# Boosting Transition to Paperless Trade – Mapping Traditional Trade Contracts to Smart Contracts

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***Abstract*— Distributed ledger technology (DLT) and blockchain, alongside with smart contracts, are seen with hope by many actors involved in international trade as a new opportunity to further facilitate and digitize international trade transactions. In order to mitigate deficiencies of the current legislation, and to avoid pitfalls that limited digitization of trade in previous decades, a carefully planned transition needs to be conducted. For this reason, we have built a solution that eases the transition to paperless trade by allowing for unobtrusive coexistence of traditional trading contracts and corresponding smart contracts running on the blockchain. Coexistence is achieved by automatically translating relevant trade terms and conditions specified in traditional trading contracts to the corresponding logic implemented in smart contracts.**

## I. INTRODUCTION

International trade can be defined as a business transaction between parties stationed across separate countries [1]. A transaction is not limited to goods, but also encompasses the transfer of services, technology - through license agreements, and even bonds and other investment vehicles. Challenges in international trade occur because individual countries' regulations may collide with each other. Different countries have distinctive economic and political systems, as well as different degrees of development and, accordingly, varying domestic private laws and commercial practices. These discrepancies have led to a set of international private rules guiding inter-country business transactions, which has created a fair set of practices and regulations to securely facilitate business transactions internationally.

However, the paperwork and processes vital to global trade, including the costs involved, as well as the complexity of documents and procedures, are a major burden for both governments and businesses. Globalization has brought most advanced trading networks the world has seen, but they all still rely on millions of paper documents. For small and medium-sized enterprises (SMEs), these costs act as a major disincentive to engaging in international trade. This is why in June 2005, after several government-led initiatives, the United Nations Economic Commission for Europe (UNECE) held its international forum entitled "Paperless Trade in International Supply Chains - Enhancing Efficiency and Security". As a result, a document named "A roadmap towards paperless trade" was drafted, which set out the key issues and made recommendations and policy-oriented suggestions on what governments and businesses need to do to move towards paper-free trading [2]. It was stated in [2] that "switching from paper documents would increase security and transparency in supply chains and provide governments and the private sector with higher revenues; by adopting electronic technologies, international trade could save billions of dollars every year".

Despite the efforts, almost fifteen years later, international trade transactions continue to rely extensively on paper [3]. Going paperless requires more than simply the technology and technical interoperability. It requires a conducive regulatory framework which provides for e-authentication methods and the recognition of e-signatures, e-documents, and e-transactions; which recognizes the authority of other government entities (both domestic and foreign) to issue required documentation, such as certificates; and allows sharing of certain types of information between government authorities. This is true at the national level, but even more at the international level. National legislation may have to be comprehensively examined and adjusted to give legal recognition to e-signatures and e-documents. To date, only a limited number of countries have legal provisions for such recognition.

Distributed ledger technology (DLT) and blockchain [4], alongside with the smart contract technology [5], are seen with hope by many actors involved in international trade as a new opportunity to further facilitate and digitize international trade transactions. In general terms, DLT is a type of a distributed database that assumes a possible presence of malicious peers in the network, while blockchain represents a distributed data structure that implements DLT, and that comprises cryptographically linked blocks that contain network transactions. By increasing transparency and making it possible to automate processes and payments, blockchain has the potential to reduce trade costs significantly, including verification, networking, processing, coordination, transportation, and logistics, as well as financial intermediation and exchange rate costs. The automatic nature of smart contracts makes them a particularly interesting tool to use in trade to automate transactions. Cost reduction estimates in the financial sector and the shipping industry range from 15 to 30 percent of total costs [3]. According to the World Economic Forum, the removal of barriers due to application of blockchain could result in more than US$ 1 trillion of new trade in the next decade [6].

Although blockchain can help accelerate the digitalization of trade and enhance the efficiency of border procedures, the road to truly paperless trade remains long [3]. High-level

political support is needed to drive trade integration and help establish a legal framework conducive to paperless trade. In order to mitigate deficiencies of the current legislation, and to avoid pitfalls that limited digitalization of trade in previous decades, a carefully planned transition needs to be conducted.

Since the current regulative framework doesn't recognise smart contracts and blockchain transactions as legally binding, we propose a solution that eases the transition to paperless by allowing for unobtrusive coexistence of traditional trading contracts and corresponding smart contracts running on the blockchain. Coexistence is achieved by automatically translating relevant trade terms and conditions specified in trading contracts to the corresponding logic implemented in smart contracts, and, afterwards, installing the resulting code on the peers of the blockchain network. Code generation relieves parties involved in the business of the cost and burden of implementing smart contracts, while automatic translation lowers the chance of occurrence of unintended mistakes and security vulnerabilities.

