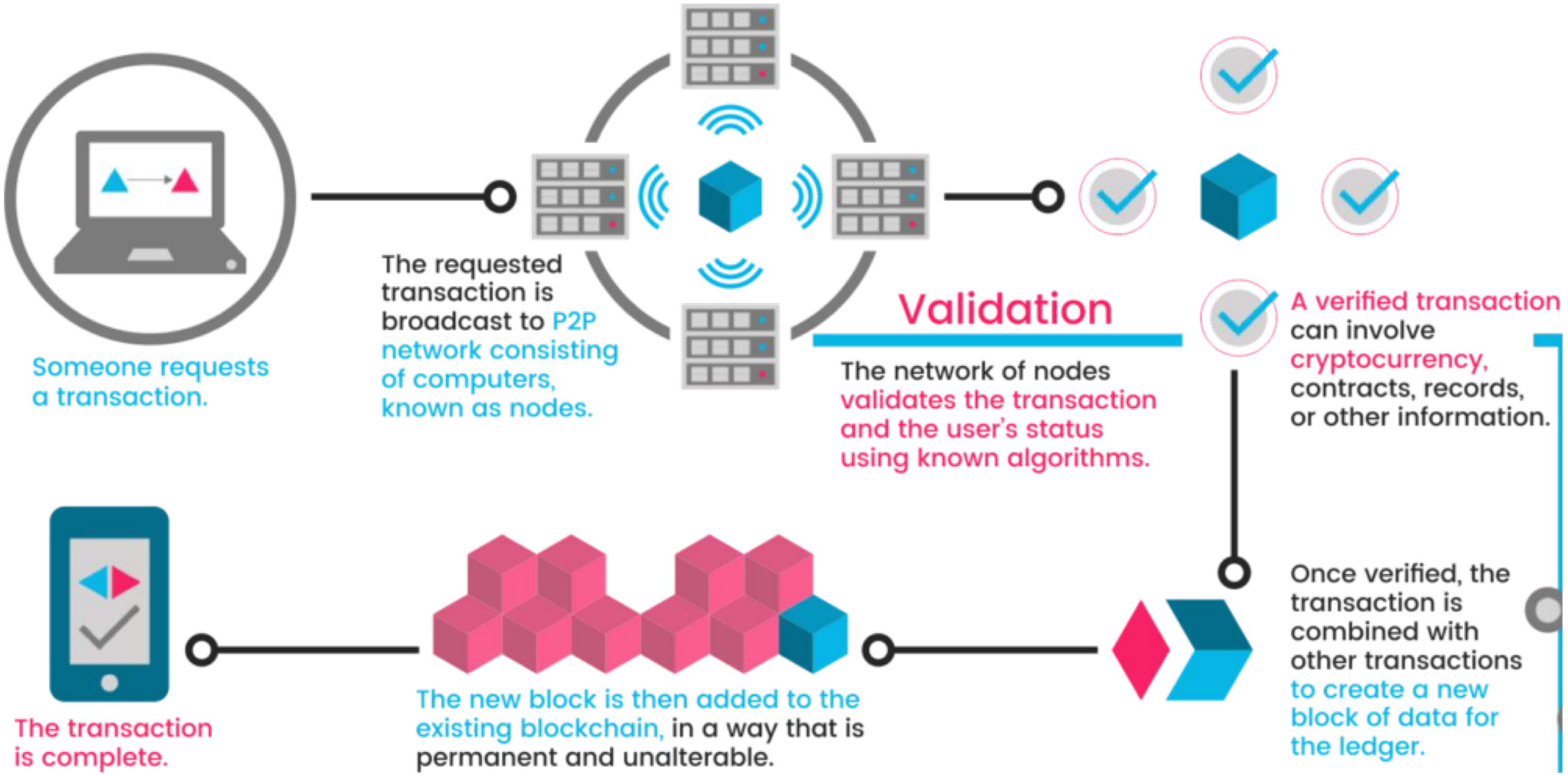
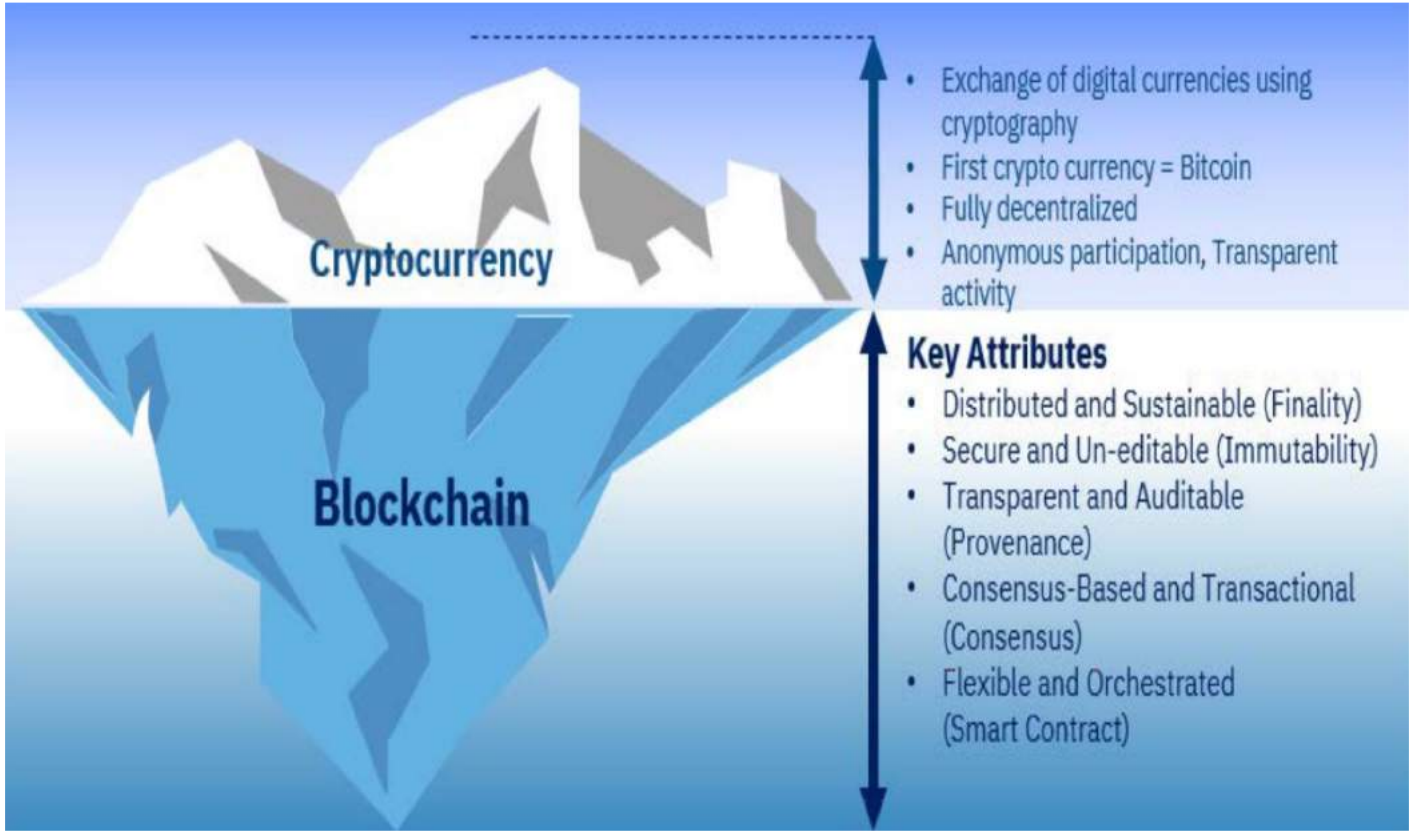


Image source: Blockgeeks

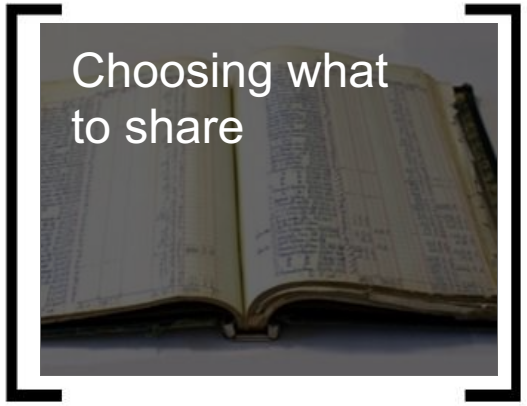
Common Misconceptions

- There is no privacy/ Everything is shared and open
- It is lack of regulation
- It is not secured, many hacks and lost cryptocurrencies
- Blockchain consumes intensive energy for mining



Requirements of Blockchain for Business

Business Network decides the assets to share on the ledger. Rules set by smart contracts



Transactions *provably* endorsed by relevant participants. e.g. sender bank, receiver bank, payments provider

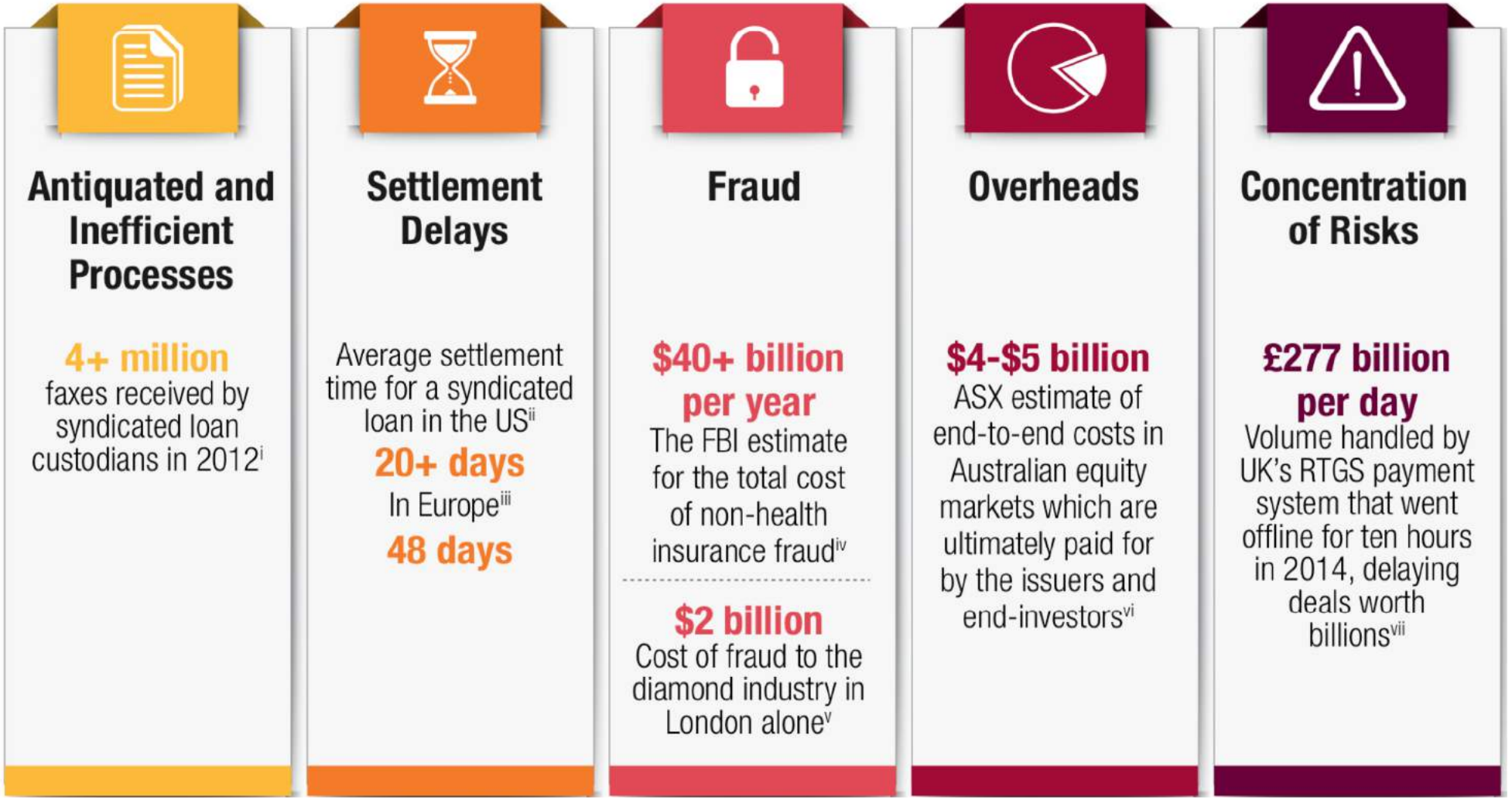
Knowing who you're dealing with e.g. KYC, AML, CFT

Transaction visibility is need-to-know.

