ADHARA

Presentation to the CEMLA Forum

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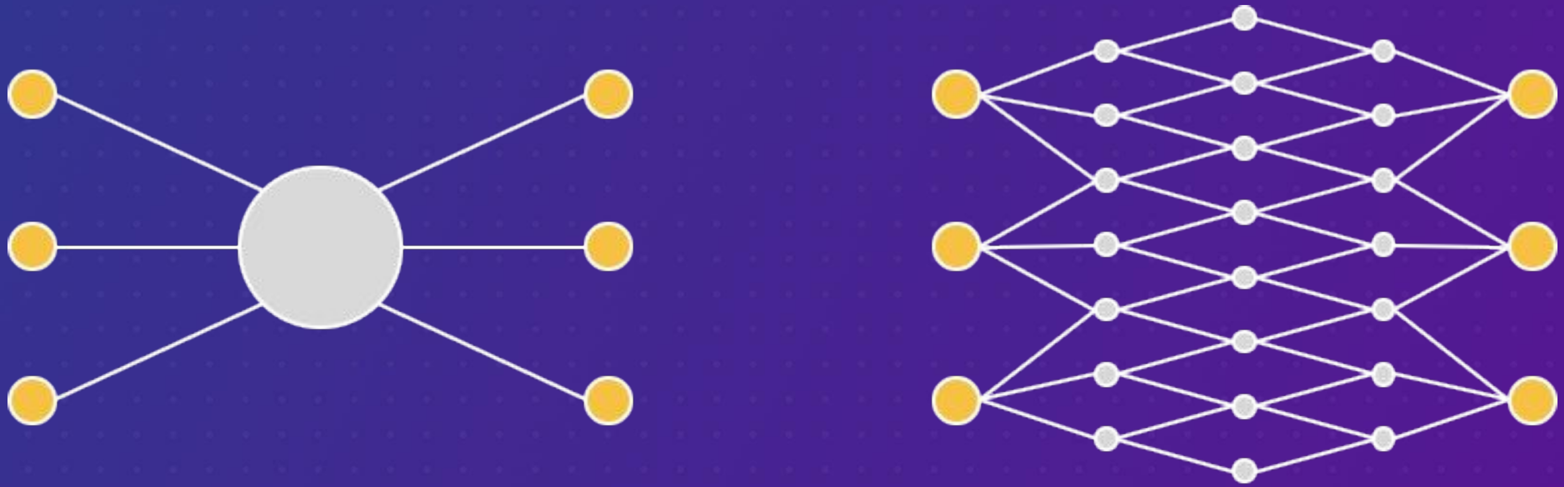
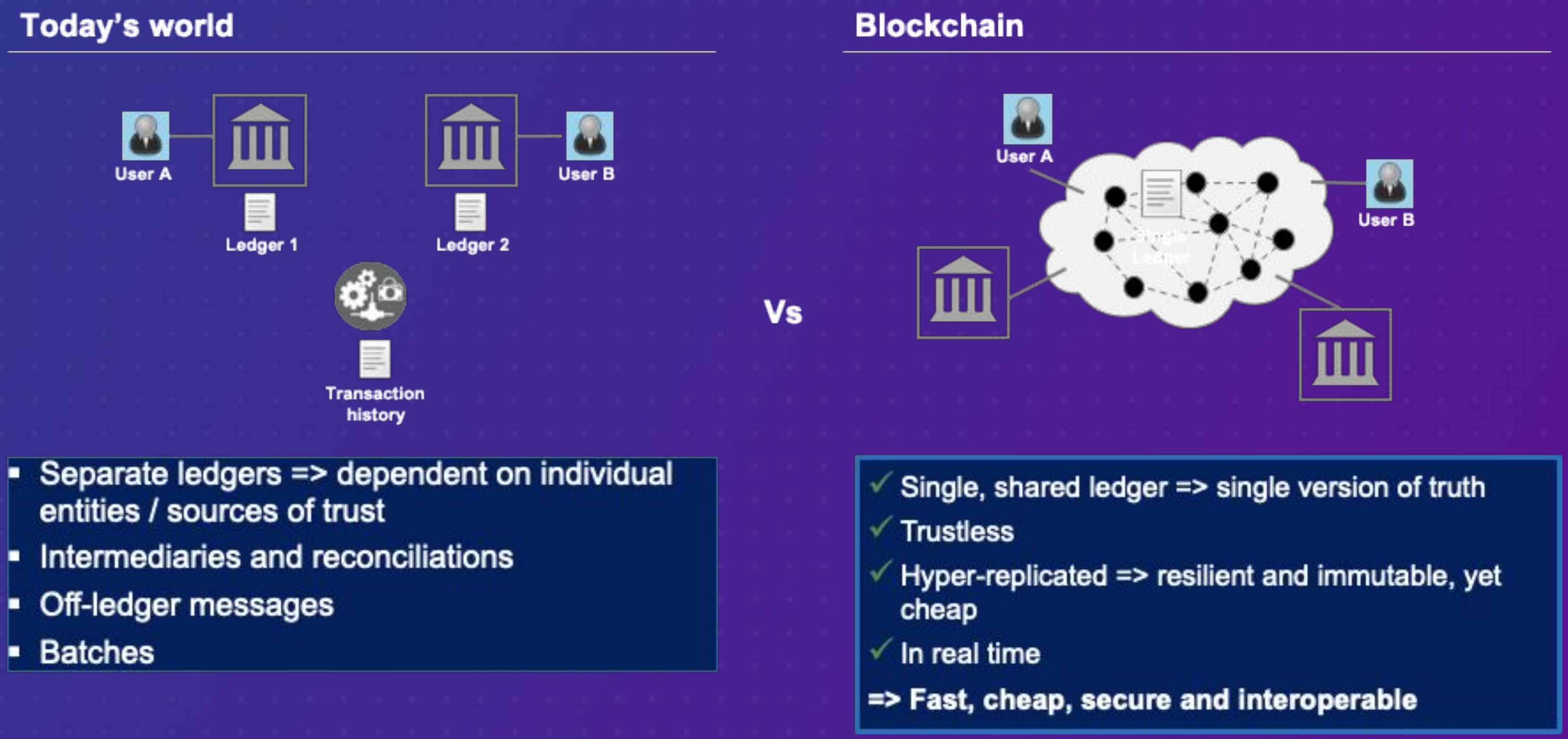
Blockchain: the “internet of value”



Blockchain does to **value**
what
internet made to **communications**

Blockchain is a shared ledger



Today's world

- Separate ledgers => dependent on individual entities / sources of trust
- Intermediaries and reconciliations
- Off-ledger messages
- Batches

