Blockchain Platform for OTC Derivatives Infrastructures

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Changsoo Hong, Ph.D

NICE Pricing and Information Inc.

"**DLT**(Distributed Ledger Technology) will likely develop hand-in-hand with **new smart contracts** that can value themselves in **real-time**, report themselves to **data repositories**, automatically calculate and perform **margin payments** and even terminate themselves in the event of **counterparty default** "

Massimo Morini & Robert Sams, Smart Derivatives Can Cure XVA Headaches, Risk Magazine (2015).

Traditional Korea Blockchain

朝鮮王朝實錄

The Annals of the Joseon Dynasty

Need of Distributed Storage and Management

史庫

Warehouse established in the country In order to keep the annals of the Joseon Danasty (Distributed Database)

What is Ledger?

"A ledger is a book, file, or other record of financial transactions."

[NOUN] A **ledger** is a book in which a company or organization writes down the amounts of money it spends and receives

Capital Markets embracing Blockchain

What aspects of Implementing Blockchain technology do you believe present the greatest challenges?

Challenge	Percentage
Business Case and Cost of Integration	32%
Legal & Regulatory Requirements	30%
Scalability & Capabilities of Technology itself	21%
Data Privacy & Security	12%
Others	4%
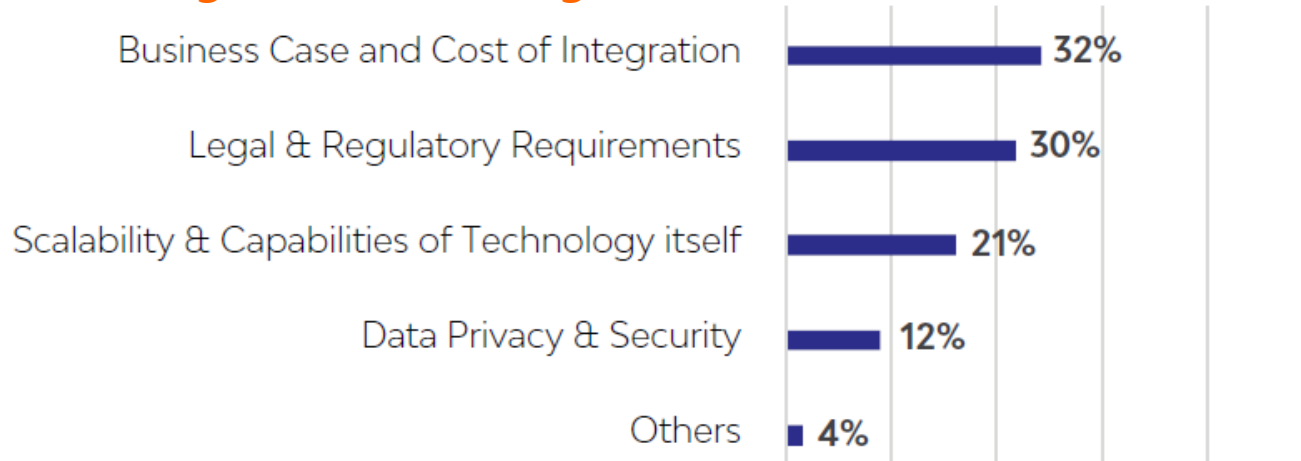
Which Blockchain Use Case should be the Industry's highest priority?

Use Case	Percentage
Clearing & Settlement	31%
Reference data	24%
Others	16%
Trade matching & confirmation	11%
Collateral management	10%
Complex OTC derivative Processing	3%
Security Issuance	3%
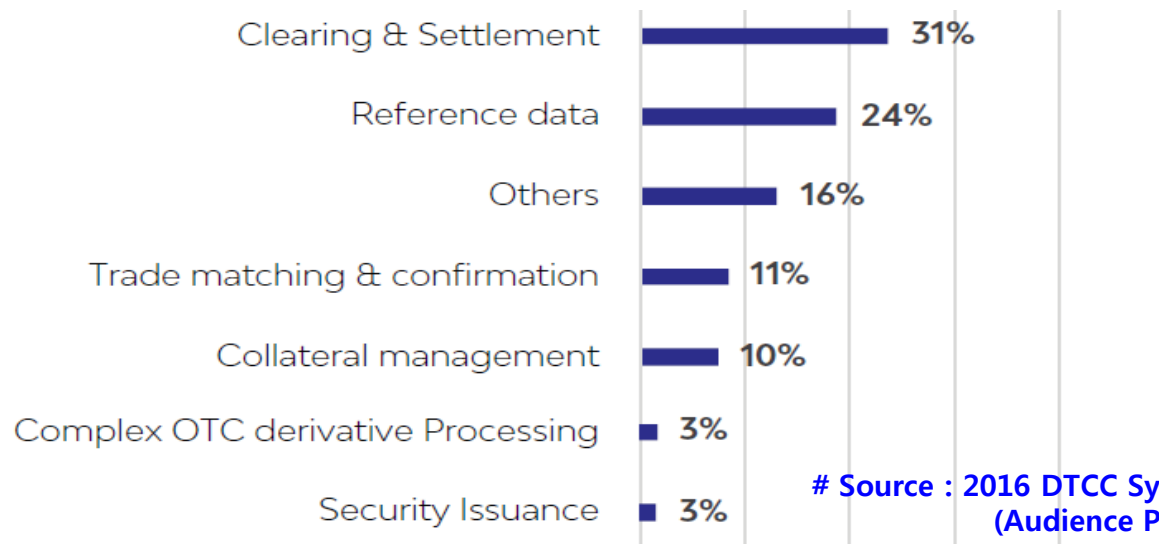
 # Source : 2016 DTCC Symposium on Blockchain (Audience Poll)

Market Structure : Centralized vs. Distributed Ledger

Current State

Clearing House

Centralised Ledger

Future State

Distributed Ledger
(simplified)
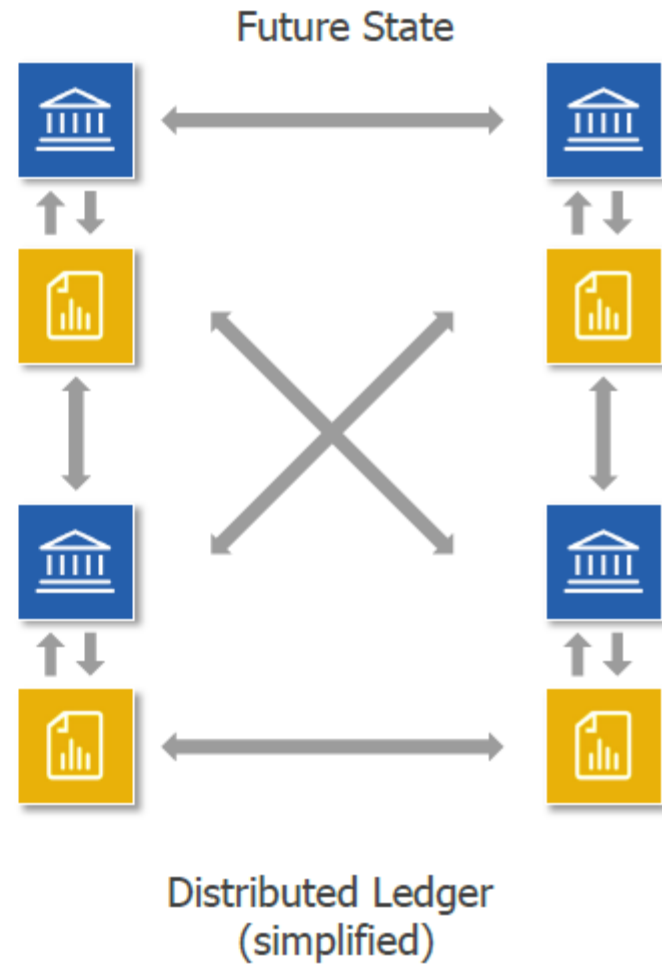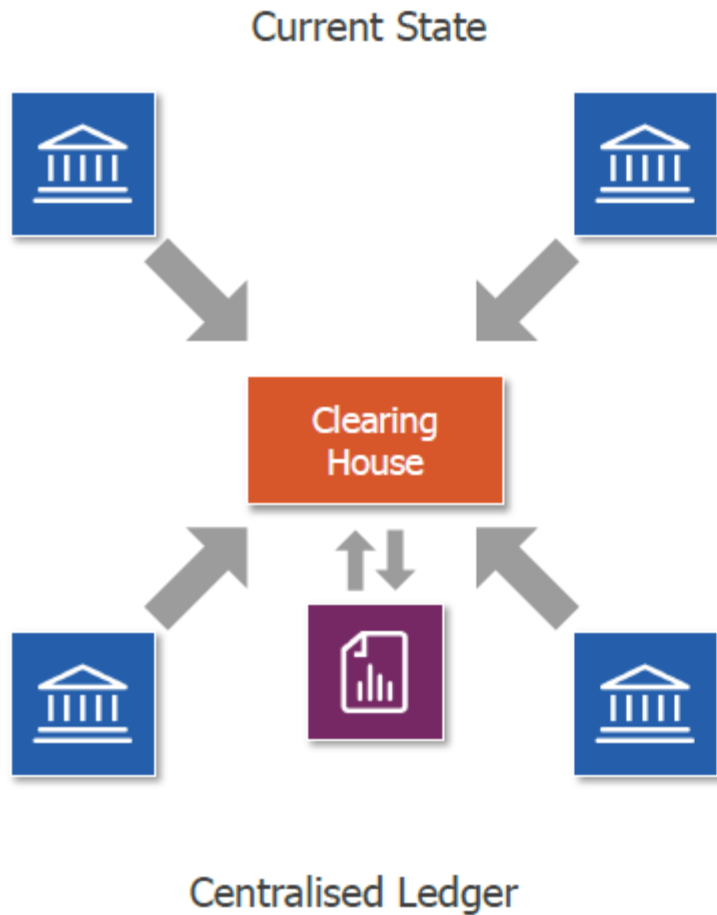
Blockchain in Capital Market

