# Case Study: The Automation of an over the Counter Financial Derivatives Transaction Using the CORDA Blockchain

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**Abstract.** We implemented the automation of a real-world Bilateral Derivatives Over-The-Counter Post Trade Confirmation financial transaction model adopting the Corda permissioned blockchain technology; this kind of transaction is currently performed manually by specialized clerks in most private banking organizations. The proposed solution design is an innovative certified sequence of the workflow states of the transaction, based on the asynchronized interaction among two parties through a smart contract coordinated and validated by the notary node. We show the business logic model of the application and the flow diagrams compatible with the current Corda R3 distribution.

**Keywords:** Distributed ledger technology · Financial transactions · Distributed ledger · Blockchain

## 1 Introduction

Many Portfolio Managers want to stipulate Over-the-Counter Derivative (OTC) contracts because of their bespoke nature. Differently from the securities or derivatives traded on exchange platforms, OTC offers full flexibility for each transaction, avoiding intermediation or regulation. Components such as Price, Quantity, Maturity or Upfront fee can be freely defined between the parties to fit the specific needs of investors. Conventionally, OTC trades have been concluded over the phone, but - thanks to the improvements of technology and the birth of the Fintech sector - electronic networks are now taking the lead and allowing the parties involved to execute trades in an easier and faster way, without errors. Contracts are often executed with counterparties with limited public information; avoiding Counterparty bankruptcy, investors ask a cash Collateral, according to the Market Value of the contract.

Once a trade is executed between the two parties, the Counterparty will have to send the Term sheet to the Investor, who is going to sign it. At the same


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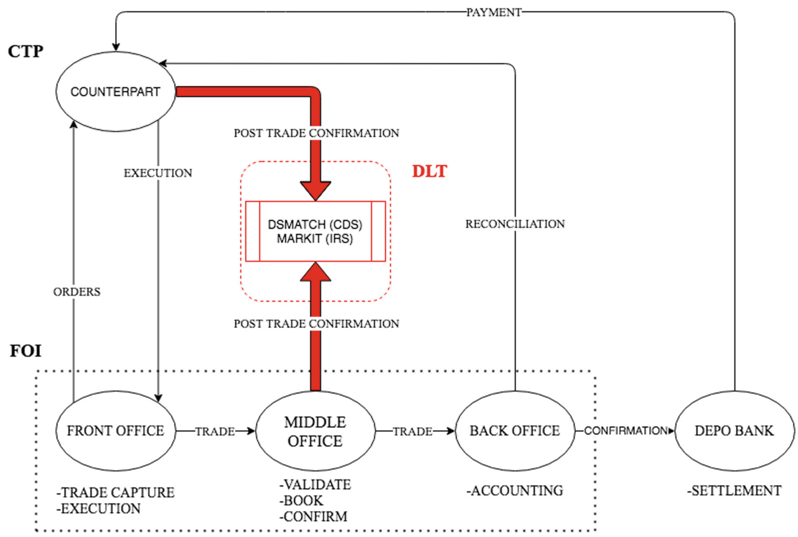


**Fig. 1.** The Over-the-Counter (OTC) trade scheme between a Counterparty (CTP) and a Front Office Investor (FOI). DSMATCH (Credit Default Swap) and MARKIT (Interest Rate Swap) functions of the Post Trade Confirmation (PTC) process is designed through a Distributed Ledger Technology (DLT) proposal.