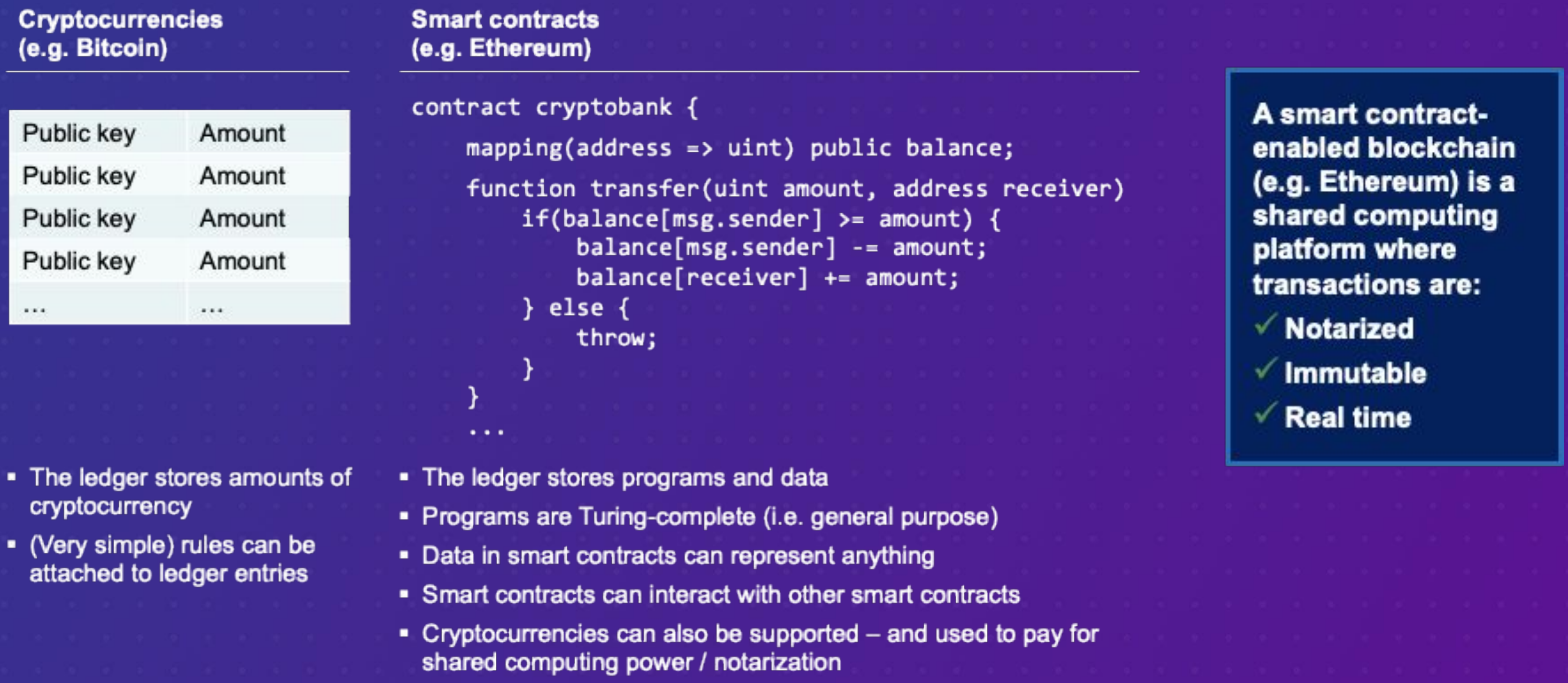
Vs

Blockchain

- ✓ Single, shared ledger => single version of truth
- ✓ Trustless
- ✓ Hyper-replicated => resilient and immutable, yet cheap
- ✓ In real time

=> Fast, cheap, secure and interoperable

Beyond cryptocurrencies: smart contracts are *programs* (and *data*) on the shared ledger



Cryptocurrencies (e.g. Bitcoin)

Public key	Amount
Public key	Amount
Public key	Amount
Public key	Amount
…	…

- The ledger stores amounts of cryptocurrency
- (Very simple) rules can be attached to ledger entries

Smart contracts (e.g. Ethereum)

```
contract cryptobank {
    mapping(address => uint) public balance;
    function transfer(uint amount, address receiver)
        if(balance[msg.sender] >= amount) {
            balance[msg.sender] -= amount;
            balance[receiver] += amount;
        } else {
            throw;
        }
    }
    ...
```

- The ledger stores programs and data
- Programs are Turing-complete (i.e. general purpose)
- Data in smart contracts can represent anything
- Smart contracts can interact with other smart contracts
- Cryptocurrencies can also be supported – and used to pay for shared computing power / notarization

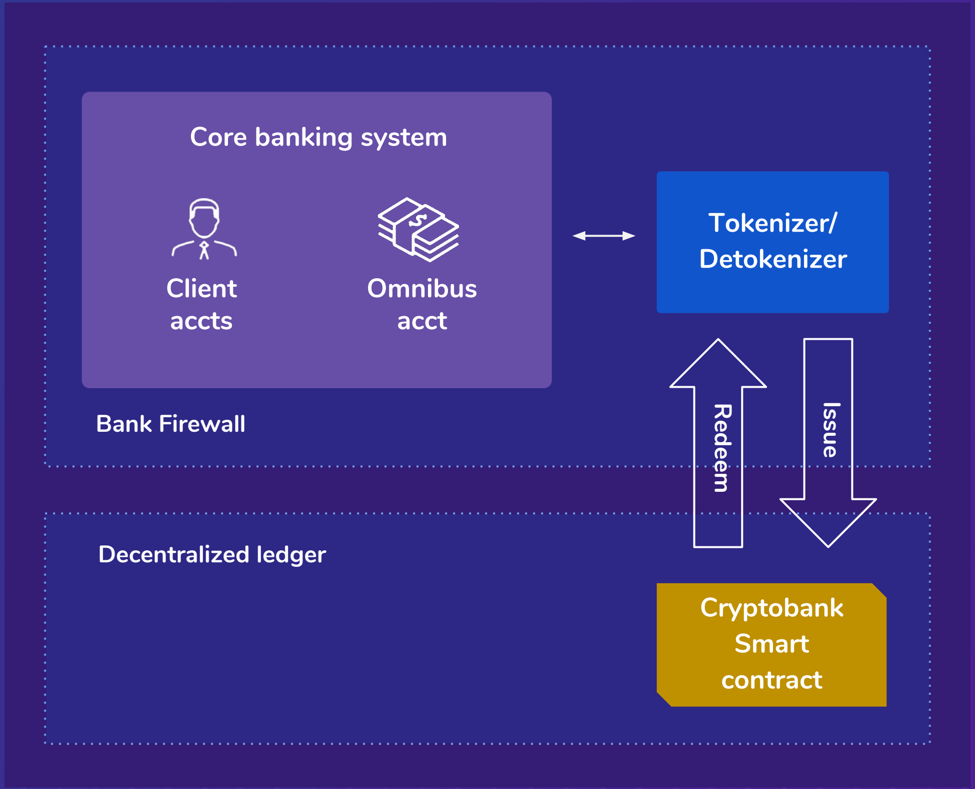
A smart contract-enabled blockchain (e.g. Ethereum) is a shared computing platform where transactions are:

✓ **Notarized**

✓ **Immutable**

✓ **Real time**

Tokenization of money makes blockchain useful in the (real) financial world



Tokenization:

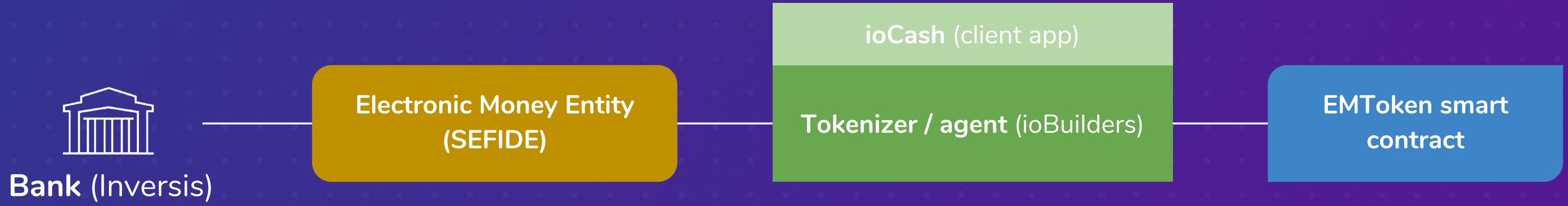
- Money is moved from client account into omnibus account
- Tokenizer issues tokens in the smart contract over the decentralized ledger
- Now money is digital, programmable and globally interoperable

