DTD powered by ACTUS - an innovative RegTech-automated legal text approach to financial reporting[1]

Authors' names and affiliations: left blank

1. Introduction

In this paper, we propose a novel, RegTech cum automated legal text approach for financial transaction as well as financial risk reporting that is based on cutting-edge distributed computing and decentralized data management technologies such as Distributed Ledger (DL) [1] and Distributed Storage Technologies [2], Algorithmic Financial Contract Standards [3], as well as on Automated Legal Text [4] and Document Engineering methods and techniques [5]. Our approach is inspired by the Internet concept of the "bearer service" and its capacity to span over existing and future technological systems and substrates [6,7]. The *bearer service*, as proposed here, generates and maintains a *"digital doppelgänger"* for every financial contract, a Dynamic Transaction Document (DTD), that is a standardized "data facility" automatically transferring important contract data from the transaction counterparties to competent regulation authorities and their authorized partners (and broadly to organizations and citizens that may have a motivation, or an interest, to be involved in the supervision of the financial system). RegTech is the space we envision to create by storing and processing such e-financial reports in the objective of providing valuable input to financial and economic analysis that is required to appreciate the health of financial institutions and markets . RegTech is also the innovative use and combination

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of several technology flavours to automate compliance tasks and deliver transparent monitoring of financial transactions mainly by: a) using a *document-as-application approach* together with modern algorithmic finance technology and, b) *instantly processing and publishing (under specific access policy rules) real-time financial information*, which is received directly and seamlessly from the Information Systems of Financial Institutions (FIs). Our approach levers previous work to develop algorithmic contract type universal standards (ACTUS) as well as the important work on Legal Entity Identifiers (LEIs) for uniquely identifying counterparties.

The new construct we propose, the Dynamic Transaction Document, (DTD) is an instantaneous, ad-hoc, and comprehensive digital representation of a particular financial contract (initially made for regulatory purposes), and as such has, in effect, similarities with a synthetic financial instrument. Obviously, the DTD should have a significant contribution to the improvement of the capability of the regulation authorities to diagnose financial markets' failures early and act to "stop crises before they start". The DTD remains synchronized, in near real-time, with the individual original financial contract it represents.

At the same time, implementing DTDs could also provide a testing and debugging environment before actually attaching legal value to future full-fledged digital contracts executed on a shared ledger where reporting and contracting would largely collapse into one and the same operation. This testing environment may already create important feedback into regulatory design as well as risk management approaches within financial institutions. As legacy financial contracts are progressively replaced by newly created algorithmic contracts with automated reporting features, this trend should accelerate further.

2. A proposal: Develop a new layer of algorithmic regulation functionality

A number of developments in recent years have combined to put the issue of financial stability at the top of global economic policy agenda, especially after the crisis of 2007-08. In the Pittsburgh Summit of G20, the leaders of the 20 major economies of the world have decided to create the Financial Stability Board (FSB) with the mission to promote global financial stability by coordinating the development of regulatory, supervisory and other financial sector policies. The FSB operates to monitor and assess systemic risks of the global financial system, draft and propose the policy actions that address these risks and monitor the implementation of the recommended policies. As part of this broad mandate to promote and supervise financial stability, the FSB has in particular focused on increasing financial transparency and limiting incentives to excessive risk taking through, among others, the creation of a framework for financial reporting to Trade Repositories (TR) for all over-the-counter (OTC) derivatives transactions [8,9,10] and recommendations for disclosure of banks' risk exposures and risk management practices [11,12,13]. The newly centralized data might produce a meaningful view over the functioning of previously opaque over-the-counter markets and help regulators and customer to assess a bank's business and its risks, and the consequences on its performance and financial position.

However, in practice, complex and heterogeneous multi-level hierarchical reporting systems, such as those practiced in the context of TRs, may induce significant organizational inefficiencies, which often appear as data quality and consistency problems (for example, we frequently report difficulties in comparing data coming from different sources, aggregating similar data, etc.) [14]. In addition, the current financial reporting systems raise serious concerns about high compliance costs for the industry [15]. The new financial reporting rules require a radical re-engineering of in-house IT systems of financial institutions (as it happens, for example, with the BCBS239 principles for risk data aggregation and reporting). Such “native inefficiencies" in the emerging institutional architecture for financial stability monitoring, and a slow industry adaptation path as a result, may delay and undermine the benefits of the regulation [15,16].