time, both will book the trade in their *Front Office* system to allow the necessary verification checks and validate the trade by signing the Term Sheet. Checks are necessary not only for the signing but also because the buyer and seller need to ensure that the trade details are correctly injected in the accounting system, and that the correct instructions are sent for settlement and asset custody, were most of the time is not an automated procedure that can lead to significant operative or cash errors. On the market there are some platforms that allow to receive trades from the counterparty and allow the investor to check and validate - if correct - the trade details, but they always require the investor's manual intervention through a human operator checking numerical values at a computer screen, because there isn't any automatic validation on the same trades received from both parties. Our solution, exploiting the Blockchain technology, provides the financial clients with an innovative public platform that connects all the single pieces together and allows to the parties to retrieve in real time each trade executed on OTC contacts, thus avoiding fat-finger and other human related errors. Clerks must verify and confirm the trade details by matching them with a public unalterable reference, and to certify the validation thanks to a unique code assigned to the specific trade and acknowledged by the market - creditors and supervisory commissions included. Furthermore, OTC transactions are mostly not public, and their prices are privately agreed between two parties, they require very fast deal closing in order to keep agreed price fixed. Each transaction's activity, if the outcome is successful, is thus invisible to anybody else but the parties involved [6].

## 2 Related Work

An OECD 2020 report [1] on blockchain technologies in Italy shows how the national economy, diversified and export-oriented, is suitable for the development, experimentation and adoption of blockchain-based solutions in a variety of sectors. International trade is one of the most interesting areas for the development of solutions based on Distributed Ledger Technologies (DLT). The sectors for which the origin of the products represents an important market value, can benefit strongly from the qualities of transparency, security and traceability offered by the blockchain. Innovative SMEs across the country are testing DLT solutions with a view to putting them to work in a variety of industries and some are starting to commercialize them. Although the application of DLT/blockchain applications are best known in the field of cryptocurrencies, new industrial applications are constantly emerging. For example, innovative projects are underway by the SIA[1] (the "SIAChain") or the Italian Banking Association (ABI), which is developing specific applications for the Italian market, based on the blockchain infrastructure proposed by the players in the international market ("Spunta Project") [1]. As for the utilities sector, since 2016 Enel has been experimenting with various systems that leverage the blockchain [1].

### 2.1 Analysis on the Spunta Project

**Spunta Banca DLT** is a project[2] coordinated and promoted by ABI Lab[3] aimed at applying the new DLT technology to the interbank process of associated partners. The Italian interbank check-off procedure is linked to an operation traditionally carried out by the back office, aimed at reconciling the flows of transactions that generate accounting records on the reciprocal accounts and managing the suspended ones. ABI Lab has signed a collaboration agreement with software company R3 to develop innovative applications and solutions on the Corda blockchain platform. In 2017, 'Spunta Project' was born to operationalize the potential and benefits of blockchain in banking, through the application of a digital ledger distributed among the banks participating in the project, NTT Data for application development and SIA as the infrastructure provider. As reported in the article of the newspaper IlSole24Ore of 28 April 2020: *"the process has been operational for the first grouping of banks since the beginning of October 2020 with 97 banks participating in the project."*

[1] https://www.sia.eu Società Interbancaria per l'Automazione.

[2] https://www.abilab.it/aree-ricerca/blockchain-dlt/spunta-banca-dlt Spunta Banca DLT.

[3] https://www.abi.it Associazione Bancaria Italiana.

## 3 Distributed Ledger Technology Design on CORDA

The aim of this paper is to design a possible DSMATCH and MARKIT software module running on a blockchain platform in order to transfer the benefits of a DLT solution - in terms of security, privacy and reliable single source - to the whole process of Post Trade Confirmation. The requirements to be matched, in order to guarantee parties and service providers involved in the confirmation process, are the following:

- Transactions must be unique and not modifiable once confirmed by parties.
- Occurring time and date of transactions must be marked with unique and read-only timestamps.
- The system must reconciliate all transactions, matching orders from parties and confirming the transactions once all parties involved have approved the correctness from their side.
- Transactions must be visible only to the parties involved and to the service provider.
- Provider of service must save all operations and disclose them to the police and regulatory authorities when needed, according to the UE-GDPR regulation.