Part II: Enterprise Applications for FS

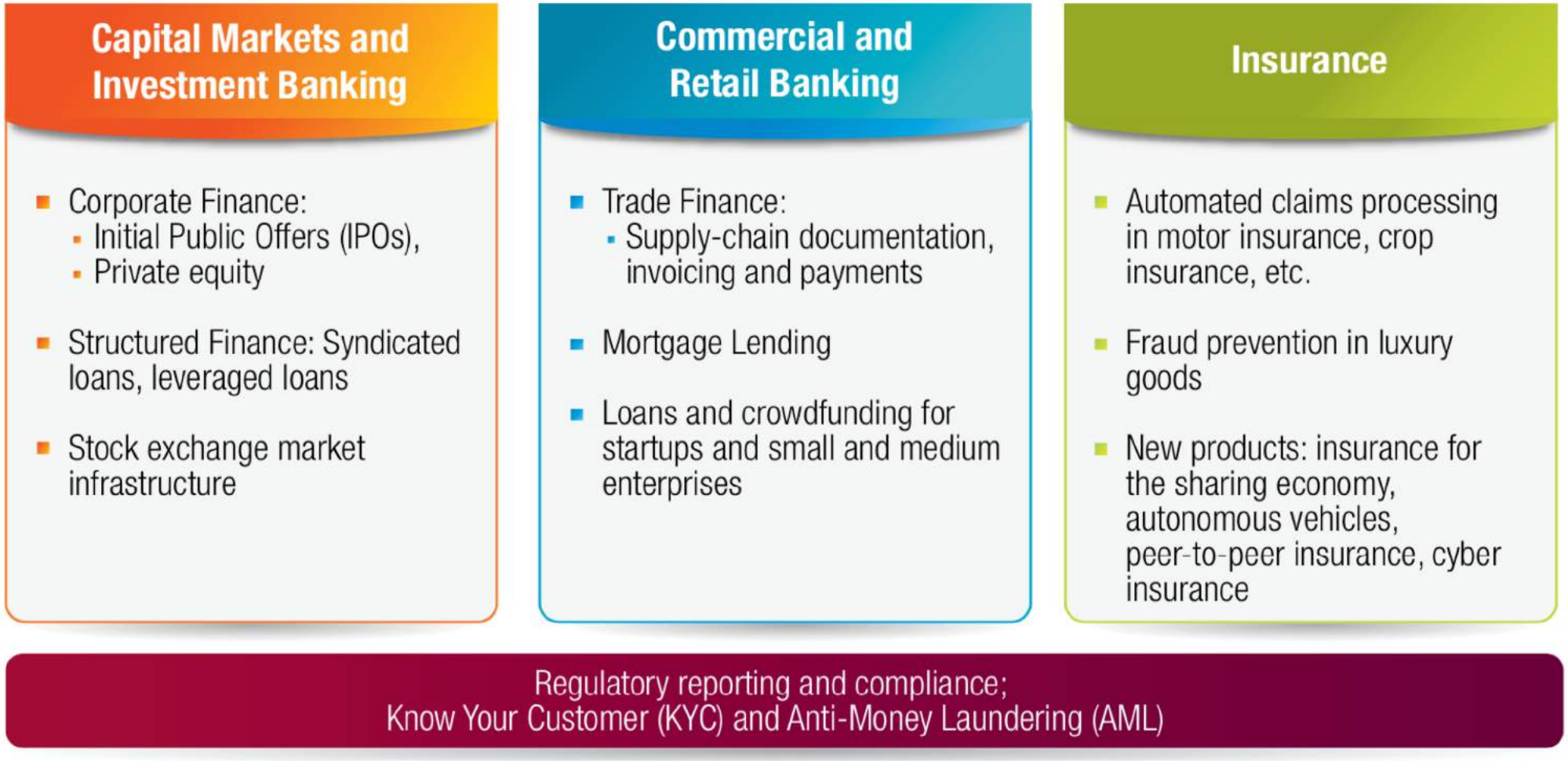
- Current Status & Challenges
- Enterprise Applications
- Platforms for Enterprise Solutions

Rising Problems with Traditional FS



Source: Smart Contracts in Financial Services: Getting from Hype to Reality, Capgemini

Existing Use Cases for FS



Source: Smart Contracts in Financial Services: Getting from Hype to Reality, Capgemini

Key Metrics about Using Blockchain

- Identifying a good blockchain use-case is not always easy
  - However there should always be:

- A **business problem** to be solved that cannot be more efficiently solved with other technologies
- An identifiable **business network** with Participants, Assets and Transactions
- A need for **trust** with Consensus, Immutability, Finality or Provenance

Applications:

- Shared KYC
- Bank Guarantee
- Micro-Insurance
- Document and Workflow Management for Trade and Logistics

What is Shared-KYC?

- Know Your Customer (KYC) identifies a set of processes that financial institutions implement when onboarding a new customer for any of the services they provide, in order to comply with existing regulations. KYC is just a portion of what is comprehensively called Customer Due Diligence (CDD).

- While this process is rather simple for single individuals, it can be quite complex for when on-boarding corporate organizations.

Our Goal with Shared KYC

- To provide a technical solution for Corporate KYC that is *faster*, *more accountable*, and eventually *cheaper*.

Corporate KYC Paint Points

Corporate Customers

- **Poor customer experience**
  - Changing requirements from bank to bank
  - Long on-boarding times

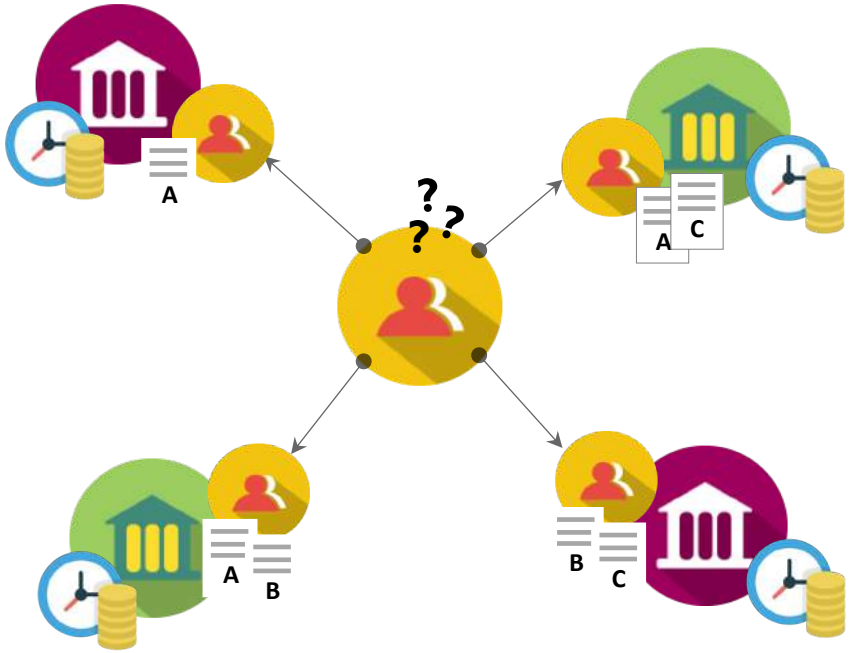
Regulators & Auditors

- **Lack of standardisation**
- **Effectiveness of audits**
  - Information access
  - Post-mortem vs real-time

Financial Institutions

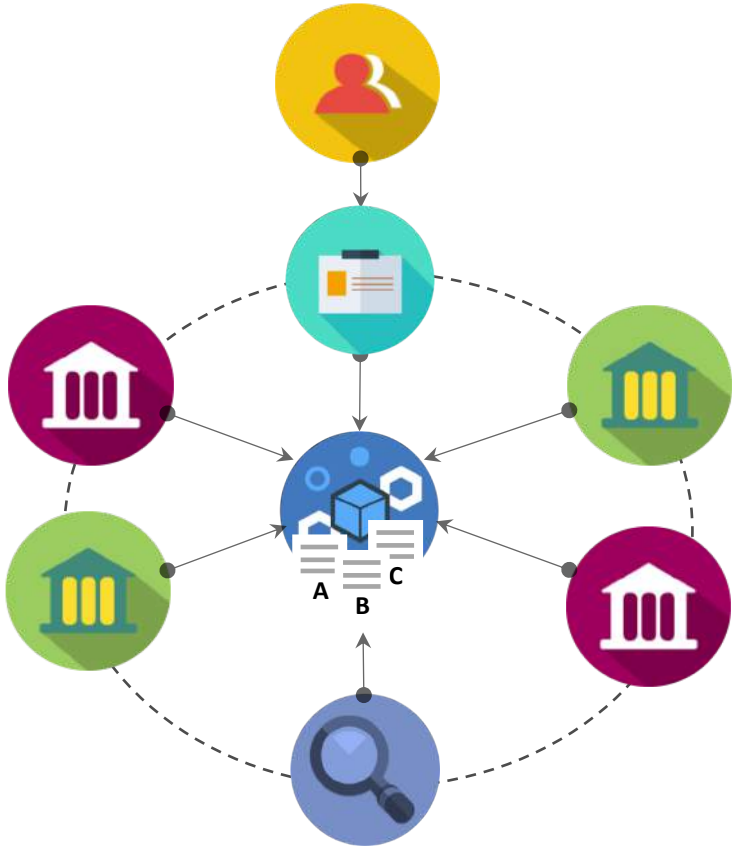
- **Expensive***
  - $60M on average in CDD/KYC spending per bank
    - 10% > 100M
    - 3% > 500M
  - Lost revenue opportunities
- **Time Consuming**
  - 5-100 documents per KYC
  - ~24 days to on-board a new client
  - KYC refresh takes 20 days
- **Reputational & Regulatory Risk**
  - Fines and shutdown for non-compliance
  - Brand damage

Revolutionizing CDD Processes



Today

Corporate customer on-boarding is today heterogeneous, rather manual, and directly affects the business of both customers and financial institutions.



Tomorrow

We imagine a future where corporate KYC is performed on top of an integrated platform, which not only makes it more effective but also develops new business opportunities.

Benefits of Shared KYC on Blockchain

By having a single integrated platform, based on a distributed shared ledger, where KYC data is securely stored, we expect to:

Increase speed from 3~4 weeks of on-boarding time, to 1 week or less by compressing data gathering and automating processes

Reduce costs decrease significantly costs to at least 20% less by eliminating duplication through shared services

Reduce risk via a redundant, distributed and shared ledger that acts as in immutable, assured audit trail of all the corporate KYC processes

Enhance experience via instant visibility across all shared information by a customer, secured through a consent-based mechanism, which controls information access

Shared KYC Scenario

Customer
Could be an individual or a corporate customer, who has an identity in the Blockchain.

KYC Portal
It is the point of access for the customer to manage its information in the network.

Fulfilling Bank
The first bank (Bank A) to establish a relationship with customer.

Requesting Bank
Another bank (Bank B) onboarding the customer and requiring the KYC information.

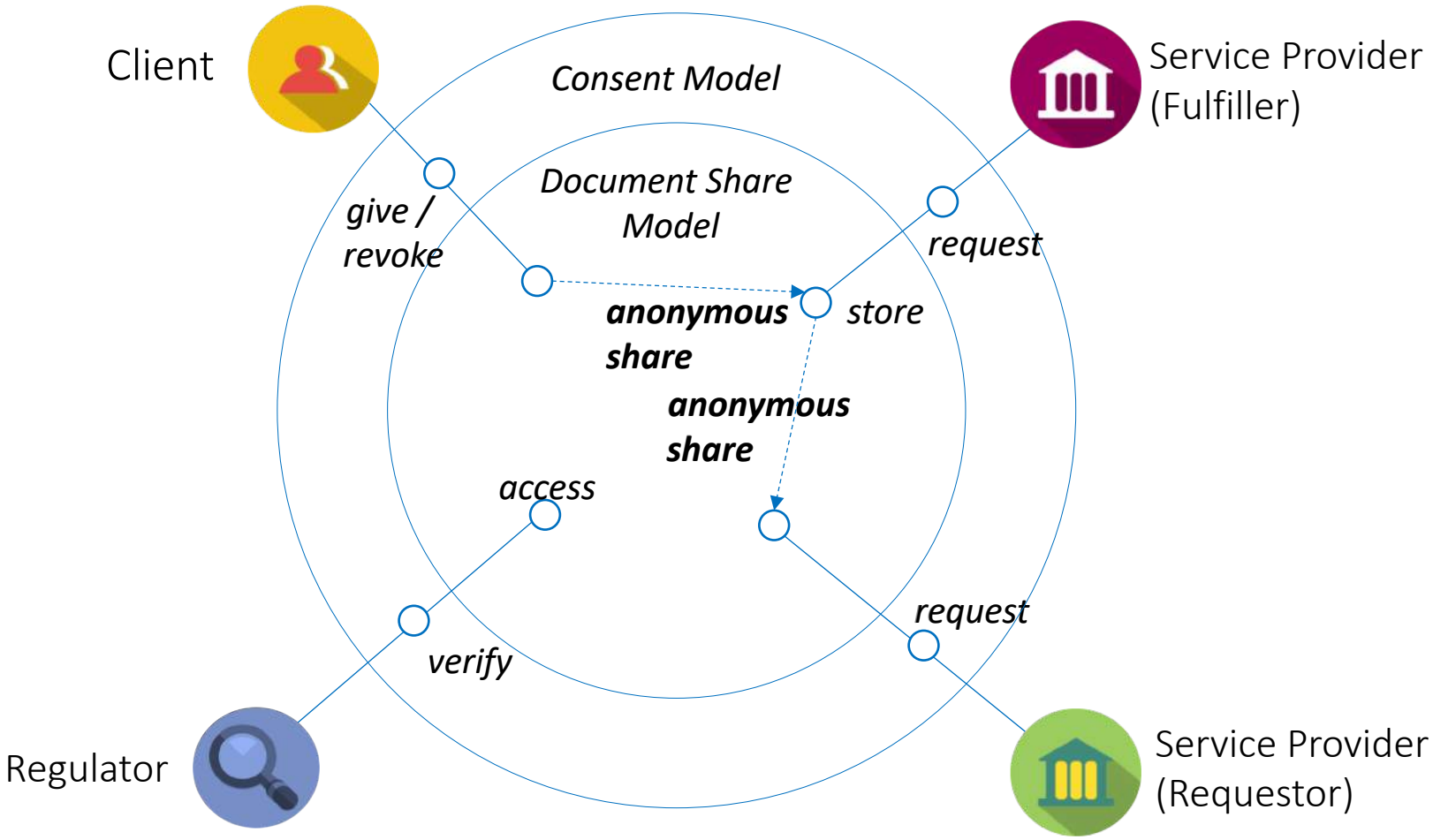
Regulator
To verify compliance, performs investigations and audits by inspecting the Blockchain.

The parties form a consortium to share KYC information while respecting business constraints. They use Blockchain as the shared permissioned network where information is exchanged.