TODAY → FUTURE
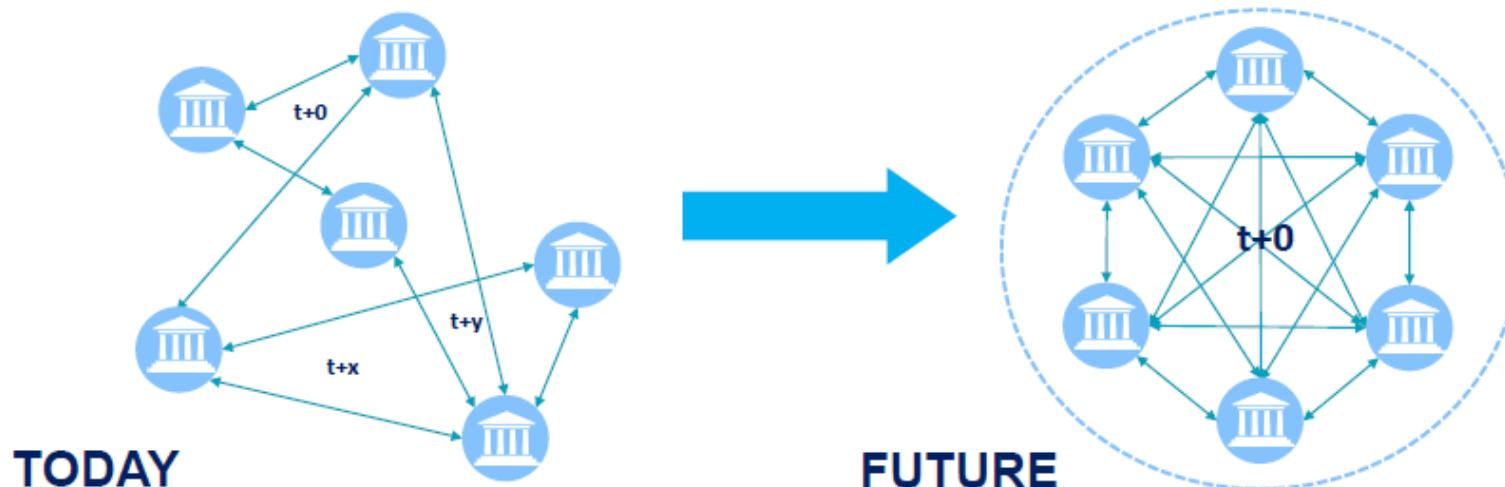
► **Financial Institutions**

- Intracompany Settlement
- Loan Settlement
- Trade Settlement
- Trading
- Collateral Management
- Derivatives Clearing
- Derivatives Agreements
- Cross-border Payments

► **Financial Regulator**

- Trade Reporting
- Compliance Reporting
- Risk Visualisation
- Transparency Regulation
- Anti-money-laundring

Blockchain Network Development
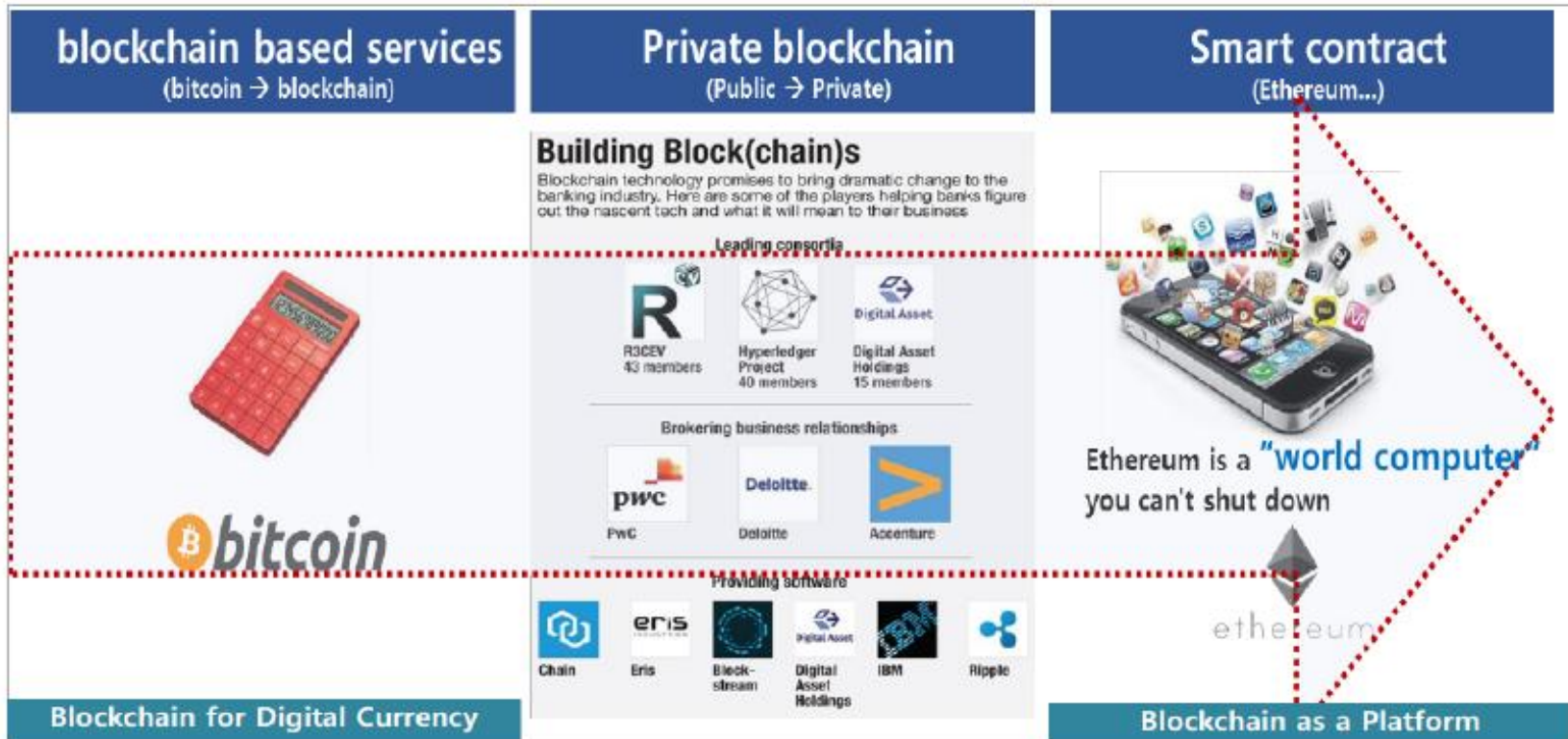
Financial Industry Applications best suit for Blockchain

► **Financial Instruments**

- Payments – Cross Border, P2P, Corporate and Interbank
- Private Equity
- Bonds
- Derivative commodities
- Trading records
- Spending records
- Mortgage/Loan records
- Microfinance
- Servicing records

► **Stack of Processes**

- Clearing Networks
- International Transfers
- Clearing and Settlement
- auditing, reconciliation, reporting, settlement
- Asset Ownership

Blockchain Potential Applications & Disruption

The blockchain is radically changing the future of transaction based industries.
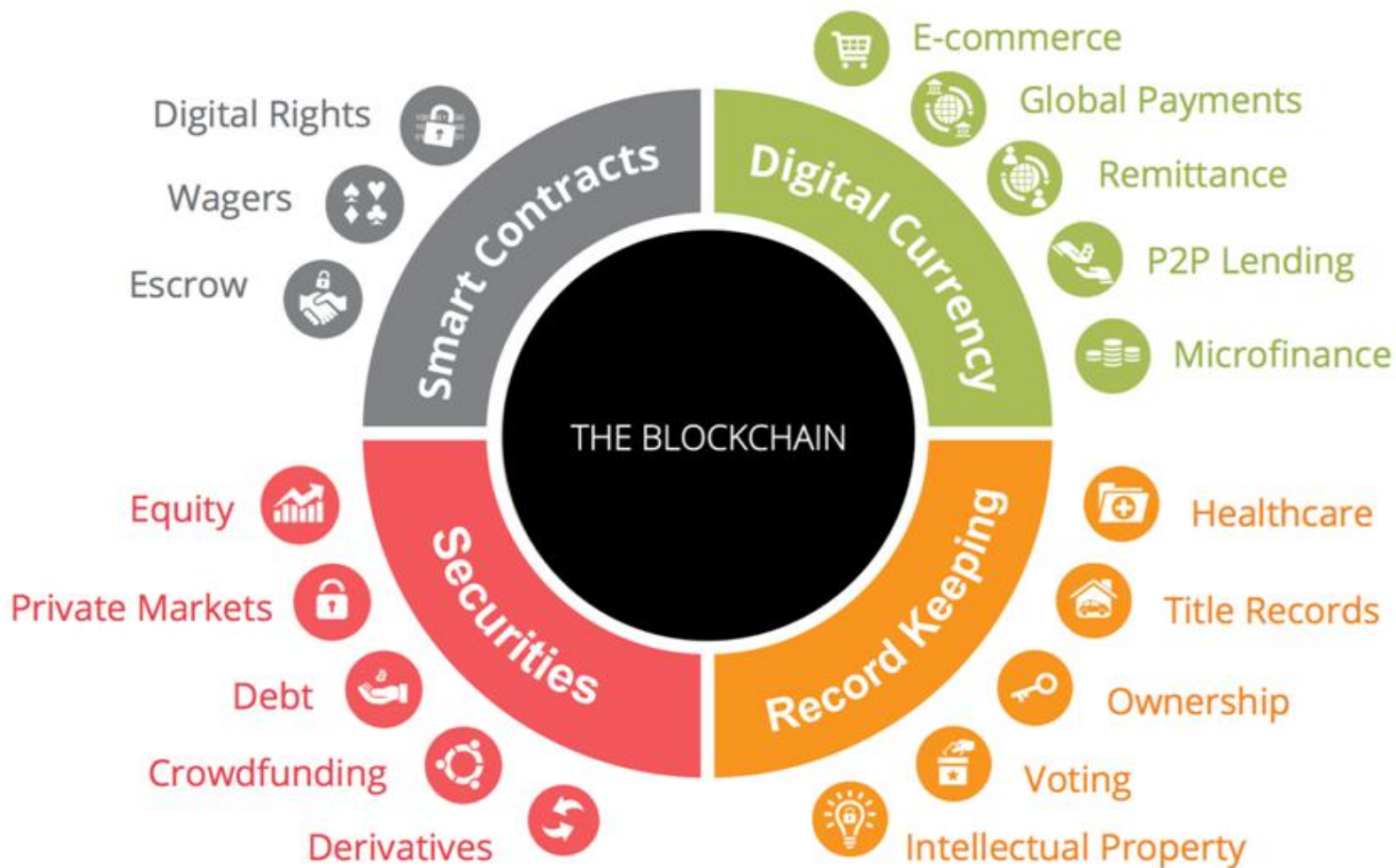
Blockchain Platform for OTC Derivatives Infrastructures