As we design a new infrastructure for financial reporting, we need to better explore the potential of emerging and established financial, computational and information technologies, so as to “optimize by design” [17] the application of new regulation. We conceive the reporting system and the monitoring of the regulation rules as a new layer of algorithmic regulation functionality that spans over existing financial technology systems, processes and data formats, and allows for single financial contracts and institutions to be tracked and monitored almost in real time. In such a perspective, we propose to transform the thriving infrastructure of trade repositories and security depositories [9,18] into a RegTech infrastructure, i.e. an ultra-distributed document management and storage system that virtually penetrates the current in-house IT systems of financial institutions (FIs).

This RegTech approach would allow to radically automate compliance tasks of regulated FIs and reduce associated operational risks and costs. Most importantly, it offers to regulators new possibilities for identifying and fixing deviant behaviours that induce “negative externalities” and risks at a large scale, including possibly removing from the market particular types of financial contracts. Hence we can progressively build the mechanisms to accurately assess and stop financial crises at the very beginning [19]. This narrower regulatory approach should increase the overall efficiency of regulation and create feedback to new data science-driven regulatory responses previously conceived as not feasible. Finally, since we envision a significant portion of this RegTech data space to be open (under specific privacy-respecting restrictions) to all organizations and citizens, it will allow for the “society at large” to acquire a role in the discovery and revealing of potential shortcomings for the financial system [20].

3. The Dynamic Transaction Document (DTD): a close to real time "digital doppelgänger” of each financial contract for the purpose of financial reporting

Conceptually, a DTD is close to a synthetic financial contract. However, it is not a contract itself, and it does not have legal value. It is a coded replication of all relevant features of the actual contract on which the firm needs to report, and it must be kept in sync with the actual contract[2]. What this paper intends to demonstrate is that via the use of the proposed DTD, regulators, financial institutions and the society at large, could rely on a shared and parsimonious digital representation of the most important categories of financial contracts and collectively keep track of their evolution in the financial system (rather than keeping them buried in legacy proprietary IT systems of FIs at high cost and little added value).

To be informational efficient, the DTD will isolate the minimally required information for the financial contract it represents. It can then be used over the entire life of a financial contract, including for, but not limited to, all sorts of regulatory reporting purposes. The DTD will store a "digital doppelgänger" for every financial contract in every relevant state of the world that

[2] This synchronization process is not trivial and outside the scope of the present paper.

materializes, where a state of the world will trigger some outcomes based on conditions laid down in the original financial contract. By doing so, workable solutions must be found that overcome the differences of legal text (to read and interpreted by humans) and legal code (to be read and executed by machines).

This paper proposes such a unique algorithmic representation of a contract essentially for regulatory purposes. Basically, the proposal is to create a standardized “data facility” which automatically transfers important contract data from the transaction counterparties to supervisors, regulators, and other competent authorities designated by law. Therefore, a DTD should track and monitor the evolution path of the actual contract during its whole life-cycle. At each stage of this cycle, DTD will provide updated quantitative information that can help the various authorities (within the limits of their respective legal mandate) to level the playing field with financial institutions (FIs) with respect to data driven insights. From this perspective, DTD is a public good potentially driving important insight at the macro and micro supervisory level while having a significant impact on the avoidance of legacy systems' drag, and eventually allowing FIs to manage their data and monitor risk more effectively.

At a first approximation, a DTD will be composed from a number of distinct components (and their associations) according to the specific requirements for the construction of transaction and risk reports (as defined by relevant legislation, technical standards, industry standards, etc.), and by following the principles and methods of Automated Legal Text and Document Engineering [4,5].

In the case of transaction reporting, each time a financial transaction takes place, the IT systems of the transaction counterparties diffuse a standard electronic message that is captured and processed by the RegTech infrastructure. This is a standardized "trace" that a financial transaction must leave behind in order to inform the competent authorities about all significant circumstances under which this transaction took place. "Traces" related to the evolution of the same financial contract will be automatically bundled together within a DTD.