Business Constraints

Anonymity of Relationships	The relationship between a customer and a bank is confidential. Therefore, when sharing/requesting information bank's identity must be hidden.
Access Control	The access to a customer profile (and corresponding documentation) must be explicitly granted by the customer (consent).
Dynamic Permissions	Consent is granted and revoked in accordance with the evolution of the customer-bank relationship.

Model for Privacy and Consent



Consent Model

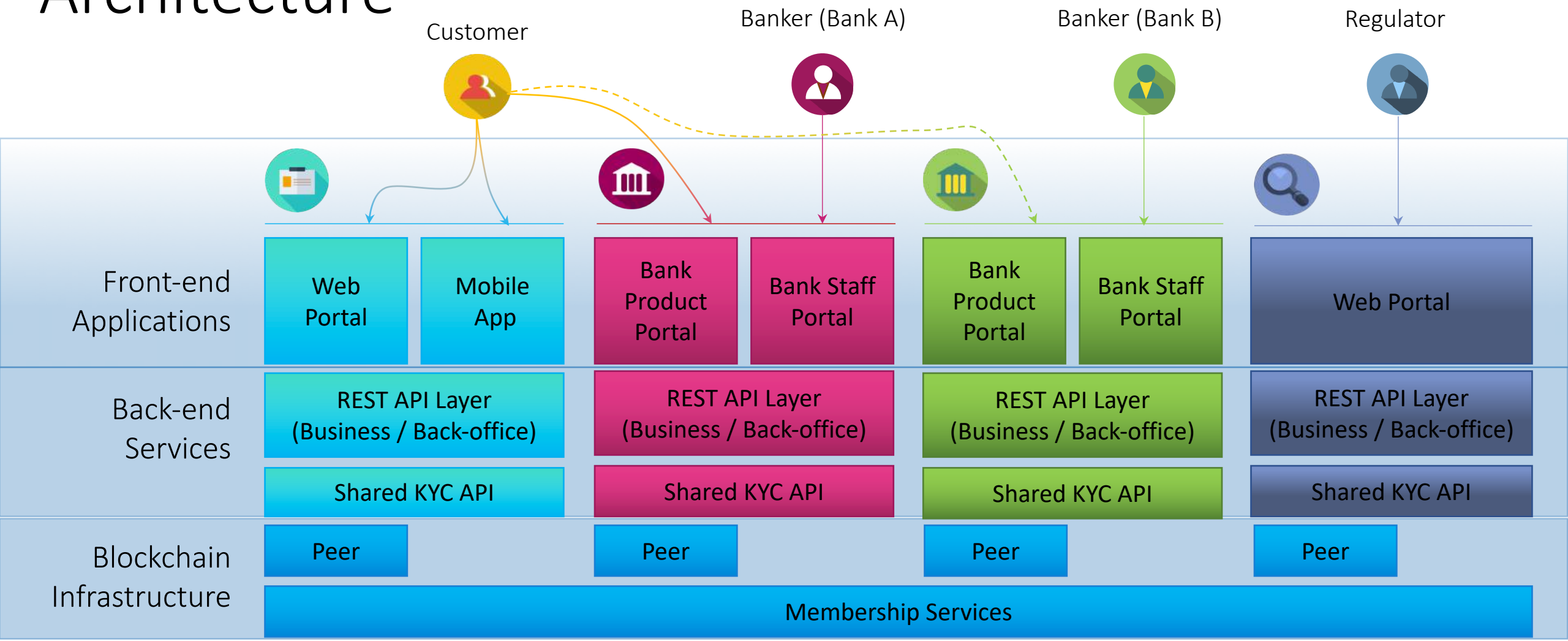
Defines how access to profile and sensitive information is managed and granted or revoked by preserving the confidentiality of the relationship.

Document Share Model

Allows for anonymous but verifiable share of documents based upon consent.

Bhaskaran, Kumar, et al. "Double-blind consent-driven data sharing on blockchain." *2018 IEEE IC2E*

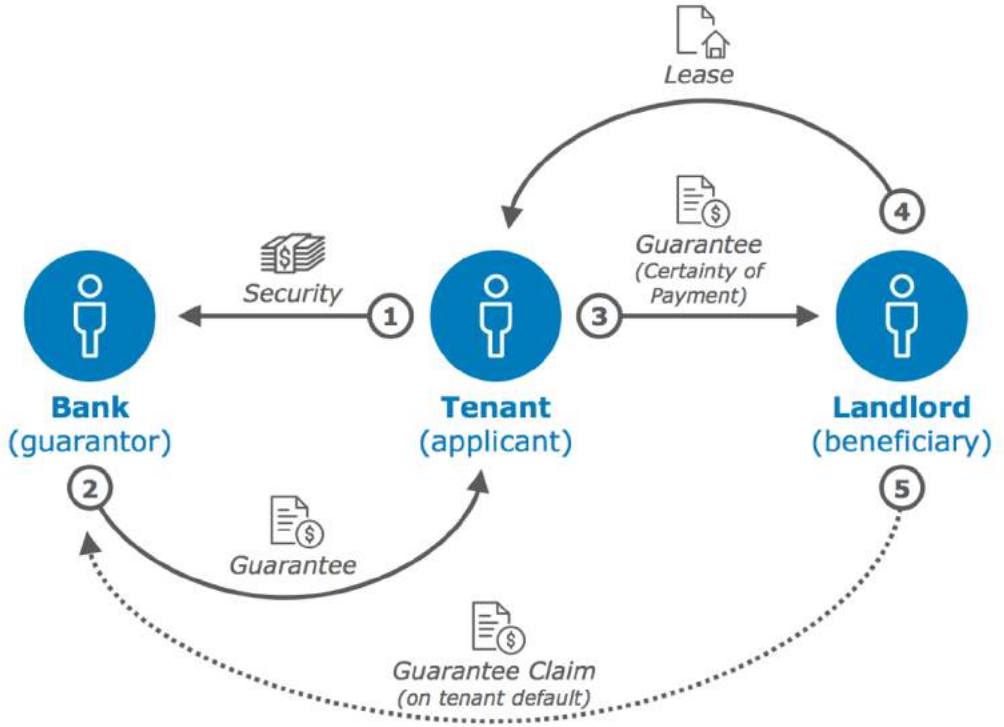
Architecture



Bank Guarantees for Commercial Property Leasing

What is Bank Guarantee?

Bank guarantee is a bank's unconditional undertaking to pay one party in the event of another's default. They are used across many industries to secure contracts, be it in the trade of goods and services, financial transactions, industrial projects, the development of property, or the leasing of assets.



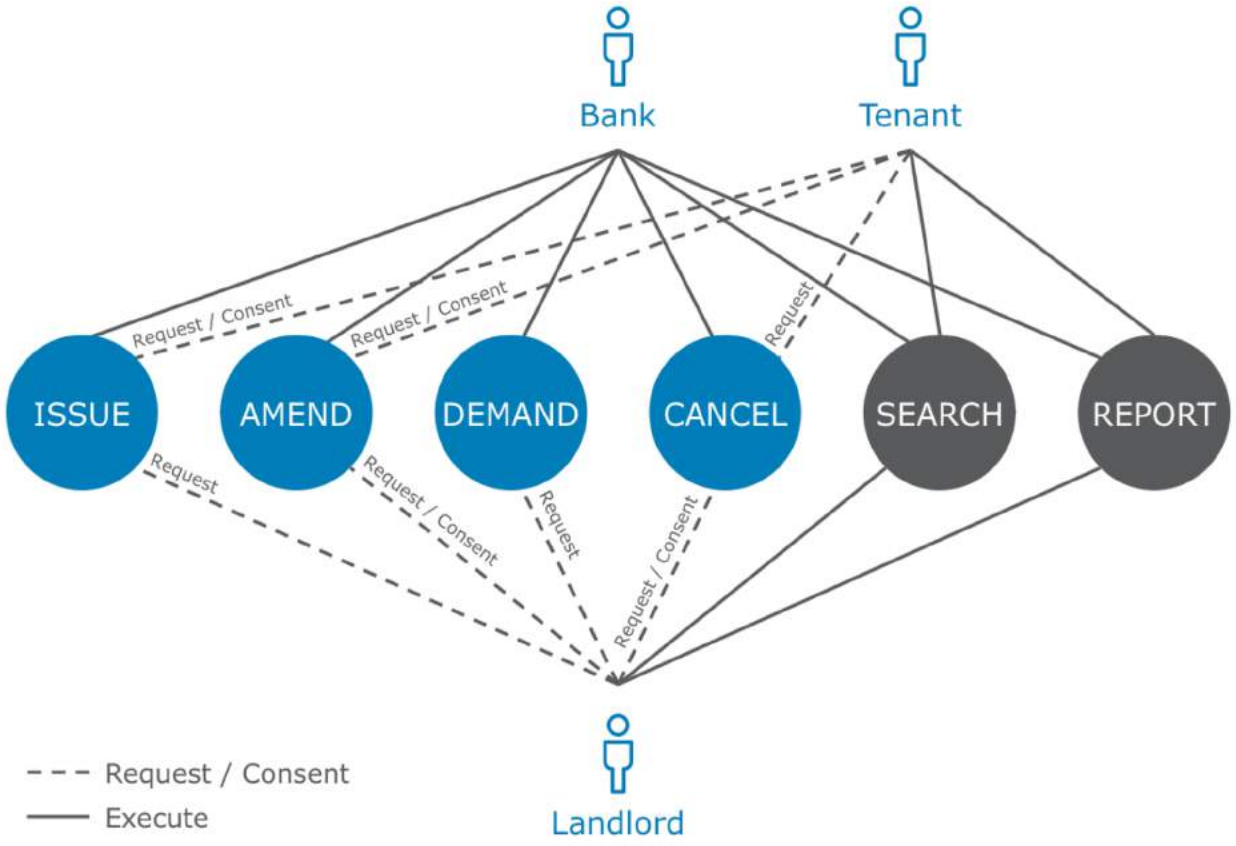
Issues in the Current System

- **Physical document management**
  - Significant costs associated with management of a paper-based guarantee
  - Guarantees as a digital asset will simplify guarantee lifecycle management
- **Fraud risk**
  - Tenant (applicant) fraud arising from the provision of forged or duplicated paper guarantees
  - A shared ledger as a single source of truth will eliminate document forgery
- **Inefficient reporting & management**
  - Storing, tracking and reporting large numbers of documents is highly inefficient
  - Analysis of digital data will greatly improve the ability to make decisions from aggregate data
- **Non-standard T&Cs and formats**
  - Variations in the articulation of contract terms and guarantee formats between banks, landlords and tenants result in a large manual review effort
  - Blockchain can embed industry standards into the business rules of the platform to drive standardization

Why Blockchain?

- Bank Guarantees are offered by multiple institutions, and many different applicants and beneficiaries require their use – A single network managing all of these provides a single point to manage all guarantees a particular user is party to
- The strong security offered by DLT technologies, and the nature of being a single source of truth greatly reduces the risk of fraud or lost documents
- Bringing guarantee providers into a single network creates a platform to drive standardisation

Scope of Proof-of-Concept



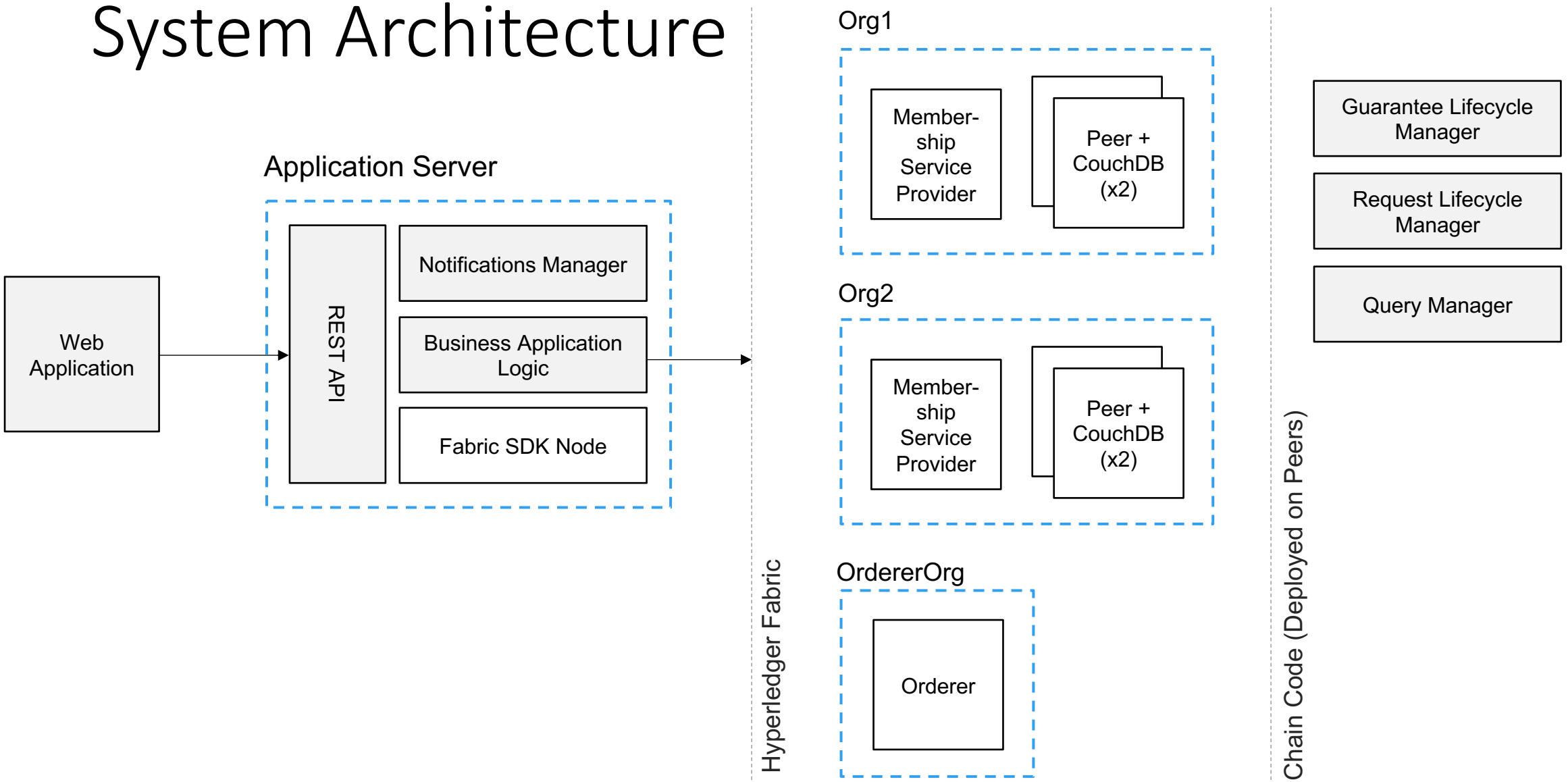
4 core capabilities are involved in implementing:

