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everis: ForceField Project

Response to Open Development Challenge (ODC)– Phase 1 Deliverable

15th December 2017

Contents

- **Introduction everis**
- Project Team & High Level Activities
- Platform and Technology Consideration
- Commercial Consideration (e.g. Trade Finance)
- Scenario - Flow I
- Scenario - Flow II
- Alliances

Our global reach

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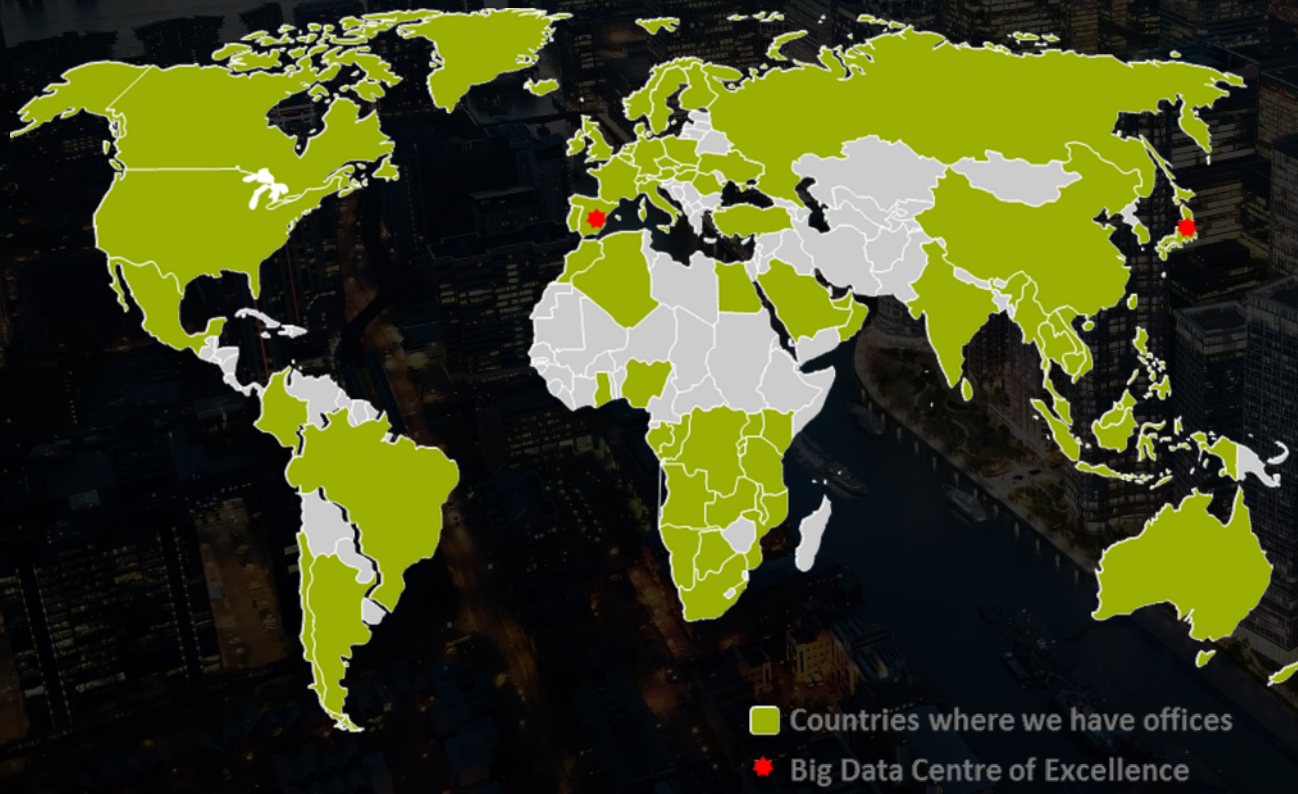
everis, as part of NTT DATA, is now the 6th global consulting firm with a global reach…



Annual revenues in 2015 of **$13.5 billion**

Operations in **41** countries

Over **900** Utilities Consultants with 75 focussed on Commodity Trading

More than **80,000** professionals

More than **200** DATA SCIENTISTS

More than **200** NICHE ARCHITECTS IN BIG DATA TECHNOLOGIES

More than **4,300** BUSINESS ANALYTICS PROFESSIONALS

More than **300** EXECUTED DATA ANALYTICS PROJECTS

The **1st** GLOBAL CONSULTANCY AND THE **4th** ORGANISATION CONTRIBUTOR** TO MARKET LEADER HADOOP Open-Source COMMUNITY SINCE **2009**

Our typical offering For Banks and Energy trading outside of Blockchain

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Disruptive and innovative digital technology → everis an NTT DATA Company **digital solutions** ← **Client & Industry business challenges**

<u>Linking digital technology and innovation to solving business challenges for clients</u>.
Clients do not have the same level of expertise or access to new technologies as everis – we help provide that link.
Our combination of deep-domain business knowledge + digital expertise & experience + access to disruptive and new technologies is unparalleled, resulting in significant value to the client
We solve client specific requirements with bespoke solutions, but look to create and leverage assets where possible. One client's issue is likely to be common across the industry, so resulting solutions can be marketed to other clients

Existing Assets

Industry knowledge

- In-depth understanding of sector, including challenges/problems faces by the industry

Technology knowledge

- Expertise and experience creating solutions using digital technology
- Big Data, BI & analytics, mobility, UX, architecture

everis NEXT

- Access to disruptive and innovative technologies and services
- The largest B2B ICT startup database in the world (>1.5m)

i-deals everis group

- Access to academic research and innovation
- Connects tech innovation to finance and markets

Tech Partners

- Existing ecosystem of partner tech companies

Everis Interledger & Blockchain teams

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Teams

Expertise & Regulatory Consulting

- ✓ Banking service offering
- ✓ Energy service offering
- ✓ Client Relations Management
- ✓ Consultancy Services
- ✓ Regulatory Change mgmt.

Technology Integration & Delivery

- ✓ Integration of Interledger & Blockchain tech into banks
- ✓ Client Relationship Management
- ✓ Implementation of PoCs and Pilots for financial use cases

Engineering & Innovation

- ✓ Technical Architecture Definition & Development
- ✓ Support to Technology Integration teams
- ✓ Development of the Everis Interledger Framework
- ✓ Creation of Connectors and Client Ledger APIs

Digital Transformation & Channels

- ✓ Sales & Client Relations
- ✓ Development of Blockchain Discovery offering
- ✓ Exploration of Use Cases & Creation of PoCs

Blockchain Product Strategy

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NTT DATA
Global IT Innovator
+
everis
an NTT DATA Company

everis and NTT Data pursue a forward-looking blockchain product strategy by growing partnerships and developing the Interledger Java framework.

Payments

everis is partnering with Ripple to accelerate the adoption of the Ripple Solution that enables banks to make real-time cross-border payments.

ILP

Connectivity

Developing an Interledger Java framework, NTT DATA and everis will set the foundation for connecting a broad variety of platforms and ledgers, contributing to the Internet of Value.

c·rda
FABRIC

Smart Contracts

With the establishment of a real-time payment and connectivity infrastructure, the expansion of blockchain technology into more complex use cases in Capital Markets and Trade Finance will take place, and Corda and Fabric are the most promising platform to make it happen.

Our typical offering for Banks and Energy trading in DLT

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SME – Trading and Risk Management

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SME – Trading & Risk Management

Summary:
12 years experience within the energy trading environment. Held positions in banking, settlements, accounting and middle office. Now leading the Blockchain practise at everis UK for use cases within Oil, Gas and Power. Everis has an agnostic approach to technology choice and project delivery.

Previous employment:
Shell (back office – crude oil), BP (middle office –crude oil), Mercuria (middle office gas and power)

Experience:
- Understanding of different needs of Oil majors vs trading houses in the scope of FF
- Understanding of trade lifecycle; pain points, actors, manual processes and typical write-offs of smaller costs
- Exposure to different ETRM systems; Endur, ICTS/Amphora and inhouse developed systems at BP
- Large reconciliation projects
- VBA programming and fixing

Languages:
- English (native)

Qualifications:
- BA (Hons) Business and Economics 2:1
- Energy risk professional part 1

SME – Trading and Risk Management

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SME – Trading & Risk Management

Summary:
13 years experience in the Oil and gas industry working on trading, chartering, credit risk and lifecycle management programmes. 10 years of experience, providing structured project management, in-depth business analysis, implementing business change, facilitating governance and delivering systems.

Previous employment:
ComFin Software & Consulting, Petroleum Authority of Thailand (PTT), Aspect Enterprise Solutions

Experience:
- Project Management & Business Analysis; leading team of 5 people; implementation of a CTRM system for Oil, Agriculture, Chartering and all related Front/Mid/Back office functions
- Commodities exposure; Oil, Gas, Metals (base and precious)
- Exposure to different ETRM systems; Triple Point, Allegro, OpenLink, Comcore, Amphora; SAP (MM, SD, IS-OIL, 4.6. ECC6.0)
- Specialised in integration to / from Trading Systems since 2007

Languages:
- German (native), English (fluent)

Qualifications:
- SDV Informatikschulen Business School, Vienna (IT, project management, economy, business administration, political science)

Consultant Blockchain

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Consultant - Blockchain

Summary:
8 years experience in Software Development, Design, Delivery and Consulting within the Oil, Mining, Metals and Agribusiness industries. Now part of the everis Blockchain initiative responsible for PoC's to address problems for the Oil industry utilising Corda platform.

Previous employment:
Portaltech, Accenture

Experience:
- Built Blockchain oil late payment interest PoC using Corda platform
- Responsible for several full cycle deployments (design – post go live support)
- Guided and coached a team of Java developers
- Delivered business analysis documents including process catalogue, AS-IS, TO-BE and Gap Analysis
- Corda, JAVA 8/J2EE API, PL/SQL, Oracle, Agile, Waterfall, Scrum, OOD, BPM, UML

Languages:
- English, Portuguese (native)

Qualifications:
- BS System Information Technology
- PSM I - Professional Scrum Master I
- ITIL Foundation Certified

Solutions Architect - Blockchain

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Solutions Architect – Blockchain

Summary:
12 years experience in Linux/Unix SysAdmin, Software Development, and System Architecture in the banking and software industries, specialised in distributed architectures including Blockchain.
Now Blockchain architect and leader of the Blockchain team in Everis Peru, in charge of several projects leveraging Ethereum smart contracts and elliptic-curve cryptography, as well as background blockchain research.

Previous employment:
Azure Mobile Engagement (Microsoft, Redmond WA)

Experience:
- Developed in Java, NodeJS, Python, Shell, C#, HTML5/CSS3
- Leaded a team of developers (full stack) on Blockchain-oriented projects (Corda, Ethereum)
- Developed Ethereum smart contracts for projects in the banking industry
- Automated administration and DevOps cycles (300+ VMs)
- Worked on HA architecture optimisation (5,000-17,000 messages/s)

Languages:
- English (TOEIC 870), French (native), Spanish

Qualifications:
- Graduated in Software Engineering and Security (INSIA, France)
- Elasticsearch Certification

Software Developer- Blockchain

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Software Developer - Blockchain

Summary:
12 years experience in Software Development, Design, Delivery and Consulting within the government and banking industries. Now part of the everis Peru Blockchain team responsible for PoC's to address problems for the banking industry utilising Corda and Ethereum platform.

Previous employment:
OSCE, SUNAT, PODER JUDICIAL, CONSORTIUM SOFWARE FACTORY

Experience:
- Corda, JAVA 8/J2EE API, PL/SQL, Spring, Oracle, Agile, Scrum, OOD, BPM, UML
- Developer microservices, Spring Boot, Spring Cloud and Docker Swarm
- NodeJS, Express, MongoDB, Elasticsearch
- Spring Security, JWT, OAuth and cryptography
- Blockchain development (Ethereum)

Languages:
- English, Spanish (native)

Qualifications:
- Systems and Information Engineer
- Software Architecture

Software Developer- Blockchain

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Software Developer - Blockchain

Summary:
4 years experience in Software Development and 1 year in Blockchain solutions. Now part of the everis Peru Blockchain team responsible for PoC's to address problems for the banking industry utilising Corda and Ethereum platform.

Previous employment:
IOP Blockchain , IBM, UNISERV, Fermat Blockchain, COMWARE

Experience:
- Corda, Hyperledger, Ethereum, Bitcoin Blockchain
- Embbeded System, Asterisk
- JAVA 7/J2EE API, PL/SQL, Oracle Tuxedo, GO, Python, Node js, C++, Kotlin

Languages:
- English, Spanish (native)

Qualifications:
- Bachelor of Computer Science
- Cisco Certified

Everis High Level Timeline & Activities

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07th – 15th December | 18th December – 19th January | 22nd January – 05th February

Phase I – Strategy Alignment

- Key deliverables:
  - Platform and Technology Consideration
  - Scenario Flow I & Flow II (Functional Specification)
  - High Level Non – Functional Requirements Specification
  - Project Team
- Duration = 7 Business Days
- Resources: SME, Consultants, Developers
- Schedule of high level activities
  - Day 1: Scenario definition
  - Day 2: Technology assessment
  - Day 3: Resources estimation
  - Day 4 – 7: Documentation
- Submission:15th December 2017
- Notification: 20th December 2017

Phase II – Build Phase

- Key deliverables:
  - Prototype for Scenario Flow I & Flow II
  - Solution Architecture
  - Build instructions/configurations
  - 3rd party software license inventory
  - Security Model
  - Implementation plan
  - Support model
- Duration = 22 Business Days
- Resources: SME, Consultants, Solutions Architect, Developers, Testers
- Schedule of high level activities
  - Day 1 – 12: Architecture design, documentation
  - Day 13 – 22: Build, test, validation, documentation
- Submission: 19th January 2018
- Notification: 24th January 2018

Phase III – Final Phase

- Key deliverables:
  - Final presentation
  - Final Prototype
  - Final implementation plan
- Duration = 8 Business Days
- Resources: SME, Consultants, Solutions Architect, Developers, Testers
- Schedule of high level activities
  - Day 1 - 3: Documentation
  - Day 4 - 5: Prep. presentation
  - Day 6 - 8: Project closure
- Presentation: 01th – 05th February 2018
- Notification: 08th February 2018

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Our thought process for choosing a platform

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Architectural & Strategic Choices

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Design Decisions

- ✓ Agreements' behaviour described in computer code and linked explicitly to legal prose
- ✓ Records only accessible to those with legitimate interest in the recorded assets and agreements
- ✓ Multiplicity of ledgers, one per asset class. Loosely coupled, autonomous, providing functional & operational independence
- ✓ Identity Infrastructure between participants

Technologies & Standards

- ✓ Open source, Open development process, Open standards
- ✓ Robust Cryptography
- ✓ Global communication networks
- ✓ Effective algorithms to ensure consistency
- ✓ Standards for the definition of financial instruments

Objectives

- ✓ Innovative new products and services

- ✓ Reduction of cost, risk and regulatory burden

Global Logical Ledgers

Requirements for a Financial and Energy Smart Contracts Platform

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- Reliability
- Scalability
- Governance
- Compliance
- Standardisation
- Identity
- Privacy and Security

Comparison of Corda and Fabric for the ForceField consortium

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Platform	r3 corda	HYPERLEDGER FABRIC
Use of a Blockchain	No	Yes
Distribution of Transaction Data	No broadcast of transaction data	Private channels
Computational Model	UTXO	Virtual Computer
Consensus Protocol	Pluggable	Pluggable
Turing complete Programming Language	Yes	Yes
Database	Relational database	“key value store” database

Hyperledger Fabric (our consideration but not chosen)

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Hyperledger Fabric

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Consortium

HYPERLEDGER

- ✓ **An open-source collaboration under the Linux Foundation that aims to advance blockchain technology by the creation of cross-industry open standards for distributed ledgers**
- ✓ **A rapidly growing number of members that cover a wide variety of industries (130+ Members)**
- ✓ **The Fabric framework has originated from IBM's contribution to Hyperledger**

Platform

FABRIC = **Private Blockchains** + **Existing Legal Requirements** + **Modular Build**

Fabric Key Features

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Key Features

Chaincode trust flexibility
In Fabric the question of transaction order is separated from transaction validity. Since endorsement is thereby decoupled from ordering, the required set of endorsers can be different for each chaincode.