To ensure these DTD features at every point in time, we propose a multi-component system structure with a *smart contract DTD* at its core. This will live in a (permissioned) distributed ledger (DL) infrastructure and act as a proxy for the DTD, since the complete DTD document (the so-called *deep DTD*) will be stored off-ledger (see [21,22] for a similar approach). Obviously, the access to the data included in both DTD versions (i,e., the smart contract DTD and the deep DTD) must be controlled by a suitable policy framework. The smart contract DTD records the relevant financial events and stores essential financial data that impact the (evolving) state of a financial contract. It also organizes the interaction with the external environment, for example to retrieve relevant market data.

4. System architecture and components: ACTUS algorithmic functionality, Distributed Ledger, Distributed Storage

In order to remain a truthful digital representation of the actual financial contract across changing states of the world, a DTD should follow a *state-transition evolution* similar to the logic of the actual financial contract. In this context, the information to be contained in a DTD can be divided into two parts:

1. A first part carrying the proper contract terms (counterparties, obligations and commitments, default provisions etc.) in conditions of "immutability by design". These are stored in different DTD components assembled into a document component model that captures the reporting standards and the requirements of use.
2. A second dynamic part that encapsulates the history of the contract, that is considered as a transition path involving a finite number of contract evolution states, defined for example as the chain of contract events. These are expressed in terms of the expected cash flows that are calculated on the basis of the contract and market data, in the sense of Brammertz et al. [23,24].

<u>4.1 The structure of a DTD</u>

More precisely, data stored in a DTD incorporates (see Figure 1):

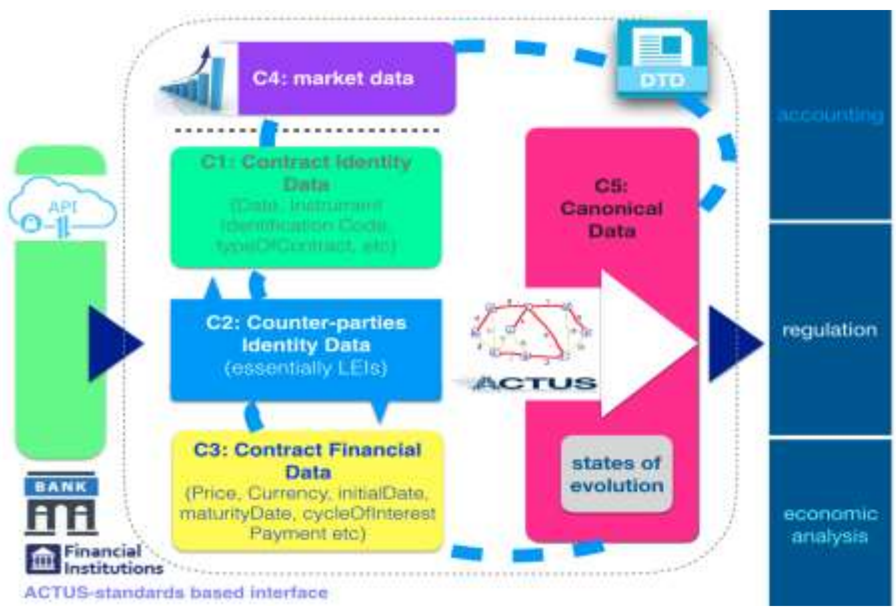

Figure 1: The structure and main components of a Dynamic Transaction Document (DTD)

I. Contractual information required by the financial reporting guidelines. It includes:

a. DTD Component C1: Contract Identity Data (indicatively)

i. Unique Transaction Identifier

ii. Product Identifier

iii. Product Information (such as contract type etc.)

iv. Underlying Information

v. Order Date & Time

vi. Trading Date & Time

vii. Trading Capacity

viii. Indicators (such as short selling, waiver etc.)

b. DTD Component C2: Counterparties Identity Data (indicatively)

i. Reporting Entity Identification Code {LEI of reporting FI, Country}

ii. Buyer Identification Code {LEI, Country} of buyer A

iii. Seller Identification Code {LEI, Country} of seller B[3]

iv. Reporting Date & Time

c. DTD Component C3: Contract Financial Data (indicatively)

i. Effective Start of Date

ii. Maturity Date

iii. Settlement period (every k months)

iv. Value {(number, currency}

v. Rate

[3] This could be a trading venue I, in this case {LEI, Country} of central counterparty for trading venue I.