Redemption:

- Redemption is requested from the smart contract
- Detokenizer eliminates the tokens and transfers the (real) money from omnibus account to the destination account

Tokens are 100% backed by 'real' fiat in bank omnibus account, with a 1:1 equivalence

Electronic tokenized money: legal construct (Example Spain)

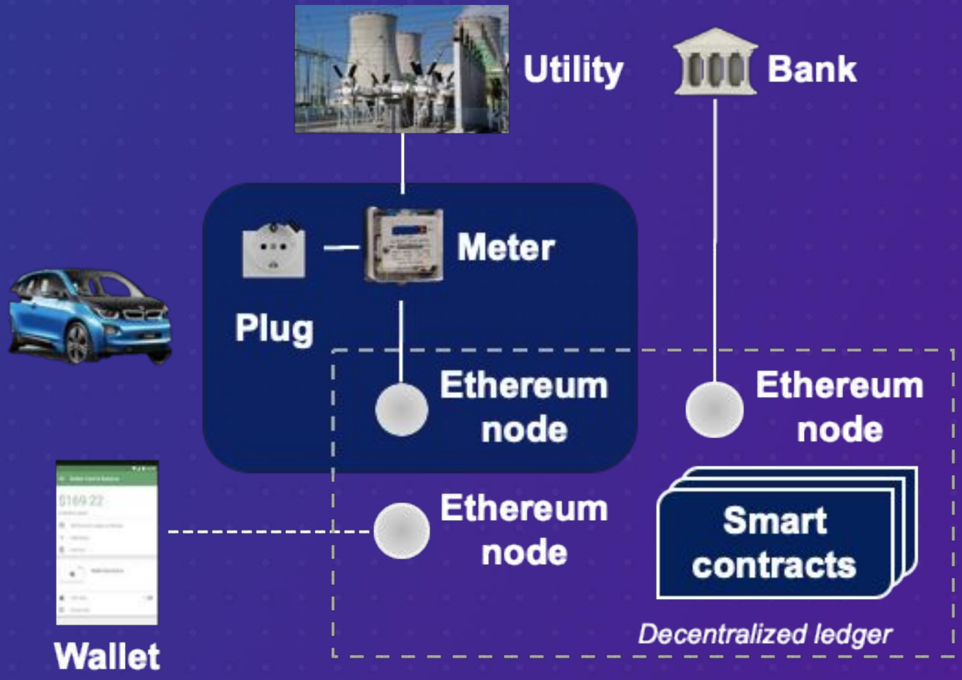

Bank (Inversis)
Electronic Money Entity (SEFIDE)
ioCash (client app)
Tokenizer / agent (ioBuilders)
EMToken smart contract

- The **Electronic Money Entity** (SEFIDE) is **legally responsible for segregating client funds** at the **EM token contract** (holds a **regulated electronic money license** with an **European passport**)
- **ioCash** is a **registered agent** for the EME, and provides electronic money services for clients
- The EME **partners** with a bank (**Inversis**, with **full banking license**) to i) operate the omnibus account, and ii) **associate IBAN numbers to electronic money wallets** (i and ii could be decoupled and done with different banks)

… this way EM wallets are very similar to bank accounts, since they have IBAN routing numbers and are **fully interoperable with the banking system** (e.g. SEPA payments can be initiated and terminated); but balances are implemented with programmable money living on a EMtoken contract

… and the same construct can be implemented directly on a **banking license**, as volumes grow

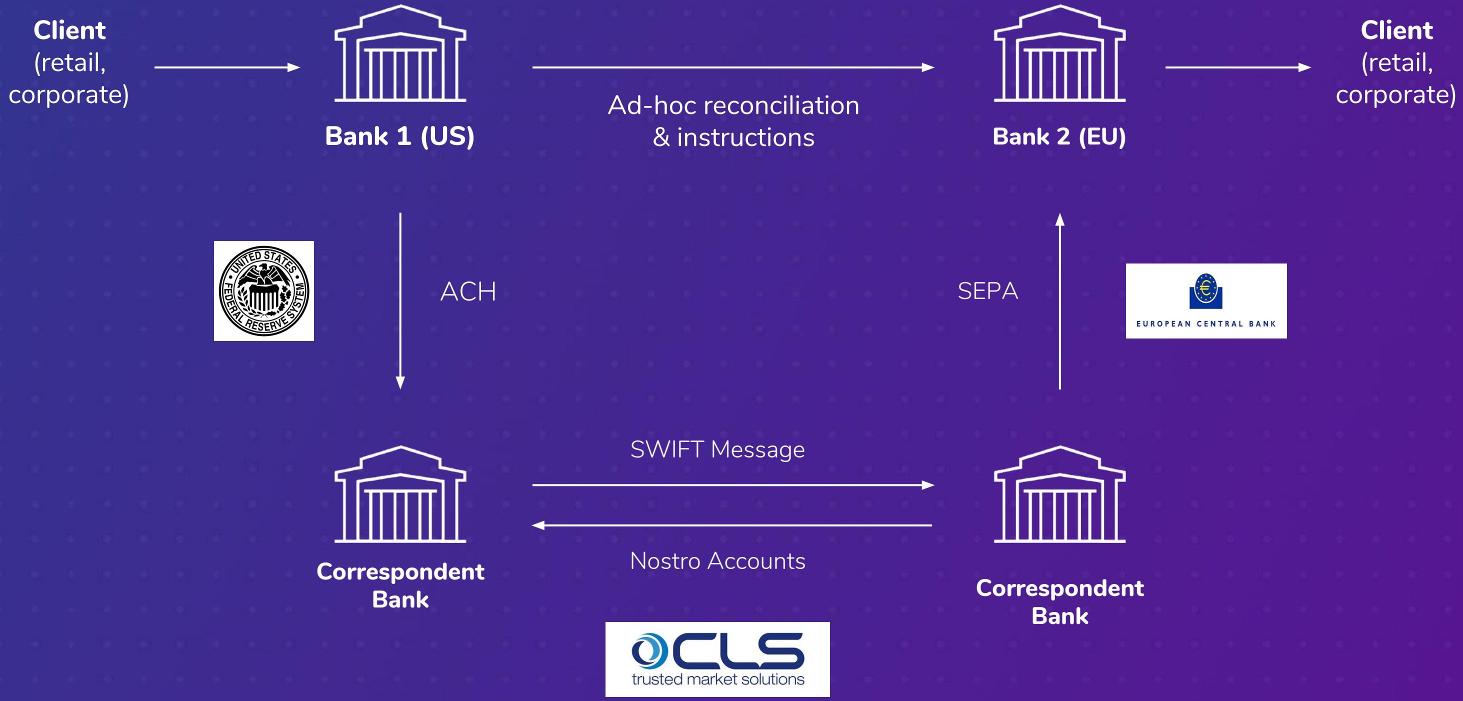
An application: recharging an electric car



- ✓ User prefunds wallet with tokenized cash
- ✓ User pays tokenized money to smart plug
- ✓ Meter delivers energy to car
- ✓ Home owner redeems cash from bank

… concept allows for *uberization* of electric car recharges

Application to international payments: Issues in the financial industry today



Client (retail, corporate)

Bank 1 (US)

Ad-hoc reconciliation & instructions

Bank 2 (EU)