Scalability
Due to endorsement being handled by disjoint sets of endorsers, chaincodes can be executed in parallel. This allows the system to scale better to high volumes of transactions.

Confidentiality
This design enables chaincodes to have confidentiality requirements regarding the content and state updates of its transactions.

Consensus modularity
Since Fabric's architecture is modular it allows for various consensus implementations, i.e. the consensus algorithm used by the ordering service.

Consensus

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Transaction Validity

The **Endorsement policies** that are imposed on a channel define which nodes need to endorse a transaction (**endorsing peers**). **All nodes** on a channel verify that these endorsement policies apply.

Transaction Order

Endorsed transactions are sent to an **ordering service** that **orders the transactions into blocks** according to the provided channel identity.

A Fabric Network

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Members

A member (e.g. a bank or a company) might **maintain multiple peers, orderers or application clients** on a network. These network components are linked to the member by its root certificate.

Ordering Service

Every network is based on a single ordering service made up of a **set of orderer nodes.** To avoid privacy issues this service could be provided by a trusted third party. Its main responsibility is to receive transactions and **order them into blocks.** For this, it provides a **shared communication channel** to clients and peers.

Channels

On a Fabric network, a channel is a **private blockchain overlay** that allows for data isolation and confidentiality. To ensure availability members may maintain any number of peers on a Channel.

NOTE: We did not use Fabric for Project Forcefield because of this feature, channels are not as secure for privacy as historical information can be easily shared when new members join a channel

Roles in a Fabric Network

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Peer Node

Committer

All peers hold the role of committers. They commit transactions and maintain the state of the ledger. Peers maintain as many ledgers as channels they participate in.

Endorser

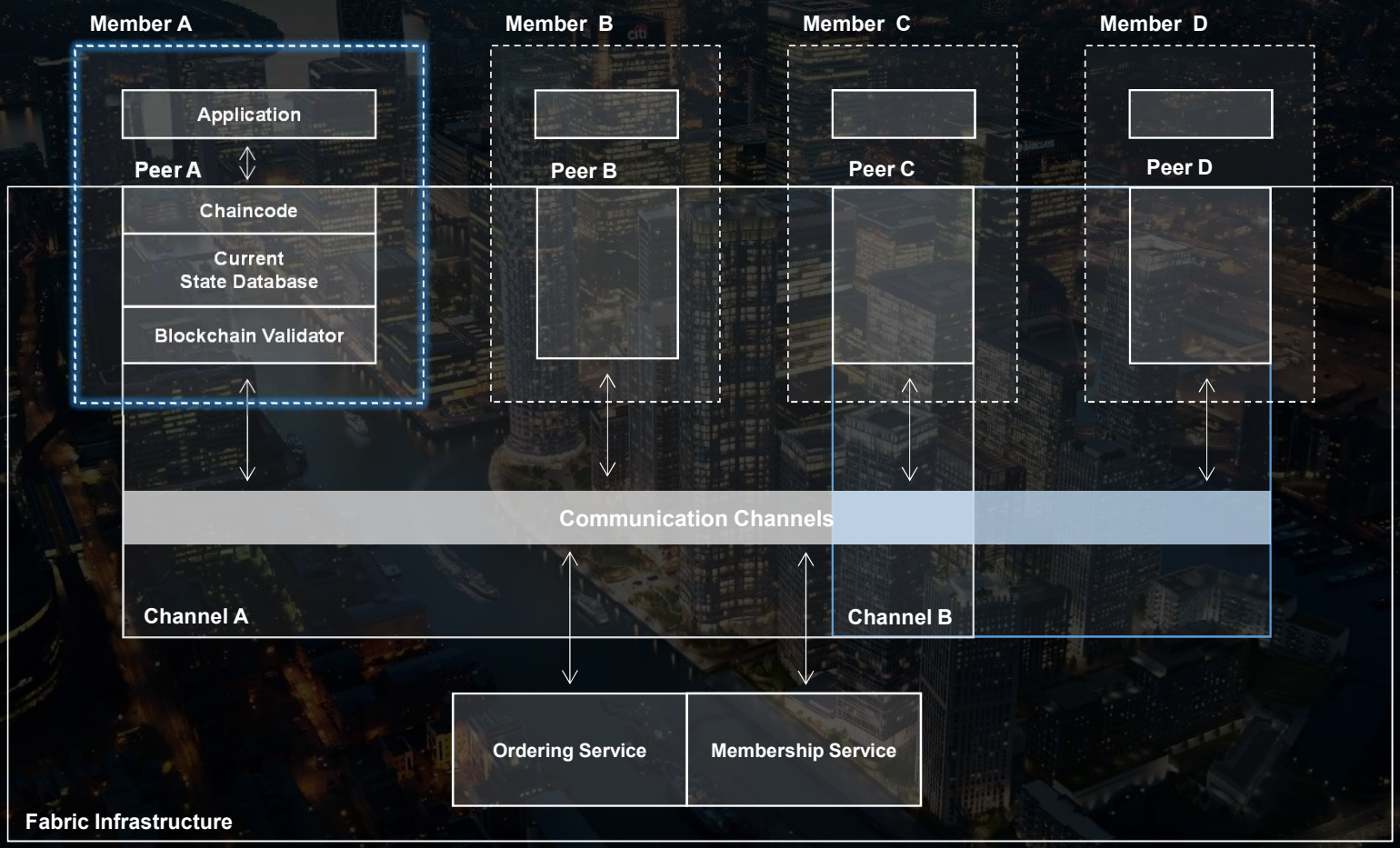
In addition to the role of a committer, peers can also function as endorsers. Endorsing peers validate transaction proposals.

Orderer Node

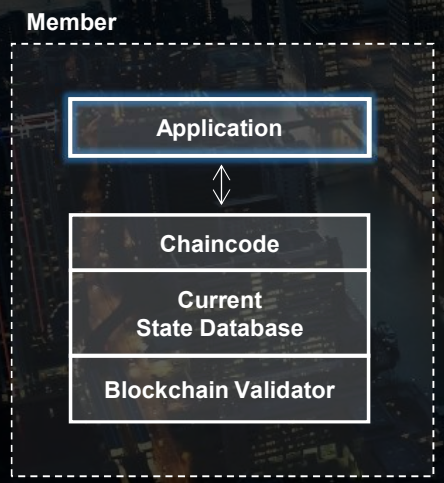
Orderer

Orderers are nodes that provide transaction ordering services.

Overview of a Fabric Network



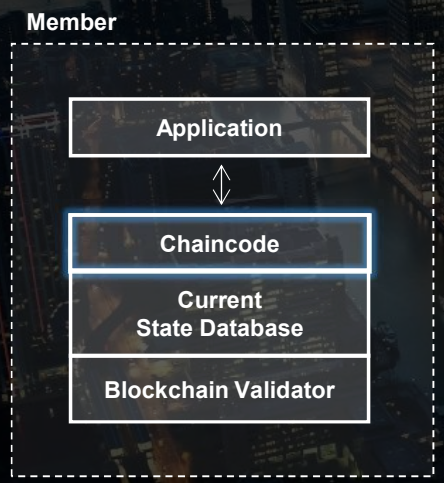
Architecture



Application

- ✓ An application can use one or more networks, each managing different asses, agreements and transactions between different sets of member nodes.
- ✓ An organization will maintain a peer in a network, which allows applications to participate in transactions.

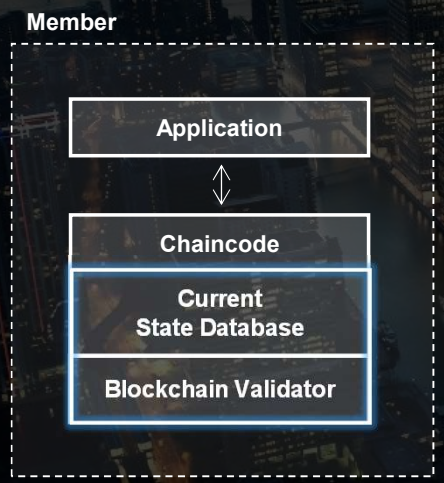
Architecture



Chaincode

- ✓ Chaincode is the business logic that defines assets and the instructions to modify these assets.
- ✓ They execute against the ledgers current state database and are initiated through a transaction proposal.

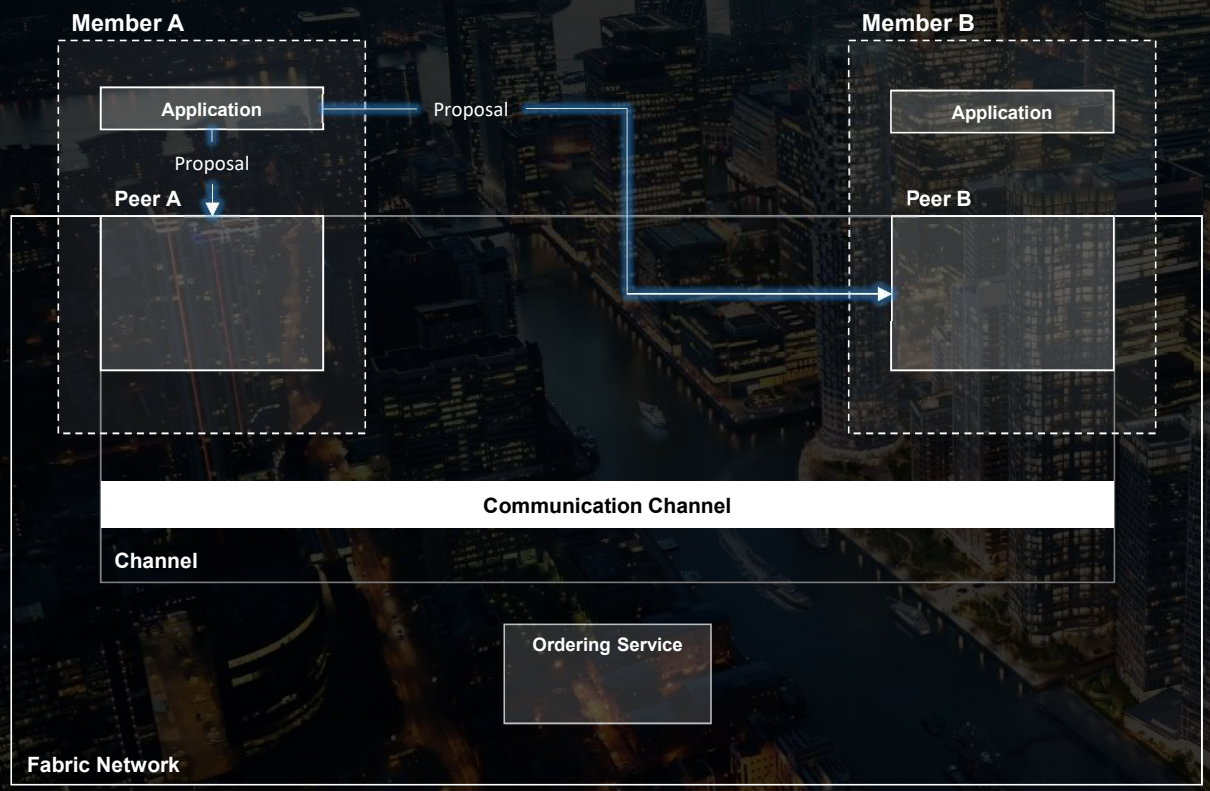
Architecture



Ledger

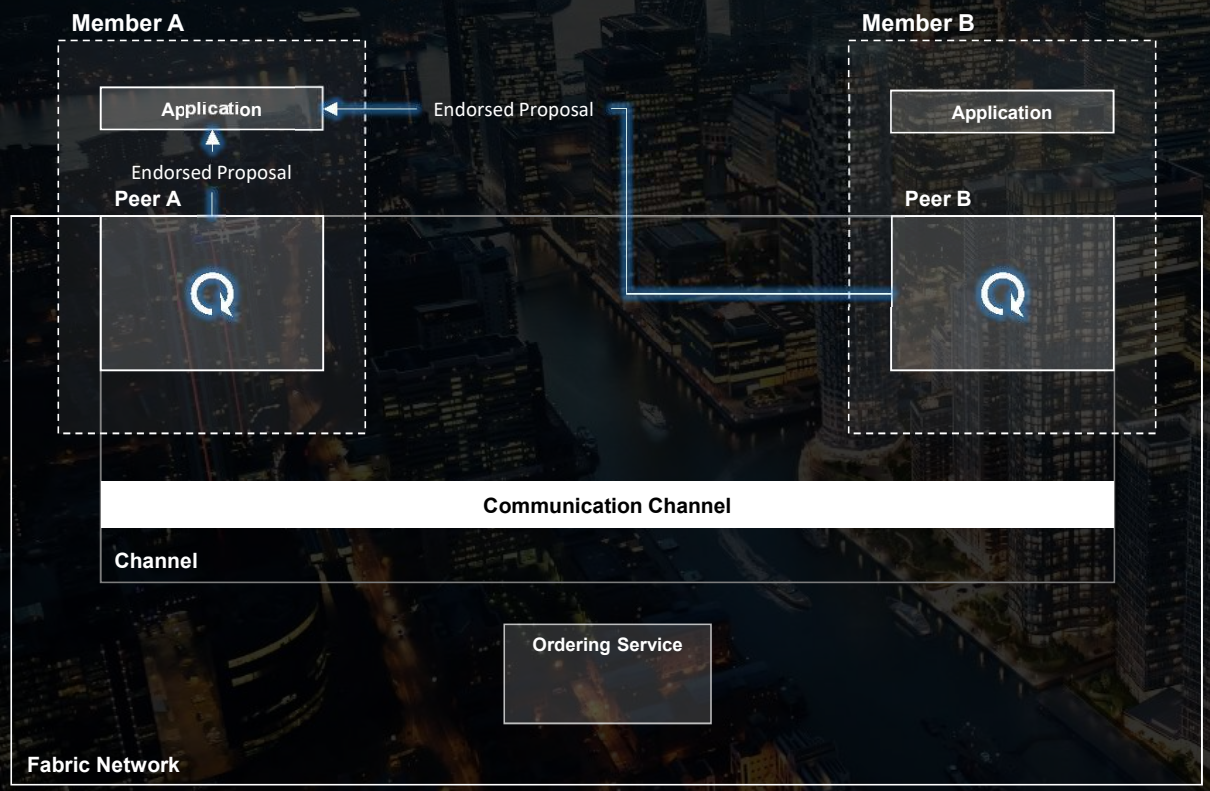
- ✓ Each peer maintains one ledger per channel.
- ✓ The ledger is constructed by the ordering service and provides a verifiable history of all successful and unsuccessful attempts to change the state.
- ✓ It is composed of a blockchain that holds an immutable record of all transactions as well as current states' database held to maintain the state of the ledger.