The DLT platform choose to implement such a modeling - among the many solutions nowadays available - is **Corda**[4]. This is an open-source distributed ledger software system, and it is meant for financial institutions in need of designing, processing and storing documents and contracts involved in financial transactions. Corda [2] is an open-source project born in 2016 as a permissioned DLT in order to allow the conservation and certification of contracts, agreements and obligations between parties trusting each other. It's based on traditional blockchain architecture with some important differences [4]. The funding block of the chain is the **"State"** or a contract instance that represent, in each instant, the evolution of the contract. States can be consumed and replaced by news ones as the contract workflow goes on, forming a ledger of non-mutable **"contract state objects"**. Transactions are only visible to parties involved, legitimate "validators" (notaries) and entities which will need to refer in a future time to their contract validity for new transactions.

To reach consensus among parties Corda defines three instruments. A special group of nodes – called **Notary Parties** - offering notarization services in terms of uniqueness of transactions, disputes resolution and timestamping. Secondly **Smart Contracts** to define the constraints on data and implementing the business logic of the agreement. Lastly a **Flow framework** to define the protocols of multi-step actions between the parties without a central controller. The overall set of this consensus instruments with data - represented as state objects - and all ancillary interface modules (APIs, communication plugins, GUIs) constitutes a ledger application called Corda Distributed Application

[4] https://www.corda.net The Corda permissioned distributed blockchain.

or CorDapp. We propose a solution aimed to implement a CorDapp representing DSMATCH and MARKIT functions and designed to be deployed on Corda Network: the official platform of R3 Consortium[5] using a private permissioned configuration, where the central authority validates user/node identity. Corda Network is natively designed to manage commercial and financial transactions and is directly owned and managed by the R3 Consortium, has its pillar is the pre-existing trust among the nodes of the network as well known and identified by the central authentication authority.

The main features are the following:

- Network protocol allows messages exchange regarding possible state transitions, once it is agreed older states are consumed.
- Each node verifies if the transaction is acceptable on its side on the business perspective of his organization.
- Consensus is reached only among nodes involved in the transaction.
- Double-spending problem is avoided through special nodes, called Notary, that certify the erasing of old states and the creation of new ones.

The structure of such a network is based thus on nodes which identity is well known and verified by R3 Consortium, on each node multiple CorDapps that can be deployed and used for the business purposes of the owner.

### 3.1 CorDapp Design Language

A useful tool to help designing and modelling CorDapps is represented by **CorDapp Design Language** (CDL)[6]. It is a set of 3 instruments, or diagrams, that allow to model a high-level representation of the CorDapp itself and how it interacts with the business environment the CorDapp is supposed to integrate with. The three logical views of CDL consist of the **Business Process Modelling Notation** a pool and swim-lane diagram to contextualize the CorDapp logic and flows within the Organization's business logic and applications, the **Smart Contract view** an acyclic graph where nodes are represented by states of the smart contract and connections represent the flows of the CorDapp and the **Ledger view** that based on the Smart Contract diagram shows the time evolution of the states defined through the possible flows.

### 3.2 Armundia DSMATCH (CDS) and MARKIT (IRS) CorDapp Solution

The scenario considered is where two parties – the **Front Office Investor** (FOI) and the **Counterpart** (CTP) - interacts directly to confirm independently the validity of the transaction's agreement. The preliminary step is to define the

[5] https://www.r3.com R3 Consortium.

[6] https://docs.corda.net/docs/cdl/cdl/cdl-overview.html CorDapp Design Language (CDL) overview.

business environment: the idea here is to have a double confirmation by CTP and FOI, both could be the initiators of the deal – as both could act as buyer or seller - and both could reject the deal in case of non-compliance with the expected result of the contract. The process of agreement starts with the initiator proposing the deal, the receiver then decide to approve or disapprove the contract through a simple logic: the Post Trade Confirmation data packet matches the one in his hand, as shown in Fig. 2. If it's the case the receiver pre-agrees the deal and sends his PTC packet to the sender; in similar way the sender decide if agreeing or not the deal matching the packet with the one in his hand. Upon the second confirmation the deal is completed, and the transaction registered and validated by a Notary node. The following Corda flows are defined:

- **Propose Deal:** initiated by seller with data related to his PTC packet
- **PreAgree Deal:** initiated by buyer with data related to his PTC packet
- **Agree Deal:** initiated by seller
- **Complete Deal:** initiated by buyer
- **Cancel Deal:** can be initiated by both parties in case of non-compliance

This business logic and interactions between Corda application flows and other non-DLT business processes and applications are modelled in the BPMN diagram (Fig. 2), in this scenario the FOI act as the seller and the CTP act as a buyer.