Client (retail, corporate)

ACH

SEPA

SWIFT Message

Nostro Accounts

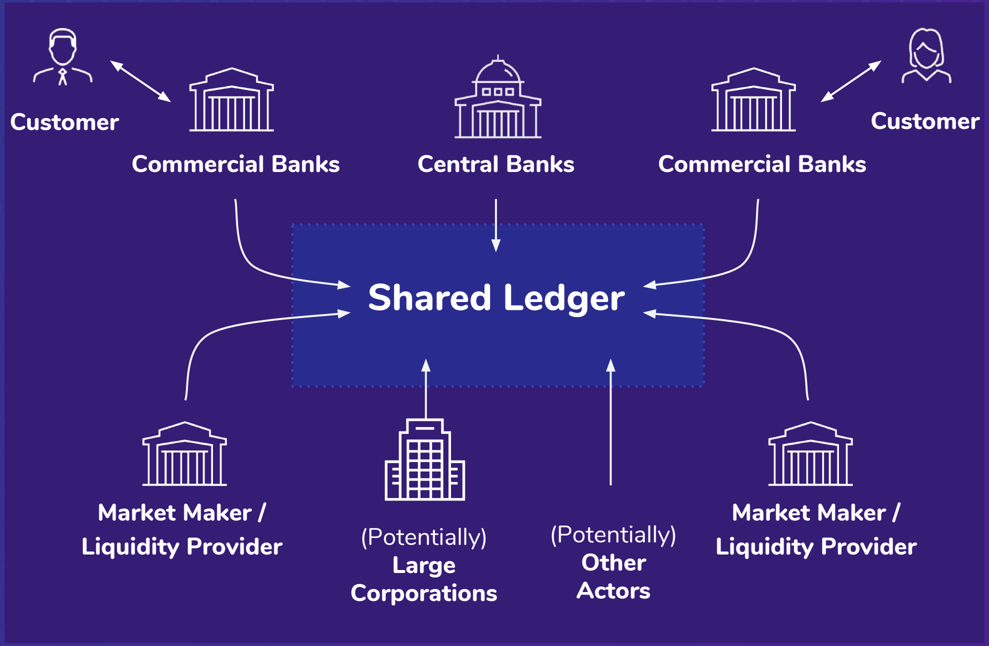
Correspondent Bank

Correspondent Bank

=> Multiple, separate ledgers communicated through messages:
i) High capital costs; ii) high operational costs; iii) settlement risk; and iv) improvable service

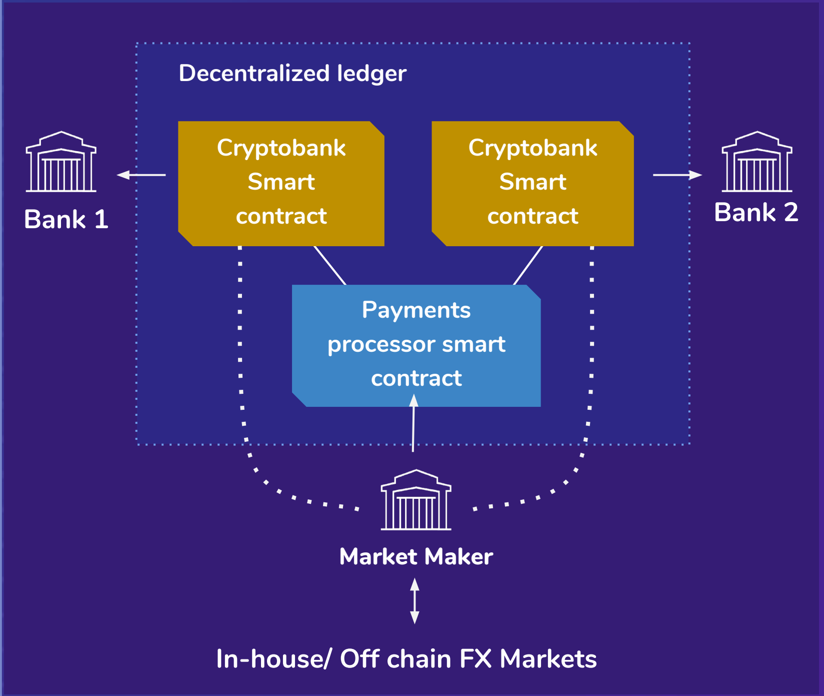
Alternative: using tokenization over a single, shared ledger

A natively digital, “parallel” financial network on a single, shared, decentralized ledger where different participants can interact and transact


Customer
Commercial Banks
Central Banks
Commercial Banks
Customer
Shared Ledger
Market Maker / Liquidity Provider
(Potentially) Large Corporations
(Potentially) Other Actors
Market Maker / Liquidity Provider

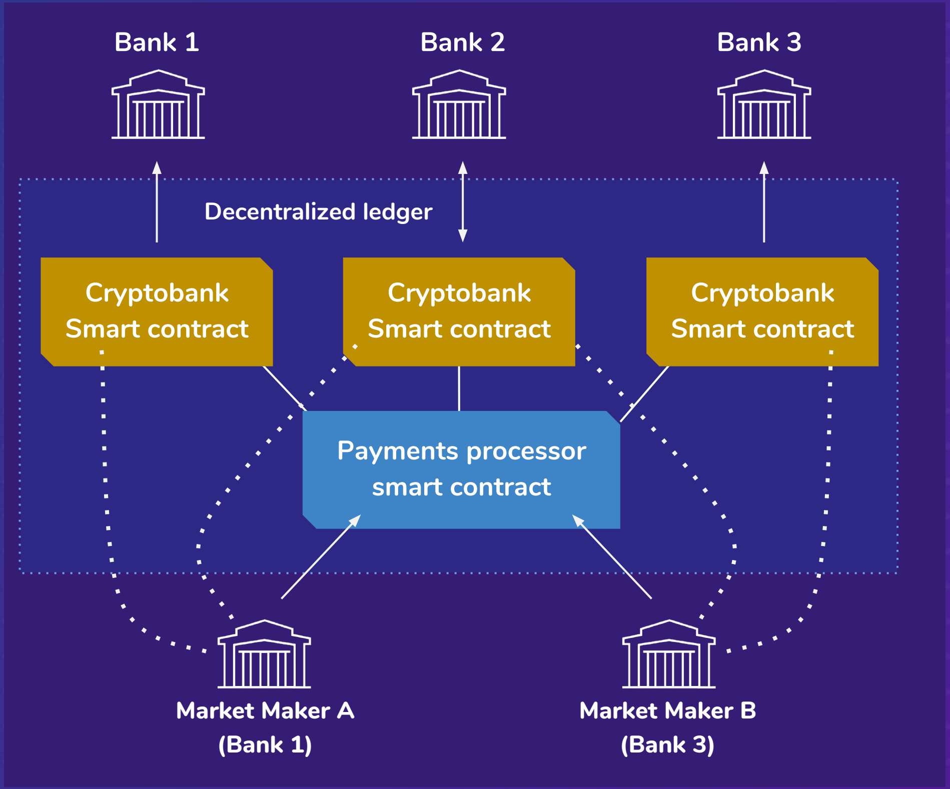
1. Participants **tokenize** their assets - i.e. they create **digital representations** on the shared ledger. **Integration is simple**
2. Participants now have a single, **shared ledger** to transact - which provides a **single version of truth**
3. Applications are **natively digital**, as they only use these **digitized assets**
4. **Smart contracts** ensure **transparency**, **immutability** and **atomicity**
5. **Enterprise-grade**, permissioned network enables **privacy** as needed
6. Network is **decentralized** - not dependent on a single IT provider (decentralized governance needed)