Transaction Lifecycle - Proposal



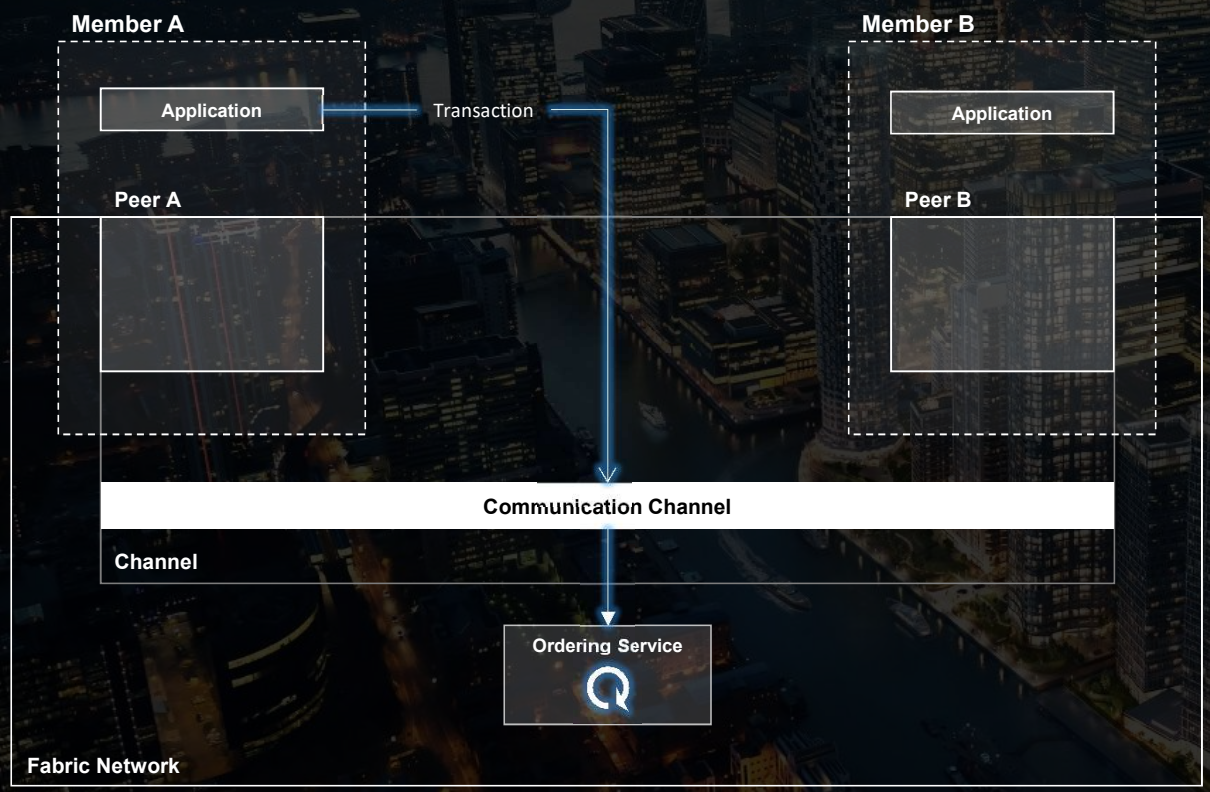
- ✓ Member A and Member B, both maintaining peers on the Fabric network, want to perform a trade. According to the channels preinstalled endorsement policies, interacting peers need to endorse the transaction.
- ✓ Member A proposes a transaction. The proposal is orchestrated by the application, which sends the transaction proposal to peer A and B.

Transaction Lifecycle - Proposal



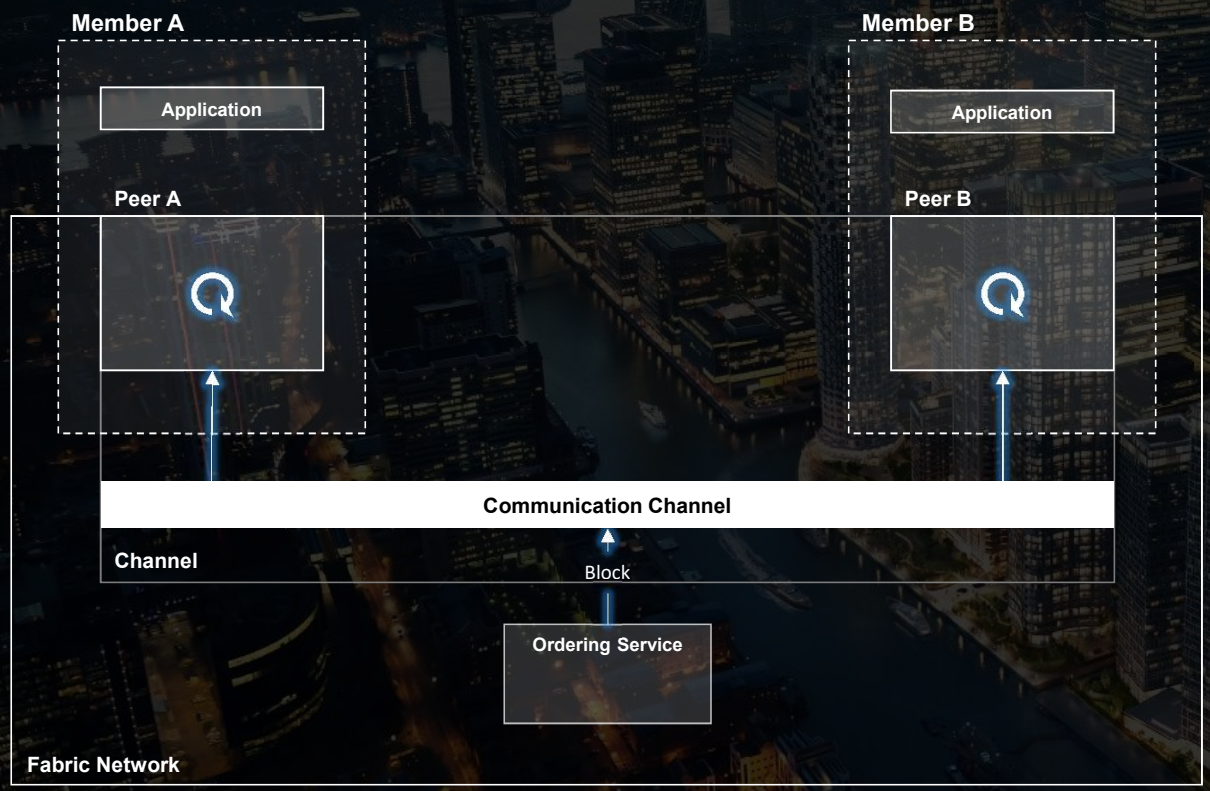
- ✓ The peers verify the signature to determine whether the submitter is authorized to perform the proposed transaction.
- ✓ If the signature is valid, the transaction is executed by the peers. Depending on the outcome, it is send back along with the peers signature and a binary yes or no endorsement statement.

Transaction Lifecycle - Proposal



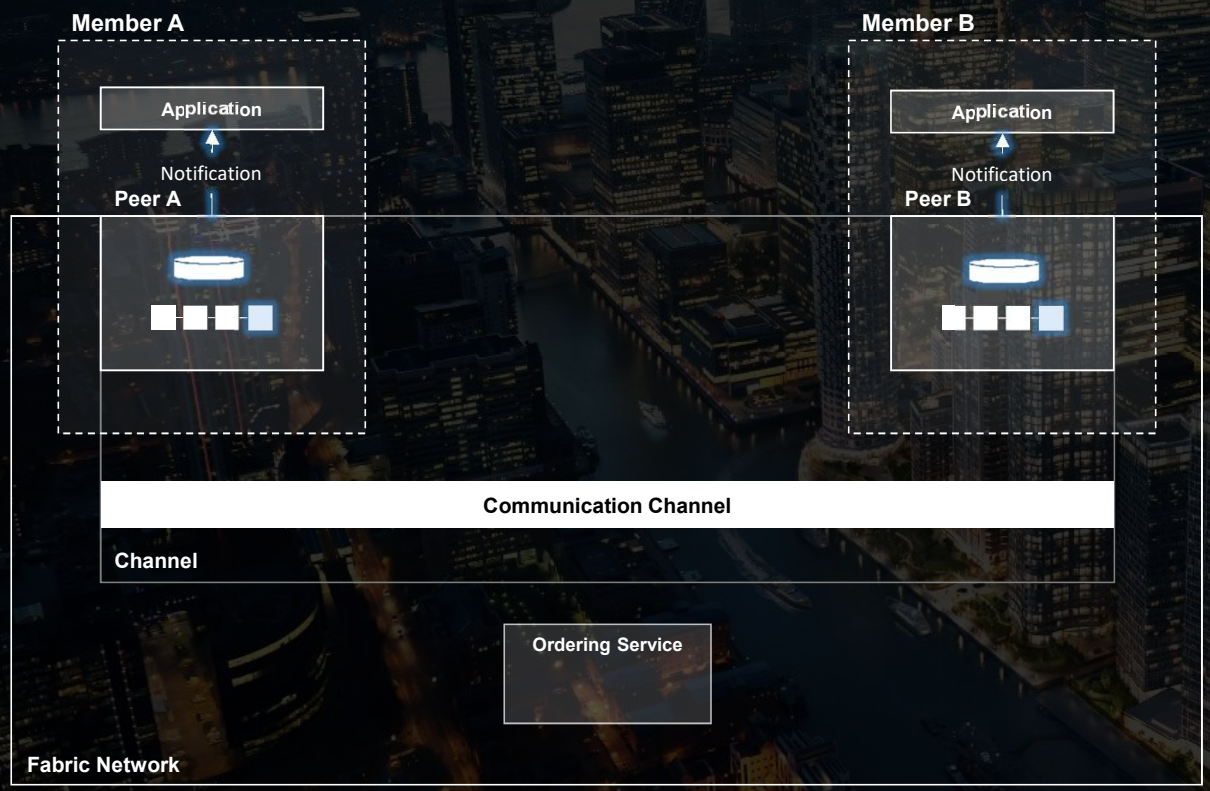
- ✓ The application broadcasts the transaction proposal and the response to the ordering service.
- ✓ The ordering service receives transactions from all channels in the network and orders them chronologically by channel into blocks.

Transaction Lifecycle - Proposal



- ✓ The ordering service distributes the block to all channel peers.
- ✓ The transactions within the block are validated to ensure the endorsement policy is fulfilled and a version check is preformed to assure that the states have not changed since the chaincode was executed.

Transaction Lifecycle - Proposal



- ✓ The peers append the block to the channel's blockchain and each valid transaction is committed to the current state database.
- ✓ Members are notified when the transaction is appended to the blockchain, and whether it was considered valid.

R3 Corda (our choice)

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R3

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Company

- ✓ **Innovation firm focused on building and empowering the next generation of global financial services technology**
- ✓ **Works to design and deliver advanced distributed ledger technologies to the global financial markets**
- ✓ **Partners more than 80 financial institutions to collaborate on research, experimentation, design and engineering (Corda Platform)**

R3's Platform

corda = Shared Ledger Fabric + Existing Legal Frameworks + Proven Technologies

Cordas's Key Features

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Key Features

Privacy and Data Access
Corda supports consensus between firms at the level of individual deals, not a global system. That means the data within an agreement is only revealed to those explicitly entitled or logically privileged to access it.

Regulatory Outreach
The recording and managing of the evolution of financial agreements and other shared data is grounded in existing legal constructs and compatible with existing and emerging regulation.

Overarching Legal Prose
To provide a legal basis in case of dispute, smart contract code is explicitly linked to human-language legal prose documents.

Pluggable Consensus Mechanisms
Uniqueness services are decoupled from the validation of transactions and provided by third parties. Therefore, they can support a variety of consensus mechanisms within the same network.