II. All **data needed to reconstruct a contract's history** during its life-cycle (along the evolution of the contract as reflected in the DTD transition path). This mainly includes data from external resources, e.g. interest rates during the transitions from one state to another and other external to the contract market conditions on which depend the mutual obligations of the counterparties, changes in the legislation etc. (DTD Component C4).

III. Standard DTD Input for Financial Analytics (CTD Component C5). This input mainly consists of the contract events, in particular cash flow events, and implies that the DTD should also incorporate **algorithmic finance technology** needed to generate this information out of the data contained in components C1-4. More specifically this consists of ACTUS algorithmic functionality, ACTUS methodology and its Contract Types taxonomy [23,24]. These components are thus an additional layer of routines which act on the information contained in C1-4 to generate the contents of C5.

In fact, the DTD document will encapsulate the contract events generated for the underlying financial contract. These events are either explicitly mentioned, or are intrinsic, in the actual contract in the sense that their generation depends on the execution rules of the contract [17]. As a result, the DTD should be developed as a *state-transition system* where: (i) the *initial state S0* represents the initiation of the underlying contract, (ii) *a finite set of intended states, denoted Si1… N,* outline the expected evolution of the DTD along the intended contract path as defined on the basis of the input received at initial state S0, (iii) *a small set of non-intended states Sni1,.. K,* define a major departure from the intended contract transition path (due to external actions that change the intended path of evolution, such as a re-selling decision which affects the ownership of the contract, a modification in the duration of the contract, in the product configuration, as in the case of a mortgage, a “cancel” or a “default” decision taken by the counterparties, etc.), and, finally, (iv) *triggering events* (normal and exceptional) necessary to define the transition from one state to another [25].

The input to define S0, and states {Si1… N} & {Sni1,.. K}, will be received directly from the counterparties. Once the transition path is generated, the DTD will successively calculate, in reference to the actual evolutionary trajectory, the “deterministic” (part of the) value of the contract at each state based on the data provided by DTD Components C1-C4. Specifically, expected a contract's cash flows will be derived from DTD states by incorporating ACTUS algorithmic function in the structure of the DTD Component 5. ACTUS algorithmic functions are tied to so-called Contract Types (CT), which standardize the state-contingent contract payoff. A given ACTUS CT implements a family of these standard cash flow patterns. All contracts reported through the DTD mechanism are mapped on ACTUS CTs.

Through the ACTUS approach the DTD can function in two modes: the real time mode and the simulation mode. This means that DTD will provide cash flows on two levels: first, actual transactional cash flows occurring during a financial contract’s life; second, future expected cash flow conditional to models of the external environment (i.e., risk models) as a standard product that can be used as input to financial analysis conducted by the DTD users. Progressively, as the process of contract automation will gain momentum, other elements can be added to the DTD structure, so to create a larger framework of contract variables within which such calculations may take place [26].

4.2. The network implementation of a DTD

To ensure these DTD features at every point in time, we propose an environment for financial reporting with a smart contract version of the DTD at its core. This will live in a (permissioned) distributed ledger (DL) infrastructure [20] and act as a proxy for the DTD, since the complete DTD document (the deep DTD) will be stored off-ledger (see [21,22] for a similar approach). Obviously, the access to the data included in both DTD versions (for example, the *Smart Contract DTD* and the *deep DTD)* will be controlled by a suitable policy framework.

The *Smart Contract DTD* records the relevant financial events and stores essential generic data (such as expected cash flows) that impact the (evolving) state of a financial contract. It also organizes the interaction with the external environment, for example to retrieve and fetch market data. Once a new transaction reported (separately from each counterparty), it should be validated by a specific number of DL participants responsible for this task, added to the most recent version of the ledger, and automatically and irrevocably stored in detail in the *deep DTD*. This "handshake" mechanism, very tailored to the needs of the use of DL technologies for managing financial reporting, should be designed carefully, so to have, at any point of time, a fair representation of the actual (underlying) financial contract.