- Issue a new guarantee
- Amend an existing guarantee
- Demand payment on a guarantee
- Cancel a guarantee

2 additional user stories improve on the usability of the solution:

- Search for a specific guarantee
- Report across multiple guarantees

System Architecture



AI Driven Micro Insurance Marketplace on Blockchain

Empowering users and insurance providers

Global Market Opportunity

Customers

Large numbers of drivers in developing countries without insurance:

- 65% to 70% in South Africa[1]
- 60% in India[2]

Insurers

Usage-based auto Insurance (UBI) is expected to grow globally[3] :

12 million in 2015 → 142 million in 2023

[1] 11.4 million cars on SA roads not insured, 2016.
[2] 60% of vehicles on Indian roads don't have insurance, 2017
[3] *IHS Automotive,* Auto Tech Report: Usage Based Insurance 2016

Value Proposition

Customers

- Lower premiums 5-30%[4]
- Increased transparency
- Make purchasing of policies easier
- Reduce complexity of the claim process

Insurers

- Innovate products and services
- Automate underwriting and claims handling by use of smart contracts
- Improve customer experience
- Reduce customer's privacy concerns on personal and sensitive data

[4] *Nielsen*, 2015 Insurance Track survey, 2016

Project Outline

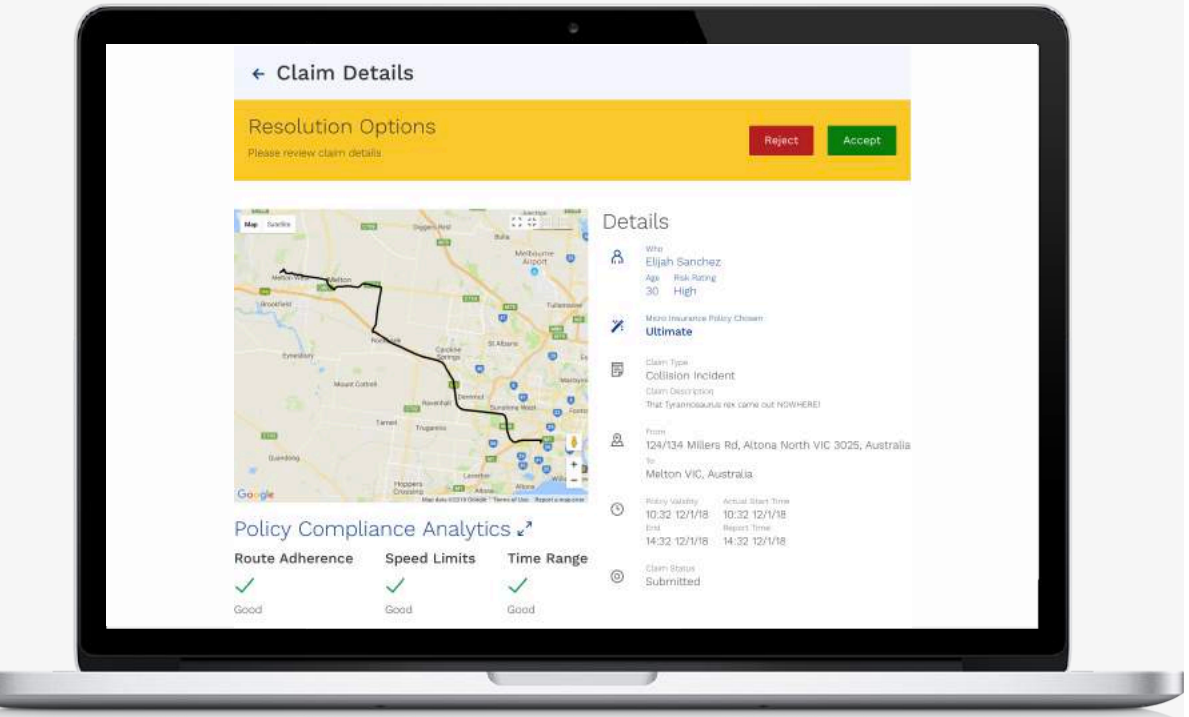
- Provide dynamic Pay-As-You-Go (PAYG) insurance for automobile drivers:
  - Link insurance cost to route, driving duration and other factors such as weather conditions, road conditions, driving behavior, etc.
  - Dynamic cost calculation gives customers more accurate quotes, allowing customers to choose which factors are most important to them
- Provide a shared ecosystem for insurance companies to share customer history:
  - For instance, this data sharing can enable insurers to build more accurate risk models for customers
  - Insurance providers can leverage dynamic quotes to adjust price based on dynamic variables, such as weather, time and demand, etc.

AI-Driven Insurance Marketplace

- Lots of useful analytics can be derived from the data we are storing in the blockchain (e.g. driver risk profile, trip and claim history etc.)
- However, much of these analytics are not part of the core business of insurance companies, therefore there is a potential for these analytics to be offered via a marketplace
- This marketplace could include analytics such as:
  - Fraudulent claims identification
  - Route adherence to micro insurance policy

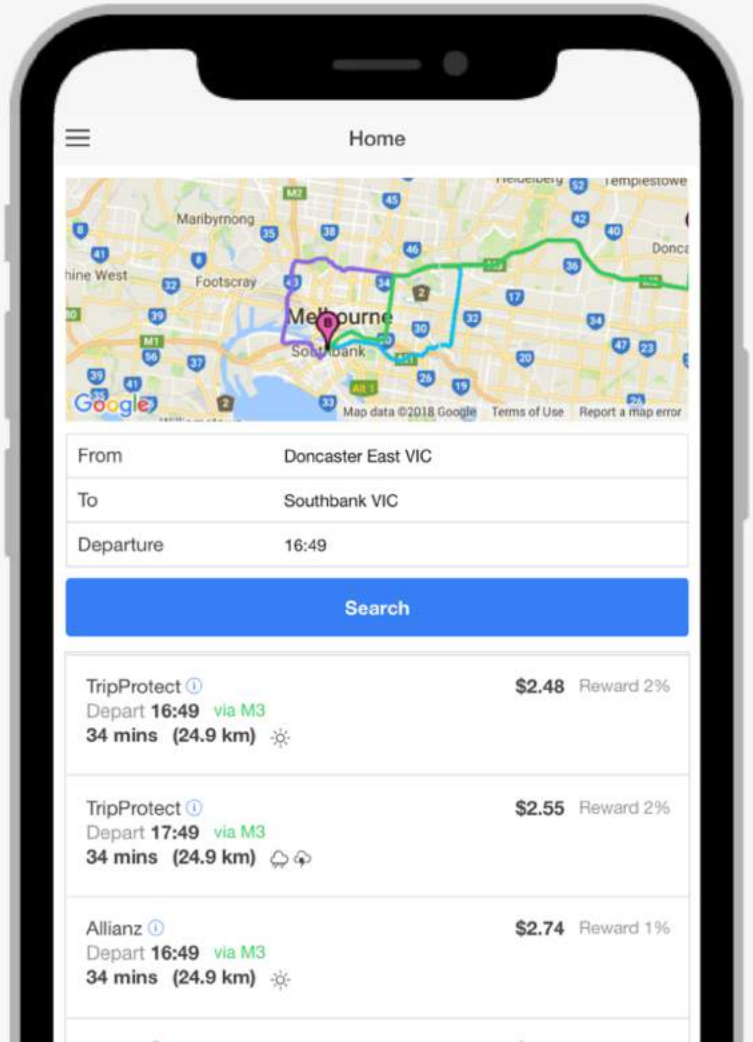
Why Blockchain

- Insurance companies have no basis for trusting each other, yet must also work together in the marketplace to ensure the allocation of policies for driver trips.
- A shared ledger is important because there is no obvious central authority that is not also an ecosystem participant.
- Insurance companies collaborate in sharing driver and driving data, yet also must compete in the marketplace, so it is reasonable to expect the insurance companies to work together ensuring the completeness and integrity of the shared ledger.
- Insurance regulators are also expected to participate in the marketplace, and a shared, permissioned ledger aids auditing and traceability of policies as assets, and regulatory oversight.



Insurance Company Portal

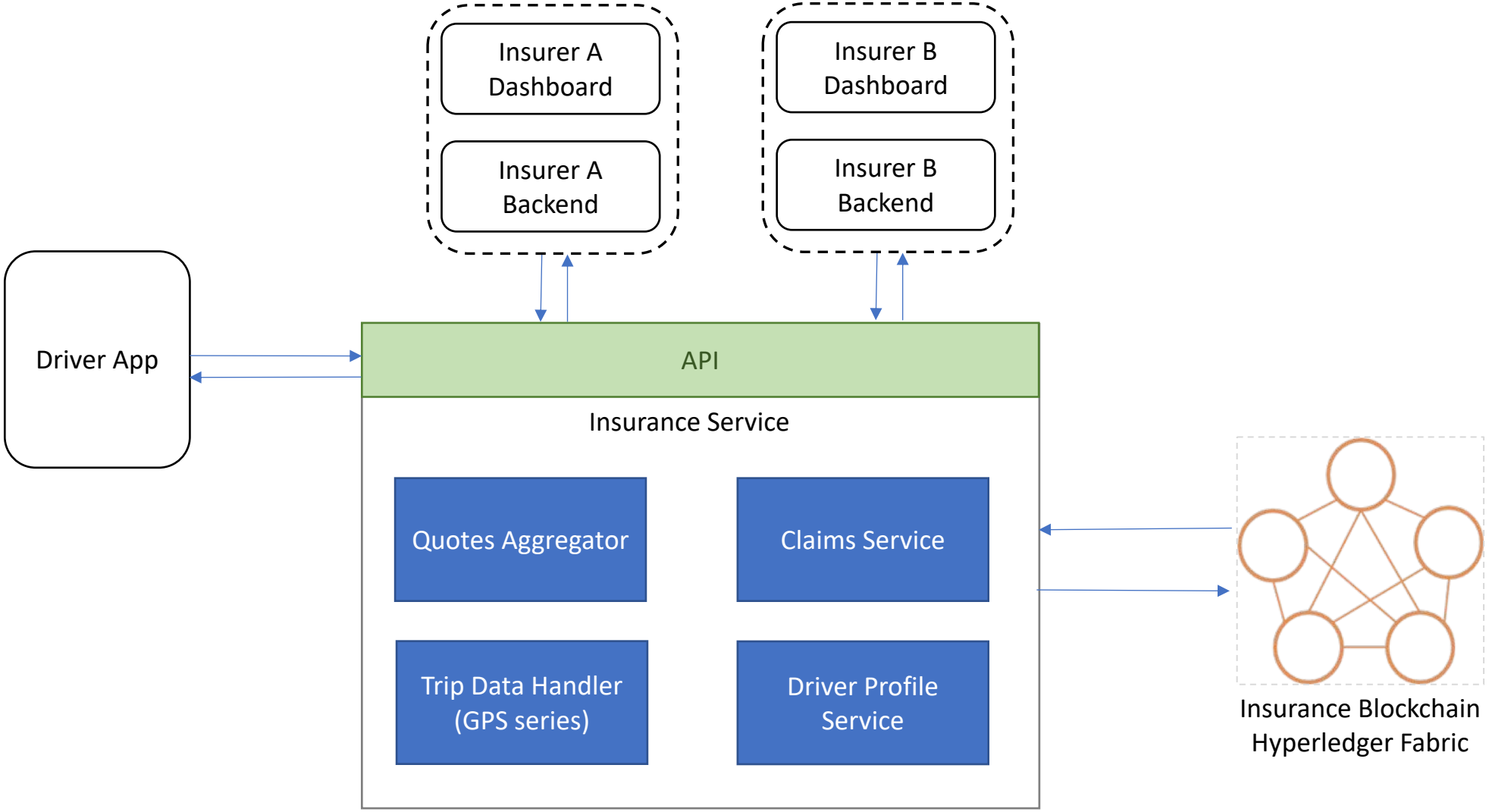
- Leverage collected data and gain insights to increase claim resolution and reduce time going over a claim's data
- The analytics will overlay a trip's timeline, bringing to the front crucial aspects for the insurer to better judge a claim
- View active trips in real time to understand market demand in a micro-insurance world – so that rates/rewards can be adjusted (think high surcharge according to demand/location/risk profile)



Micro-Insurance Driver App

- A blockchain marketplace for insurance consumers PAYG micro-insurance
- Integrated with real-time weather forecasting (dynamic quoting)
- Insurance companies can adjust rewards based on demand, customer risk, time, etc.

