Contractual Abstractions for Economic Activities

Mike Bennett[1]

[1] Hypercube Limited, London, England, UK
mbennett@hypercube.co.uk

Abstract. This paper sets out to explore the potential in re-framing the concepts in the REA Ontology to cover a broader range of agreements. These are further extended by introducing the notion of a 'conditional' commitment, as a precursor to entering into any formal agreement. These, alongside a more detailed break-down of delivery concepts into possession, rights and availability, constitute a potential general ontology for a wide range of economic activities. Some possible future directions for this work include smart contracts for supply chains and novel arrangements for trade finance.

Keywords: REA, Contract, Economic Exchange.

1 Introduction

This paper is intended to promote discussion on the potential for an ontological framework of semantically primitive concepts for economic activities. These concepts are based on the REA Ontology for transactions. These are first elevated to describe all agreements, not just those that can be considered in terms of transactions. We then introduce the notion of a 'conditional' commitment as a means to model a number of existing and novel economic scenarios that may result in transactions or agreements. Recent work on the nature of delivery, that is the nature of satisfying or discharging some commitment, gives rise to a further breakdown of economic scenarios such as supply chain management, in terms of possession versus title, among other things. Finally, we see potential in using these semantic primitives to define smart contracts.

2 The Financial Industry Business Ontology

The Financial Industry Business Ontology (FIBO) [1] was originally conceived as a conceptual ontology, setting out the real-world conditions for membership of real world classes of thing. That is, the focus was on the 'truth makers' for membership of a given class of thing, without reference to data. While FIBO itself has not continued down that path, focusing instead on data-oriented ontologies for identifiable application use cases, the work on these underlying business abstractions has continued informally under a community known as the Semantic Shed [2].

One of the core concepts modeled in FIBO was that of the financial instrument. The term 'Financial Instrument' is defined in the existing ISO standard ISO 10962 'Classification of Financial Instruments [3] as:

> "Financial instruments are cash, evidence of an ownership interest in an entity, or a contractual right to receive, or deliver, cash or another financial instrument."

This definition implies a logical union of a set of different kinds of thing, and covers both centrally (e.g. exchange) traded securities and bilaterally traded instruments like derivatives and short term debt. What these have in common is that they are all contracts of one sort or another.

In the original FIBO work the notion of a 'contract' was fleshed out, with the necessary and sufficient conditions for any kind of contract expressed in terms of something with parties, terms, effective date, jurisdiction and one or two other essential features that are inherited by all contracts. Separately the notion of a 'transaction' was framed in accordance with the REA ontology for transactions [4]. These concepts were adopted and re-framed within the existing conceptual FIBO top level ontology as described in [5].

2.1 Extending FIBO

Building on the original FIBO conceptual framework, the Semantic Shed revisited these abstractions and recognized that rather than limiting the REA terms to the sub-set of contracts that were those that embodied transactions, the basic REA notions whereby two parties each exchange one or a bundle of commitments with the other, could be applied to any kind of contract. This also meant that the original FIBO notion of 'Contract Terms Set' (corresponding to 'contract terms' in most data models, with the name singularized in line with ontology labeling best practice) was in fact the very same thing as the 'commitment' in REA terms, the individual properties of the 'terms set' being in fact the properties of some commitment. This work is summarized in [6].

The corollary of this approach was that not all commitments were capable of being expressed in monetary terms (as they would be in a transaction) and not all commitments were exchanged as a transaction. Figure 1 shows the resulting ontology.
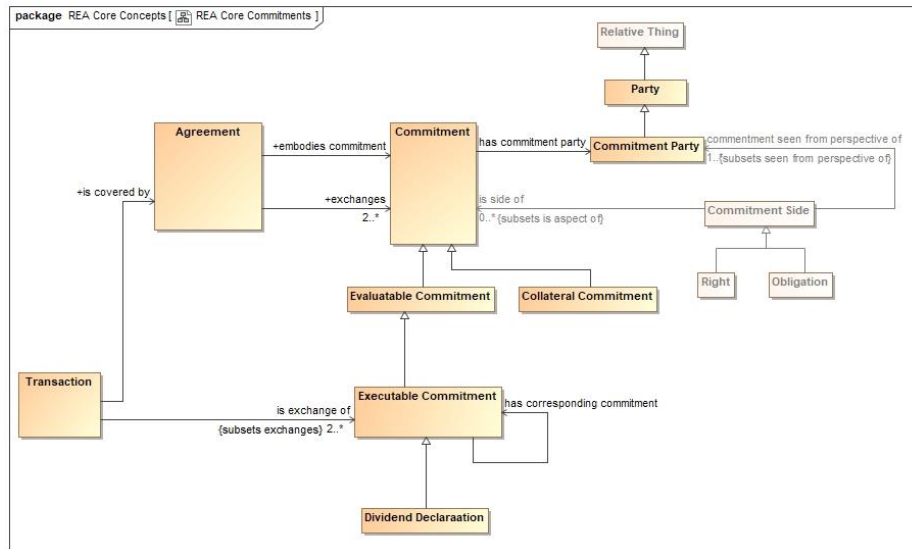
Fig. 1. Semantic Shed Foundational Ontology: Core Commitment concepts abstracted from REA.