## II. THE PROPOSED SOLUTION ARCHITECTURE

The goal of our solution is to enable the automatic translation of relevant trade terms and conditions specified in trading contracts to the corresponding logic implemented in smart contracts. After the translation gets accomplished, the resulting smart contract should be installed on the blockchain network. To achieve this goal, we have designed solution architecture depicted in Figure 1. Components of the architecture are explained in detail in the following sub-sections.

### A. Contract specification

For proper transactions to be made, detailed and specific sales contracts should be carefully negotiated to specify the relevant trade terms and conditions [1]. These include determination of the quantity and quality of the contracted items, time and means of transportation, foreign exchange stipulations, and other safeguards with banks and insurers. In addition, it is advisable for the contracting parties to specify in detail what qualifies as a fundamental breach. Inspectors may also be required, for example, at the stage of enforcing the contract, through the pre-shipment inspection, to inspect the goods to ensure that they are indeed prepared for appropriately contracted delivery.

To support a sufficiently detailed specification of a contract, we based our solution on the Model International Sale Contract (MISC) [7] provided by the International Chamber of Commerce (ICC) [8]. ICC is the largest and most diverse business organisation in the world. It offers an extensive array of voluntary rules, guidelines, and codes which facilitate cross-border transactions. ICC Model Contracts comprise lists of terms, with the responsibilities of the parties clearly set out. They are flexible enough to allow users either to incorporate only the general conditions common to all contracts or to include the specific conditions, which set out standard terms common to all contracts incorporating the ICC General Conditions of Sale. The ICC MISC is of particular interest for this paper, because it was explicitly

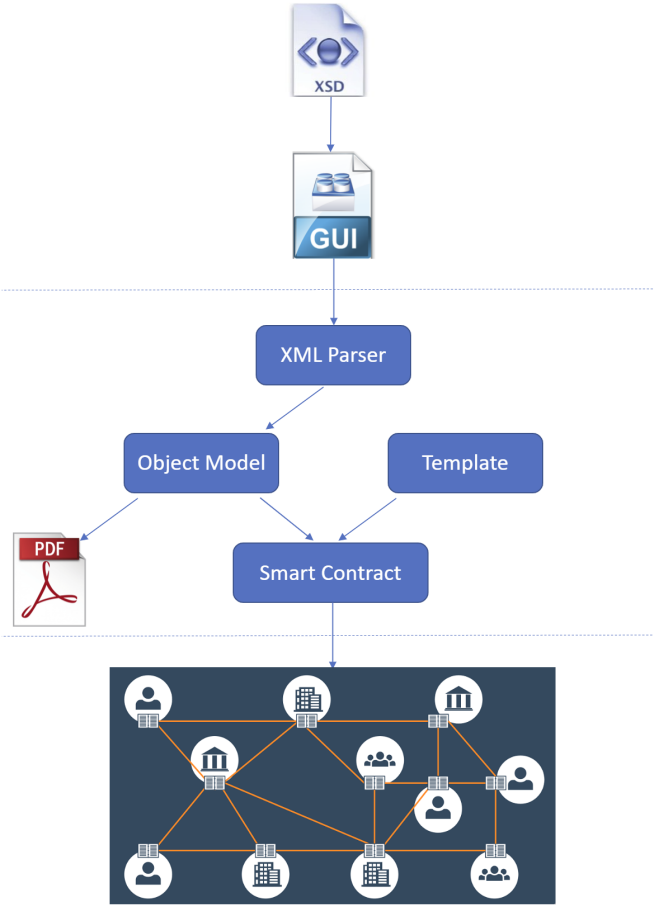


Fig. 1. The proposed solution architecture

developed for sales of manufactured goods intended for resale, where the purchaser is not a consumer and where the contract is an independent transaction rather than part of a long-term supply arrangement.