System Architecture



Document and Workflow Management in Trade and Logistics

Value Proposition

- More than **$16 trillion in goods** are shipped across international borders each year
- **80% of the goods** consumers use daily are carried by the ocean shipping industry
- By reducing barriers within the international supply chain, global trade could **increase by nearly 15%,** boosting economies and creating jobs[1]

[1] The World Economic Forum: Enabling Trade Valuing Growth Opportunities 2013

Pain Points

Global trade is highly inefficient and burdened by **paper-based processes**

- Data trapped in organizational silos
- Disparate perspectives on transaction state
- Manual and time-consuming processes
- Clearance processes subject to fraud

Digitizing the Global Supply Chain

- **Connects the ecosystem**
  - Brings together all parties in the supply chain - including traders, freight forwarders, inland transportation, ports and terminals, ocean carriers, customs and other government authorities, and others - onto a Blockchain- based platform with a secure permission and identity framework
- **Drives true information sharing**
  - Provides for the seamless, secure sharing of real-time, actionable supply chain information across all parties to a trade - encompassing shipping milestones, cargo details, trade documents, the structured data embedded in trade documents, customs filings, sensor readings, and more
- **Fosters collaboration and trust**
  - Enables the digitization and automation of the cross-organization business processes integral to global trade, including import and export clearance, with Blockchain ensuring secure, auditable, and non-repudiable transactions

Why Blockchain

Blockchain addresses the underlying challenges inherent in collaborating across a distributed, fragmented supply chain ecosystem

SHARED LEDGER

Append-only distributed system of record shared across business network

A network of industry participants maintains a distributed, permissioned ledger with copies of document filings, relevant supply chain events, authority approval status, and full audit history; every change results in a new, immutable block

SMART CONTRACT

Shared business logic governing what transactions may be written to the ledger

Cross-organizational business processes, such as import and export clearance, are pre- programmed and built into Blockchain and distributed to and executed on the network, preventing any member from changing the business logic

PRIVACY

Ensuring appropriate visibility; transactions are secure, authenticated and verifiable

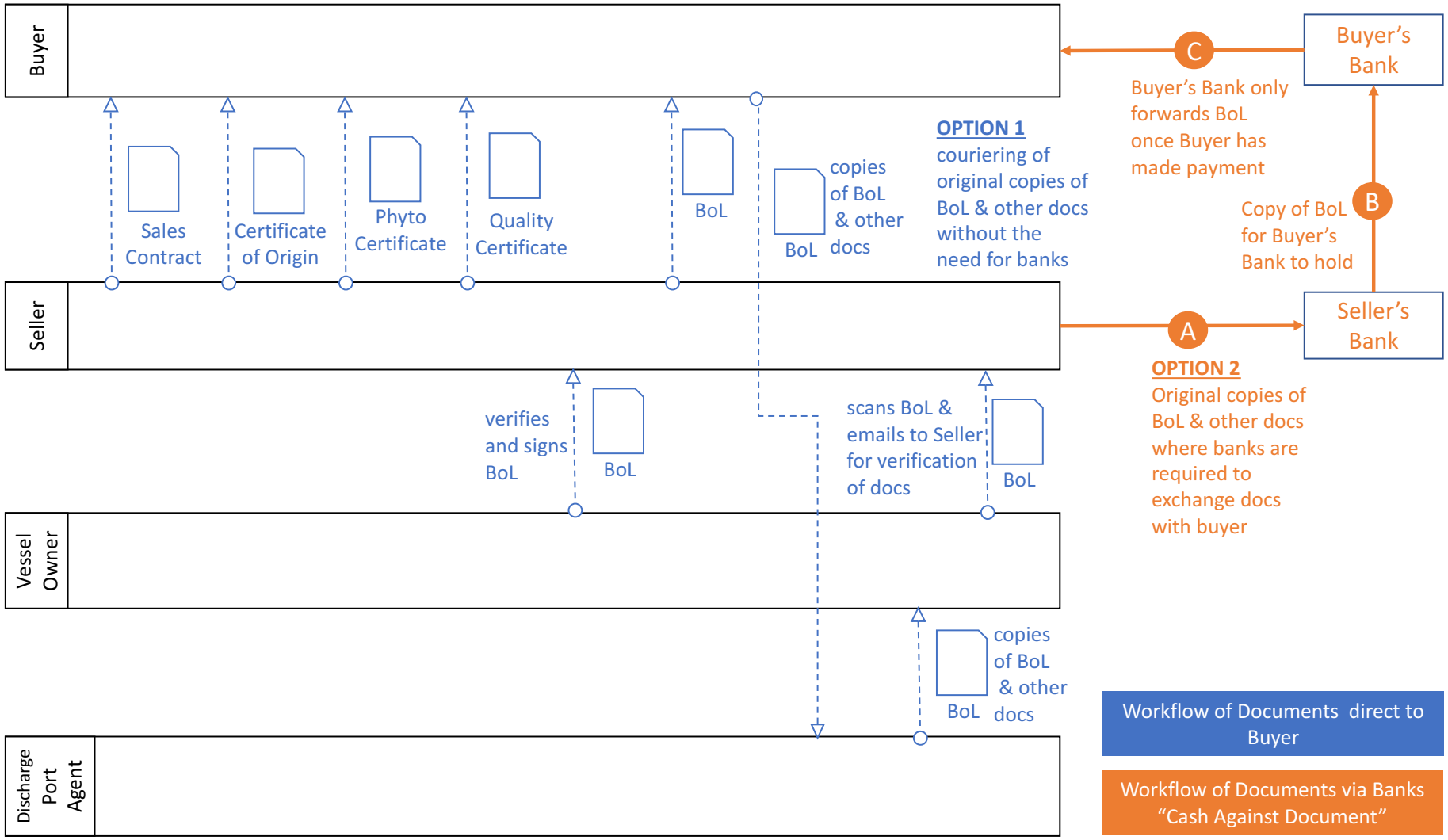
Cryptography enables permissioned access so only the parties participating in a specific shipment can submit, edit or approve related data

TRUST

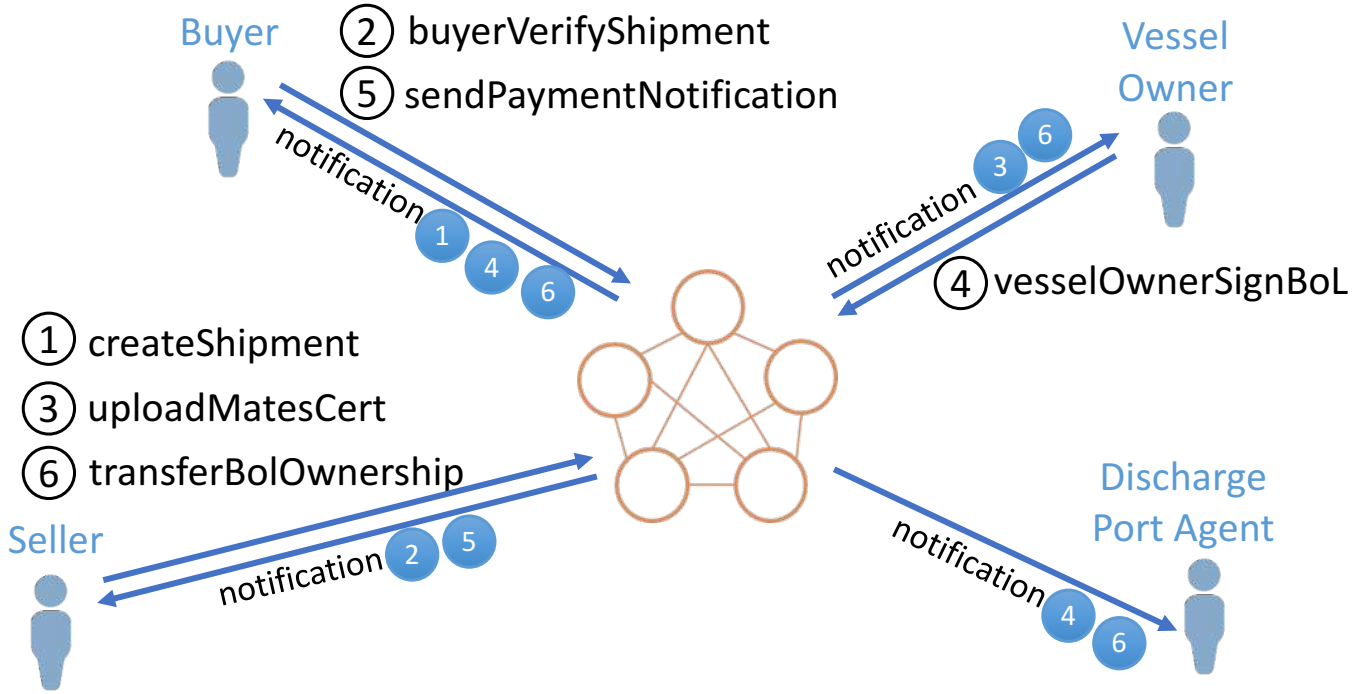
Transactions are endorsed by relevant participants

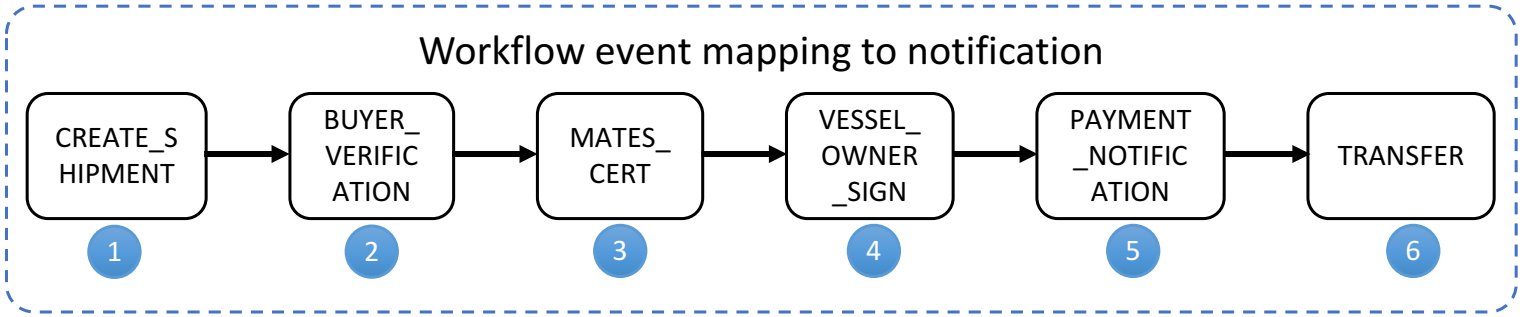
Information such as documentation filings and authority approvals can only be changed if endorsed by the parties taking part in the shipment; full audit history maintained on the Blockchain

Workflow and Payments in Current Systems



The Blockchain System Design





Z Wang, et al. "Distributed Ledger Technology for Document and Workflow Management in Trade and Logistics", *ACM CIKM* 2018.

Part II-b: Platforms for Enterprise Solutions

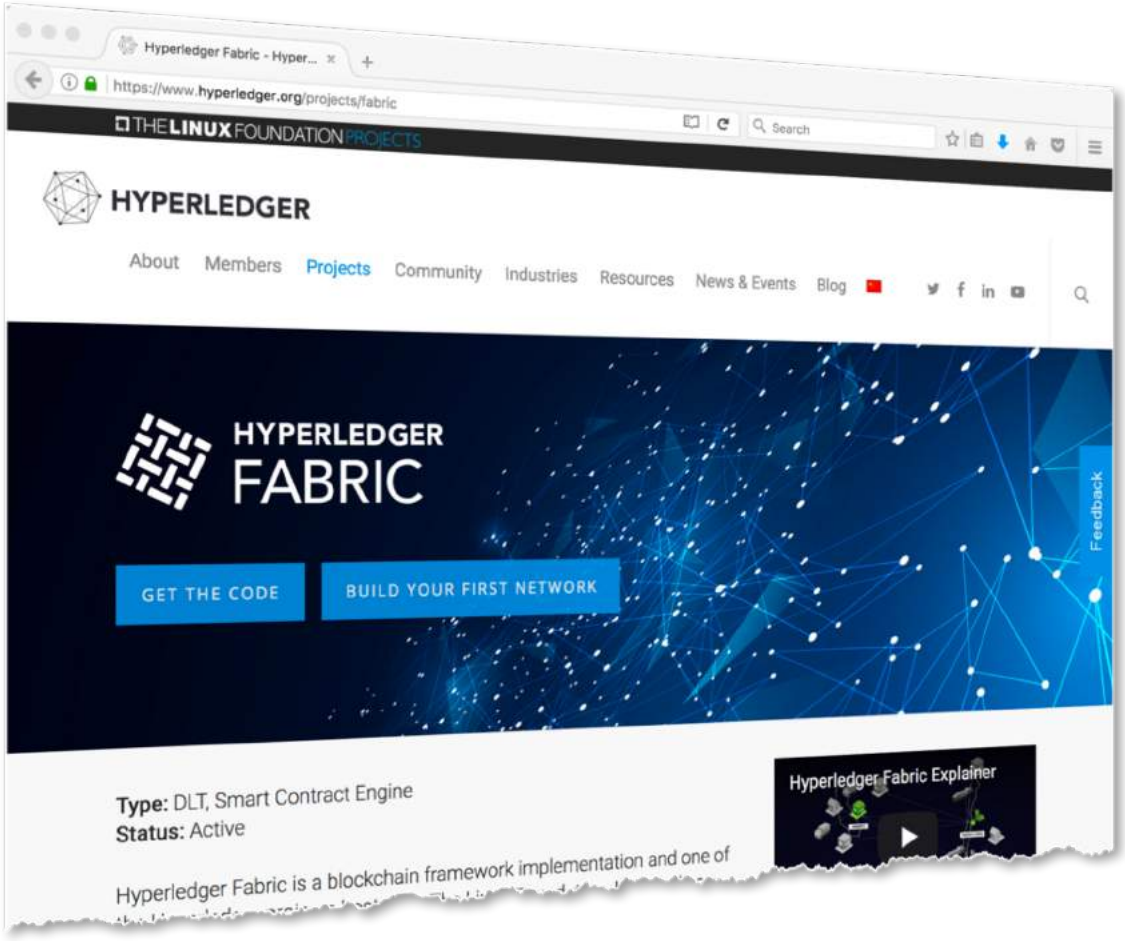
- Hyperledger Fabric
- R3 Corda

Hyperledger: A Linux Foundation project

- A collaborative effort created to advance cross-industry blockchain technologies for business
- Founded February 2016; now more than 230 member organizations
- Open source, open standards, open governance
- Five frameworks and five tools projects

www.hyperledger.org

HYPERLEDGER FABRIC



- An implementation of blockchain technology that is a foundation for developing blockchain applications
- Emphasis on ledger, smart contracts, consensus, confidentiality, resiliency and scalability.
- V1.4 released
  - focus on stability and production operations
- IBM is one of the many contributing organizations

http://hyperledger-fabric.readthedocs.io/

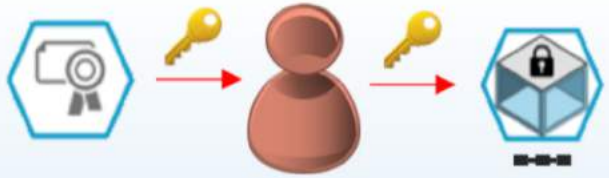
Hyperledger Fabric v1 – Design Goals

- Better reflect business processes by specifying who endorses transactions
- Support broader regulatory requirements for privacy and confidentiality
- Scale the number of participants and transaction throughput
- Eliminate non deterministic transactions
- Support rich data queries of the ledger
- Dynamically upgrade the network and chaincode
- Support for multiple credential and cryptographic services for identity
- Support for ”bring your own identity”