Blockchain technology offers a way for market participants to access dematerialized assets **directly** without always going through other participants needlessly

Centralized Repository (today's system): most participants are disconnected from their asset depository, settling transaction would require participants to collaborate in a flow that is **slow**, **inefficient,** and **expensive**
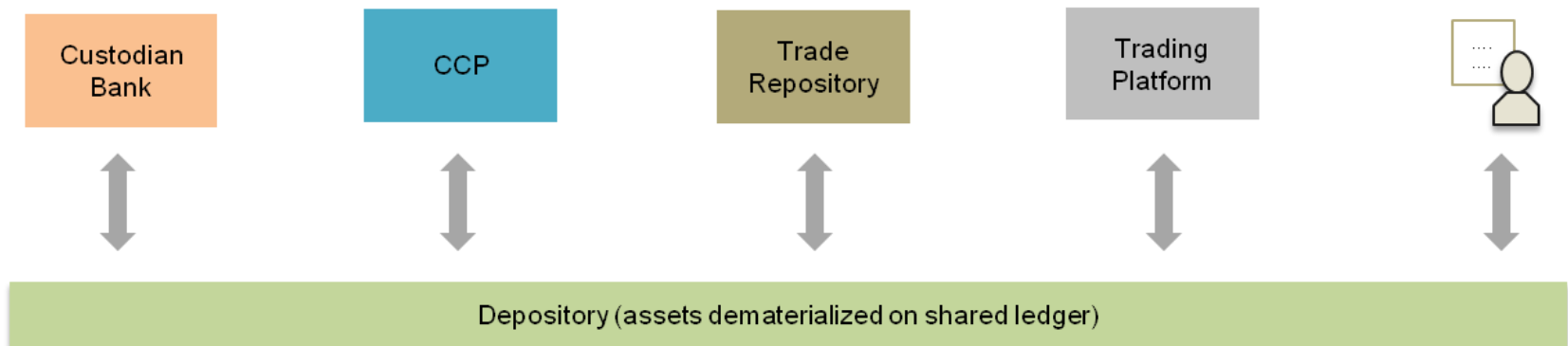
Shared Repository: all participants can interact with depository directly without going involving third parties, potentially making post trade operations **cheaper** and **faster**

OTC Derivatives : Primary Challenge and Opportunities

Primary Challenge - Complexity

► **Reduce efficiency**

► **Increase Cost**

► **Creates Operational Risk**

► **Challenges for Regulatory Compliance**

Opportunities - Technology

► **Standardization**

   Process – operating models and interactions

   Data – identifier and format

   Documentation – umbrella/master and product

► **Collaboration**

   Counterparties, Infrastructures, Vendors, Regulators

   Solicit views to ensure end state is suitable for all

► **Technology : FinTech, RegTech, Smart Contracts**

Potential Area in OTC Derivatives Trade Processing where Blockchain can be deployed

► **Reconciliation** – reduction of intermediaries involved in processing of trades, and thereby, reducing costs and the constant effort that goes in reconciling information kept at silo-based legacy systems.

► **Trade Validation** – Blockchains supports smart contracts where rules of the contract are embedded into a code or deployed on the Blockchain.

► **Reference Data** – Reference data consists of asset or security information, calendar days, ticker symbols, client data, and so on, and is essential for processing a trade to its final settlement.

► **Netting and Clearing** – reduce settlement failure using Blockchain.

► **Faster Settlement** – In theory, the Blockchain technology could reduce settlement processes.

► **Collateral Management** – collateral purpose could also be extended to the distributed ledger.

► **Regulatory Reporting** – regulatory and auditing purpose.

► **Audit Trail** – companies can write their transactions directly into a distributed ledger.

How does Blockchain Cryptography work?
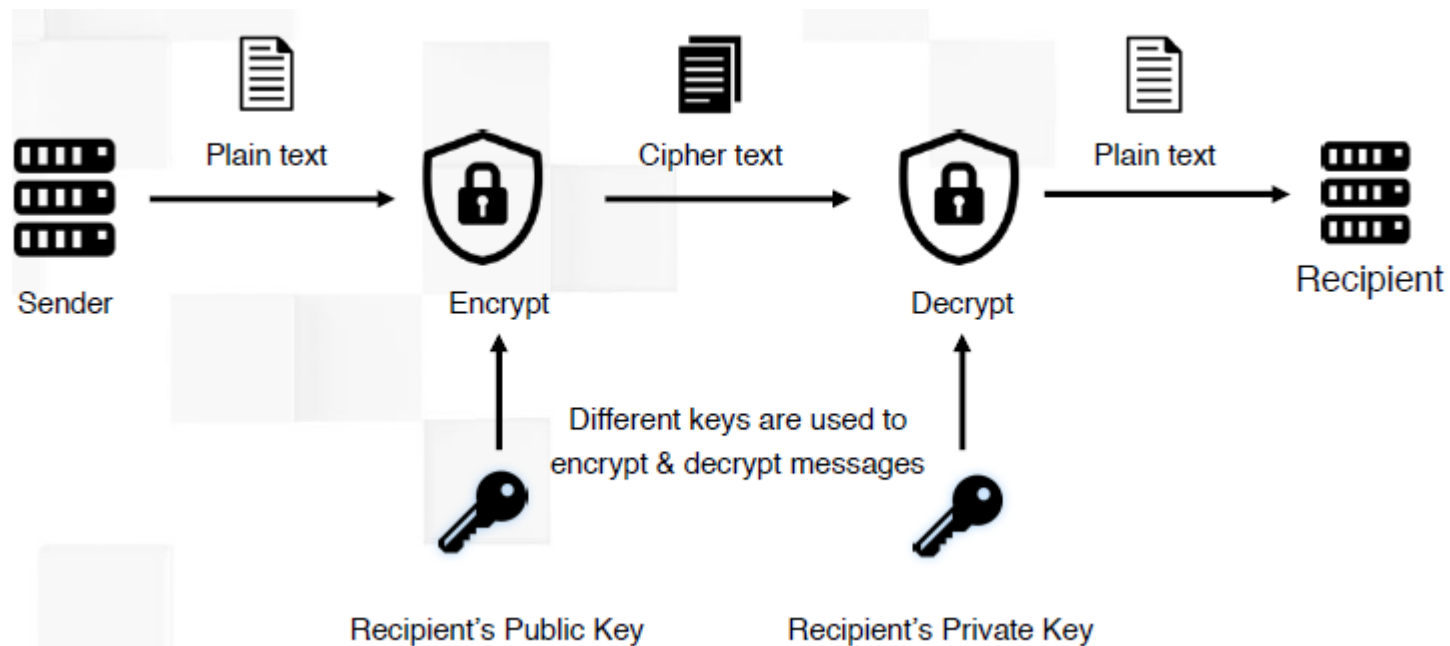
Blockchains are an emerging technology pattern that can radically improve banking, supply-chain and other transaction networks, giving them new opportunities for innovation and growth while reducing cost and risk.

Blockchain Technology : P2P, Public Key Cryptography, Distributed Consensus

Peer-to-Peer Networking · Public Key Cryptography · Distributed Consensus
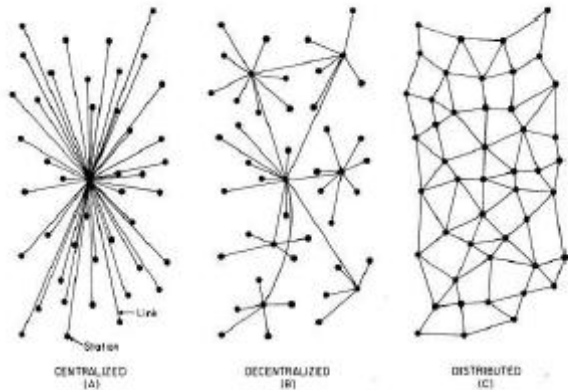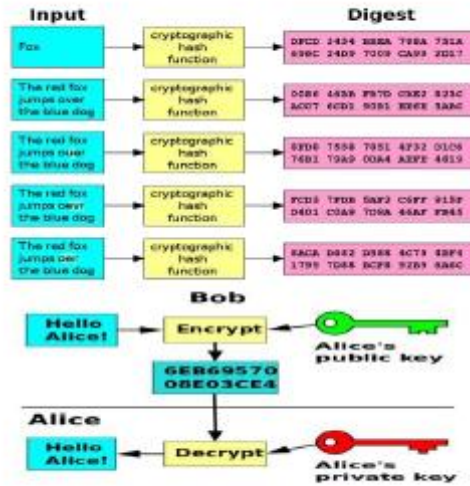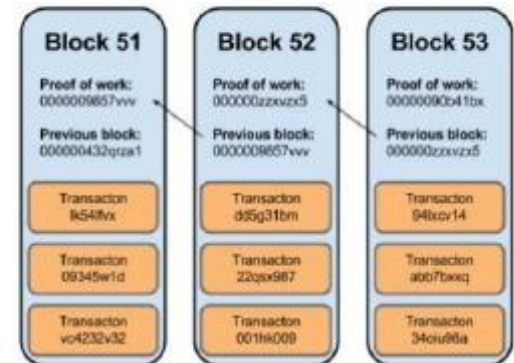
OTC Derivatives Infrastructures : CCP

► A **Central Clearing Counterparty** imposes itself as the legal counterparty to every trade.