Since contracts comprise semi-structured data, we have used eXtensible Markup Language (XML) for contract modelling and specification. Based on the ICC model contract, we have designed an XML Schema Definition (XSD) document as a meta-model which includes all of the necessary elements that are needed to support machine-readable contract specification. To enable end-users to write XML contract specifications that correspond to the XSD document, we have included the web-based, schema-driven GUI component to our solution. The component is based on the Xonomy XML editor [9], customised with document specification that corresponds to the XSD document. Xonomy's data-centric, 'laic' mode emulates the look and feel of a text editor with syntax highlighting, code folding and auto-completion. It hides the XML code away and presents the document in a kind of structured tree-view, which makes it convenient to use by end-users with a non-technical background. Since Xonomy is schema-driven, it offers document validation, that enforces users to specify contracts according to the ICC model contract specification. Additionally, for the occasions

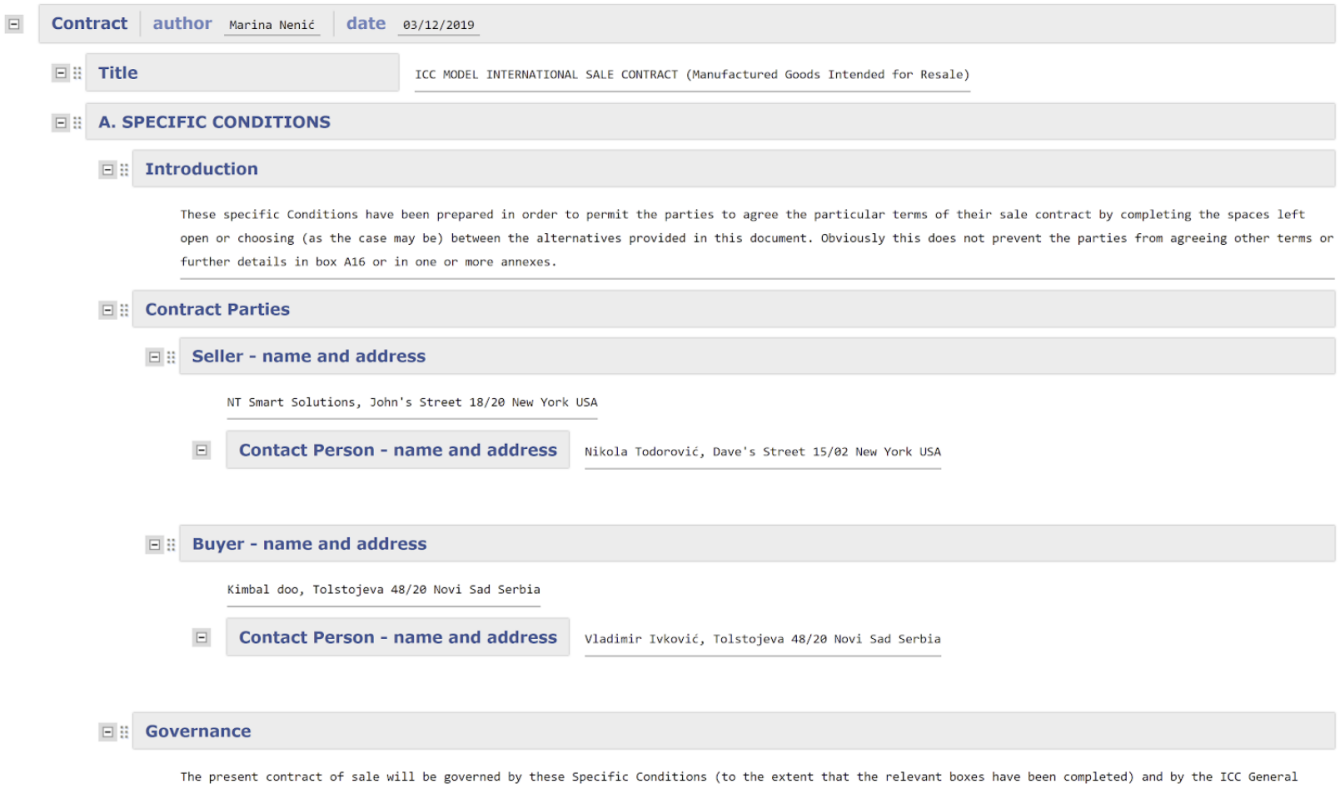


Fig. 2. Segment from a sample contract specified using the GUI component

when Xonomy's document specification is not expressive enough to impose structure on the document, Xonomy enables writing custom validation functions in JavaScript. A segment of a sample contract specified using Xonomy editor can be seen in Figure 2.

### B. Contract generation

When a user submits the final version of the contract, an XML parser is used to transform the under-laying XML document to the object model. Based on the object model, two outputs are generated: a PDF version of the contract, which is legally binding after it gets signed by legal representatives of trading companies, and a smart contract, that is further going to be deployed on the DLT network. A smart contract is generated by populating previously prepared smart contract templates and contains procedures that are necessary to support contract lifecycle management (CLM) for trading contracts. Since generated smart contracts highly depend on the underlying blockchain network, we propose a sample network that could be used to support a traditional international trading flow, shown in Section III, based on which we defined our smart contract templates.