Hyperledger Fabric Overview

Peers are the networked services that maintain ledger state and run smart contracts

Channels are defined subsets of the peer network that share a single ledger



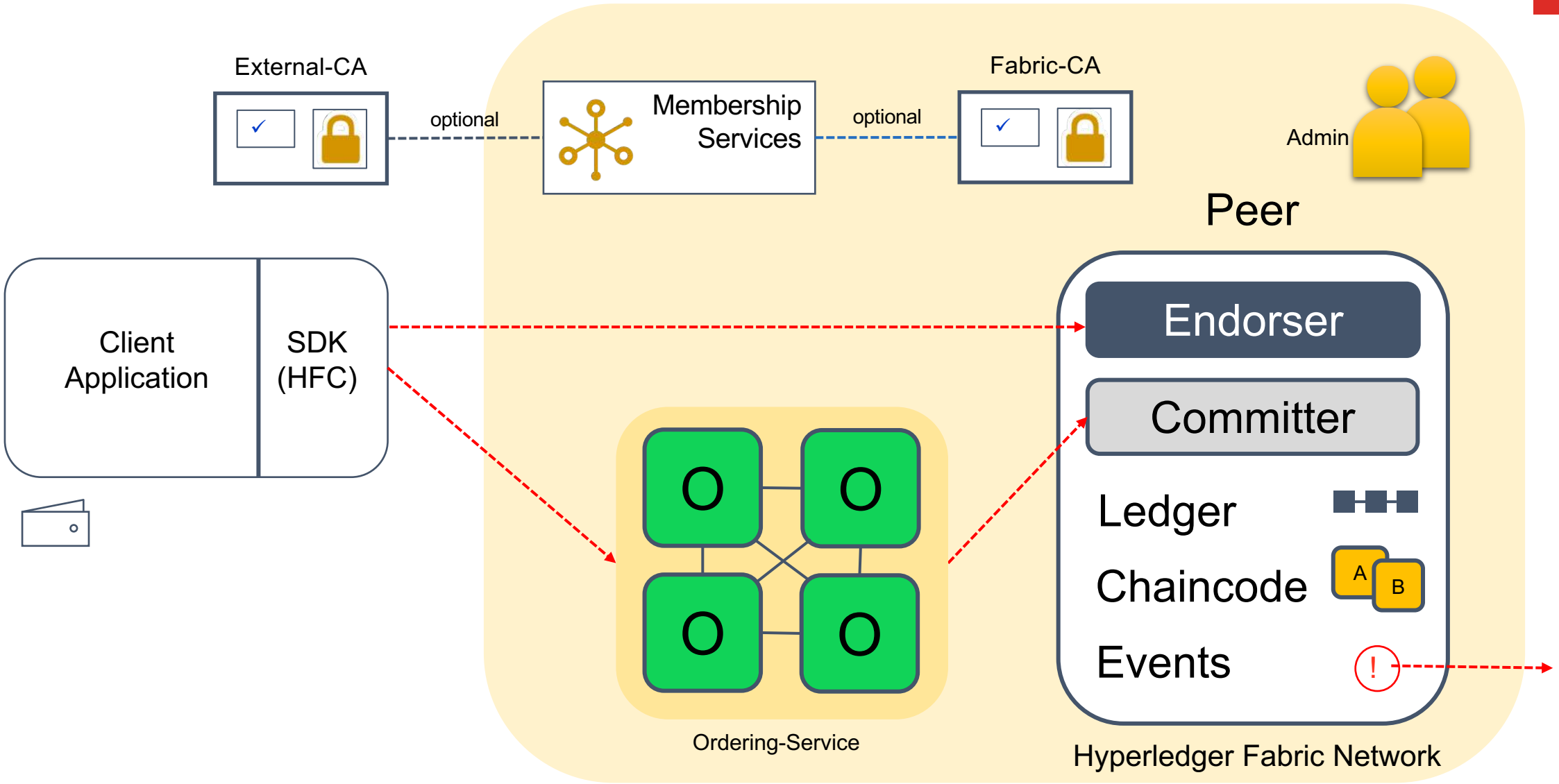
Certificate authorities provide identity services to participants on the network

Smart contracts constitute the transaction logic whose output is agreed by the peer network

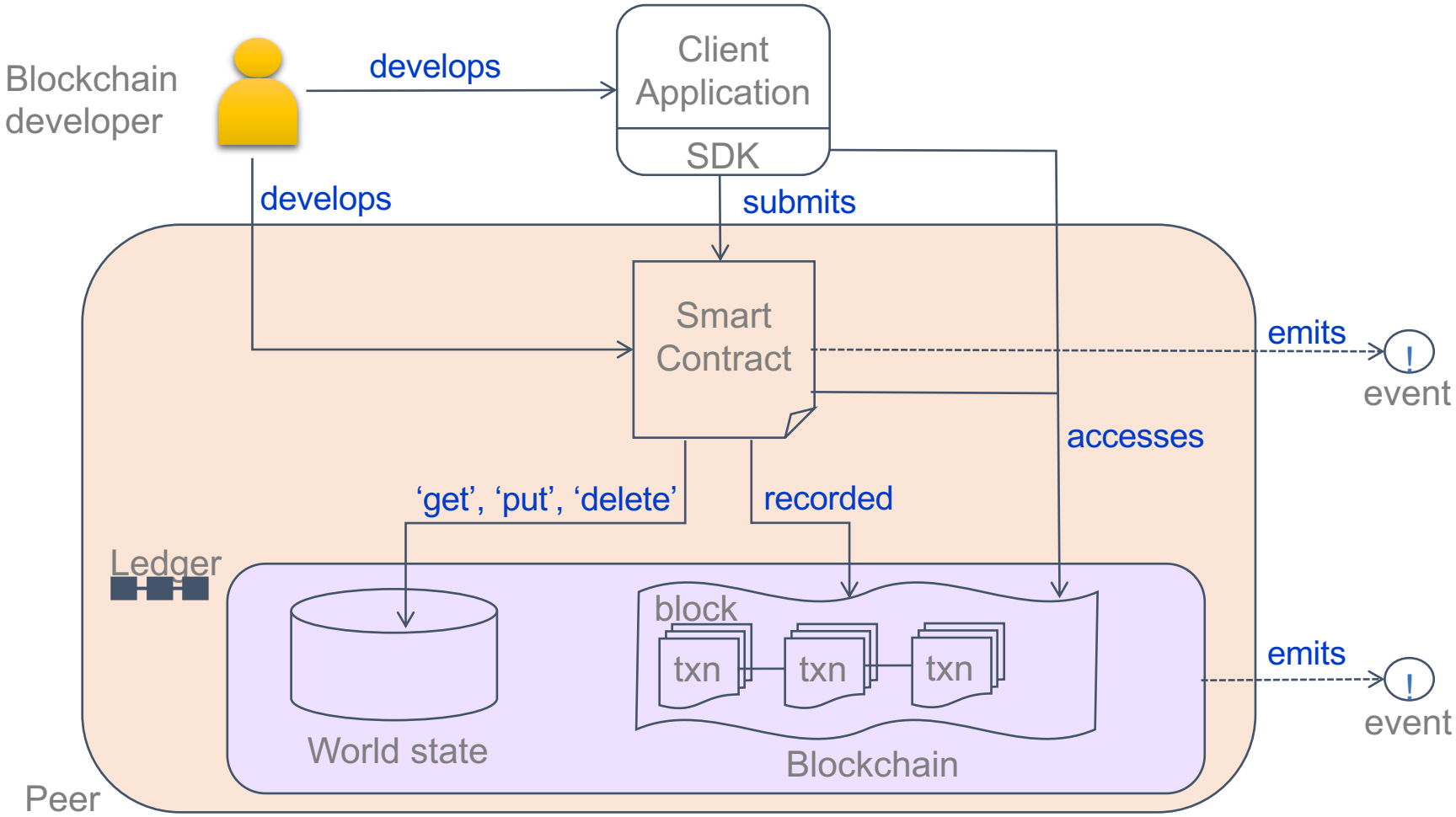
Consensus is the process by which agreement is obtained on the peer network

The **Ordering Service** agrees transaction sequence and distributes blocks to peers

Fabric V1 Architecture

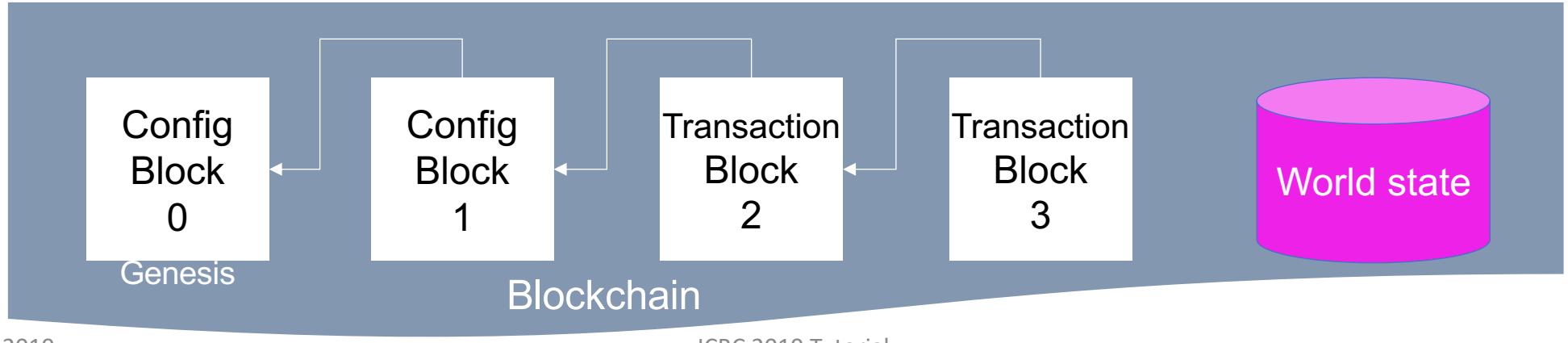


How Applications Interact with the Ledger



Fabric Ledger

- The Fabric ledger is maintained by each peer and includes the blockchain and world state
- A separate ledger is maintained for each channel the peer joins
- Transaction read/write sets are written to the blockchain
- Channel configurations are also written to the blockchain
- The world state can be either LevelDB (default) or CouchDB
  - LevelDB is a simple key/value store
  - CouchDB is a document store that allows complex queries
- The smart contact decides what is written to the world state



R3 and Corda

- R3 leads a consortium of more than 80 of the worlds biggest financial institutions
- Consortium started in 2015 with 9 financial companies (CBA, JPMC, Goldman …).
- Some of the key members, JPMC, Goldman, Morgan Stanley, Santander have since left the consortium.
- The consortium seems to have taken a requirements driven approach to designing a DLT that is suited specifically for FSS.
- Built Corda based on these requirements and open sourced it in late 2016

Corda Design Principles

- No blockchains
- No broadcast: all communication is point-to-point
  - Rejects the notion that data should be broadcast to all participants – or to predefined groups
  - Data is shared on a need-to-know basis and peers only see what they need to see
  - Not sending is preferable to sending and encrypting
  - Message senders need to know the identity of recipients
- Unspent Transaction Output (**UTXO**) for recording states (like Bitcoin) i.e. Does not use an account model like Ethereum, Fabric etc.
- Platform is JVM-based, written in Kotlin (can use Java, Clojure, etc)
- Supports industry-standard protocols: AMQP, JDBC, PKIX, etc.

Legal Agreements as a Foundational Concept

Elements of a Legal Agreement (State)

Issuer: Australia and New Zealand Banking Group

Beneficiary: Scentre Group

Applicant: Smith Co.

Amount: $...

Interest: ..%

Effective date:
- From: May 10th 2018
- To: May 10th 2020

Amount payable to be computed based on share price as of ….

Parties (Identities, Private Ledger)

Time (Time Windows)
- Before (Expiry)
- After (Maturity date)
- Within period

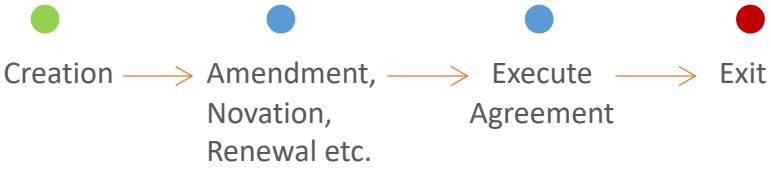
External facts and conditions that govern the contract (Oracles)
Corporate Action, Interest rates, share price, bankruptcy, FX conversion etc.