Corda's Smart Contracts

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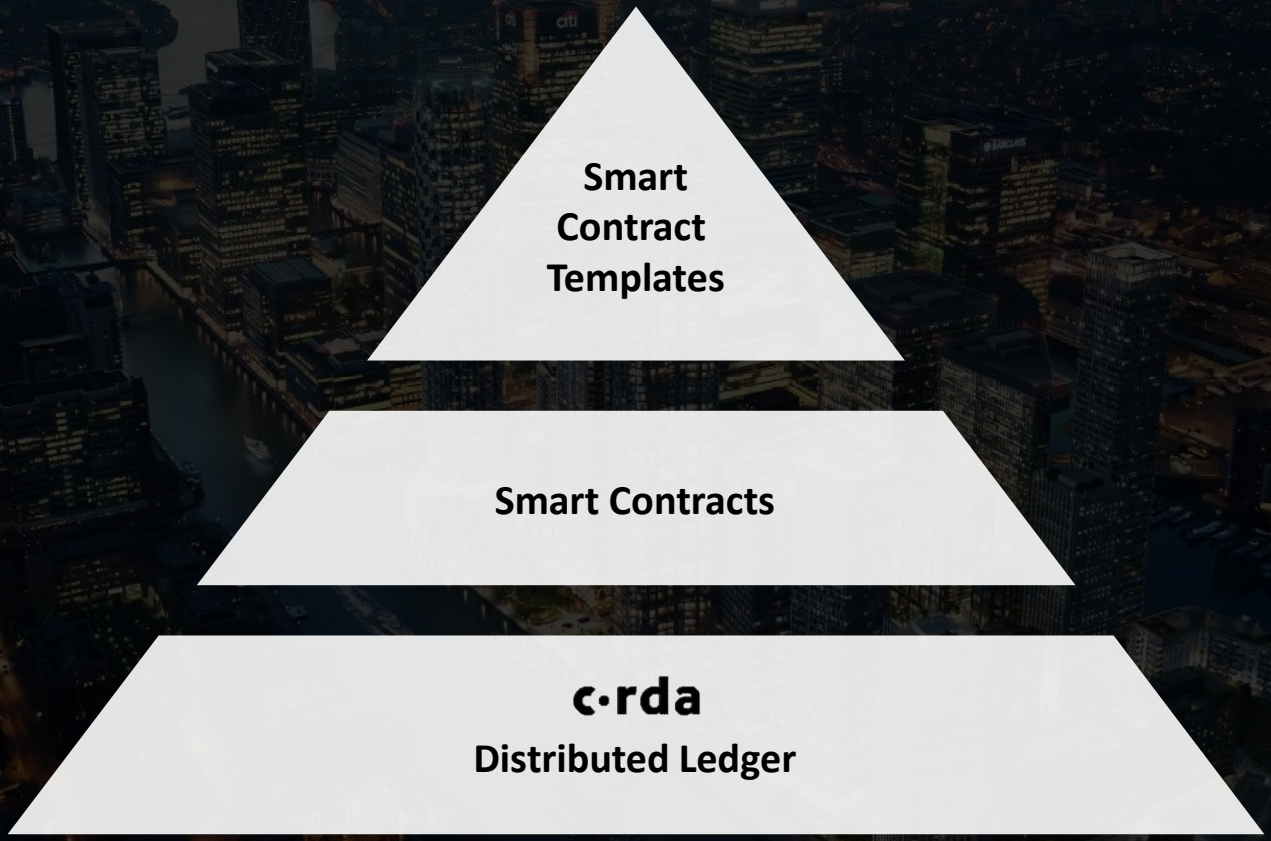

CorDapps

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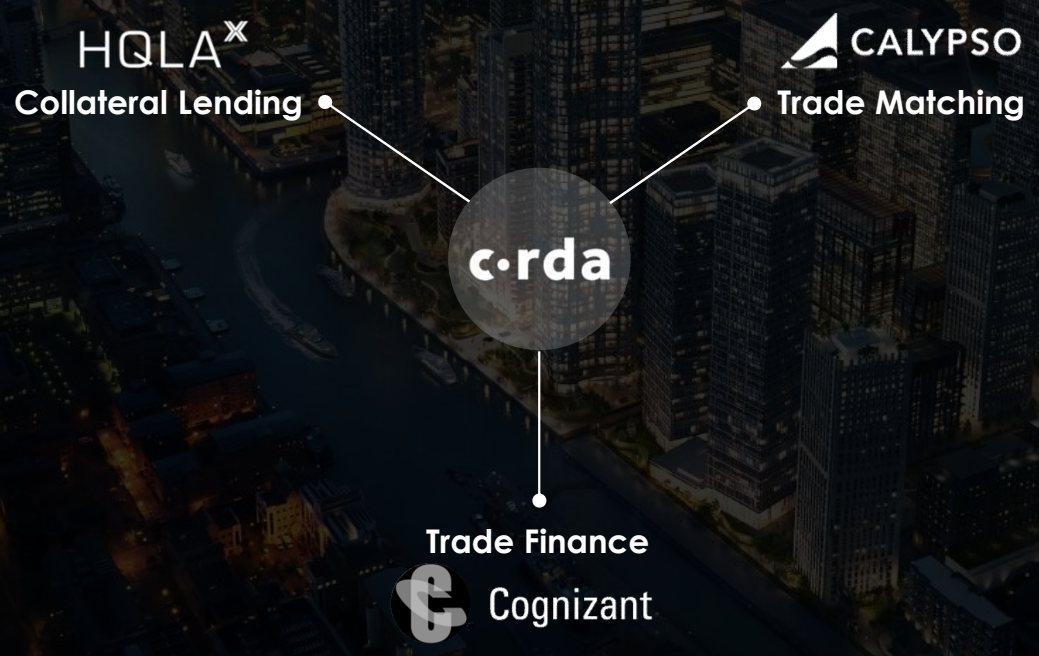
- ✓ Corda is intended to become a shared platform for the development of **Corda distributed applications (CorDapps)** that extend the distributed ledger with new capabilities, using Corda's API and plugin system. They define new data types, new flows to modify and create state, and smart contracts that determine the allowed changes.
- ✓ To advance the adoption of Corda, **R3 is building an ecosystem of partners** to build financial applications that can cover every area of financial services. Once adoption among market participants grows, third party application providers will enter the market. The application of Corda to energy trading is new but relevant and it is also a highly regulated environment.



Principles

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Consensus

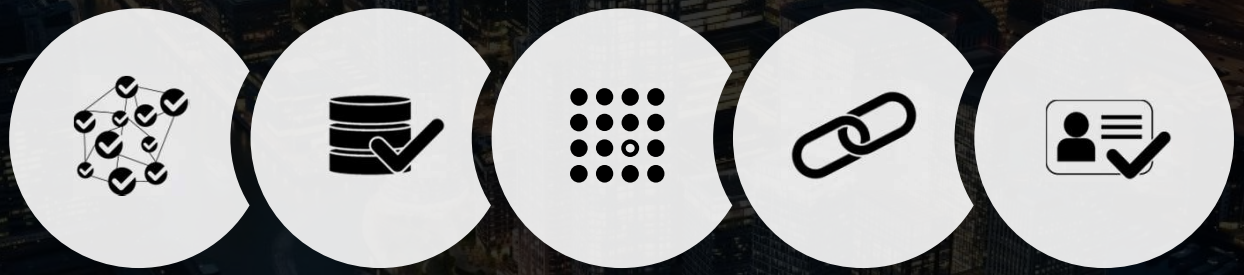
With Corda consensus is reached between parties involved in the transaction, not between all participants.

Uniqueness

Uniqueness services are used to determine if a valid transaction is the unique consumer of its input states.

Authentication

Corda uses an authenticated peer to peer network.



Validity

In Corda Participants validate the transactions by independently running the same contract code.

Immutability

In Corda states are never altered. When consumed as an input state by a valid transaction, a new output state will be created.

Consensus

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Transaction Validity

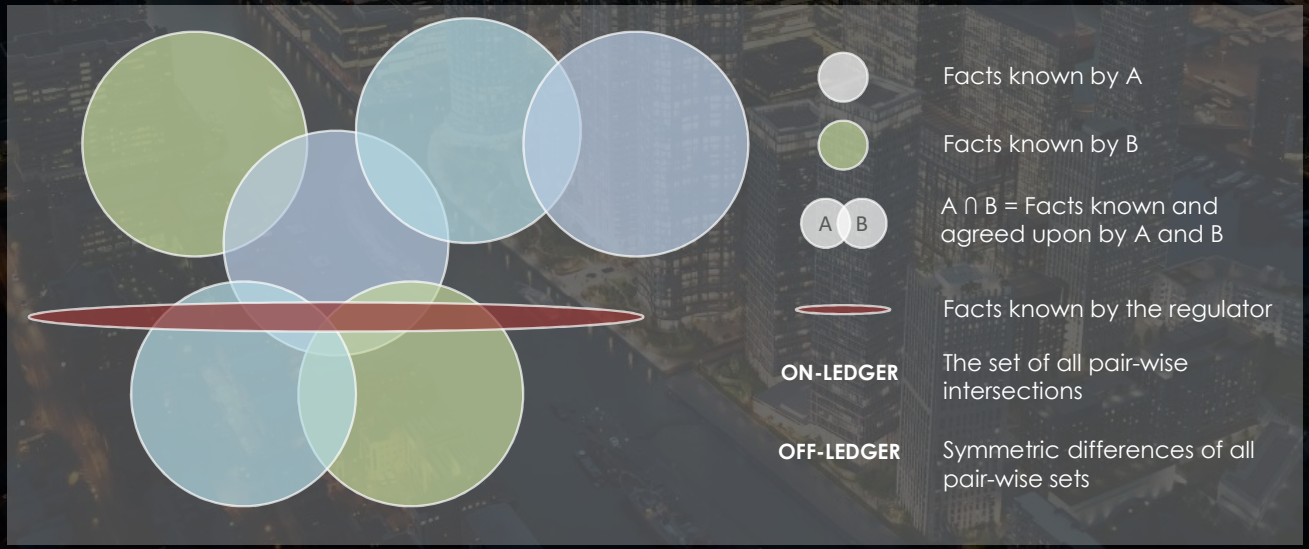
Parties reach certainty that a proposed update **transaction defining output states is valid** by checking that the **associated contract code runs successfully** and has **all the required signatures.**

Transaction Uniqueness

Parties reach certainty that a proposed **transaction is the unique consumer of all its input states**, and that there is no other previous consensus transaction that consumes any of the same states.

Transaction Validity

- ✓ In Corda consensus is not reached over the state of the entire ledger, but rather at the level of individual deals. Therefore, data is only shared with those parties who require to see it
- ✓ Actors only see a subset of the data managed by the Corda system. If at least two parties are in consensus over a piece of data it is considered "on-ledger". Data only held by one actor is "off-ledger"
- ✓ Consensus over transaction validity is performed only by parties to the transaction in question



Transaction Validity

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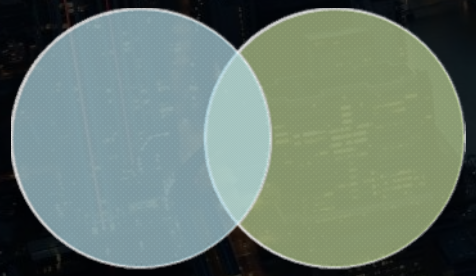

Shared Facts

Legally binding

Accepted as admissible evidence and legally binding for all parties, by contract and for any dispute.

Authoritative

Authoritative rather than shadows of authoritative data. This enables settlements to take place directly across the platform.

Final and immutable

Errors must be processed through a subsequent transaction.

Transaction Uniqueness

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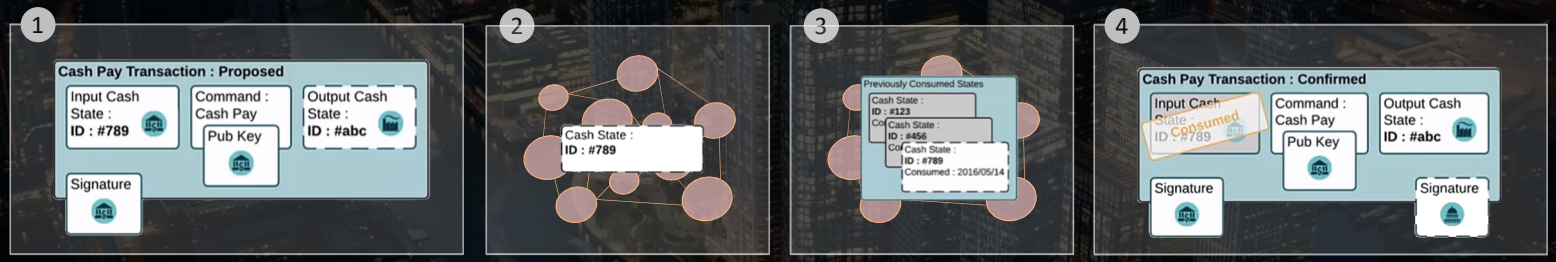
- ✓ Consensus over uniqueness requires a predetermined observer, which may be required to be independent.
- ✓ Corda's design enables pluggable uniqueness services to improve privacy, scalability, legal-system compatibility and algorithmic agility. The participants can choose, whether this service will get to see the full contents of the transaction.
- ✓ An obvious use case of this functionality will be seen in the Project when we start the flow of **execute letter of credit**



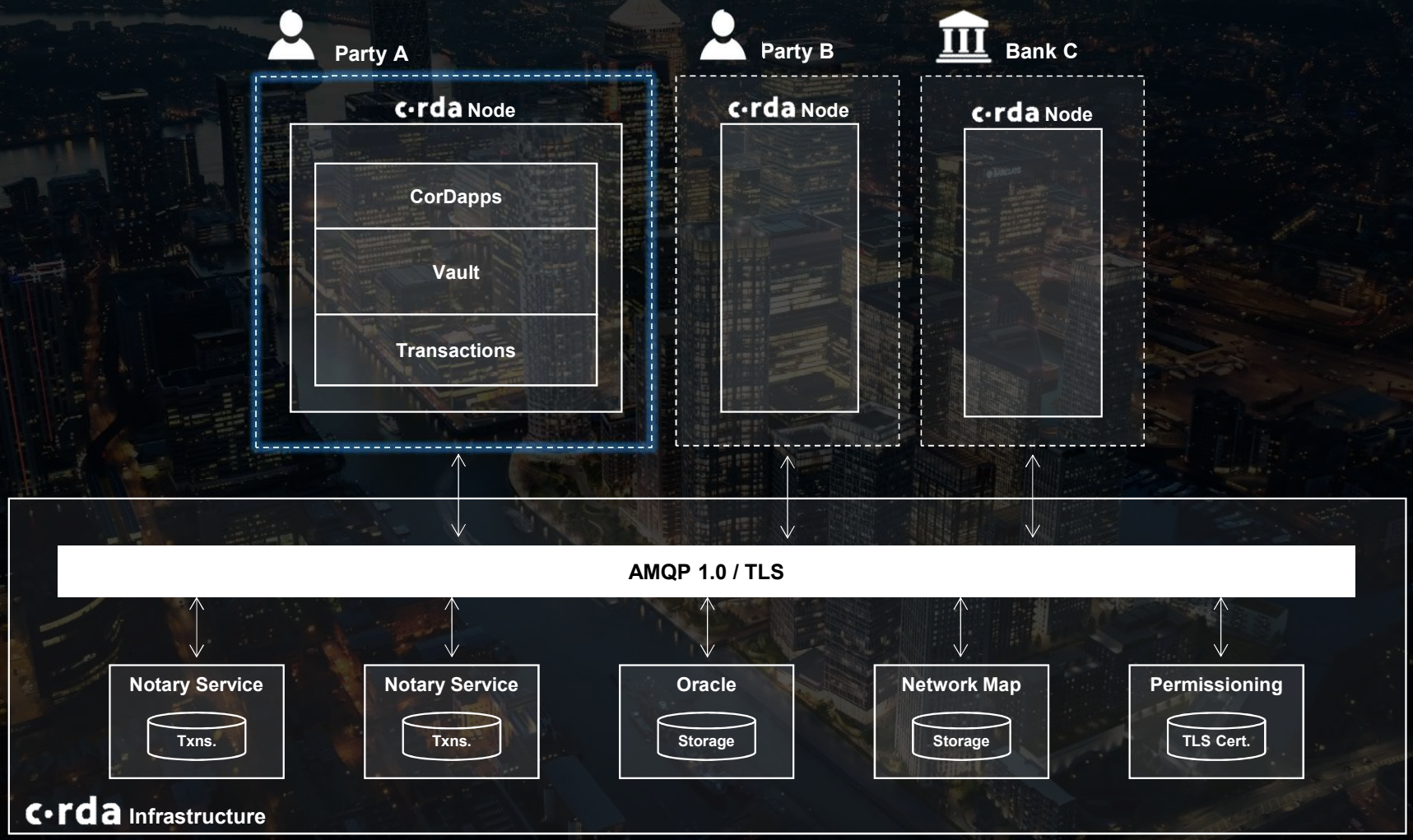
Bank A sends out an uniqueness request to the responsible notary.