Using tokenized money for (simple) international payments


Decentralized ledger
Bank 1
Cryptobank Smart contract
Cryptobank Smart contract
Bank 2
Payments processor smart contract
Market Maker
In-house/ Off chain FX Markets

- **Bank 1** and **Bank 2** deploy simple **tokenizers**
- **Market Maker prefunds nostro** liquidity account at Bank 2 and **tokenizes** some of it
- A **distributed Fx order book** is implemented in a payments processor **smart contract**, where the market maker posts liquidity **quotes** (with markups)
- Bank 1 submits payment to the payments processor. Now the **payment is a single digital object** with a transparent, unique status
- Client money is tokenized and put in **escrow** at the smart contract; the corresponding (tokenized) liquidity is deducted from the market maker and put in escrow as well. **Herstatt risk** is thus **eliminated**
- **Payment instructions** are shared only between **participating banks**, and linked (through a hash) to the payment contract
- Bank 2 checks payment instructions and triggers **execution**: client funds go to market maker, and reserved (tokenized) liquidity is redeemed and transferred to the receiver - **atomically**!

Leveraging the global liquidity network

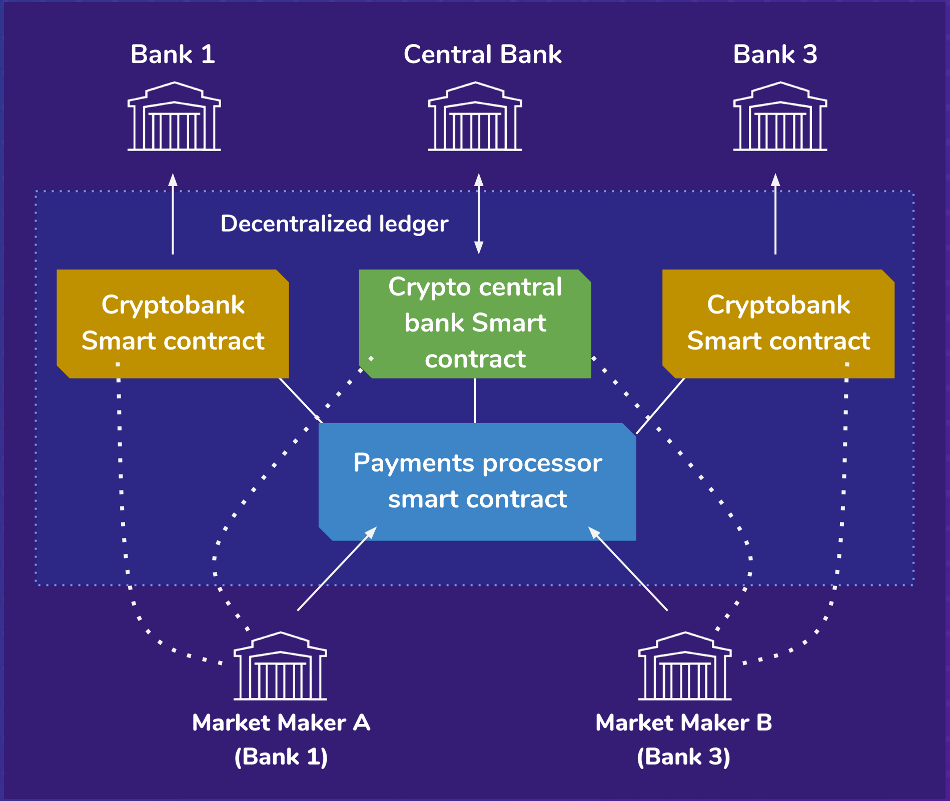


Bank 1
Bank 2
Bank 3
Decentralized ledger
Cryptobank Smart contract
Cryptobank Smart contract
Cryptobank Smart contract
Payments processor smart contract
Market Maker A (Bank 1)
Market Maker B (Bank 3)

- Market Maker A holds tokenized (nostro) liquidity in Bank 1 and 2, but not on Bank 3
- Market Maker B holds liquidity in Bank 2 and 3, but not on Bank 1
- A payment from Bank 1 to Bank 3 can then be routed by **chaining Market Makers** A and B, which exchange value with **tokens** issued by Bank 2
- Therefore, **no extra liquidity buffer** is needed by Market Maker 1 in Bank 3
- Each bank implements its own market maker, thus keeping business and markups

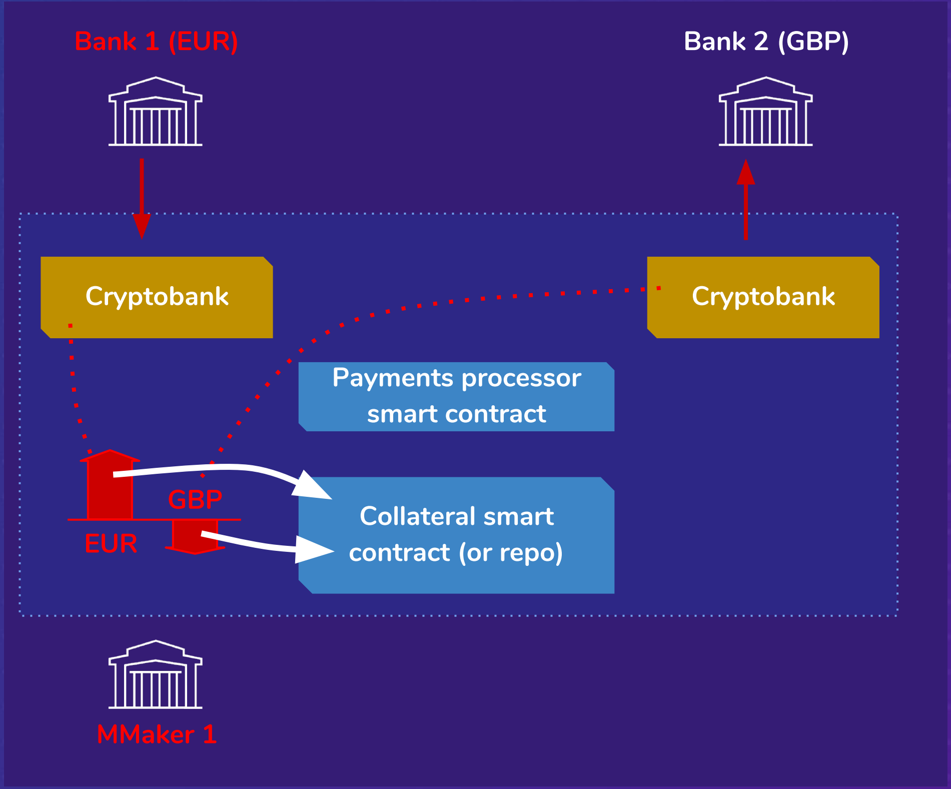
→ **Potential to reduce liquidity at systemic banks (~x3-x5)**

Adding tokenized fiat from central banks


Bank 1
Central Bank
Bank 3
Decentralized ledger
Cryptobank Smart contract
Crypto central bank Smart contract
Cryptobank Smart contract
Payments processor smart contract
Market Maker A (Bank 1)
Market Maker B (Bank 3)