Witness (Notaries, Observers)

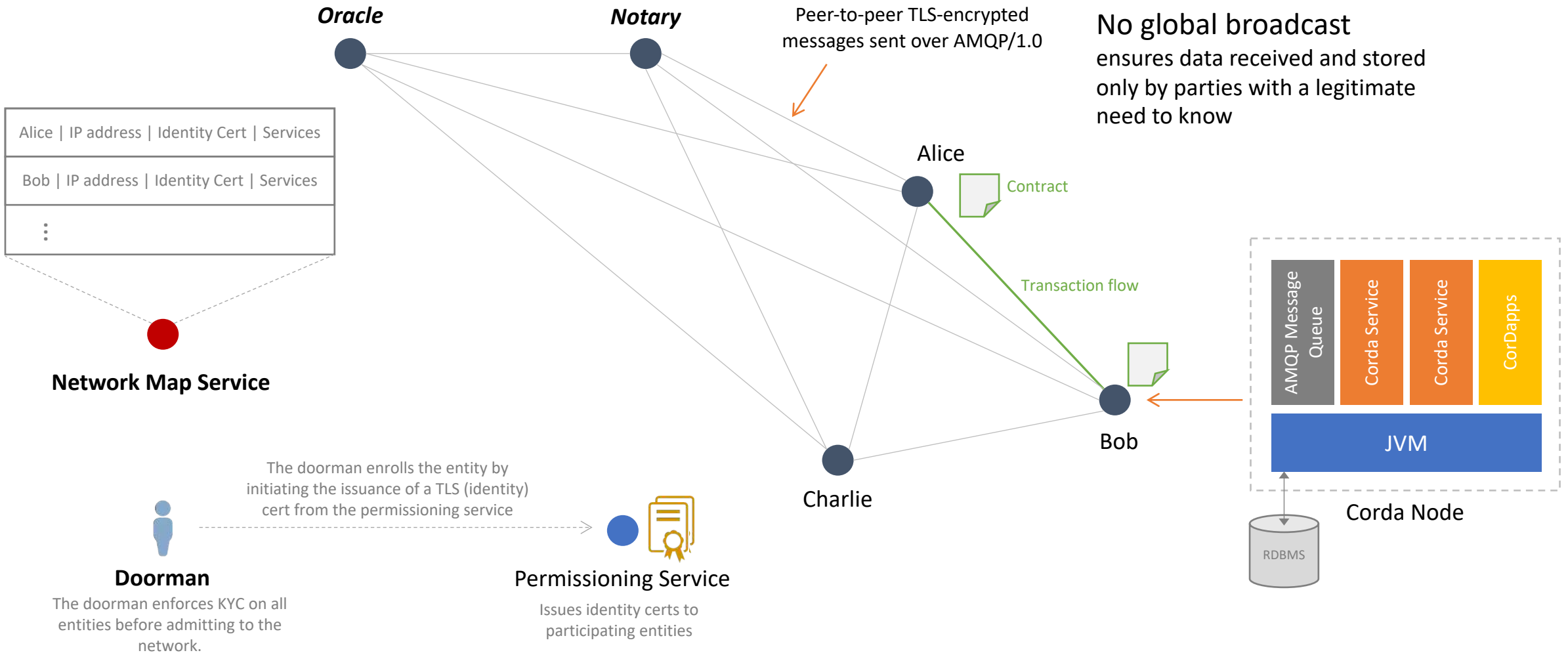
Terms and Conditions (Legal Prose)

Supporting documentation (Attachments)

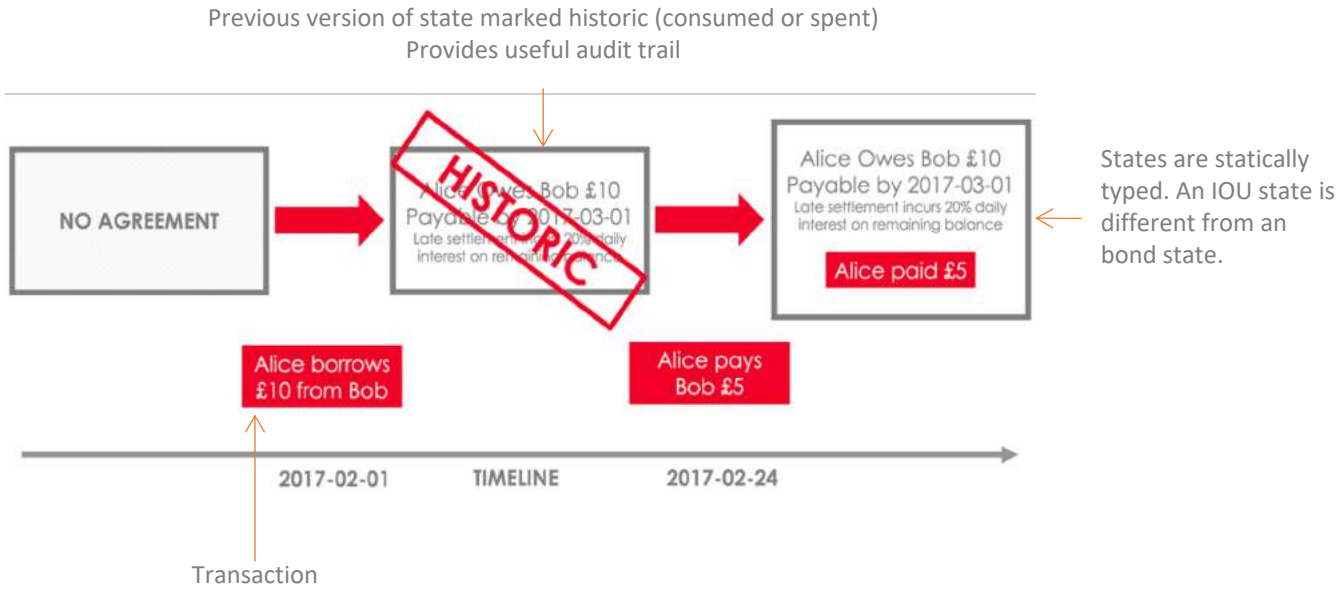
Lifecycle of an Agreement



The Corda Peer-to-Peer Network



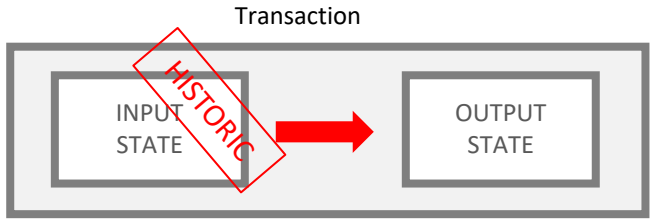
UTXO State-Machine Model



- Shared facts are represented by *states* using a UTXO state-machine model.
- States are similar to Bitcoin transactions, but can represent arbitrary data.
- States are immutable and represent a shared fact at specific point in time.
- States evolve by allowing new states to replace old states, resulting in a state sequence.

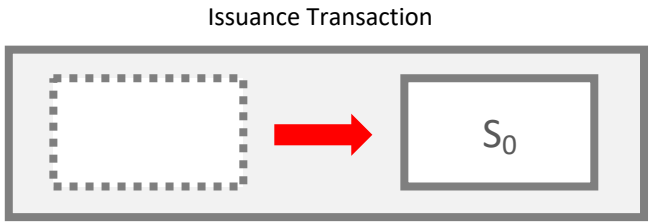
Transactions

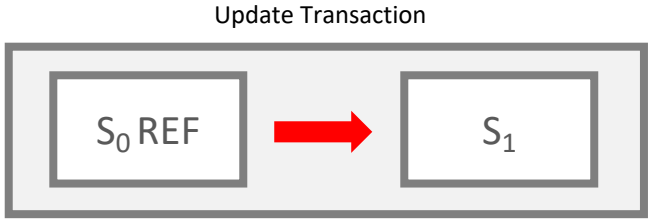
- Transactions reference zero or more input states and create zero or more output states.
- The newly created output states replaces the inputs states which are marked as historic.

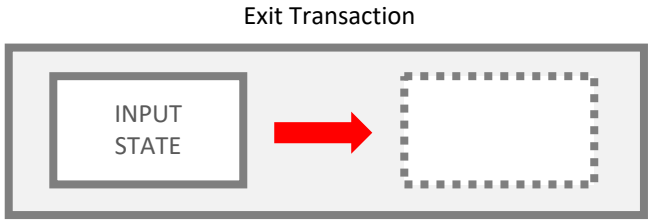


- There are three broad types of changes which can be facilitated by transactions:
  - Issuances
  - Updates
  - Exists

Models the life-cycle of legal agreements







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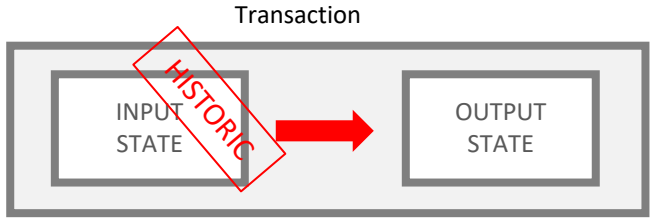

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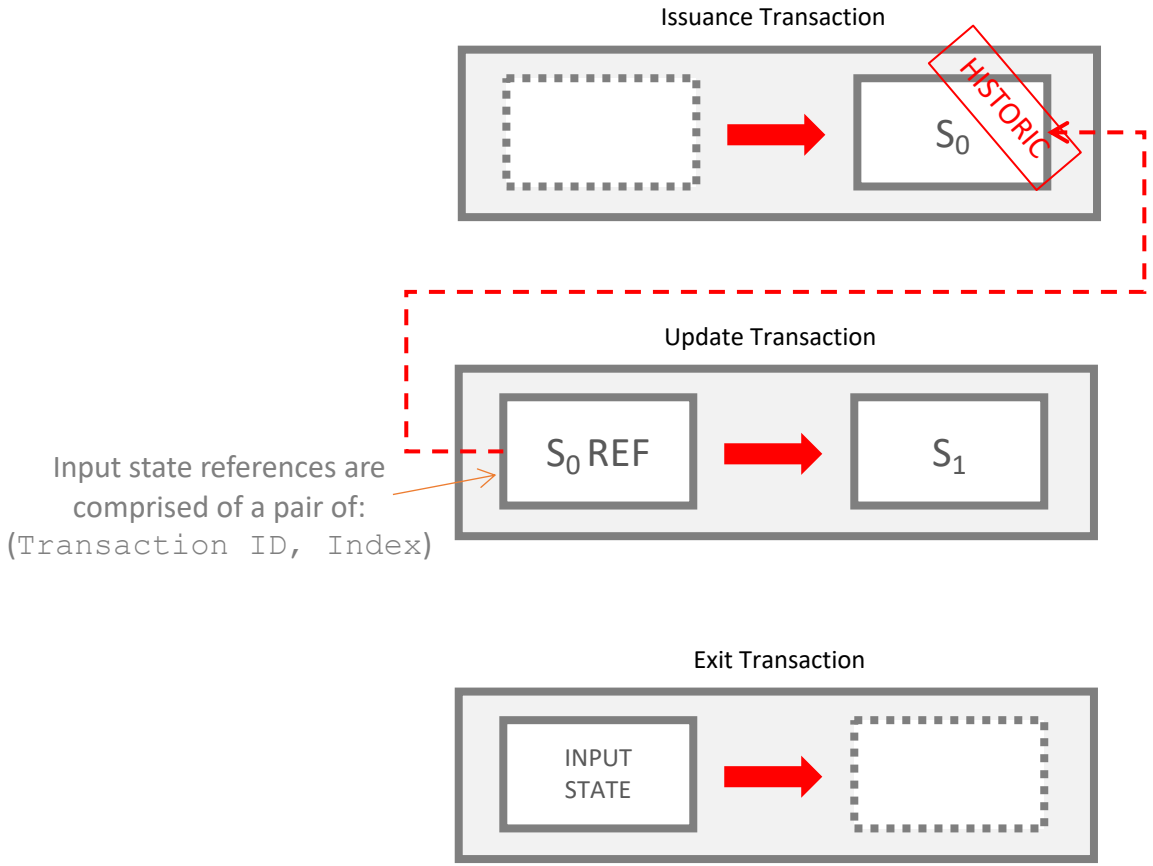

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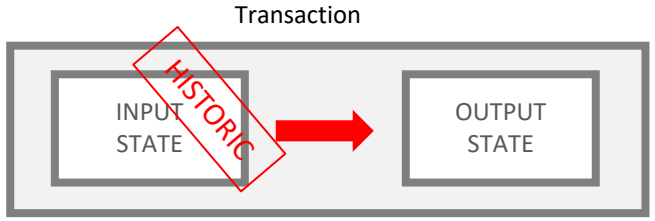

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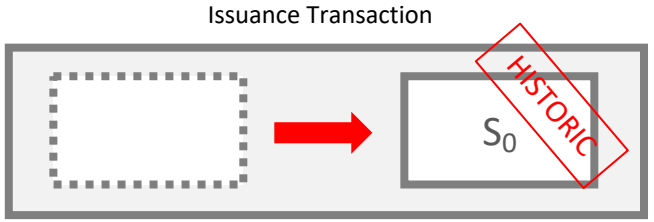
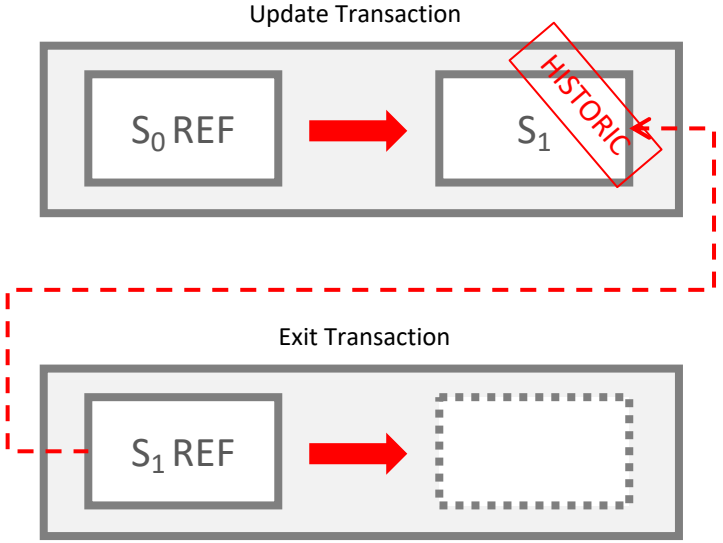