► This substitution of counterparties by CCP typically occurs through a process known as novation, which discharges the contracts between the original trading entities and creates two new, legally binding contracts – one between each of the original trading parties and the CCP.
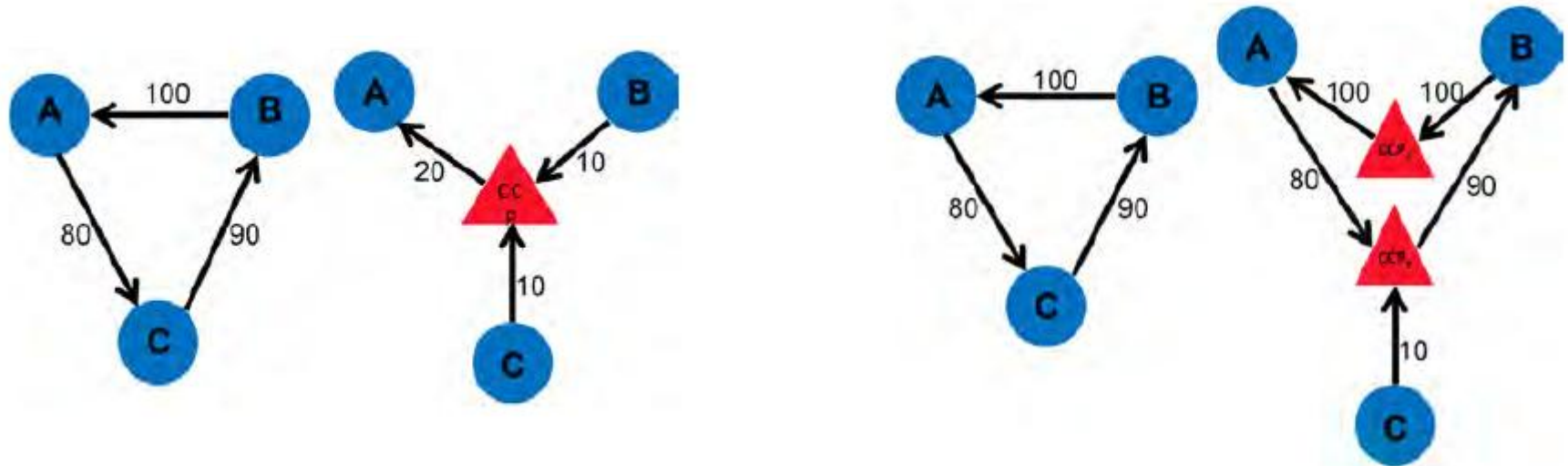
Figure : Duffie 2015, presentation to Basel Committee

OTC Derivatives Infrastructures : CCP

Web of bilateral OTC derivatives
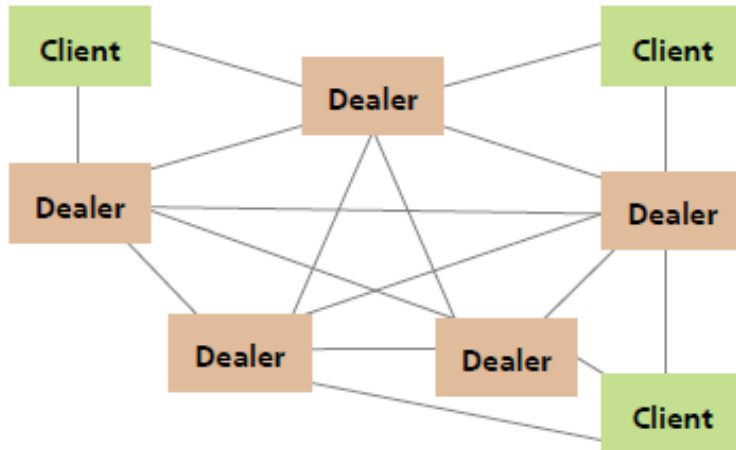
Central counterparty clearing
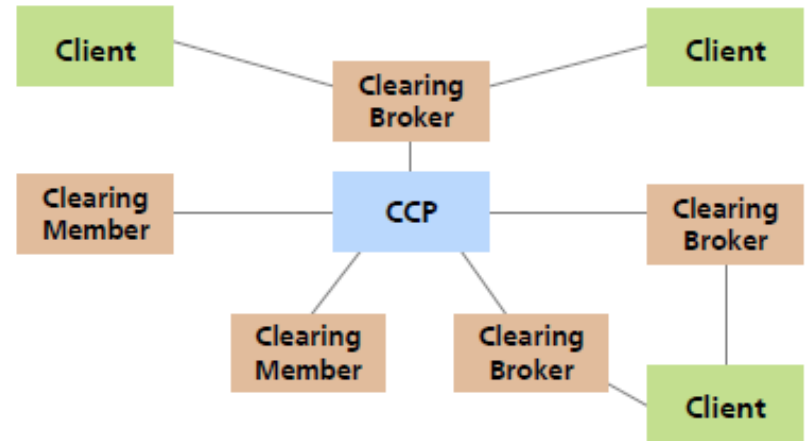
- Prior to the financial crisis, OTC derivatives were mostly held bilaterally and hardly collateralised.
- A complex and opaque web of counterparty credit risk emerged, which amplified the financial crises through a higher systemic risk.

- In the future all standardised OTC derivatives have to be centrally cleared.
- The counterparty credit risk is transferred to the CCP (central counterparty) and reduced by the exchange of initial and variation margin.
- The likelihood of an adverse impact from a counterparty default and the complexity is substantially reduced.

OTC Derivatives Infrastructures : LEI

► **Legal Entity Identifier**

- The LEI is Unique 20-character alphanumeric code based on the ISO 17442 standard developed by ISO, which is assigned to legal entities that are counterparties to financial transactions. The LEO code itself is neutral, with no embedded intelligence or country codes

- Actually some 430,000 such LEIs have been delivered worldwide (US only 105,000) to entities mainly active in derivative markets.

► **Four Key principles underlie the LEI**

- It is a global standard

- A Single, unique identifier assigned to each legal entity active in financial market

- It is supported by high data quality

- It is a public good, free of charge for all users.

OTC Derivatives Infrastructures : TR

► A **Trade Repository** (or **Swap Data Repository**) is an entity that centrally collects and maintains the records of OTC Derivatives. These electronic platforms, acting as authoritative registries of key information regarding open OTC derivatives trades, provide an effective tool for mitigating the inherent opacity of OTC derivatives markets.

| Client data | → | - Analysis of derivatives positions
- Delta production | → | Data aggregation and validation | → | Report file generation | → | Users analyze and sign off on reports | → | Trade repository |

← Drilldown
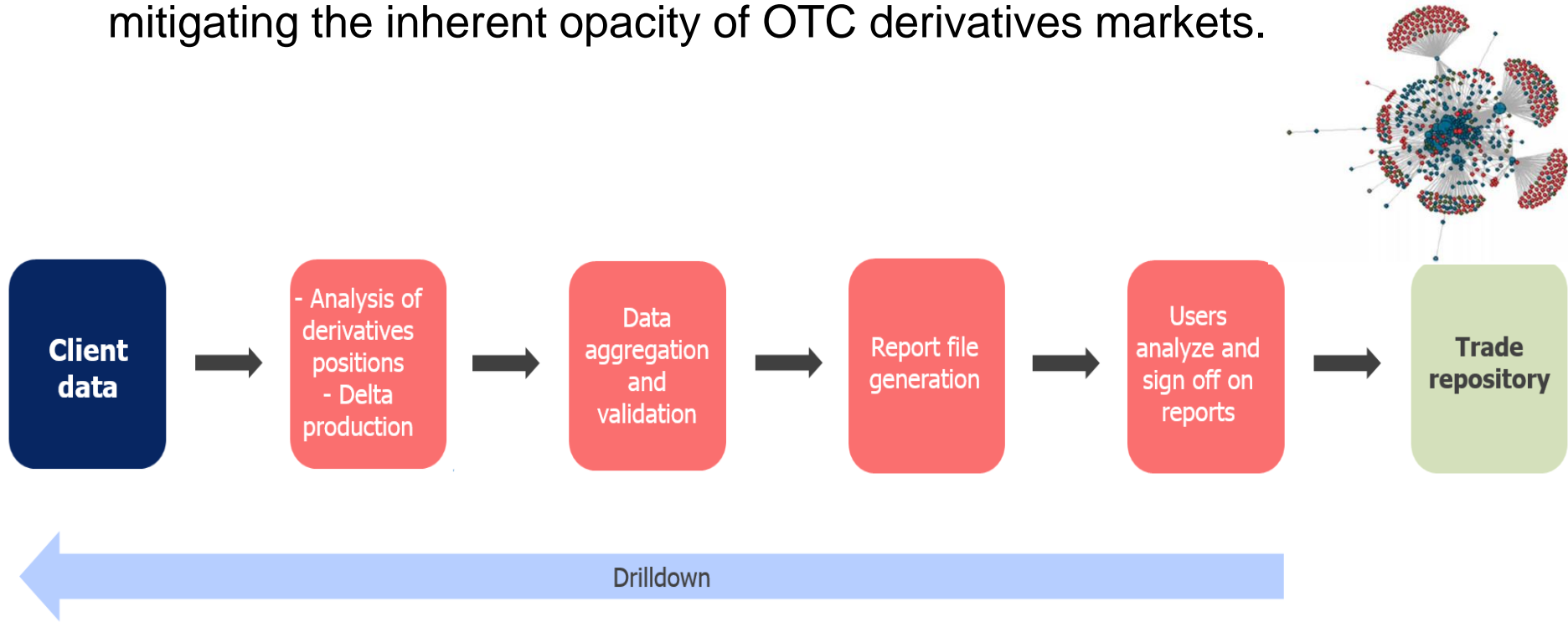
OTC Derivatives Infrastructures : TR UPI - Equity