The notary checks whether the transactions input state has already been consumed by a previous transaction.

If the transactions doesn't conflict the notary will sign the transaction and record the state as consumed.

The signed transaction is send back to Bank A which now has certainty over the transactions uniqueness.

Network Overview



Corda Networks' Components

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Example of a Corda network

Nodes

- ✓ Corda is a distributed ledger made up of mutually distrusting nodes arranged in an authenticated p2p network
- ✓ Its design directly enables regulatory and supervisory observer nodes
- ✓ There is no global broadcast

Notary Services

1 ~ N

- ✓ Provide uniqueness services in form of timestamping or ordering services
- ✓ A service can consist of several nodes
- ✓ They improve privacy, scalability and legal-system compatibility

Oracle Services

0 ~ N

- ✓ Well known services that sign transactions if they state a fact and that fact is considered to be true
- ✓ Using Oracles, the ledger can be connected to the real world, despite being fully deterministic

Permissioning Service

- ✓ To gain access to the network participants are required to obtain an identity signed by a root authority
- ✓ The permissioning service automates the process of provisioning TLS certificates

Network Map Service

- ✓ Publishes the nodes' IP addresses to enable reachability of all network nodes
- ✓ A new node's first action is the registration with the Map Service

Notaries

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Uniqueness and Timestamping Services
In a Corda network notaries' main task is to provide uniqueness and timestamping services.

Algorithmic Agility
Notary services are provided by mutually distrusting parties, who use a standard algorithm (e.g. BFT algorithm) to reach consensus. Scalability is increased by bringing in new nodes.

Validating vs. Non-validating
On a Corda network notaries can either be validating or non-validating. This enables participants to choose a node depending on the trade-off they are willing to accept. A state that represents a specific deal between two parties would likely point to a non-validating notary, while for liquid assets a validating notary should be used.

Guaranteed Data Distribution
Since there is no global broadcast of transactions in Corda, participants can't always be sure of having the latest state of the database. To solve this, nodes send the certificate linking state's public keys to the notary. Once the transaction has been committed the node looks up affected parties and notifies them.

Doorman

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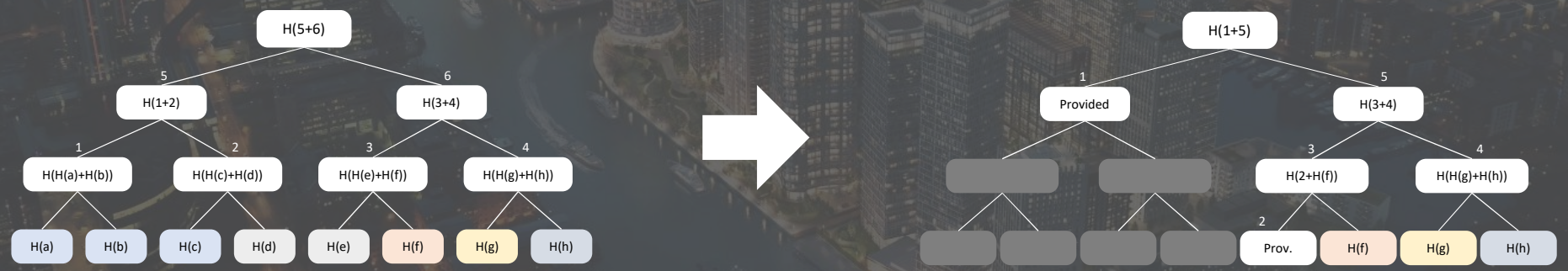
Access to the Network
In a Corda network doorman main task is to grant access to parties that want to join the network.

Know-your-customer
To join the network parties must provide Doorman with minimal information that satisfies the network's requirement.

Certificates
Doorman provides root-authority-signed TLS certificate from the network permissioning service when it is satisfied with the participant KYC information. This certificate certificates the node's identity when communicating with other participants in the network.

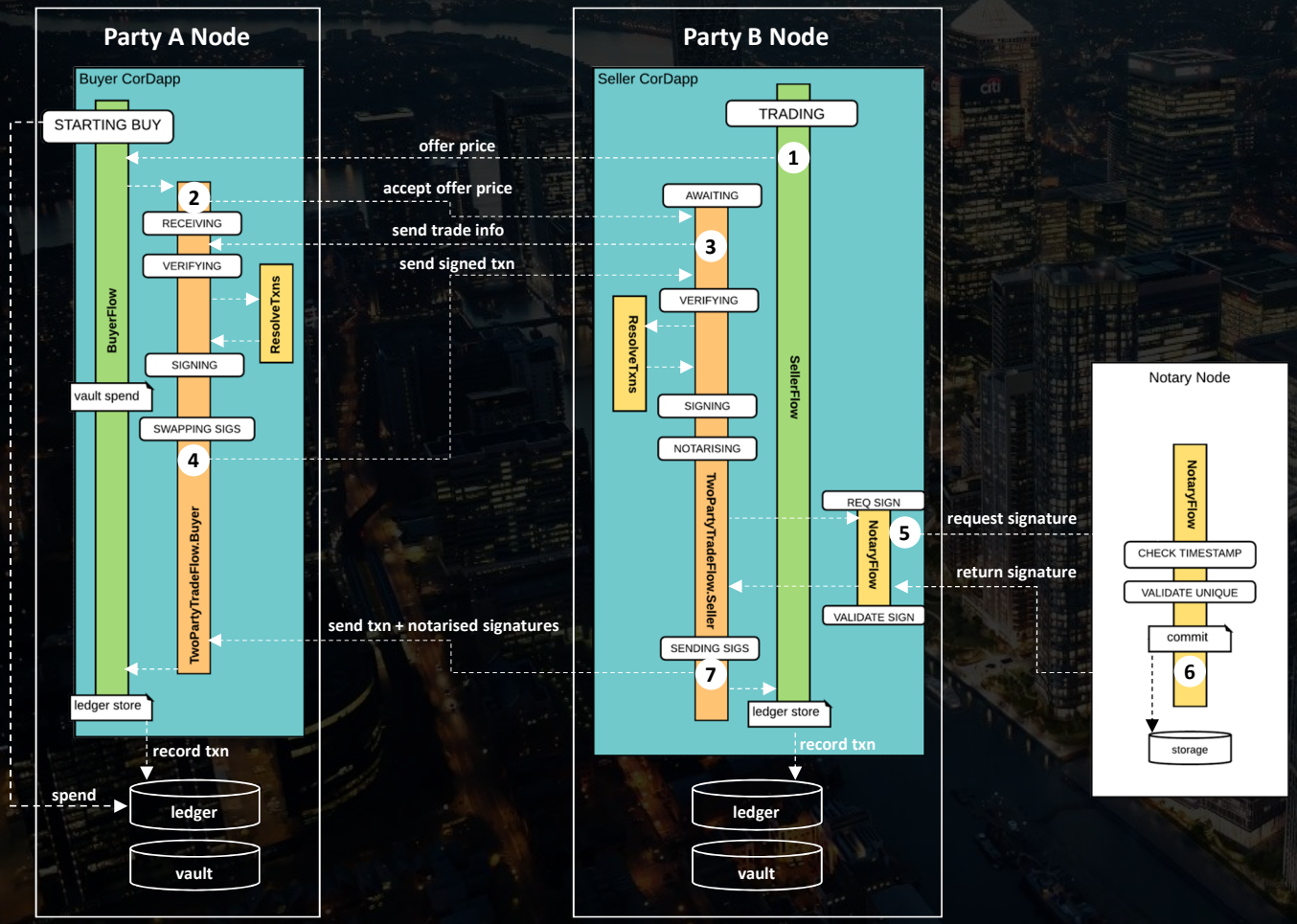
Oracles eg. Price assessment agencies, FX rate provider, IR provider

- ✓ All calculations on the ledger must be **deterministic**, i.e. every node must come to the exact same conclusion over a transactions validity. Therefore, a trusted third party is needed to **sign a transaction** containing off-ledger statements. The notary is trusted to set statements that are considered to be true.
- ✓ To keep the transaction data provided to the Oracle to a minimum, irrelevant data is **"torn off".** This is made possible by structuring the transaction as a **Merkle hash tree**.



Example: Hiding data and providing the proof that it formed a part of a transaction is done by constructing Partial Merkle Trees.

Corda Flows



- ✓ Flows are transactions-building protocols that enable complex **inter-firm workflows**. The underlying **protocol** is AMPQ/1.0 over TLS.
- ✓ Corda provides a **framework** for the writing of flows. It features include routing flows, progress tracking, providing libraries of reusable subflows, and more.
- ✓ The **exemplary workflow**, shown on the left, includes **3 participants**: A buyer, a seller and a notary. The **custom written buyer and seller flows** (green) invoke financial (orange) and core (yellow) **library flows**. The flow **interacts with the vault** to trigger a spending activity **and the ledger** to record the fully signed transaction. Flows operating on different parties' nodes interact using send, receive and sendReceive messaging semantics.

Consensus in Corda Flows

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State's Verify Function

1. Making sure that **all parties** who need to sign the transaction are specified in the command.

2. Ensuring that the **public keys** specified on the command are those of the parties whose signatures would be required to make the transaction valid.

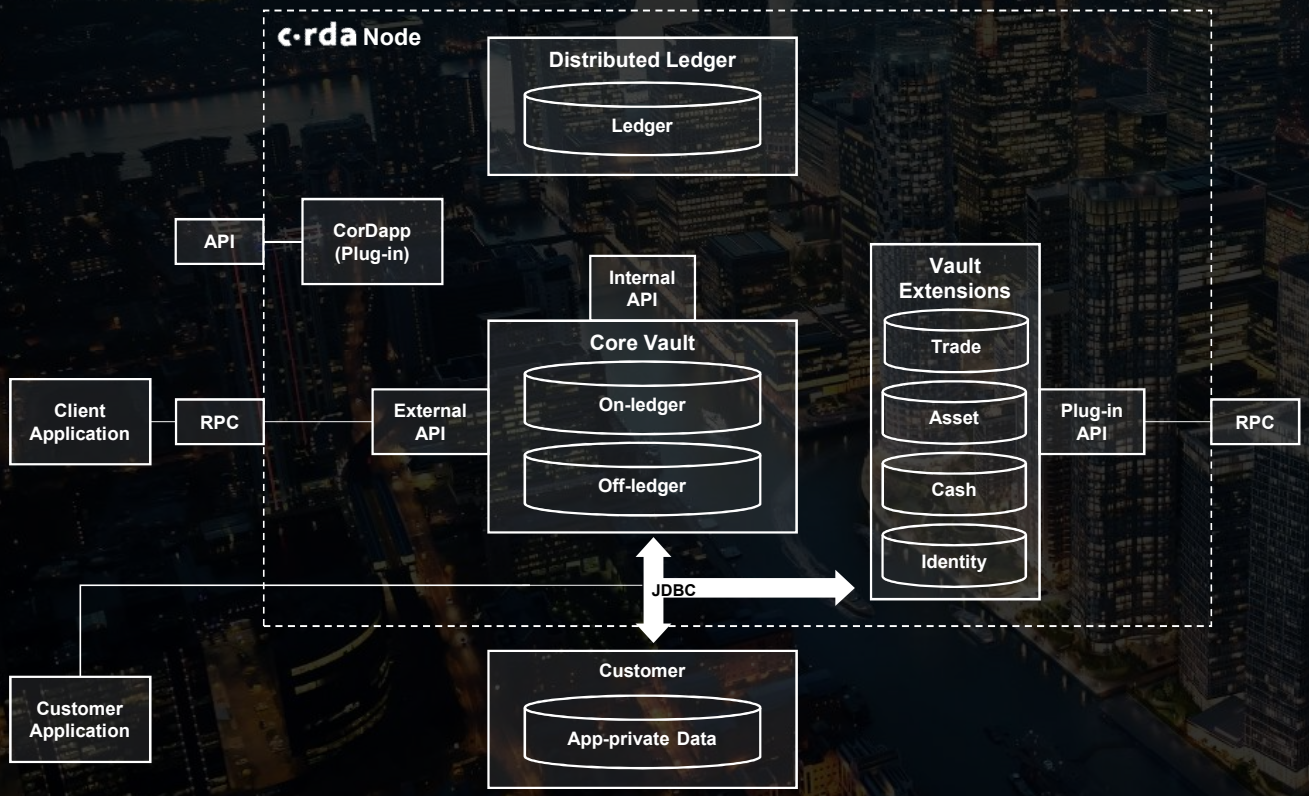
Notaries

Providing uniqueness services to make sure that the transaction is the unique consumer of the state.