Why a dual DTD identity might be preferable? Essentially, *Smart Contract DTD* works as a proxy for DTD. It provides *deep DTD* location identification and at the same time it makes publicly available, through the Distributed Ledger, the essential transaction reporting information. At the same time, the *deep DTD* structure effectively stores the complete contract history and complete reporting data.

Smart Contract DTD is a program that encodes the logic, conditions, and basic rules regarding the financial transactions generated by a financial contract as input for the reporting process and automatically carries out the specified terms. *Smart Contract DTD* will run at every node of the distributed ledger (private and publics). The code of *Smart Contract DTD* will execute functions such as: DTDcontractCreate, DTDcontractUpdate, DTDcontractStore, DTDcontactGet, DTDcontractCancel, and so on. The rights over *Smart Contract DTD's* functions and meta-data elements, the holders' rights as well, are stored as data and policy rules (also executing functions) in the distributed ledger itself. A specific function (deepDTDsetURL) allows for initializing the longer version of the transaction report (i.e. the complete transaction report) in a distributed data store, with storage nodes being co-located with distributed ledger private nodes (off-ledger). A combination of functions (deepDTDstore & DTDcontractGetUpdates) allows for transferring the complete reporting information from the financial contract counterparties to *Smart Contract DTD* and then to the *deep DTD.*

Because smart contracts are machine readable/executable they can include conditions that allow them to interact with other IT systems (such as a distributed data storage system). In this context, the *deep DTD* constantly monitors the state of the *Smart Contract DTD* to retrieve and pull any content or status modification. The *Smart Contract DTD i*s responsible also for collecting market data at each state of the DTD evolution. The *deep DTD* stores the sum of the reporting information from the whole evolution of a financial contract, as presented in a previous section.

4.3. Demonstrate the feasibility of the DTD concept through a case study

We can demonstrate the DTD functionality as to risk reporting[4] with a concrete example. We consider three market participants A, B, C, and the regulator R:

- A gives a loan to B (say a PAM fixed)
- B gives a loan to C (say an ANN variable)
- C gives a loan to A (say a LAM fixed)

We set a certain market condition and we look how the DTD is built and evolved across a number of simple transition states. On the basis of the analytical results the R can obtain by processing these DTDs, it asks the banks to do a market stress test by shocking an interest rate up (obviously, this decision is communicated outside of the reporting system) and computing the cash flows generated by the DTDs under these conditions. If we look at the stress scenarios of A, B and C, we can see that B and C are heavily exposed: one gaining and one losing under such a scenario. Then we add a fourth contract, a SWAP (SWPPV) to the system. An additional DTD is naturally produced for this SWAP. The R processes now the four DTDs and applies the same stress scenario (by using its own analytical tools). We will see that the exposure has changed. In the example, we also explain how ACTUS standards can help to both, easily capturing the essential of a financial contract and producing, on the basis of the captured information, valuable cash flow results.

5. Conclusion: DTD allowing for close to real time, "end-to-end", granular regulatory reporting

[4] A similar example could be constructed for the case of transaction reporting.

The DTD will provide a unique presentation of each financial contract that can be used at every step in the processing chain, including but not limited to all varieties of regulatory reporting. The reporting is done only once and it is the different users of the DTD (regulators, their partners, research institutions, the representatives of the «society at large») who decide how the information will be aggregated (obviously under the applying document access policy).

The information of a transaction being carried out is sent to the DTD supporting infrastructure where it will be automatically included in the aggregated picture and, eventually, be available for detailed granular analysis. Essentially, consistent transaction processing and nearly instantaneous regulatory reporting of these transactions would become possible. The DTD supporting infrastructure will be designed *end-to-end* (from Financial Institutions to Regulating Authorities and their partners, to citizens and consumers), to keep uses computable. The benefits of such a "narrow regulation" enabled by a DTD-based approach are obvious for all partners involved in the complex financial system [27]. FIs are legally required to report on transactions as well as on the evolution of risk. DTDs could help reduce compliance costs and progressively close the gap between the operational and the analytical departments, i.e., integrating front, middle and back office. Overall transparency of the global financial system will increase, first benefitting supervisory authorities and regulators, second financial research and legislation, and finally financial education at large.

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