| Suggested UPI reference data element	Suggested UPI reference data element values			
Asset class	Equities			
Instrument type	Swap	Option	Forward	Other
Option style	N/A	American, European, Bermudan etc.	N/A	
Option type	N/A	Put, Call, Chooser etc.	N/A	
Return, pricing method or payout trigger	Price, Dividend, Total Return, Variance, Volatility, Contract for Difference (CFD) etc.	Vanilla, Asian, Digital (Binary), Barrier, Digital Barrier, Lookback, Other Path-Dependent, Other etc.	Spreadbet, Forward Price of underlying instrument etc.	
Delivery type	Cash, Physical, Elect at Settlement etc.			
Underlying asset/contract type	Single name, Index, Basket etc.	Single name, Index, Basket, Options, Forwards, Futures etc.	Single name, Index, Basket, Options, Futures etc.	
Underlier ID source	The origin, or publisher, of the associated underlier ID.			
Underlier ID	An identifier that can be used to determine the asset(s) or index (indices) underlying a contract.			

Trade Repository : Equity Swap Reporting Eg.

EQ-Swap Reporting Eg.

Basic Layer	Structure Layer				공통	Equity Leg	Interest Leg	KRX-TR 보고항목
	Layer1	Layer2	Layer3	Layer4				
계약기간	계약일				Trade Date			
	종료일				Expiration Date			Expiration Date
					Expiration Date Business Day Convention			Expiration Date Business Day Convention
					Expiration Date Business Centers (;)			Expiration Date Business Centers (;)
	MCA TYPE				MCA Type			MCA Type
	내재옵션 취소/연장가능				Embedded Option Indicator			Embedded Option Indicator
					Embedded Option Type			Embedded Option Type
		옵션보유자			Embedded Option Buyer			Embedded Option Buyer
		행사스타일			Embedded Option Style			Embedded Option Style
		행사일			Embedded Opti Embedded Option First Exercise Date			Embedded Option Exercise Date (;)
					Embedded Option Final Exercise Date			Embedded Option First Exercise Date
					Embedded Option Exercise Period			Embedded Option Final Exercise Date
					Embedded Option Exercise Period Multiplier			Embedded Option Exercise Period
					Embedded Option Roll Convention			Embedded Option Exercise Period Multiplier
								Embedded Option Roll Convention
					Embedded Option Exercise Date Business Day Convention			Embedded Option Exercise Date Business Day Con
					Embedded Option Exercise Date Business Centers (;)			Embedded Option Exercise Date Business Centers
유효일						Effective Date	Effective Date	Effective Date_EquityLeg, InterestLeg
계약당사자 지급자						Payer Value	Payer Value	Payer Value_EquityLeg, InterestLeg
계약규모	명목금액					Notional Amount	Notional Amount	Notional Amount_EquityLeg, InterestLeg
	명목통화					Notional Currency	Notional Currency	Notional Currency_EquityLeg, InterestLeg
	수량					Quantity		Quantity_EquityLeg, InterestLeg
손익구조	LEG TYPE Rates		Fixed	Coupon			Fixed Rate	Fixed Rate
							Fixed Rate Notation	Fixed Rate Notation
			Floating	Floating Index			Floating Rate Index Prefix	
							Floating Rate Index Value	
							Floating Rate Tenor Period Multipiler	
							Floating Rate Tenor Period	
							Floating Rate Spread	Floating Rate Spread
							Floating Rate Spread Notation	Floating Rate Spread Notation
	Equities	기초자산	공통			Equity Asset Type		Equity Asset Type
			Single/Index			Equity Asset ID Prefix		Equity Asset ID Prefix
						Equity Asset ID Value		Equity Asset ID Value

[Illustrated]

Distributed Ledger Technology in OTC Derivatives
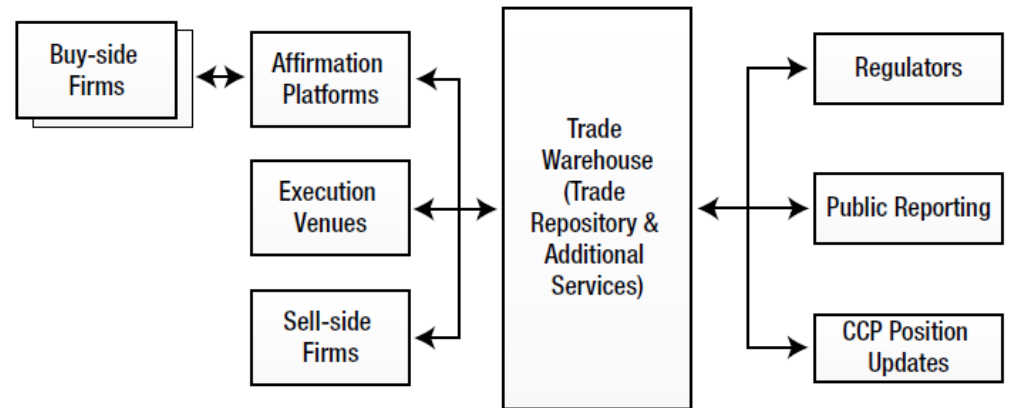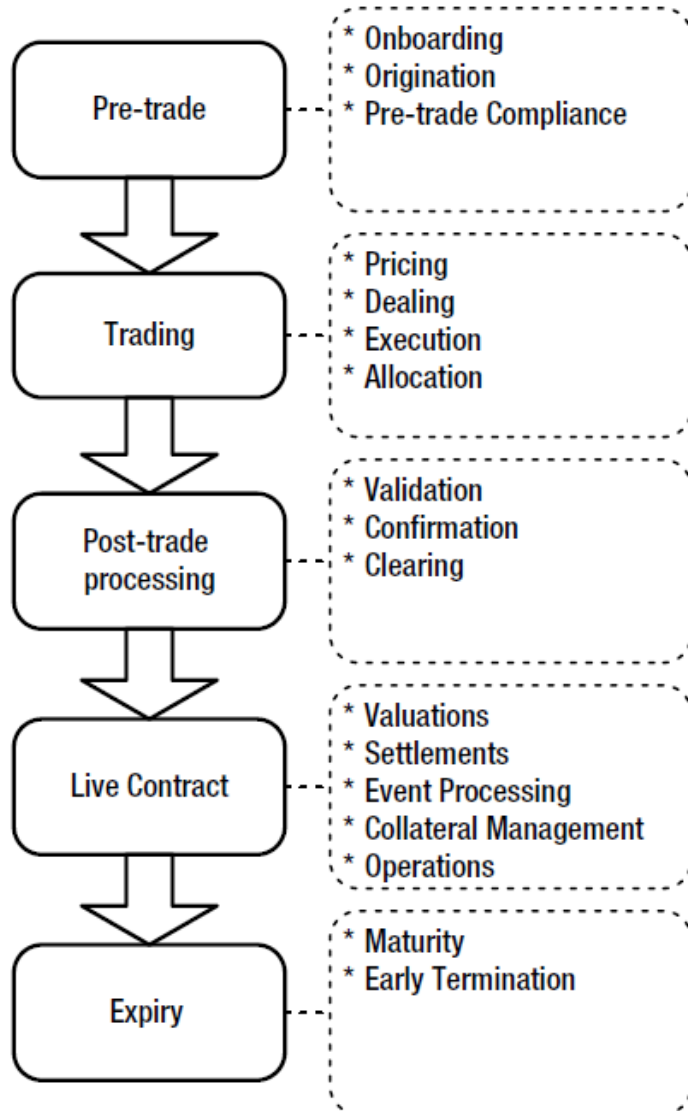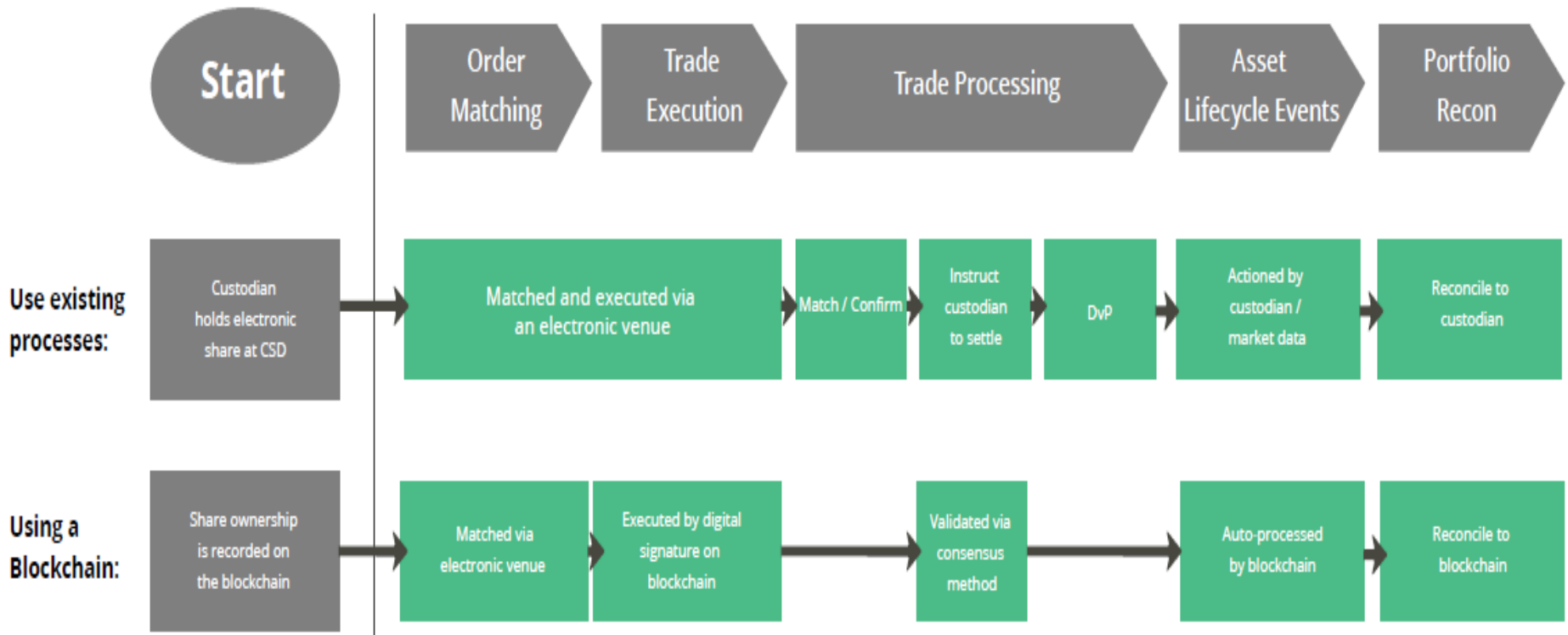