In the resulting ontology, the kind of commitment relating to an economic transaction as generally understood is re-labeled as 'Executable Commitment' and is also a kind of Evaluatable Commitment.

It could be considered that many of the kinds of economic exchange that we think of as contracts, such as for example a loan contract, can just as easily be considered to be a transaction in a very broad sense; and almost any commitment can, in principle at least, be evaluated in monetary terms, even if in practice this is not always the case.

3 Isolating the Semantic Primitives

Extending the basic REA notions of commitment, along with economic resource and economic event, to cover all contracts, or more properly, all agreements (whether legally enforceable as contracts or not), gives rise to a set of semantically primitive terms which, if these have been abstracted adequately, can be used to describe a range of possible economic scenarios, including potentially those that have not yet been invented. This has potential for new technology, such as distributed ledger technology and micro-finance applications.

In the activities described in this paper, the focus was on the use of commitment primitives in a range of different economic activities.

3.1 Contract Primitives

The basis for this work is described in the VMBO 2020 paper on equity and debt semantics [7]. As described in that paper, the REA ontology provides the building blocks

for a transaction between two or more parties in which some bundle of commitments is exchanged by each party with the other. Any transaction can be considered as an exchange of two or more sets of Commitments. While a contract must involve some 'consideration', not every commitment in a contract need be capable of being defined in economic terms. These may include commitments to do or to refrain from doing some thing.

3.2 Commitment and Activity

A taxonomic hierarchy of kinds of commitment can be considered. As with any generalization-based taxonomy, the sub-classes of the most general class (commitment) are distinguished according to some defined differentiating features.

If we consider every commitment as being some 'commitment to act' (where acting includes refraining from acting) then a taxonomy of kinds of commitment would correspond to a taxonomy of kinds of act. The acts, like verbs in natural language, may be acts that have two parties (known in linguistics as 'agent' and 'patient'), acts that only have an agent but no patient, acts that result in the production of something, and so on. For example the act of delivering some good would be the kind of act both that has a patient (the beneficiary) and that is productive of some good. Note here that already more than one classification facet of 'act' is in play.

For each distinct kind of act, there can be a corresponding kind of commitment which is a commitment to that act. The contract then consists of two parties exchanging bundles of such commitments with one another. In the original simple case of a binary transaction for goods, these are a commitment to deliver the goods, and a commitment to deliver money in settlement for those goods.

The ambition of this work is that the widest possible range of economic scenarios can be covered. Just as we have shown in previous work [5] that complex financial instrument transactions can be represented as transactions in which one or both of the 'sides' may involve a complex process workflow (where a process workflow is framed as a kind of REA Event), so we hope also to be able to abstract the remaining features of the REA ontology to cover different kinds of delivery (goods and services) and different ways in which economic exchanges come into being.

In developing this thinking at the Semantic Shed we also made extensive reference to Porello et al (2020) [8]. In particular, this paper recognizes the relationship of Event (of which Act is a kind, having an Actor), in relation to Commitment. We retain both concepts and the relationship between them whereby any commitment is a commitment to some act. This paper also defines 'conditional commitment' in a very similar way to where we were headed and in more detail. We did not consider the motivations that might give rise to the existence of some contract and did not want to limit the work to contracts that are struck via a typical contract negotiation relationship.