- **Central bank-backed tokens** provide an optimal, **universal** solution to exchange value between market makers
- Two main alternatives:
  - Through a **tokenization vehicle** that uses a **RTGS account as an omnibus** account to store and redeem the tokens (e.g. Utility Settlement Coin)
  - By **natively implementing RTGS accounts on the smart contract**, i.e. tokens constituting legal tender (e.g. project Khokha or project UBIN)
- Market makers only need to have a tokenized RTGS account at the central bank to **settle in real time** with one another

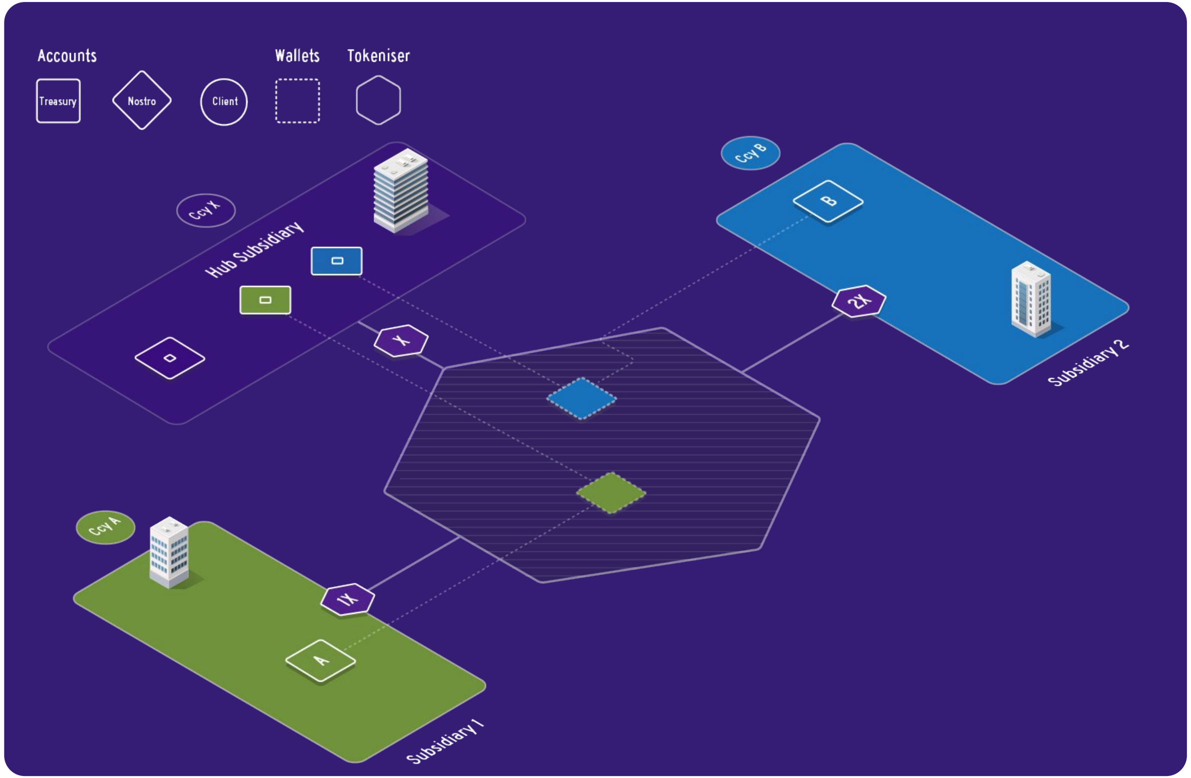
Borrowing collateralized liquidity (and repos)


Bank 1 (EUR)
Bank 2 (GBP)
Cryptobank
Cryptobank
Payments processor smart contract
GBP
EUR
Collateral smart contract (or repo)
MMaker 1

- Market Maker 1 accumulates EUR tokens (issued by Bank 1) from client payments, and pays GBP tokens from its tokenized nostro account in Bank 2
- Eventually, Market Maker 1's nostro account in Bank 2 gets empty, while Bank 1 needs to keep sending client payments in that direction
- (As an alternative to simply replenishing the GBP nostro account through conventional channels) Market Maker 1 can apply for a **credit line** from Bank 2 to keep sending payments, and **pledge** the EUR **tokens** from Bank 1 as **collateral** implemented on a **smart contract.** I.e. funding is done through a repo
- This alternative **reduces the need to prefund** nostro accounts **without increasing capital** consumption at the lender due to **collateralization**

Application: liquidity hub at a multinational banking group

Designated entity in the banking group country produces tokenized fiat in a Hub CCY (eg USD). All bank subsidiaries have one (tokenized) nostro account at the hub. Subsidiaries settle payments in Hub CCY issued by the Hub entity

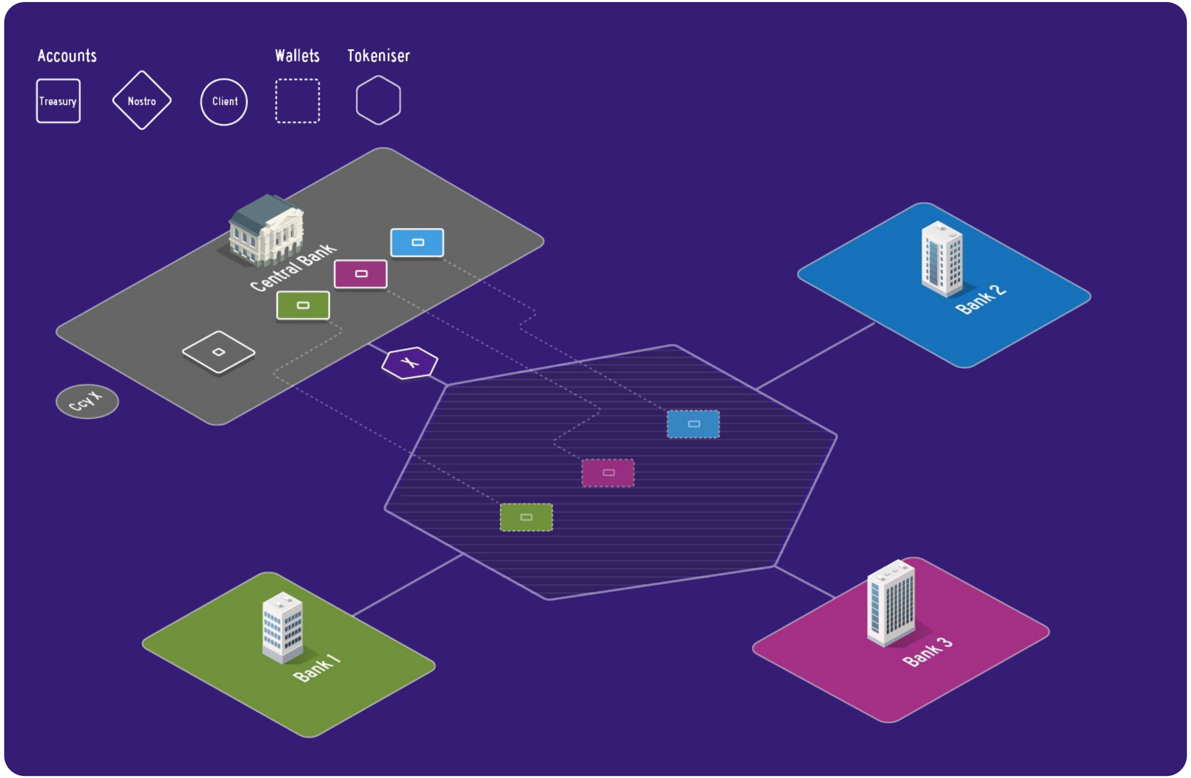


Benefits:

- Real time payments with full settlement between subsidiaries
- No subsidiary needs to hold foreign currency (except hubbing CCY at the hub)
- Much lower nostro pre-funding requirements (just one nostro at the hub) & Market risk easy to hedge (against Hub CCY)
- Full transparency & visibility by the hub => easy regulatory reporting
- Scalable, and expandable to connect to other banking groups globally

Application: local and regional payments platforms

The Central Bank (or a USC) runs a single tokeniser, this tokenises their currency (fiat). The commercial banks instruct the central bank to tokenise part of their RTL balances. Each commercial bank has a digital RTGS account (wallet) from which RTGS payments are settled in real time

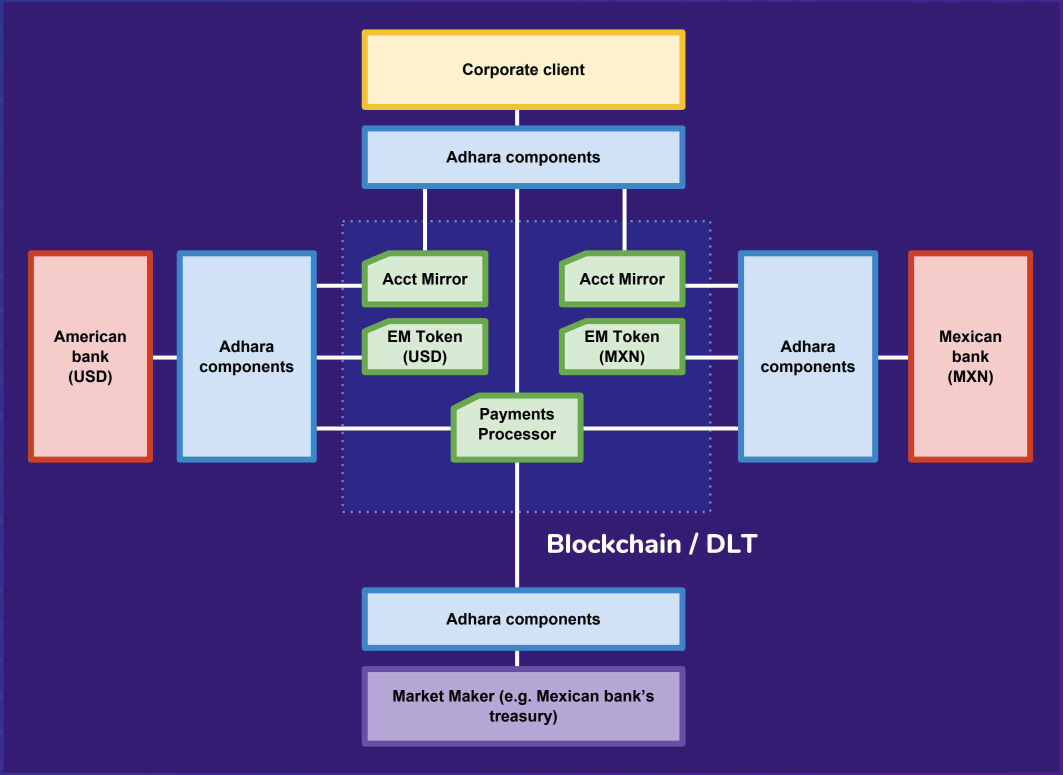


Benefits:

- Real time payments with full settlement between all banks (domestic and regional)
- Low pre-funding requirements -(only one RTGS account is needed)
- Central bank gets full visibility of all payments, domestic and international
- Full compliance, easy reporting and total control by central bank as needed
- Domestic payments system connected in real time with other geographies

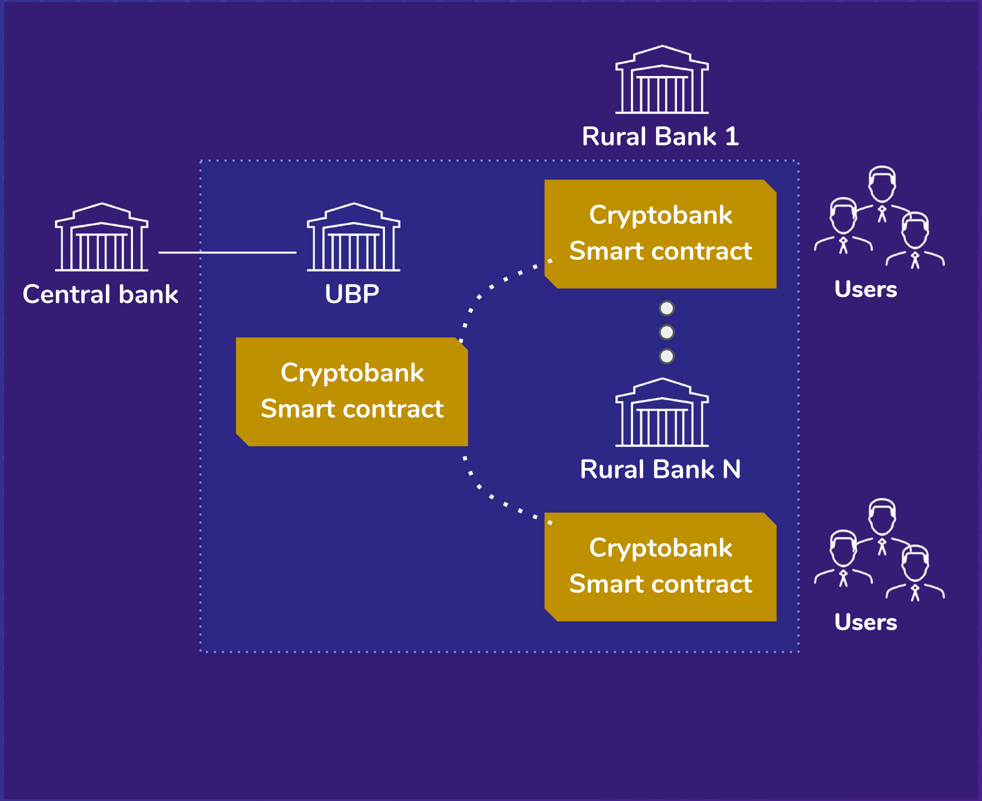
Cases: Bermuda, South Africa, LatAm

Application: corporate payments



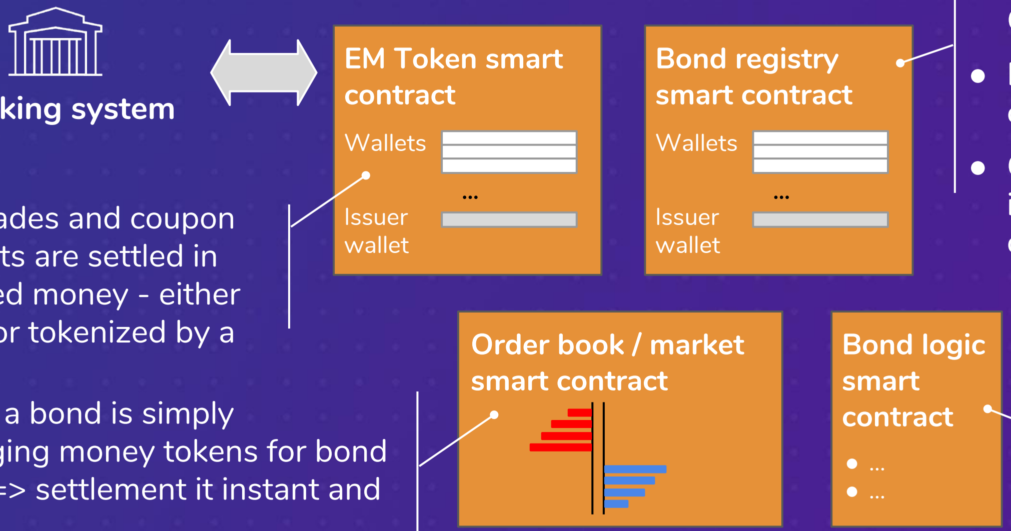
- **Corporate client can issue payment orders directly over blockchain:**
  - Avoids direct (custom) integration with each bank
  - Has visibility on applied rates upon payment submission
  - Has real time visibility on payment order status
- **Corporate client can also do proper treasury management:**
  - Has visibility on balances in treasury accounts in all countries
  - Can instruct payments and perform cash pooling
  - Over time, can perform more advanced operations: hedging fx exposure, requesting credit, investing excess cash, notional cash pooling, …