### C. DLT network

After the contract is specified, it gets translated into a smart contract, that is further installed and instantiated on the DLT network. In our work, we have used Hyperledger Fabric [10], an open source enterprise-grade permissioned DLT platform, designed for use in enterprise contexts. Hyperledger Fabric is one the projects within the Hyperledger enterprise blockchain initiative [11], led by the Linux Foundation since 2015. As an oldest and the most mature project in Hyperledger, Fabric is known for modular architecture that maximises the confidentiality, resilience, and flexibility of blockchain solutions [12]. Permissioned membership, high transaction throughput, configurable consensus mechanisms, and scalability are some of the most important features that favour Hyperledger Fabric for enterprise-level use. Since Fabric is a blockchain based DLT, nodes of the network maintain a copy of the ledger by applying transactions that have been validated by a consensus protocol, grouped into blocks that include a hash that binds each block to the preceding block. A smart contract, also called "chaincode" in the context of Hyperledger Fabric, functions as a trusted distributed application that gains its security/trust from the blockchain and the underlying consensus among the peers. It is the business logic of a blockchain application. Contract lifecycle management is supported by using smart contract procedures and transaction endorsement policies.

## III. SAMPLE NETWORK

Contract lifecycle management is implemented using smart contract procedures and transaction endorsement policies. Since they highly depend on the underlying blockchain network, we propose a sample network that could be used to support a traditional international trade flow. Following the signing of the traditional contract, the typical trade process starts with issuing a Letter of Credit (LC) that the