► **DLT has quickly caught the attention of many in finance for its potential to streamline financial processes and to save costs.**

► **Central Clearing Counterparty and Trade Repository focus on Post-Trade OTC Derivatives.**
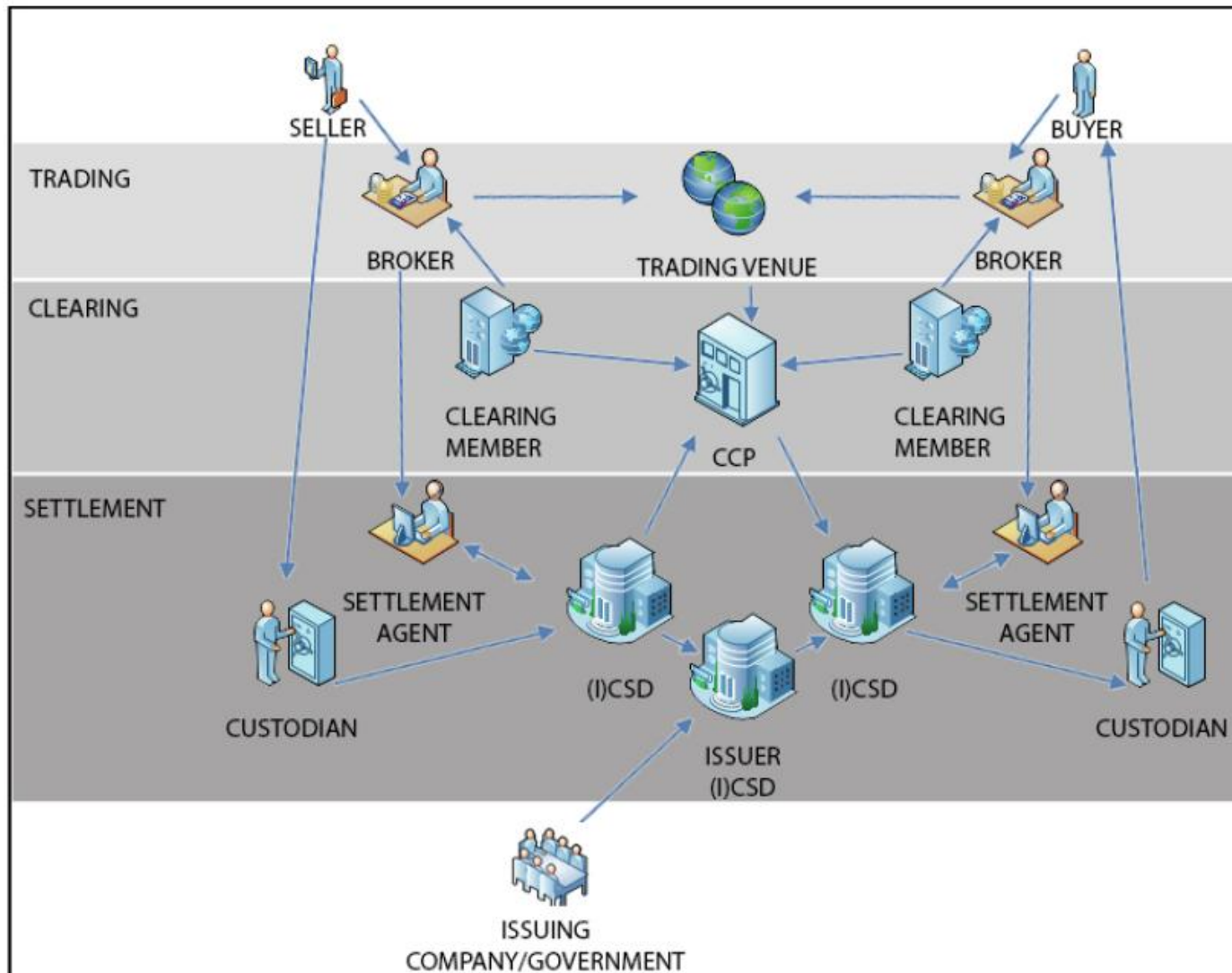
Distributed Ledger Technology in OTC Derivatives

The Blockchain Technology could reduced transaction processes.
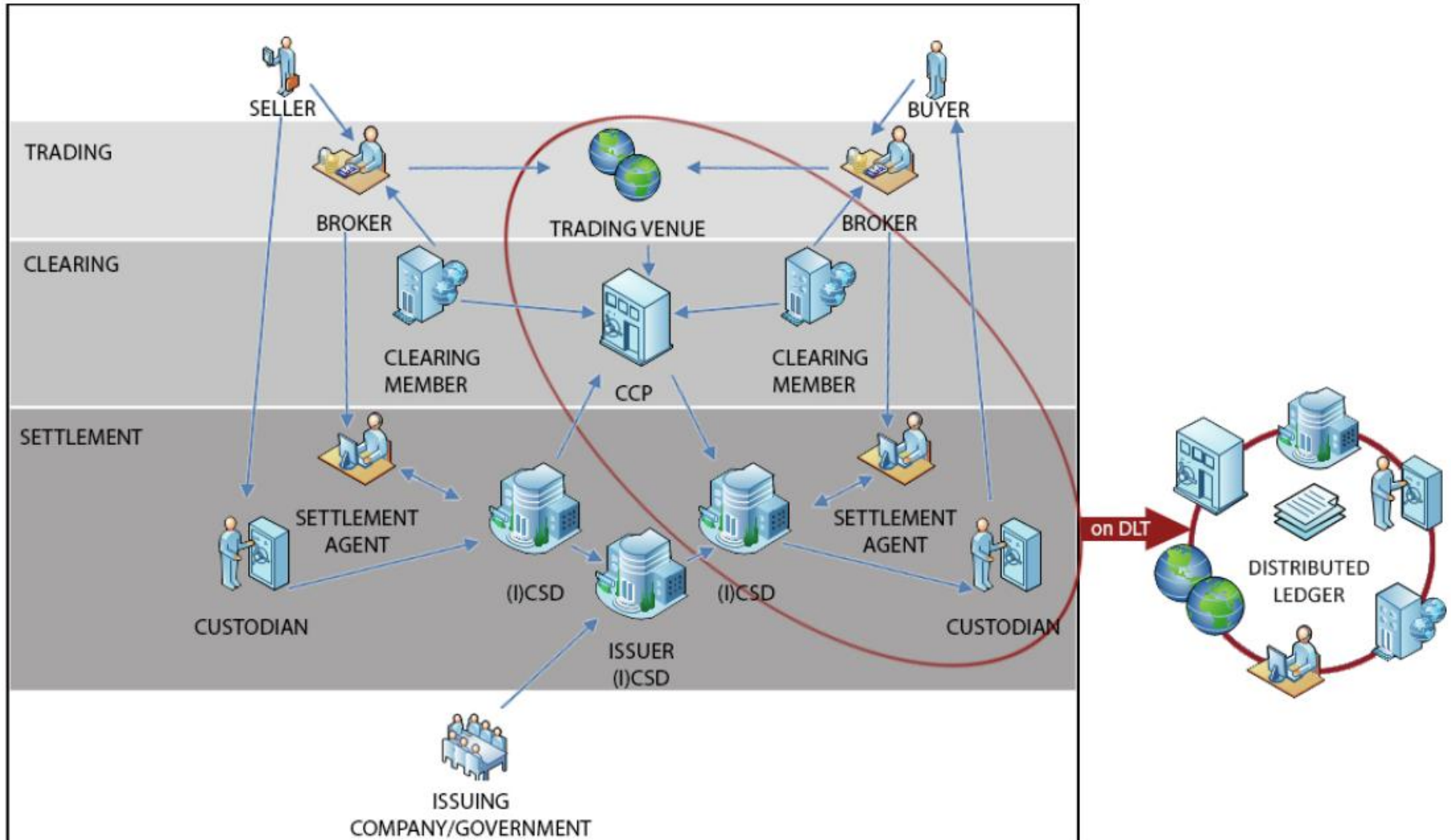
Distributed Ledger Technology in OTC Derivatives