Application: rural banking in Philippines


Rural Bank 1
Central bank
UBP
Cryptobank Smart contract
Users
Cryptobank Smart contract
Rural Bank N
Cryptobank Smart contract
Users

- **UBP** serves rural banks as a "pseudo central bank"
- **Rural banks** run their **ledgers** on cryptobank **smart contracts** - which is a very cost effective yet very functional way vs what they have today
- **End clients** have their **accounts** implemented directly as **token wallets**, which can be operated through **mobile apps**
- Now implementing **international remittances** with Adhara technology, using the same token standards

Beyond tokenization: building native digital assets on smart contracts (ex. cryptobond)



Banking system

EM Token smart contract

Wallets

...

Issuer wallet

Bond registry smart contract

Wallets

...

Issuer wallet

Order book / market smart contract

Bond logic smart contract

- ...
- ...

- Bond trades and coupon payments are settled in tokenized money - either ioCash or tokenized by a bank
- Trading a bond is simply exchanging money tokens for bond tokens => settlement it instant and atomic
- Order book is built by market makers and market participants
- Market smart contract is “owned” by a licensed market operator (e.g. the stock market)

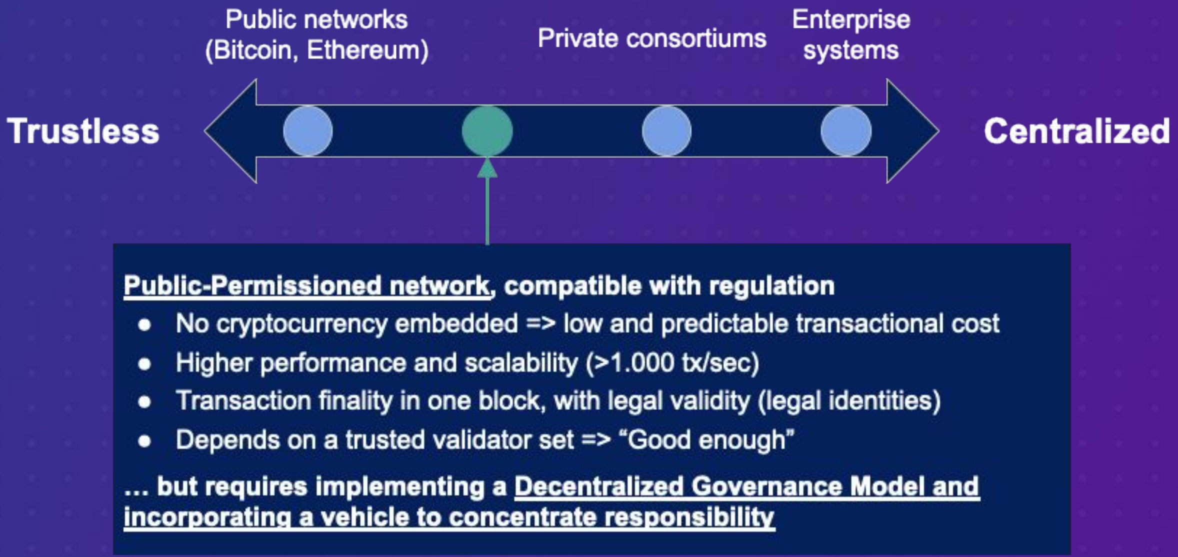
- Bond registry records ownership of bond holdings
- Registry is “owned” by a licensed CSD, who is liable
- KYC / MiFID for bond holders is cleared at this level
- Only licensed agents can annotate in the registry (e.g. banks on behalf of clients)

- Bond’s terms, conditions and convenants are coded in a separate smart contract (e.g. coupon schedules, interest rate colaculations, endorsability, etc.)
- Terms are enforced atomically as part of the trading transactions (they are code)
- Bond logic contract is established and owned by issuer (or bank on its behalf)

Towards enterprise blockchains: key aspects needed

1. Permissioning
2. Performance
3. Confidentiality
4. Responsibility and governance

Responsibility and governance



<u>Public-Permissioned network</u>, compatible with regulation

- No cryptocurrency embedded => low and predictable transactional cost
- Higher performance and scalability (>1.000 tx/sec)
- Transaction finality in one block, with legal validity (legal identities)
- Depends on a trusted validator set => “Good enough”

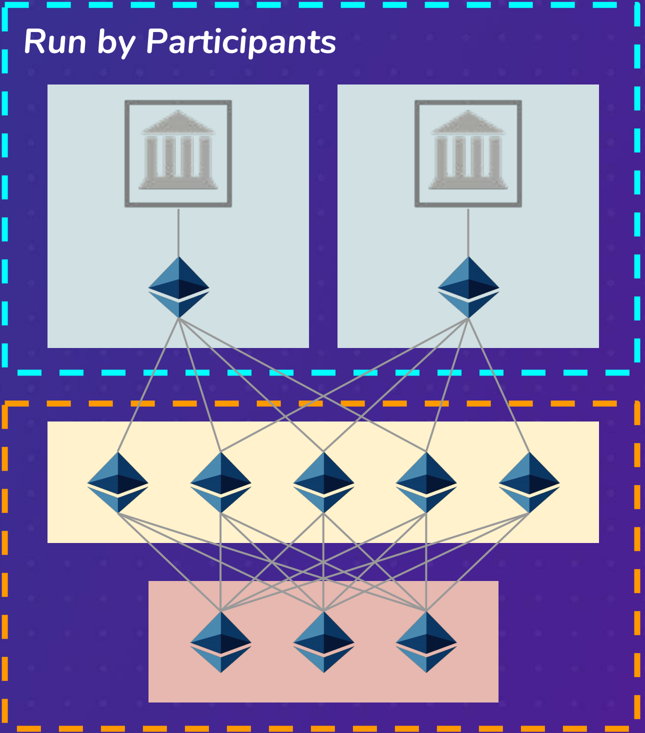
… but requires implementing a <u>Decentralized Governance Model and incorporating a vehicle to concentrate responsibility</u>

Initial initiatives towards establishing enterprise grade, governed blockchain networks:

- Alastria
- LacChain
- Utility Settlement Coin (USC)

… plus many more

Topology of a permissioned network



Participant systems

Participant nodes

Permissioning nodes

Validator nodes

- **Participants** connect their systems to **Ethereum nodes deployed locally** within their firewall; **participant nodes** connect to **permissioning nodes**
- **Permissioning nodes** regulate the whitelist of nodes that can connect. They bear higher load / traffic
- **Validator nodes** run the consensus algorithm. They are **highly critical**, closely **monitored**, and **not reachable** from outside

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Thank You