Corda Framework

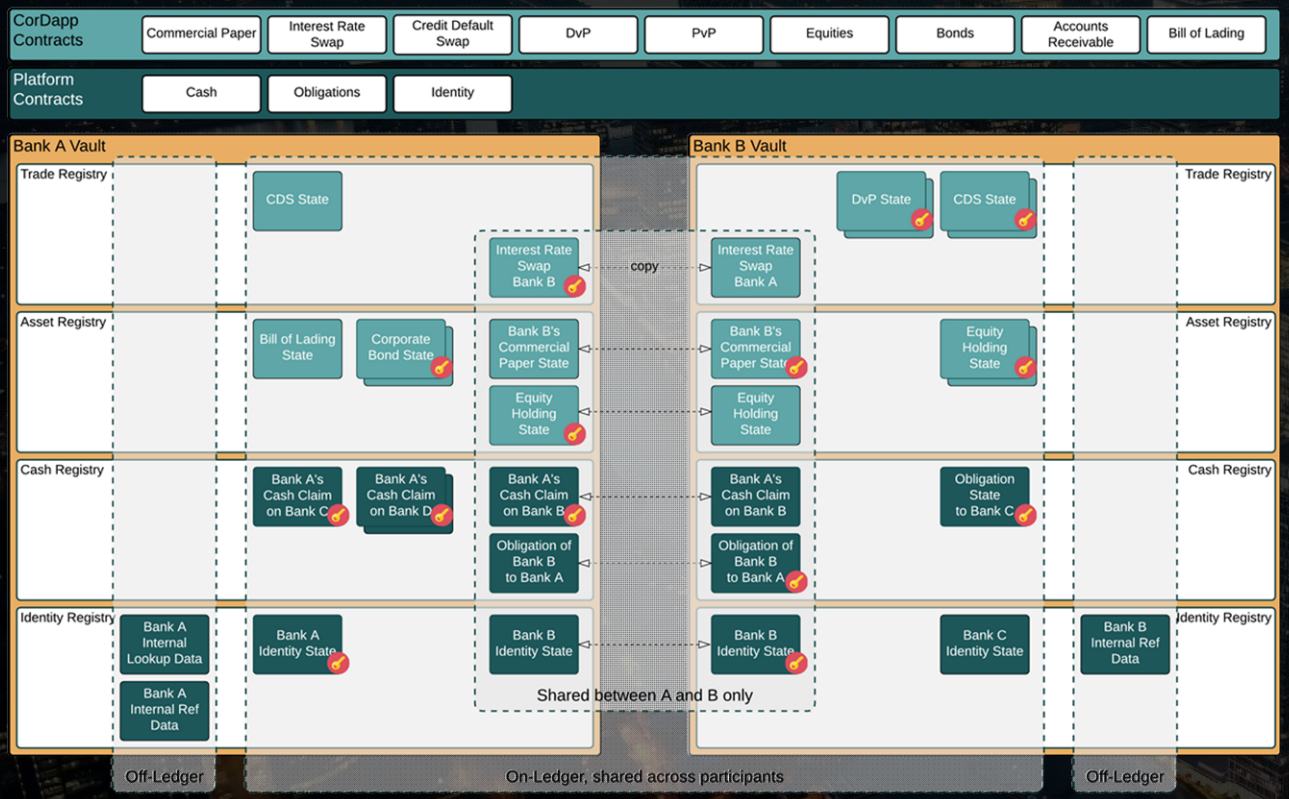
Checking that the **transaction** has been **signed by all keys** listed by all commands in the transaction.

A Corda Node



- ✓ The vault stores **consumed and unconsumed state** and can be extended by customer specific **off-ledger data**. The customer's **private store** contains internal organisational data that may be joined with the vault data. By adding custom vault extensions , specific contract attributes can be queried.
- ✓ While the vault **external API** is exposed to developers to query the data using standard Corda RPC and CorDapp plugin mechanisms, the **internal API** is used by transaction recording flows to update the vault. The vault database is directly accessible via the **Java Database Connectivity (JDBC) API** for customer joins and queries.
- ✓ Using the **Corda Shell**, node administrators and developers can easily control and monitor the node. It enables them, among other, to invoke PRCs, start flows and download and upload files from the attachment.

The Vault



- ✓ The vault contains **data extracted from the ledger** that is considered relevant to the node's owner. It keeps track of unconsumed states, available for spending, evolution or transfer, as well as consumed states for reporting, audit and archival.
- ✓ The data held in the vault is divided into **on-ledger and off-ledger data**. The on-ledger store tracks distributed ledger state and is updated internally by the node upon recording a transaction on the ledger. Off-ledger data refers to additional data added by the node's owner (e.g. internal reference).
- ✓ The Corda vault can **create transactions** by combining fungible states. To prevent unintentional double-spends the **soft locking** feature reserves states to prevent the vault from simultaneously creating transactions that use the same output.

State Object

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- ✓ State Objects are the fundamental unit of consensus in Corda and cannot exist outside of the transactions that created them.
- ✓ They are immutable digital objects that records existence, content and current state of an instance of a contract. Should have the effect of a legally binding contract

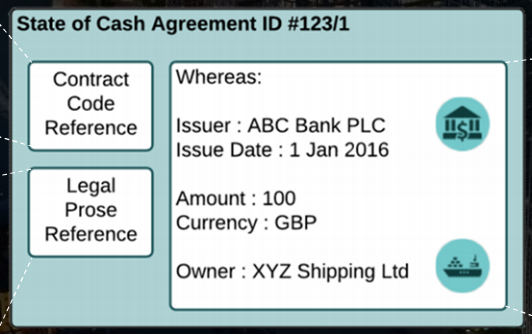
---

Contract Code:

The contract code defines valid operations on the state objects (e.g. issue, pay or redeem for cash)

Legal Prose :

The state may contain a reference to legal prose to ground the behaviour of the state and its contract code in a governing legal context



Details:

Contains important information, like the issuer and the owner

Digitally signed by the parties in a not reproducible way

States' Life Cycle

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1. Issuance of a state

State objects are brought onto the ledger through issuance transactions. They can contain arbitrary data, such as an issuer, an owner, a maturity date, etc.

2. Evolution of a state

During its life cycle the attributes of a state are changed through transactions. What transactions are considered as valid depends on the type of the agreement. While fungible assets can be traded through pay transactions, states that represent a deal might be subject to periodical fixing.

3. Exit/Redemption of a state

When and how a state is exited from the ledger is determined by the underlying agreement. Cash for example can be exited from the ledger by the owner of the state at any given time. A Commercial Paper on the other hand is bound to a certain maturity date and can only be redeemed by its issuer.

Issuance of a State

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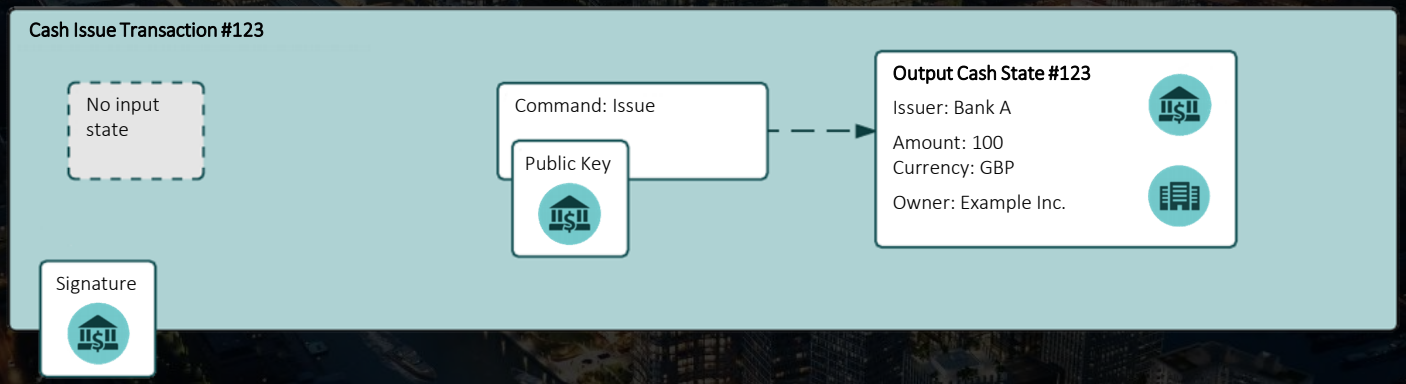

Evolution of a State

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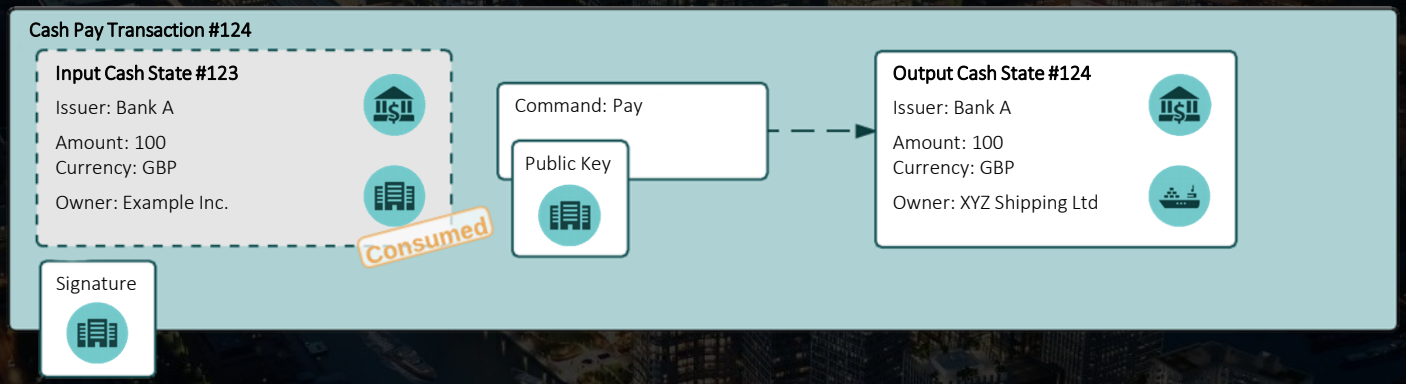
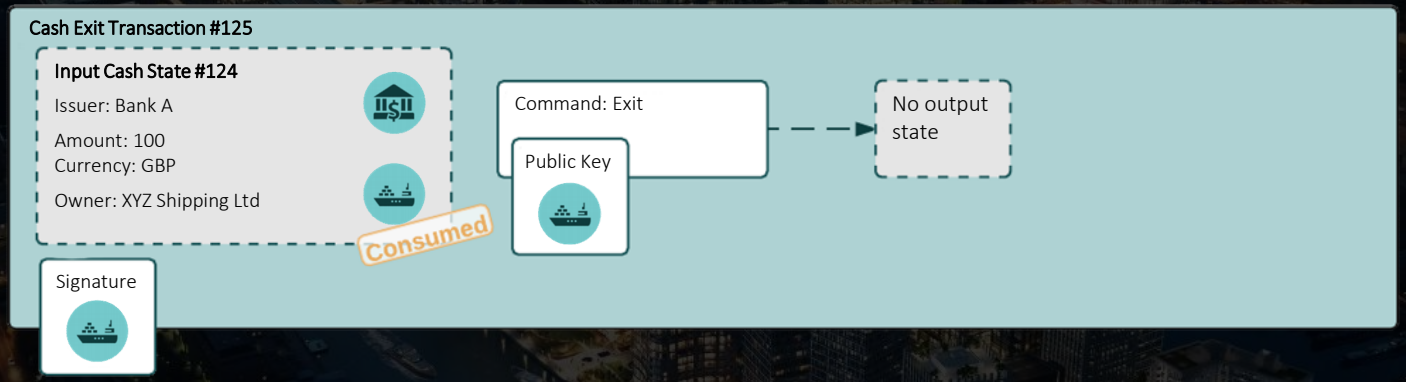


Exit/Redemption of a State



Transactions

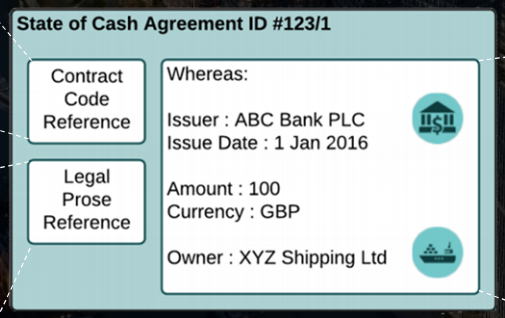
- ✓ A transaction is the means by which states are both created and consumed. Any state whether consumed or not can be identified by the identifier of the creating transaction and the index of the state in the outputs list.
- ✓ All transactions have to be signed by their input state notary for the output states to be valid (apart from issue transactions, containing no input states). They may execute in parallel, on different nodes, without either node being aware of the other's transactions.
- ✓ New transaction types can be defined using JVM bytecode.

Contract Code:

The contract code defines valid operations on the state objects (e.g. issue, pay or redeem for cash)

Legal Prose :

The state may contain a reference to legal prose to ground the behaviour of the state and its contract code in a governing legal context



Details:

Contains important information, like the issuer and the owner

Digitally signed by the parties in a not reproducible way

Transactions

Input references
These are pairs that point to the states a transaction is consuming.

Attachments
Transactions specify an ordered list of zip file hashes. Each zip file may contain code, data, certificates or supporting documentation for the transaction. Contract code has access to the contents of the attachments when checking the transaction for validity.

Signatures
The set of required signatures is equal to the union of the commands' public keys.

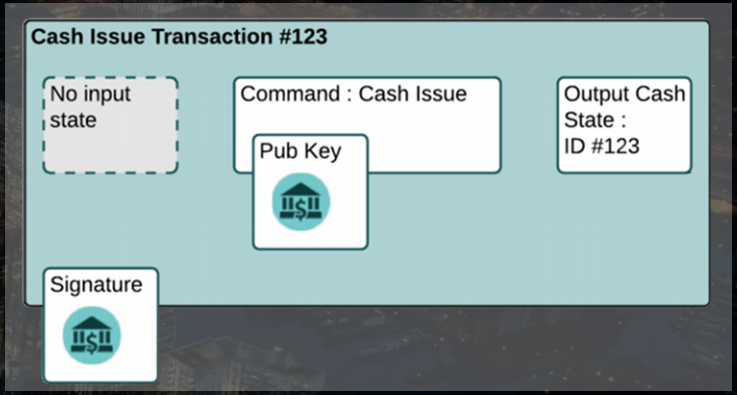
Timestamp
When present, a timestamp denes a time range in which the transaction is considered to have occurred.

Output states
Each state species the notary for the new state, the contract(s) that define its allowed transition functions and finally the data itself.

Commands
There may be multiple allowed output states from any given input state. A command is a parameter to the contract that specifies more information than is obtainable from examination of the states by themselves. Each command has an associated list of public keys.

Type
Transactions can either be normal or notary-changing. The validation rules for each are different.

Summaries
Textual summaries of what the transaction does, checked by the involved smart contracts. This field is useful for secure signing devices.



Who is the best choice **for ForceField**?

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Can **industry standard T&Cs** be set in code with an intelligent **smart contract**?

Our strategic partnership with **R3 Corda**

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Oil related **smart contracts**

Challenges faced

Multitude of systems:
Trading, logistics and accounting systems.