The composition of the **Post Confirmation Packet** – that is the core data managed by the CorDapp - must reflect and resume properly the nature of the deal between the parties, the following fields are the one selected for our proposal:

- Seller, Buyer: name of the party acting as a seller or buyer respectively;
- SellerID, BuyerID, TradeID: unique identifiers;
- InstrumentIDc, InstrumentIDp: unique identifier of the underlying guarantee title expected by consenter and used by proposer;
- AmountP, AmountC: value of the transaction set by proposer and expected by consenter;
- Proposer, Consenter: party proposing or consenting the flow;
- rejectionReason, rejectedBy: party and reason of rejecting the deal;

The states of the smart contract are defined as per flows determined in the BPMN and are the following: **Proposed, Preagreed, Agreed** and **Rejected**. In order to shape a business logic adherent and consistent with the Post Trade Confirmation process the Corda paradigm requires the definition of constraints at various logical levels and for all modules and components, the ones defined for this model are the following:

- Buyer and Seller, Consenter and Proposer must be different parties;
- Proposer must be either Buyer or Seller, Consenter must be either Buyer or Seller;
- InstrumentID must be a valid ISIN (International Security Identification Number) Code [3];

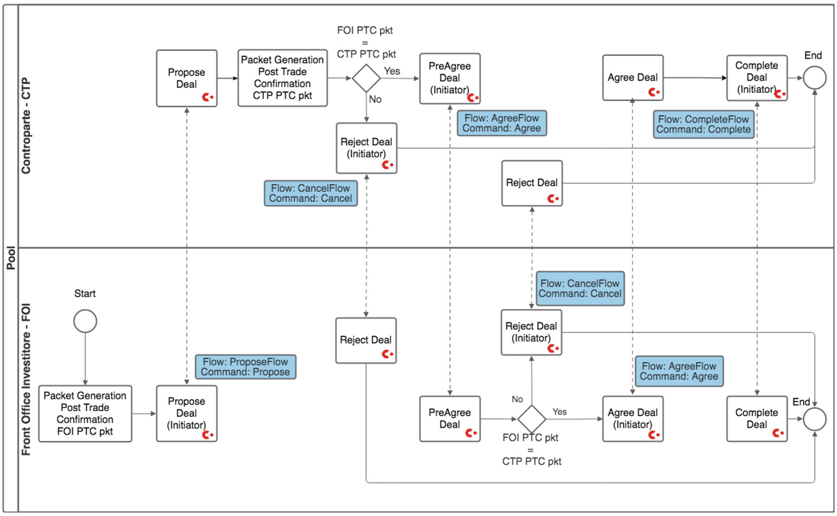


**Fig. 2.** Business process modeling notation view of DSMATCH (CDS) and MARKIT (IRS) CorDapp

- BuyerID and SellerID must be valid LEI (Legal Entity Identifier)[7] Codes;
- TradeID must be a valid UTI (Unique Transaction Identifier) Code [5];

Flows and Status constraints are also defined in order to establish how flows are initiated, agreed and rejected and what status changes rules are.

Once the Smart contract view is defined (Fig. 3), the business logic governing the corDapp is set. To describe all possible evolutions the smart contract may have, there is a final instrument represented by the Ledger evolution view.