Post-trade Process in the securities leg of current transactions

source : Distributed ledger technologies in securities post-trading, 2016, ECB

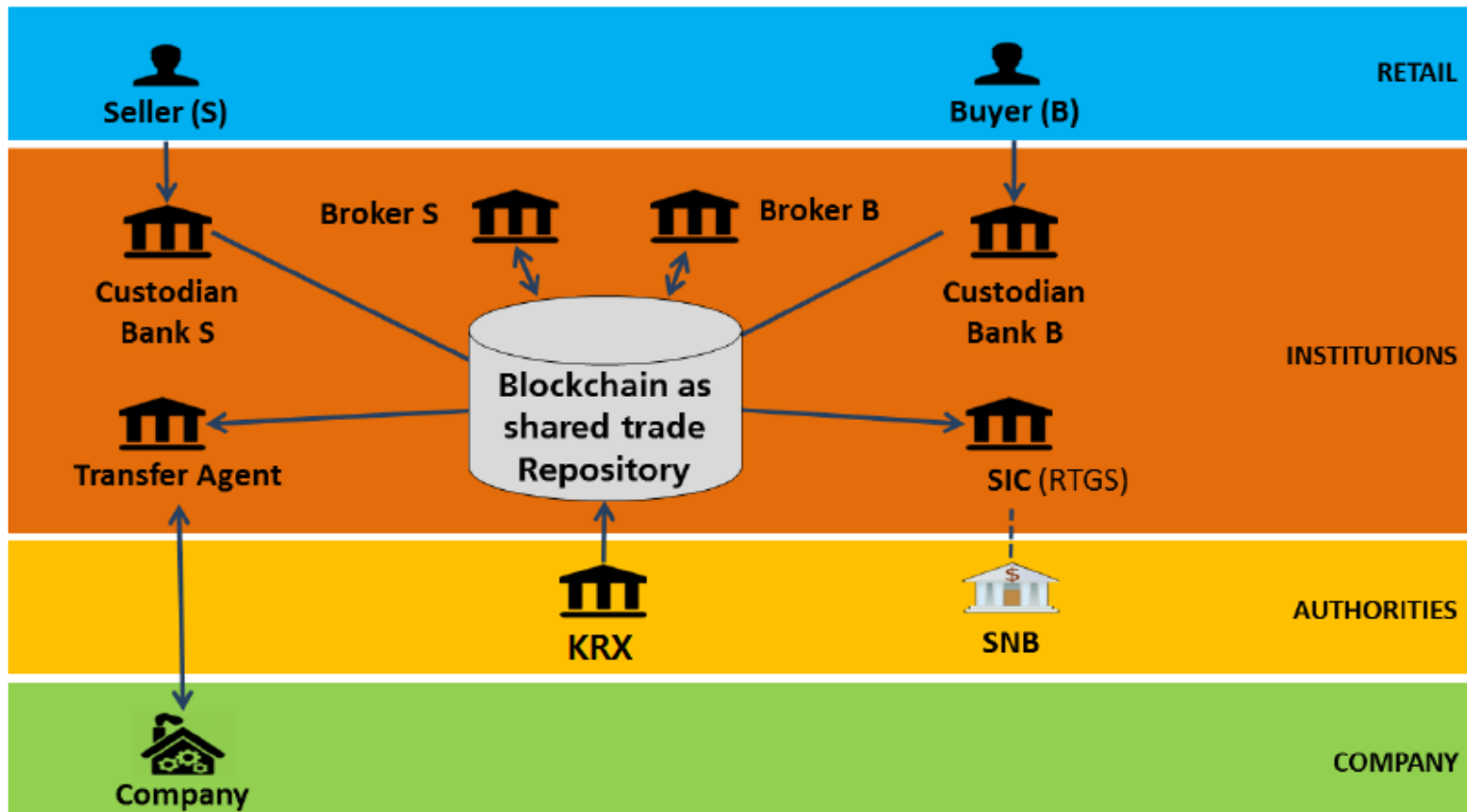# Distributed Ledger Technology in OTC Derivatives

How a distributed ledger may affect the efficiency of post-trade in the securities market, assuming current business practice continues

Distributed Ledger Technology in OTC Derivatives

Blockchain platform as shared Trade Repository

Smart Contract for OTC Derivatives

"Smart Contract : legal contract terms implemented as executable computer code."

Smart Contract for OTC Derivatives

► An obvious application of smart contracts and distributed ledger technology would be securities settlement, and in particular derivatives

deal can be smart contract cryptographically signed by both counterparts. As a standard cryptocurrency transaction can command to move X units of money from wallet A to wallet B now (ten minutes in practice), a Smart Contract transaction can for example move

$$\max\left(S_{1Y} - X, 0\right)$$

► From wallet A to wallet B in 1 year from now, where S_{1Y} is the price of a given stock in 1 year, provided that an amount of money (the value of this contract) is transferred, say by ten minutes from now, from wallet B to wallet A. This is clearly a sketch of the implementation of a call option transaction, where A is the option seller and B is the option buyer.

Smart Contract : Comparison of Consortium Blockchain

Characteristic	Ethereum	Hyperledger Fabric	R3 Corda
Description of platform	– Generic blockchain platform	– Modular blockchain platform	– Specialized distributed ledger platform for financial industry
Governance	– Ethereum developers	– Linux Foundation	– R3
Mode of operation	– Permissionless, public or private[4]	– Permissioned, private	– Permissioned, private
Consensus	– Mining based on proof-of-work (PoW) – Ledger level	– Broad understanding of consensus that allows multiple approaches – Transaction level	– Specific understanding of consensus (i.e., notary nodes) – Transaction level
Smart contracts	– Smart contract code (e.g., Solidity)	– Smart contract code (e.g., Go, Java)	– Smart contract code (e.g., Kotlin, Java) – Smart legal contract (legal prose)
Currency	– Ether – Tokens via smart contract	– None – Currency and tokens via chaincode	– None

Smart Contract for OTC Derivatives : A Challenges

► The Documentation Architecture published by ISDA

(Master agreements, Confirmations)

► Global Smart Contract Design for OTC Derivatives Products

→ UTI(Unique Transaction Identifier), UPI(Unique Product Identifier) , CDE(Critical Data Elements) in CPMI of BIS

→ Trade Matching and Confirmation (Reconciliation & Validation)

► Derivatives collaterals (Initial Margin and Variation Margin)

→ Automatic margin call management

→ Smart contract logic would need to be based on the business done by the firm, their broker relationships and their collateral management process and embedded with the corresponding transaction valuation logic.

► Derivatives Life Cycle Events Management (Action Type)

→ New Transaction, Modify, Delete, Early Termination, Correct

► Financial Supervisory Reporting Framework

Smart Contract for OTC Derivatives

Enforcing a standard set of rules and conditions to a transaction enabled by smart contracts optimizes post-trade processing of OTC derivatives.
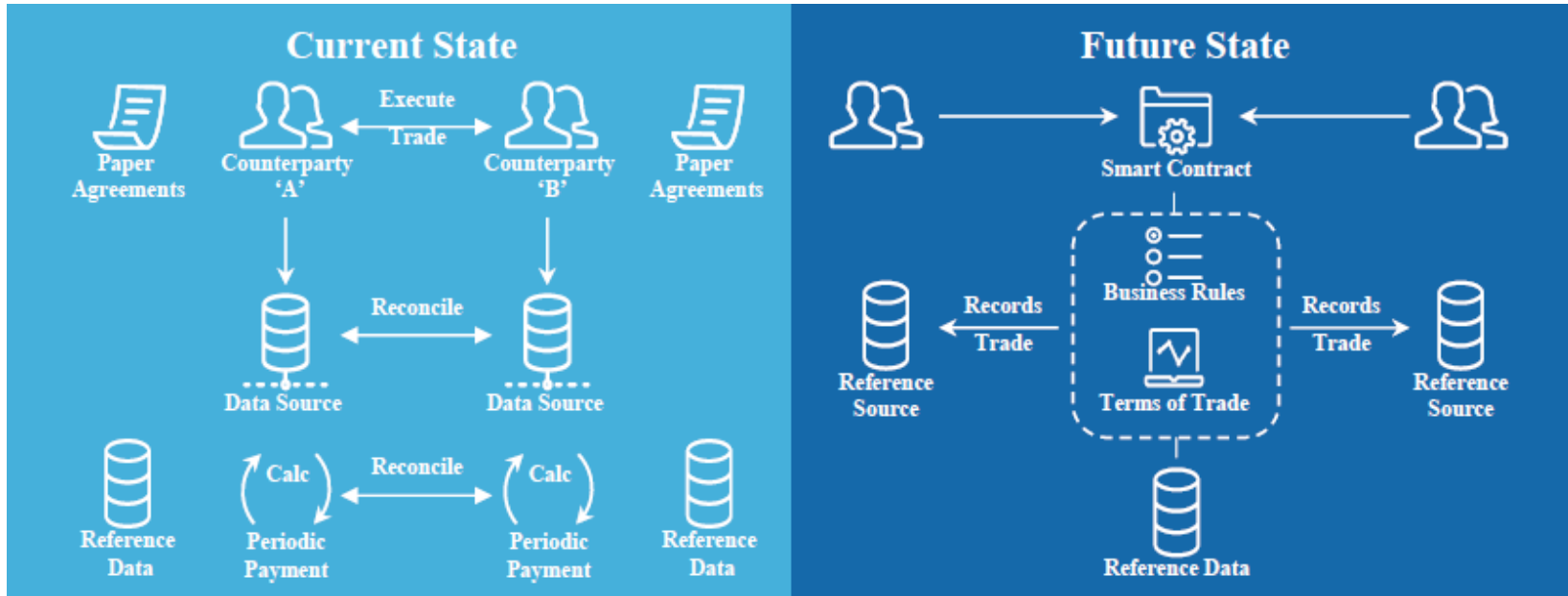
► Redundant and time-consuming process due to asset servicing being managed independently by each counterparty for most OTC derivatives

► Paper-based transaction agreements that contain terms, trade agreements and post-trade confirmation.