Part III: Key Lessons We Learnt

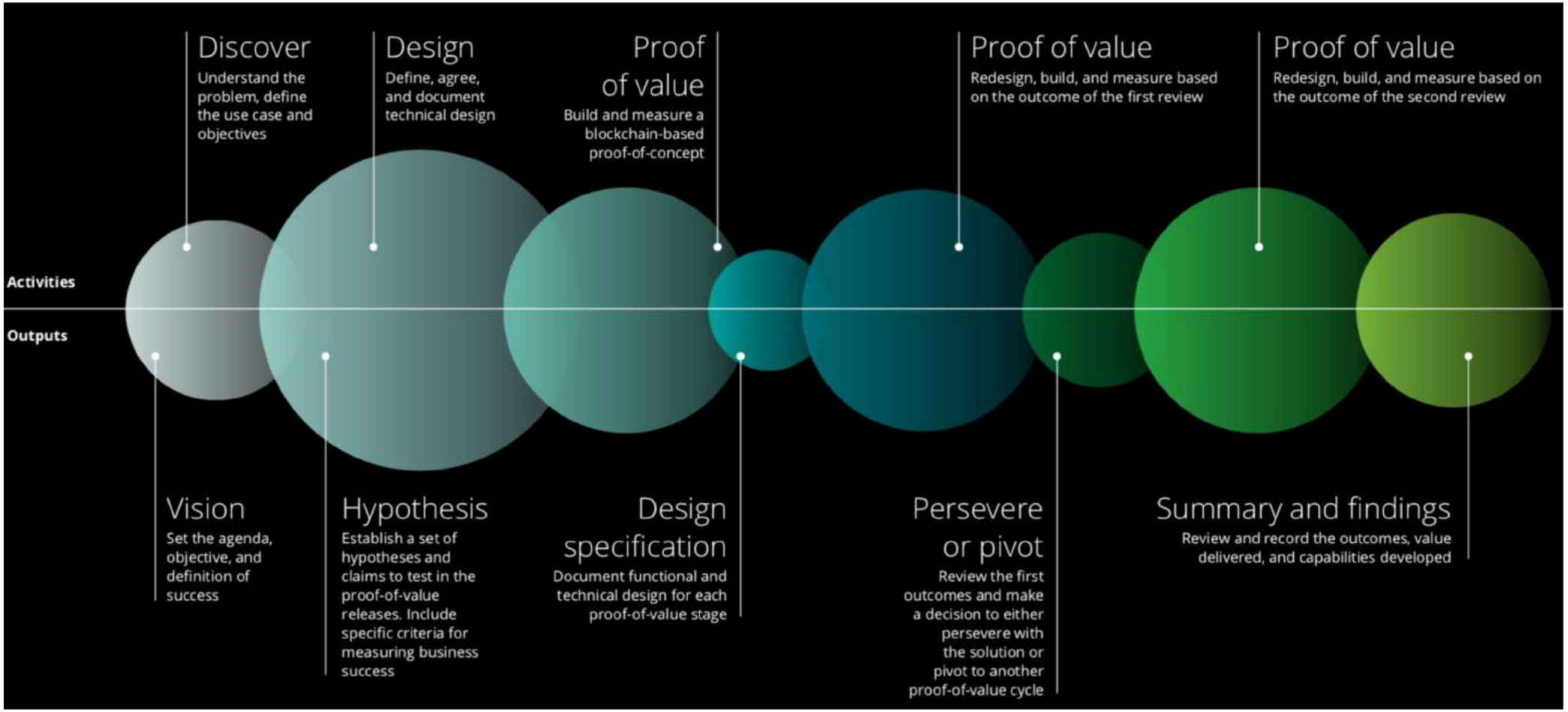
- Challenges related to moving from PoCs to production
- Governance and business models to accelerate the adoption

Barriers to Making it Mainstream

- Unwilling to share organizational data
- Privacy and Regulatory compliance
- Security challenges
- Limited transaction speed

Path to Enterprise Adoption

Think big, but start small. Prove value with iterative bursts of design, build, and review to quickly learn from results—and adjust.



Source: Deloitte, Blockchain for Finance, 2018

Path to Enterprise Adoption

Enterprise Impact and Industry Impact
Meaningful issues should revolve around significant costs to enterprise and industry

Existing business process is distilled down to blockchain-based model
Reinventing the business based on a trust system

Technology to align with the business imperatives
Technology design decisions and deployment options

Integration with down stream transaction systems reflecting on critical business systems

Source: IBM, Making Blockchain Real for Business, 2018

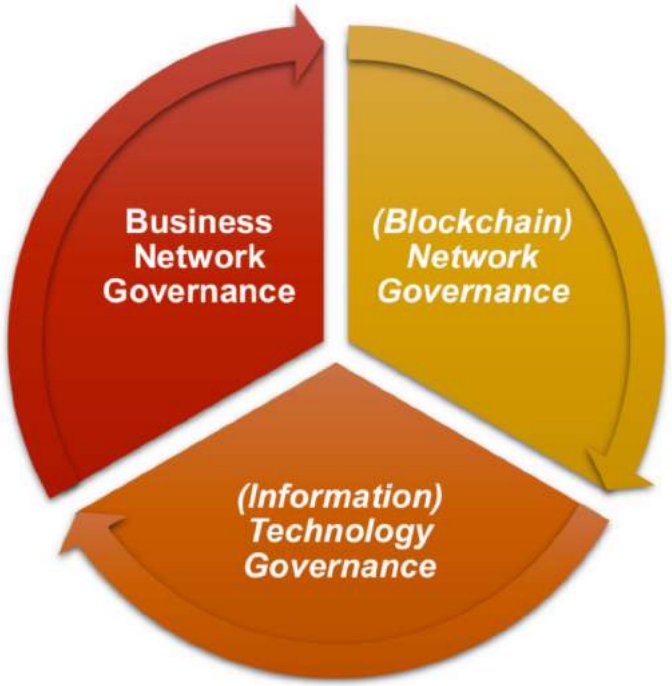
Key Lessons Learnt

- Governance
  - Setting and maintaining good governance is imperative for steady progress
  - Early agreement on a RACI matrix are critical for a smooth transition to operation
- Scope and Method
  - Jointly agree both the Functional and Non-Functional MVP scope early
  - Locking down what is considered ‘done’ in Agile is not obvious for large programmes
- Estimation
  - Estimate wisely and calibrate the initial story points extremely accurately
- Solution
  - Do not underestimate user onboarding along with identity and access management

Building Blocks of Governance Model

Industry and use case-specific which need to factor various facets and evolution of the industry itself.

- Common/shared services management, such as KYC, audits, reporting, etc.
- Product and business network evolution
- Enforcement of legal and regulatory frameworks



An equitable cost structure that is fairly spread based on participant activity.

- Membership onboarding/off-boarding
- Data ownership structure – for business entities joining and leaving the network
- Network support services –include business network SLA enforcement, and membership services

Focused on IT infrastructures, performance, cost structures, and business risk.

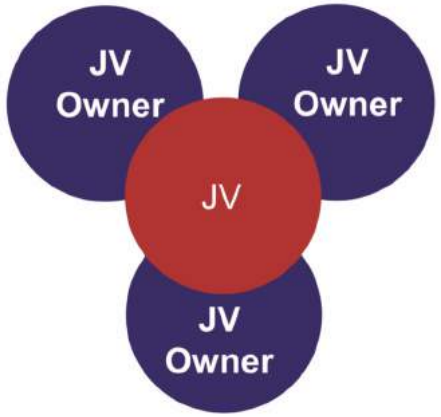
- A distributed IT management structure
- Model for distributed maintenance – software/HW updates, upgrades, path management
- Technology adoption and assessment – leads to keeping up with technology evolution and economic deployment models

Business Models

Founder-Led Network

Single company driving the initial project then others join the network

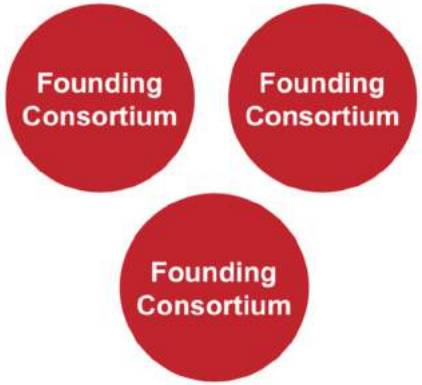
eg. UC4: Trade& Logistics



Joint Venture Network

2 or more create a JV to govern the initial network

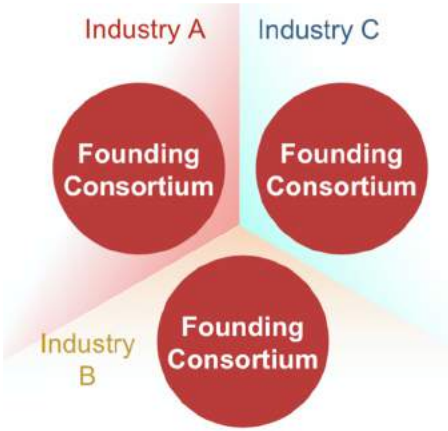
eg. UC2: Bank Guarantee, Maersk-IBM



Consortium Network

A consortium as the initial network and governance in a specific industry or sector

eg. UC1: Shared KYC

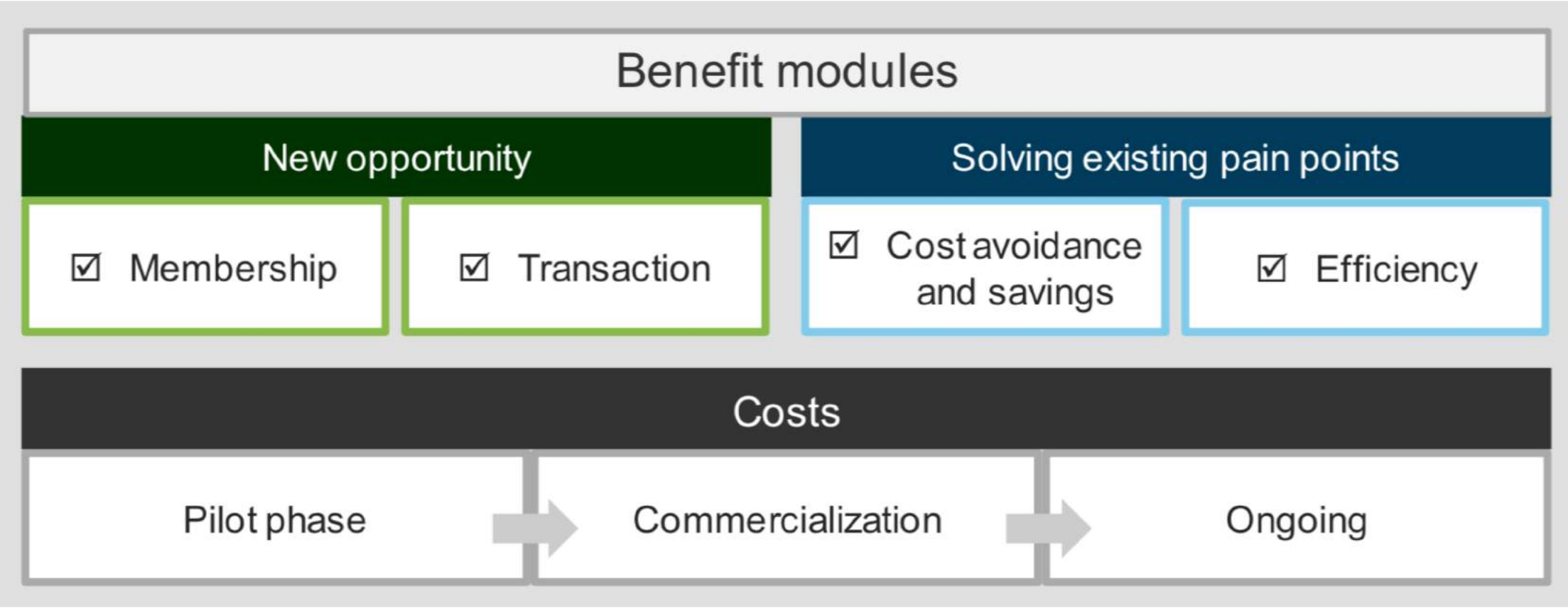


Business Ecosystem

A Consortium Network working across multiple industries or sectors

eg. UC3: Micro-Insurance

Total Economic Impact



Source: Forrester, Emerging Technology Projection: The Total Economic Impact Of IBM Blockchain, 2018

Our Solutions

- Application and impact-driven research
  - Decentralized identity management
  - Consumer Data Rights for open banking
  - Anti-Money-Laundering with AU Regulator
  - Interoperability of public and permissioned blockchain
- Production-level development
  - ArtChain: a blockchain-based platform for artwork registration, tracking, and authentication.
- Professional training
  - Short courses

Our Partners

Takeaways

- Rethink on the notion of trust
  - Enable exchange of value without trusting intermediaries.
  - Maintain a single source of truth and a shared set of business rules across separate entities without anyone being able to alter them and control the system.
  - Shift the cost of trust
- More value-added when combined with other technologies (AI and IoT)
- We look forward to exploring these opportunities with you

Thank you!

Contact

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