In this example (Fig. 4) we describe the smart contract evolution in the scenario where both parties agree the deal. The first transaction $T \times 1$ represent the proposal from the FOI party that brings the status of the agreement to “Proposed”, all variables are set to their values except rejectionReason and rejectedBy that can be set to NULL as per constraint rules of this state. In $T \times 2$ the CTP checks the variables AmountP and InstrumentIDp finding them compliant to what expected and thus the smart contract state is updated to “Preagreed”, accordingly to the PreAgree arrow in Smart Contract view, and the AmountC and InstrumentIDc are written with relevant consenter values. At this point the FOI double-checks the Amount and Instrument values and finding them compliant with their business logic expectations activate the $T \times 3$ bringing the status of the contract to “Agreed”. At this point both the parties close the process through the $T \times 4$ of completion of the deal. To complete the back-end design of the Post Trade Confirmation module we have to define the way the Service provider can access the transactions in case of authority request for information. As stated before, we designed the CorDapp in order to be deployed on Corda

[7] https://www.gleif.org Global Legal Entity Identifier Foundation.

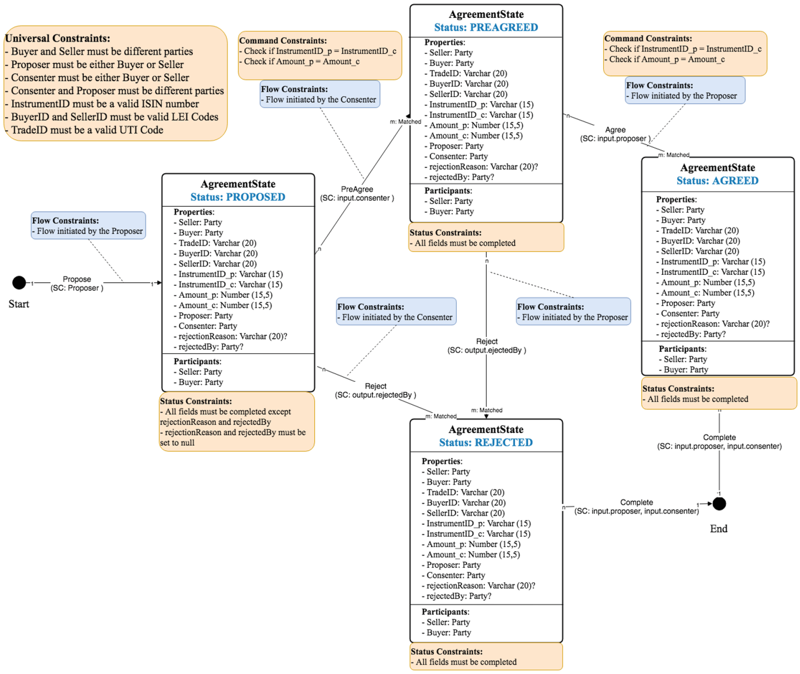


**Fig. 3.** Smart contract view of DSMATCH (CDS) and MARKIT (IRS) CorDapp

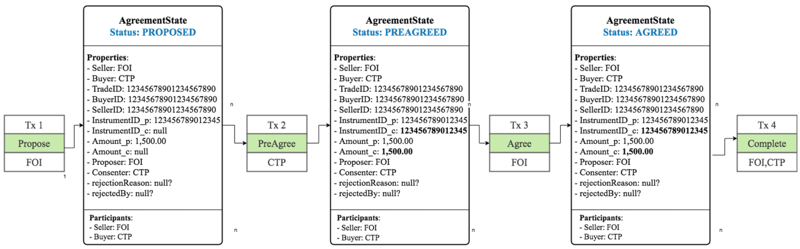


**Fig. 4.** Ledger evolution view of DSMATCH (CDS) and MARKIT (IRS) CorDapp

Network. This cloud service run by R3 gives basically remote access to nodes on dedicated virtual machines to deploy clients' applications; the access to each single node is possible through password protected accounts.