External parties as well as internal:
Danger of compromising privacy of information. How new members join, what level of transactional detail is available

Various updates:
Contractual terms, Vetting, Nomination, Actualisation of Q&Q, optionality in pricing source

Multiple documents of reference:
Structured contract/master agreements, Letter of Credit, bill of lading, inspection document, certificate of origin, vetting docs, etc

Corda functionality

Interoperability with different systems is enabled due to **common programming language** and holds information about the transaction in each parties' **vault**

There is a **doorman functionality** to allow new members to connect to the network. There are **no broadcast networks**, peer to peer messaging is how information flows

Each action creates a flow that require validation and can have **set protocols** ie. How to price/manage going over operational tolerance

The Corda platform can **securely hold related documentation on-ledger or off-ledger** for various stages of the same transaction in different file types

Post-trade: Use Case example PoC has been developed

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Creation of **late payment interest** template with pricing methodology and settlement

LPI calculation for settlement billing selected using trade information:

- LIBOR rates
- Pre agreed formula; eg. BP's T&Cs 3 percentage points above LIBOR + any withholding tax
- Value date of pre-agreed payment date
- Actual payment date
- Notional value of contract USD

63.9 **Interest**

63.9.1 If either party (the "Paying Party") fails to pay in full any sums on the due date for payment, the other party (the "Receiving Party") shall have the right to require the payment by the Paying Party of interest on any unpaid amount at 3 percentage points above the London Interbank Offered Rate ("LIBOR") for one month US dollar as administered by the ICE Benchmark Administration ("IBA") or any other entity which takes over the administration of that rate and published on the due date by Thomson Reuters on behalf of the IBA, such interest to run from the due date until the date payment is received by the Receiving Party's bank. Interest shall continue to accrue under this Section 63.9 until payment notwithstanding the termination of the Agreement for any cause whatsoever. The amount of interest payable to the Receiving Party shall be engrossed for withholding tax, if any, such that the net amount received by the Receiving Party after the deduction of any such withholding tax shall be equal to the full amount of interest due.

63.9.2 The provisions of this Section 63.9 shall not be construed as an indication of any willingness on the part of the Receiving Party to provide extended credit as a matter of course, and shall be without prejudice to any rights and remedies which the Receiving Party may have under the Agreement or otherwise. Any expenses incurred by the Receiving Party, including reasonable legal fees, court costs and collection agency fees, caused by delayed or non-payment by the Paying Party of the amount(s) due shall be for the account of the Paying Party and payable upon demand with supporting documentation.

Source: https://www.bp.com/content/dam/bptrading/en/global/trading/Documents/BPTradingGTCs

Benefits of smart contract versus traditional contract:

- **Automatic settlement calculation** – increased efficiency using Corda functionality of having IR provider setup as an oracle
- **Fewer aged debt items** at month-end – commercial argument
- **Removed manual processes** – Corda to SAP interoperability is currently under development

Blockchain requirements - Confidentiality

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Transaction Details

In Corda transactions are only shared in a need-to-know basis, which means that only the transaction involved participants would have access to the full information. In order to provide confidentiality to the data on the trade we decided to use different Corda States between the different parties involved.

For example, from the Recap State trade created by buyer and seller operators a new Voyage State and Inspection State will be created to transact with Inspection/Shipping Agencies, that way 3rd parties will never have access to the Recap State information and being limited to the information on the Voyage State and Inspection only, hiding trade monetary values. Worth to mention that Shipping agencies and Inspection agencies would not have access to each other information as well. With a

Transaction Summary

With a similar approach to the transaction details a specific Recap Summary State will be created to be made public. For example, if the buyer and seller identity needs to be hiden the Recap Summary State would not contain those information, and only the receiver would be a party in the transaction. Also, any public keys that would have to be on a summary transaction would be easily anonymised by using the AnonymousParty object that identifies a party by its public key only.

Blockchain requirements - Consensus Mechanism

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Flexibility of consensus

Corda has "pluggable" consensus, allowing notaries to choose a consensus algorithm based on their requirements in terms of privacy, scalability, legal-system compatibility and algorithmic agility.
In particular, notaries may differ in terms of:

- Structure - a notary may be a single network node, a cluster of mutually-trusting nodes, or a cluster of mutually-distrusting nodes
- Consensus algorithm - a notary service may choose to run a high-speed, high-trust algorithm such as RAFT, a low-speed, low-trust algorithm such as BFT, or any other consensus algorithm it chooses

Validation

A notary service must also decide whether or not to provide validity consensus by validating each transaction before committing it. In making this decision, they face the following trade-off:

- If a transaction is not checked for validity, it creates the risk of "denial of state" attacks, where a node knowingly builds an invalid transaction consuming some set of existing states and sends it to the notary, causing the states to be marked as consumed
- If the transaction is checked for validity, the notary will need to see the full contents of the transaction and its dependencies. This leaks potentially private data to the notary

Blockchain requirements - Support multiple chains

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Because there is no single Blockchain it becomes possible to merge two independent networks together by simply establishing two-way connectivity between their nodes then configuring each side to trust each other's notaries and certificate authorities.

When merging networks, both sides must trust that each other's notaries have never signed double spends. When merging an organisation-private network into the global ledger it should be possible to simply rely on incentives to provide this guarantee: there is no point in a company double spending against itself. However, if more evidence is desired, a standalone notary could be run against a hardware security module with audit logging enabled. The notary itself would simply use a private database and run on a single machine, with the logs exported to the people running a global network for asynchronous post-hoc verification.

Blockchain requirements

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Security

Corda networks are semi-private. Each network has a doorman service that enforces rules regarding the information that nodes must provide and the know-your-customer processes that they must complete before being admitted to the network.

Storage – off chain storage

Corda offers the option to expose all or some part of a contract state to an Object Relational Mapping (ORM) tool to be persisted in a RDBMS. The purpose of this is to assist vault development by effectively indexing persisted contract states held in the vault to run queries over them and to allow relational joins between Corda data and private data local to the organisation owning a node.

Storage - Translations to multiple ETRM systems/formats

The nodes owner has access RPC access to the node, and its vault. To provide different data formats each Operator Node will provide a Restful API that will have access to the nodes vault and transform queried data into different formats, i.e. JSON and XML.

Central Node additional requirements – Transaction auditing

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The central node will provide a Restful API auditor and regulators will be able to access and query any data stored in the Central Nodes vault and since all data will be anonymised there are no risks of confidentiality and privacy exposure. The restful API will have its own OAuth mechanism to give access to those off ledger parties, providing than a fast and secure way to access data on-ledger.

Network Node Types

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To better meet the requirements of each participant in the network the nodes are built by CorDapps (Corda Distributed Applications), their goal is to allow nodes to reach agreement on updates to the ledger. They achieve this goal by defining flows that the Corda node owners can invoke through RPC calls.

Cordapps allow nodes to be customized according to its need, privacy and confidentiality. It means that each node will have a specific set of CorDapps and its respective flows granting more or less permission in network.

The proposed network will be composed of the following node types:

- Notary Node – This node type is responsible for providing uniqueness consensus on all input and output states that are consumed. There can be different types of consensus that a notary node that can pluggable into the network.

- Regular/Operator Node – This node type is the responsible for the trade creation, amendments and acceptance, ship agency and inspector assignment for load/discharge flows.

- Ship Agency Node – This node type is responsible for providing the ship assignment, load and discharge quantity inputs flows.

Network Node Types

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- Inspection Agency Node – This node type is responsible for providing inspector assignment, load and discharge quality inputs flows.

- Regulators/Auditing Node – This node type is responsible for have access to all anonymised transactions from the moment they join the network onwards.

- Central Node – There will be only one central node that will be responsible for gathering all the anonymised transactions in the network. Also, this node will take part on providing an API access to 3rd parties off chain, i.e. Shipping and Inspection agencies, auditors and regulators.

It is worthwhile to mention that Ship Agency and Inspection Agency nodes can be easily available if the Central node will handle most of the 3rd parties.

Contents

- Introduction everis
- Project Team & High Level Activities
- Platform and Technology Consideration
- **Commercial Consideration (e.g. Trade Finance)**
- Scenario - Flow I
- Scenario - Flow II
- Alliances

Understanding financing

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Current state:

Representation of **transaction details** sent to trading and accounting systems of both parties for use by:

- Treasury **(cashflow forecasting)**
- Middle office **(position and pnl reporting)**
- Back office **(settlement and reconciliation)**
- Compliance **(reporting and post trade)**
- Legal **(in case of dispute)**
- Auditors **(post trade)**
- Tax **(VAT)**
- Credit **(use of LC or closure of LC)**

Understanding financing

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Incorporating this into the envisioned network(s)

How would the network extend the flow to include banks for financing and the ultimate payment undertaking considering the following two scenarios?

Scenario 1) Banks are in the same Blockchain network as the traders.

Banks can join the same Corda network as their own node per bank. Corda was first built and tailored for banks, which is why its features assume a highly regulated environment.

Scenario 2) Banks are on another platform, perhaps even using different Blockchain technology

During the ODC we teamed up with Quorum to address this point. The underlying technology that would sit between Quorum and Corda is the ILP (InterLedger Protocol) which was developed by our owner NTT Data. Our technology partner Ripple can act of the payment of cash upon exercise of a letter of credit in any real/fiat currency.

Use Cases in Trade Finance

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The Corda and Fabric platforms were specifically designed to make traditionally paper-based processes more secure, cost-effective and efficient, thereby holding the key to transforming trade financing for modern financial markets. With Corda and Fabric Trade Finance can become a transparent end-to-end process.

Trade Finance Solution built on Corda

r3 + Cognizant + MIZUHO

Cognizant has been selected by Mizuho Financial Group to develop a distributed ledger solution for the digitalisation of trade documents on R3's platform Corda. Mizuho Financial Group will use this solution to explore how DLT can reduce the business risks arising from paper-based processes, and provide enhanced visibility to all parties involved in the trade and transport value chain.

Trade Finance Application built on Fabric

IBM + HSBC + Bank of America Merrill Lynch + iDA SINGAPORE

Bank of America Merrill Lynch, HSBC and the Infocomm Development Authority of Singapore are building an application on Hyperledger Fabric to streamline letter of credit transactions, supported by IBM. The application will be used to share information between importers, exporters, and their respective banks, and will allow them to execute trade deals automatically through a series of digital smart contracts.

Trade Finance

Competing Goals

- ✓ International trade exposes exporters and importers to a spectrum of risk
- ✓ Trade Finance helps importers and exporters mitigate trade risk by relying on financial institutions to take on their risk positions

Trade Finance
Difficulties

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Paper-based Processes
Trade documents, such as bills of lading or invoices, that build the foundation for the trade finance process, exist largely in paper form.

Reconciliation Costs
Having to deal with largely paper-based documentation makes reconciliation between the financial institutions a lengthy and costly process.

Documentary Fraud
One of the most common form of documentary fraud is the double financing approach where importers and exporters collaborate to receive multiple funding for the same trade.

Compliance
Financial Institutions rely on taking random samples, rather than automation. This makes it hard to detect cases of money laundering, terrorist funding or child labour.

Trade Finance

Benefits of Blockchain Technology

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Paper-based Processes

→ **Digitalisation of Trade**

Reconciliation Costs

→ **Automated Reconciliation**

Documentary Fraud

→ **Double Spending Prevention**

Compliance

→ **Automated Compliance**

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Flow 1

Visualized on R3 Corda

RECAP:
Buyer: Trader A
Seller: Trader B
Volume and operational tolerance %: 100KB
Inco term: CIF
Pricing: Fixed
Pricing period: fixed price $60
Settlement date: 30 after b/l
Credit: Bilateral
Laycan: (5-7 Feb 2018)
Grade: Morties
T&Cs: Big Major T&Cs

T+30mins

The Trade Recap Flow (step 1):
Seller transmits a trade recap to the counterparty you've traded with, **ensuring no other participant on the platform has knowledge of the trade done**

Corda deliverables:
Private peer to peer messaging occurs, C and D exist on the same network but have no idea for A and B's activity.

Flow 1

Visualized on R3 Corda

RECAP:
Buyer: Trader A
Seller: Trader B
Volume and operational tolerance %: 100KB
Inco term: FOB
Pricing: Fixed
Pricing period: fixed price $60
Settlement date: 30 after b/l
Credit: Bilateral
Laycan: (5-7 Feb 2018)
Grade: Morties
T&Cs: Big Major T&Cs

T+60mins

The Trade Recap Flow (step 2):

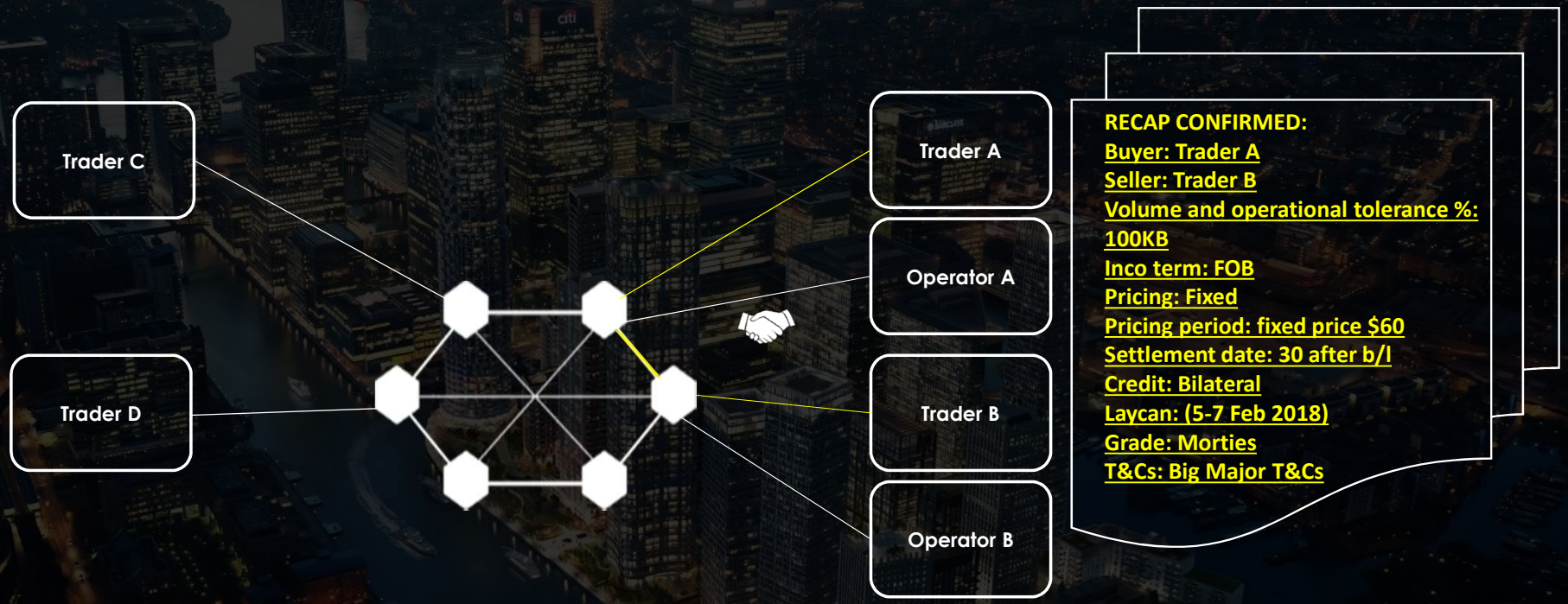
Allow the counterparty to **negotiate the recap by transmitting a proposed modification** to the recap back to you