► Automated settlement of obligations while executing triggered processing of trade events. (e.g. periodic payments)

► Automated external event processing (e.g. credit) and succession events.

► Enable real-time valuation of positions for real-time exposure monitoring, while reducing errors and disputes.

Smart Derivative Contracts
Detaching Transactions from Counterparty Credit Risk
- Specification, Parametrisation, Valuation -

Christian P. Fries   Peter Kohl-Landgraf
email@christian-fries.de   peter@kohl-landgraf.de

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Version 0.7.1

Abstract

In this note we describe a *smart derivative contract* with a fully deterministic termination to remove many of the inefficiencies in collateralized OTC transactions. The automatic termination procedure embedded in the smart contracts replaces the counterparty default by an option right of the counterparty.

The application of smart contracts to cure issues in xVAs has been described before, see [9, 10]. However, a direct implementation of an OTC derivative as a smart contract may come with its own issues:

- If the smart contract is implemented on a crypto-currency blockchain it will introduce a currency conversion risk.
- If the smart contract has an automatic termination in case of insufficient wallet amounts, the contract essentially contains a bilateral American option. Both counterparts can willingly terminate the contract by emptying the wallet. This would render the contract useless.

In this note we will fully describe the terms of a smart contract to replace a collateralized OTC transaction. We introduce a penalty payment to modify the American option right in the contract. The penalty and the excess amount in the wallet can be seen as a combination of default fund contribution and initial margin, inducing a per-contract termination probability. Hence, each contract come with its own termination probability (corresponding to the default probability). Based on this, ratings could be assigned on a per-contract basis.

Such smart contracts are also interesting with respect to the mathematical theory of systemic risk, since each contract represents an individual counterparty, increasing the numbers of individual counterparties in the whole system and possibly justifying the application of mean filed theory (compared to a setup with a large central counterpart (CCP)).

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Smart Contract for OTC Derivatives : IR Caplet

Placeholder for future Libor fixing

Calculation of interest on notional

**Note that debt obligation must be of positive amount.
Hence exercise is only valid if floating leg is larger than fixed leg.**

```
arrange {
    actions {
        (acmeCorp or highStreetBank).may {
            "exercise".anytime {
                val floating = interest(notional, "act/365",
                                fix("LIBOR", "2016-04-01", Tenor("6M")),
                                "2016-04-01", "2016-10-01")
                val fixed = interest(notional, "act/365",
                                0.5,
                                "2016-04-01", "2016-10-01")

                highStreetBank.owes(acmeCorp, floating - fixed, GBP)
            }
        }
    }
}
```

Smart Contract for OTC Derivatives : IR Caplet

Following transaction applying fixing

```
arrange {
    actions {
        (acmeCorp or highStreetBank).may {
            "exercise".anytime {
                val floating = interest(notional, "act/365",
                                    0.67,
                                    "2016-04-01", "2016-10-01")
                val fixed = interest(notional, "act/365",
                                    0.5,
                                    "2016-04-01", "2016-10-01")

                highStreetBank.owes(acmeCorp, floating - fixed, GBP)
            }
        }
    }
}
```

> **Placeholder replaced with actual fixing**

Smart Contract for OTC Derivatives : IR Caplet

Resulting state following exercise

arrange {

      val floating = interest(notional, "act/365",

                    0.67,

                    "2016-04-01", "2016-10-01")

      val fixed = interest(notional, "act/365",

                 0.5,

                 "2016-04-01", "2016-10-01")

    highStreetBank.owes(acmeCorp, floating - fixed, GBP)

Reduces to obligation

}

Central Clearing Counterparty : Blochain use

► CCPs may adopt private forms of Blockchain Technology. They may take three approaches, in increasing order of disruption.

► A CCP may use financial cryptography tolls like hashing, digital receipts And smart contract to make its business process more streamlined and Auditable.

► Alternatively, a CCP may keep its business model but try to get savings through tokenization of collateral and faster blockchain settlements.

► This is mutualization technology : we can mutualize capital, data, Computations, collateral, rating… in a world where banks may face the Competition of internet giants, each one dominating its own market, a Technology for mutualization processes, resources and risk management through distributed automation rather than centralized exchanges/CCPs or custodians is interesting for banks. Yet…

Central Clearing Counterparty : Blockchain Limits

► The European Market Infrastructure Regulation (**EMIR)**requires certain standardized OTC derivative contracts to be cleared through a central counterparty (**CCP).** If market participants were to set up a DLT network to clear these transactions, the DLT network would need to comply with the requirements in EMIR. However, the European Securities and Markets Authority (**ESMA)** is of the view that the clearing of some spot transactions with DLT as the underlying seems the more likely near term scenario. Spot transactions are not within the scope of the clearing obligation under EMIR.

► In the longer term, the development of DLT might see the disintermediation of CCPs if it could facilitate the immediate execution and settlement of transactions(although this is currently not viewed as a priority by many market participants). It would then be acting as the definitive record of title to the traded derivatives. However, the removal of CCPs could introduce new systemic risk and is likely to require amendments to EMIR.

LEI Use Case – Blockchain / Distributed Ledger

1. Using identity labels (unique keys) in Blockchain / distributed ledger applications

    Example: Using the Legal Entity Identifier (LEI) in a distributed ledger system for trading financial instruments

    > Defacto the standard due to legal and regulatory requirements

2. Using Blockchain / distributed ledger for creating and managing identity labels (unique keys)

    Example: Using Blockchain / distributed ledger for managing the LEI creation and administration itself

    > Long-term research project, many open questions but with interesting aspects for the evolution of the LEI system

LEI Digital Identity - Issue

► Permissioned & Private Blockchain / Distributed Ledger require mapping between real world entities and their Digital ID.

► This is handled via cryptographic algorithms creating Public / Private Key pairs linked to reference data.

► The Owner of the Private Key can writ into the chain.

► This raise two major concern :

  1. Are we going to see multiple digital IDs depending on the application or are we going to use one ID to access all applications?

  2. What is the appropriate management platform for all these IDs?

LEI Digital Identity – a Proposal

► A proposal to overcome these issues :

► Each entity should have its own label and digital identity.

► The LEI as part of a digital certificate would bind the identity
   to the actual individual or group of individuals.

► Transactions signed with such a certificate could be
   unambiguously tracked back to the originator
   (in finance : Counterparty Identification, KYC, AML)

► Validation and verification of individuals or groups need
   to be done anyway, but then only once, and not multiple times,
   as it is today. Use existing standards.

► Blockchain / Distributed Ledger should consider these
   digital certificates and the underlying standards instead of
   creating new diversity.

Risk of Blockchain Platform for OTC Derivatives

►The Use case Cost / Benefit compelling?

►Cost mutualisation / who funds the overhaul of old systems?

►Misaligned incentives

►Issues

►Legal Risks

►Crptology / security

►Simplicity / Interoperability

Conclusion – Blockchain Platform as Financial Market Infrastructures (FMIs)

► **Payment Systems (PS)** - sets "of instruments, procedures, and rules for the transfer of funds between or among participants; the system includes the participants and the entity operating the arrangement";

► **Central Securities Depositories (CSD)** - which, "provides securities accounts, central safekeeping services, and asset services, which may include the administration of corporate actions and redemptions, and plays an important role in helping to ensure the integrity of securities issues (that is, ensure that securities are not accidentally or fraudulently created or destroyed or their details changed)";

► **Securities Settlement Systems (SSS)** - enabling "securities to be transferred and settled by book entry according to a set of predetermined multilateral rules";

► **Central Counterparties (CCP)** - "interposes itself between counterparties to contracts traded in one or more financial markets, becoming the buyer to every seller and the seller to every buyer and thereby ensuring the performance of open contracts";

► **Trade Repositories (TR)** - "an entity that maintains a centralised electronic record (database) of transaction data."

금융시장인프라에 관한 원칙
Principles for financial market infrastructures

BIS 지급결제제도위원회
국제증권감독기구 기술위원회

Conclusion – Blockchain Platform as Financial Market Infrastructures (FMIs)

► CCPs or TR could also benefit from the movement of their infrastructure to a DLT, saving costs but more importantly allowing for their business to be conducted in a more capital efficient and somewhat more transparent manner while giving them the tools to control the markets they oversee. We take this one step further, and if combined on a common platform managed by multiple FMIs, a DLT could offer a multi-purpose FMI platform which registered and regulated entities use to move and manage assets and contracts with and on behalf of their customers.

► Moreover, given the way that a DLT can be built, we believe that there is a possibility that such a platform could be built in a way that allows for it to be extremely default remote. This would mean that if a CSD or CCP managing their business on this platform were itself to default, the integrity of the underlying DLT could still be maintained, and an administrator could move the business to a solvent entity. To us the possibility of building the next generation, multi-purpose market infrastructure platform using DLT, in a way that enables FMIs and their customers to operate in a more efficient, less risky manner is the whole reason to use blockchains. It will be tough, and won't happen overnight; it will require that incumbents in these business keep an open mind and actively engage in building a better product for themselves and their clients.