## 4 Front Office Application

A front-end application, based on the DLT described in Sect. 3.2, may be proposed for Armundia's clients in need to perform Over-the-Counter operations as per Fig. 1. We refer to the module allowing the Post Trade Confirmation activities. A first preliminary analysis of the problem brings to define the Actors involved in such a process both on the internal and on the external side:

- Middle Office Operator of the FOI: personnel operating on client's side in order to book, validate and confirm securities exchanges on the platform They interact both directly with the counterpart and with other actors internal to the FOI (Front Office Operators and Back Office Operators);
- Counterpart Operator: personnel of the counterpart office entitled to manage the Post Trade Confirmation duties.
- Armundia Compliance: supervisors of the system that manage the technical and financial functions of both the DLT back-end and Front office front-end modules.
- Control Authority Officer: Police, Institutional and Commercial entities meant to check and retrieve information from Armundia's system
- Front Office Operator of the FOI: secondary actor representing the internal part of the FOI interacting with the Middle Office operator.
- Back Office Operator of the FOI: secondary actor representing the internal part of the FOI interacting with the Middle Office operator.

A simple use case to define the functionalities think for the front office application could be the one described in Fig. 5:

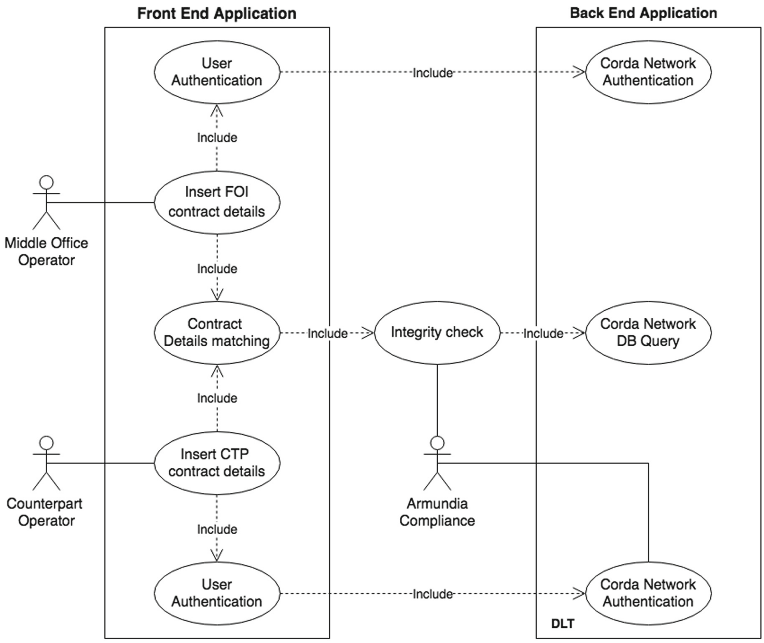


**Fig. 5.** Use case for Post trade confirmation operations

The use case described explains the interactions among actors and the system's modules, during the post trade confirmation process. The Counterpart and Middle Office operators place their respective orders details, after authentication on the front-end, and ask Armundia's system to execute the MARKIT an DSMATCH functions along with an integrity check of all relevant information.

The Front-end software application could be imagined as a web-based solution installed on Armundia facilities – for its technical and administrative personnel - and on its client's premises; in both cases interacting through a VPN encrypted connection with the Corda Network set of nodes. Armundia's instances could have access to all nodes of Corda Network with administrative privileges in order to check and retrieve all the relevant information may be requested by regulation bodies in case of fraud and unlawful behaviour. Each instance of the application thus exchanges information regarding the transactions only with its own dedicated Corda node; a messaging function with Armundia and between counterparts, outside the Corda Network, may be considered in order to facilitate communications and synchronizations of back-office's processes.

## 5 Conclusions

We have shown a scheme of a Derivative OTC Post Trade Confirmation financial transaction implemented over the Corda blockchain, ready to be integrated with conventional fintech software tools, that can automate with all the necessary warranties a procedure so far carried out manually by human clerk between banks. The system is implemented on a Corda test net, to validate how a real DLT scenario can reduce the errors and save time compared to a classic deployment configuration with manual operations.

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