Corda deliverables:

Private peer to peer messaging occurs again and the message can highlight what has changed, both nodes are **validating nodes**

Flow 1

Visualized on R3 Corda



The Trade Recap Flow (step 3):

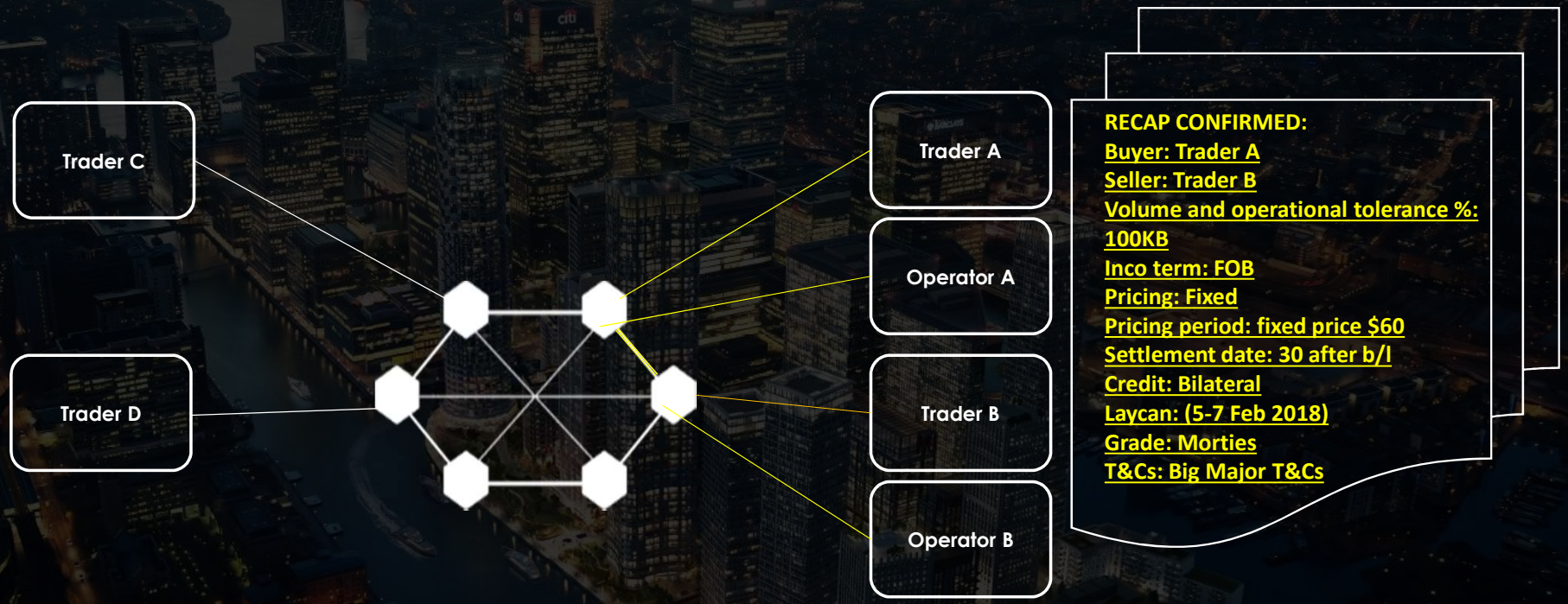
Once all negotiation is complete, affirm the recap

Corda deliverables:

After the **validation** the deal moves to an **affirmed state**

Flow 1

Visualized on R3 Corda



The Trade Recap Flow (step 4):

The trade is now considered executed and will live in the system until it comes time to schedule it

Corda deliverables:

The **affirmed state** starts various flows, first it moves this to a **to be nominated state** and the **trigger event for nomination** will send a flow to the operator A (FOB Buyer)

Flow: **RecapConfirmationFlow**, State: **RecapState** and associated transactions

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amendB means "Amended by Buyer"
amendS means "Amended by Seller"

RecapState schema:

- buyer
- seller
- grade
- price
- pricing period
- laycanStart
- laycanEnd
- Incoterm
- quality
- loadPort
- dischargePort
- dealDate
- tolerance
- totalVolume
- remainingVolume
- Status
- creditTerm
- StandardT+C

Graph of `RecapState`, with the `transactions()` required to go from one state to the other.
`seller:` / **`buyer:`** refer to the entity authorised to execute the transaction (enforced by the contract).

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- Project Team & High Level Activities
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- Scenario - Flow I
- **Scenario - Flow II**
- Alliances

Flow 2 – High level node structure

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Visualized on R3 Corda

Flow 2 – steps 1 of 2 (75KB)

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Oil Morties contract (Bilateral)

0

Trader A (buyer)

Trader B (seller)

Contract department: Smart contract code with flows

1

Triggered by smart contract @ b/l – 20 days: Operator A (FOB – buyer) nomination requests for ship and inspector re voyage Hound point to Rotterdam, Operator B responsible for vetting

Nomination schedule

Voyage: Hound Point to Rotterdam
Typical quality: Gravity 38.7 API, Sulfur 0.79% Laycan: (5-7 Feb 2018)

3

Operators A and B Update trading systems with nominated ship and inspector data (later this would interface with internal trading systems)

5

Operators A and B Update trading systems with received Q&Q data (later this would interface with internal trading systems)

2

Shipping Agent AB sends back ship details assigned to operators A and B B/L date

Inspector AB assigns A and B the schedule for testing of quality B/L date + 2

4

Load port: Shipping Agent AB records **quantity** of parcels loaded. This update is sent to Operator A and B.

Load port: Inspector AB records **quality** of parcels loaded. This update is sent to Operator A and B

Data transferred to shipment co: commodity, quantity, load location, discharge location, load laycan date

Flow 2 – steps 2 of 2 (75KB)

Oil Morties contract (Bilateral)

6

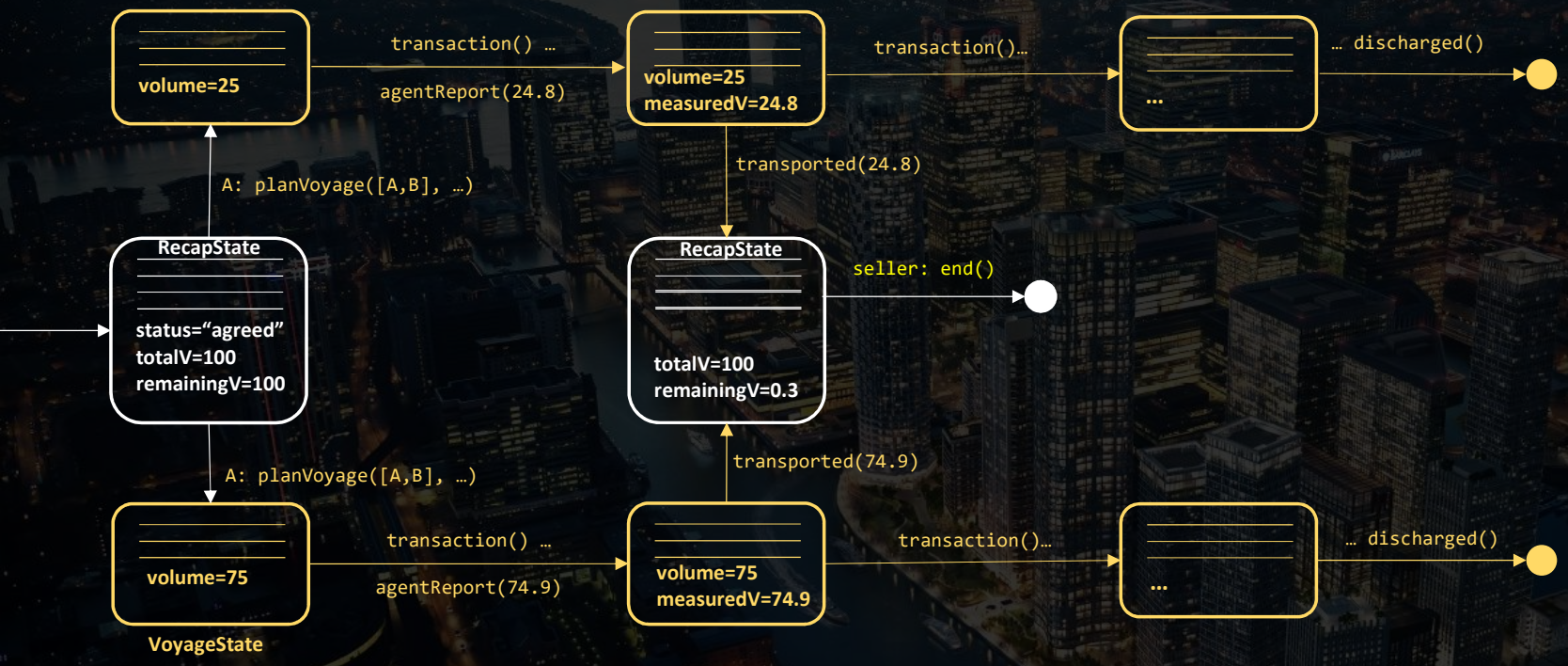
Discharge port: Shipping Agent AB records **quantity** of parcels discharged. This update is sent to Operator A and C

Discharge port: Inspector records **quality** of parcels discharged. This update is sent to Operator A and C

7

Operators A and C Update trading systems with received Q&Q data of discharge (later this would interface with internal trading systems)

Flow: **DealSchedulingFlow**, States: **RecapState**, **VoyageState** and associated transactions



Note: there are too many possible transactions to fit on the diagram.

- planVoyage()
- vetVessel()
- productReady()
- vesselReady()
- assignLoadInspector()
- assignLoadAgent()
- agentReport()
- sail()
- assignDischargeInspector()
- assignDischargeAgent()
- vesselArrived()
- discharged()

VoyageState schema:

- loadLocation
- dischargeLocation
- productReadyTime
- vesselReadyTime
- volume
- loadedVolume
- dischargedVolume
- quality
- loadedQuality
- dischargedQuality
- vesselName
- vesselOwner
- loadInspector
- loadAgent
- dischargeInspector
- dischargeAgent
- vesselDepartedTime
- vesselArrivalTime

Unmentioned activities due to simplification

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Incorporating this into the envisioned network(s)

Pre trade recap flow:

Credit – Who is setup to trade/who needs on boarding, what credit lines we have open for bilateral and what need to be covered by SBLC. The Corda functionality of an ID framework could assist with this flow once historical data exists on the network for KYC.

Compliance – are there any black listed counterparties we are banned from trading with, any current embargoes to take into consideration for route,

Post trade recap affirmation:

Contracts flow – Contract creation and negotiation. Credit term should trigger next flow to credit department if needed.

Advising bank – This bank will either be a member of the same platform or another platform and will be able to communicate with the issuing bank of the letter of credit and be contacted by parties that require financing

Port operator and customs – linking these to the shipping agent, a mobile platform should be able to link to the network

Issuing bank – This bank ultimately issues the letter of credit to the counterparty buying the cargo and will be the bank to close the LC if it is not utilised.

Structured deals – In the longer term, the platform will need to communicate with the other types of trading desks on the same node as some deals will be structured longer term deals linking to spot purchases and sales

Credit flow – If a deal requires trade finance then the credit team will receive a flow from contracts that this needs to be requested

Middle office flow – After trade entry the middle office will manage the risk and pnl reporting of the transaction

Market risk – market risk must ensure the overall population of the transactions have the correct valuation for VaR purposes

Operations flow – freight and insurance needed by party A as a FOB buyer

Insurer – providing cover and documentation of policy, this can be the value of the cargo or even terrorist and piracy clauses that would need to be created as flows

Unmentioned activities due to simplification

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Incorporating this into the envisioned network(s)

Post trade recap affirmation continued:

Compliance Flow – Information of transaction for compliance review and analysis

Treasury – cashflow reporting systems must be linked to the updates such as bill of lading that drives settlement date

Price assessment agencies – these will be linked as oracles to the network feeding only the information needed

Post settlement:

Contracts flow – all costs related to credit, freight, port, vetting, inspection, demurrage, late payment interest

Advising bank – flow from issuing bank to advise upon wording of final LC in example where trade finance is needed

Issuing bank – Opening/execution/closure of LC

Credit flow – request to use LC in case of default/request to close LC if not utilised

Middle office flow –Reserves and provisions

Compliance Flow – Information of transaction for compliance review and analysis

Tax VAT - cross border implications of ports chosen

Accounting and Operations – Inventory management and reporting for period ends

Regulator and Auditor – reporting needs should be met by a dynamic reporting element using the observer node. This would not be executed by them but by the party to the information.

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Everis' alliances using the **ForceField network of participants**

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Finding the **best fit** in the **shortest time**

The network provided to us upon entering Project ForceField we viewed as an immediate opportunity.

The surgeries with open Q&A and the #alliances slack channel provided us a space to broadcast our interest in collaborating on different levels.

Our objective was first to find a good fit in terms of what we planned to deliver, we had already made our choice on Corda.

We also understood that different Blockchain platforms should be tested for interoperability; we hoped to team with either Fabric or Quorum because of our level of existing research and application knowledge; we were not disappointed.

Platform choice Corda with team member synergies:

This was a must have. We had planned on entering the competition with our technology partner R3 Corda originally; our development team had shrunk.

We approached **ThoughtWorks** and generated a good rapport. We found we could trade SME knowledge for extra Corda development resources.

Platform for trade finance use case with Corda interoperability:

This was also a must have. We understood that a consortium of Banks, Trading Houses and Oil Majors calls for a sold trade finance solution.

We approached **Trade Quorum** and they were as keen as us to collaborate in terms of testing our independent solutions for interoperability. We hope very much to meet them in Phase 2.