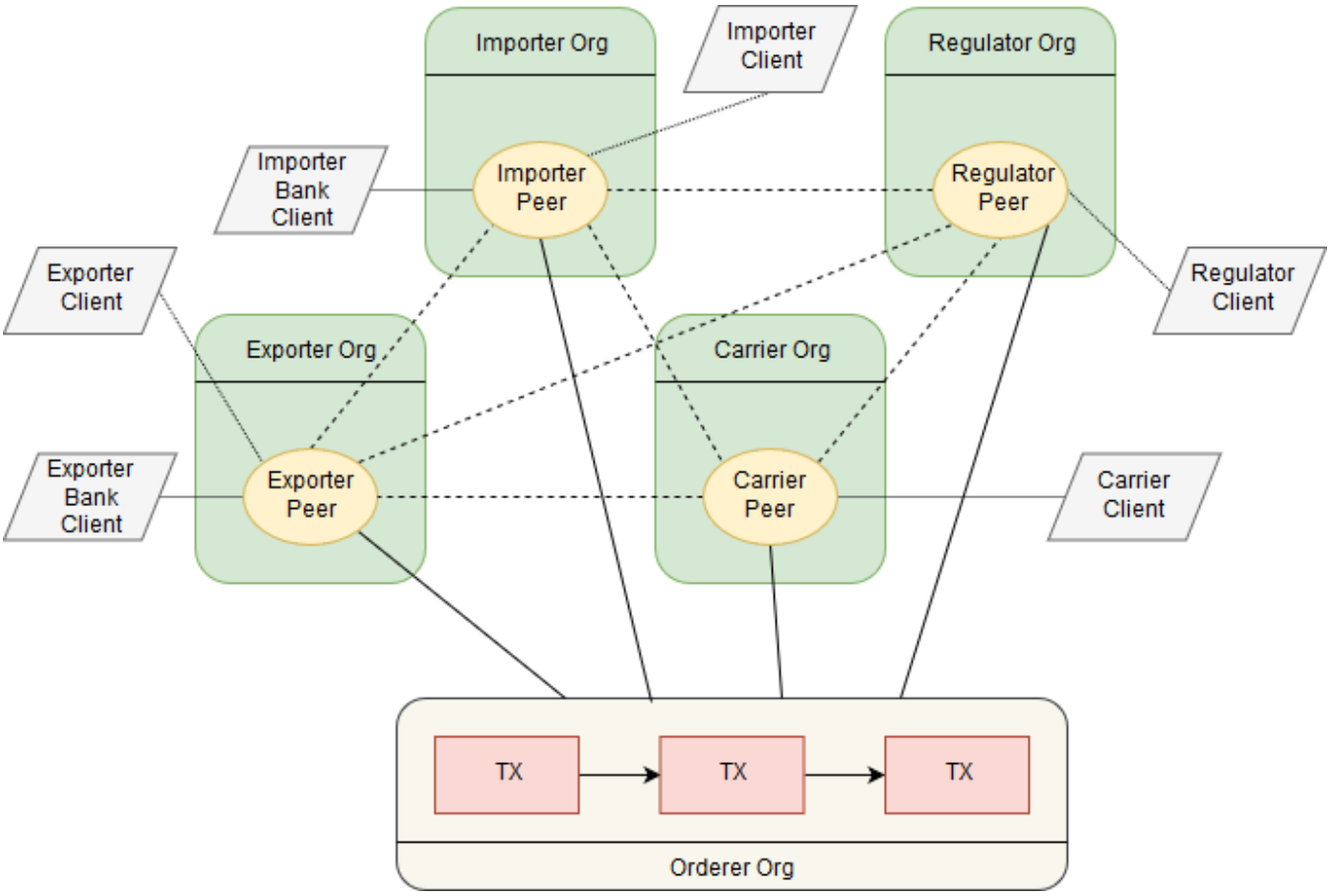


Fig. 3. Sample blockchain network for international trade

buyer's bank sends to importer's bank as a guarantee for payment. The next step is issuing a Certificate of Origin that the producer sends to the exporter as proof of the quality of goods. Afterwards, a shipping step takes place with all transport documents needed such as a Bill of Lading. In this step, the transporter also has the role of a validator, so exporter is able to monitor the transportation of goods. When the transportation process is finished, the importer provides documents required for import clearance. After completion of import customs formalities, importer receives the shipment and initiates payment after finishing the validation process. The whole process would be presented as a sequence of high-level abstracted steps performed as the execution of smart contracts. Every step in the international trade process should be validated by relevant network members authorised within smart contract definition and should result with the creation of related documents on the blockchain. All of the document types mentioned above could be created using well-defined templates and automatically populated with data retrieved from the blockchain.

A sample blockchain network for international trade is presented in Figure 3. The network consists of four organisations: ExporterOrg, ImporterOrg, CarrierOrg, and RegulatorOrg. There is also a Fabric-specific separate organisation OrdererOrg responsible for ordering transactions and submitting them to the distributed ledger. Exporter and exporter's bank are supposed to have already established mutual trust, so they are represented as a single participant in the network, which is also the case with importer and importer's bank. Appropriate payment procedures are selected from smart contract templates. These payment procedures usually involve both exporter's and importer's bank and presume there exists communication between those banks as actors in international trade. Furthermore, transportation terms and conditions are translated into a sequence of actions and events that need to be completed in order to the entire international trade transaction succeed. Thus, at least one transport company needs to be a part of a blockchain network, so the sample network contains an organisation called CarrierOrg.

The main impact of applying blockchain technology is in providing payment certainty to sellers, by automating payment methods, as well as providing delivery assurance to buyers, through trade asset tokenisation. Asset tokenisation would indicate supervision or ownership of the goods and link their transfer between trade transaction participants on the blockchain network with the movement of the physical asset, establishing a transparent chain of provenance. Payment methods and the underlying trade contracts are modelled as smart contracts on the blockchain to provide

payment certainty to the seller. This leads to automation of compliance verification with contract terms and guarantees faster payment to sellers by preventing disputes from the start due to ambiguities in the payment contracts. Trade shipment documents and other trade-related documents can be also tokenised on the blockchain, to provide delivery assurance to the buyer.

## IV. RELATED WORK

Many ongoing projects are trying to leverage blockchain technology and smart contracts to streamline financial flows between buyers, sellers, and financiers, and, as well, enhance security, speed, transparency, and reliability of supply chain financing. An example of such a project is the we.trade initiative, a joint venture between twelve major European banks formed in 2017 [13][14]. In this "bank-centric platform" based on Hyperledger Fabric, traders register to the platform via their banks. Importers and exporters can then record their transactions on the platform after having agreed on the terms of their contract (goods concerned, price, payment term, settlement conditions). A smart contract provides the guarantee of payment, and automatic settlement when the conditions determined between the parties get met. However, this project is still in the early stages of development and doesn't fully comply with the current legislation, and its application is therefore limited to a small set of European countries.

## V. CONCLUSIONS

In this paper, we presented a permissioned blockchain solution for international trade that eases the transition to paperless trade by enabling seamless concurrent use of both traditional trading contracts, which ensures compliance with the current legislative, and corresponding smart contracts, which are deployed to the blockchain network. This is achieved by automatically translating relevant trade terms and conditions specified in trading contracts to the corresponding logic implemented in smart contracts. By generating code, parties involved in business transactions are relieved of the cost and burden of implementing smart contracts. In addition, automatic translation lowers the chance of occurrence of unintended mistakes and security vulnerabilities, which increases trust in the newly introduced technology.

Future work should enable support for additional trading contract templates other than ICC MISC, with the ultimate goal of achieving support for any provided trading contract template.

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