3.3 Conditional Commitments

In order to understand the notion of a 'conditional commitment' we first looked at the nature of a financial options contract. In an option instrument, one party is committed to buying or selling something from or to the other, at some predetermined date or date

window, for an agreed price (the strike price). If the conditions are not favorable to the option counterparty (the buyer of the option) they have no obligation to take up that offer. If they are favorable, they have the right to do so, and invariably will (but are not coerced into doing so). This distinguishes an option from a future contract where both sides are equally committed to the future transaction under terms agreed in the present.

On the face of it, one side makes a commitment just as they would in any other transaction, the difference being that the other side does not.

An alternative way to frame this was to consider the nature of a commitment, to which one is committed but which is not necessarily going to happen, as a 'conditional commitment'. If this is considered as a sibling of the regular kind of commitment (to an event that will happen, i.e. an act that the obligor is obliged to carry out), such that a conditional commitment may become an actual commitment, then it becomes possible to model the world as it is before a contract (including a transaction agreement) comes into being.

For example in retail, the act of displaying goods with marked prices constitutes an 'invitation to treat' under most jurisdictions. That is, the potential seller is already committed to a transaction in which the sale takes place, provided only that some, as yet unknown, buyer advances to them some consideration that matches the condition under which the seller is obligated to execute against that commitment.

This retail invitation to treat is also a lot like a tender offer. We can explore novel economic models, such as the on-line offering of kinds of product or service. Someone with a set of requirements, if they are able to formally define those requirements, can look for a match in a marketplace of entities offering products or services that match those requirements. Further, if those requirements can be standardized (via a common data model or better, by a common ontology) then new economic models can be explored that break out from the well-known existing scenarios or retail sales, tender requests, auctions or contract negotiations.

Similarly, events during the negotiation of a contract can be framed in terms of more nuanced conditional commitments: I will commit to this if you would commit to that or that in return. That is, a gambit.

So far, it appears that by defining 'conditional commitment' separately from commitment, and by making this any kind of commitment at all (covering delivery of goods, services or intellectual property, that is any kind of REA Economic Resource), it should be possible to model a range of current and future economic scenarios.

3.4   Services

Considering services, a common approach has been to define these ontologically in terms of some activity. Alter [9] sets out a 'Work System Method' in which both products and services, as outcomes, are tied to business process in the work system. In the Nordic School view developed by Grönroos [10], "A service is a process that consists of activities that are more or less tangible. The activities are usually but not necessarily always taking place in the interaction between a customer and service personnel, and/or physical resources or products and/or the system of the service provider. The service is a solution to a customer's problem."

More recently this approach is taken in discussions in the Industrial Ontology Foundation (IOF) [11].

As with the commitment to deliver goods or payments, services are definable in terms of some commitment to act. If commitments are classified in terms of the kinds of act that they represent, it should be possible to categorize kinds of service in terms of the different ways that the relevant activities are conceptualized.

One way to conceptualize services is to consider the ways in which service providers charge for their services. Some may charge for time and materials, while others may charge a fixed price for some desired end point. For example one provider may charge for the time it takes to cut your lawn and trim some trees, while another may describe what your garden will be like when they are done, and come to an agreement in which the end state of your garden is formally specified. In both cases the activities that make up the service may be the same but the billing is different.

In terms of the economic exchange, we should not care what the delivering entity does internally – this is not part of the relationship between the supplier and the consumer. In a conceptualist ontology framework, the billing arrangement is the conceptualization of the service, and the conceptualization is what goes in the ontology. As with other knotty ontological problems, what matters in business is not the fundamental nature of things (which in any case cannot be known), but rather the way it is conceptualized in management thinking, in organizational data, in reports and, as in this case in billing and subsequent accounting. Similarly, how you source things from your upstream suppliers is a matter of how those are conceptualized at the point of sale.

A third kind of service conceptualization is the kind exemplified by a telephone dial tone. This is service as the availability of some facility. Typically this kind of service is billed for a fixed period of time, and generally involves a service level agreement (SLA) since very few kinds of facility may be available 24x7 throughout the defined period.

3.5   Delivery

In considering the nature of delivery in an REA transaction, we need to consider the nature of ownership. This is explored more generally in [7] for the purposes of equity definition, but is more general: ownership is made up of a defined set of rights. Meanwhile some kinds of economic resource are defined simply as intellectual property, also a kind of right.

Unpacking these, we can think of the typical transaction as involving two kinds of delivery: the delivery of the thing, and the delivery of the ownership rights to that thing. By treating these as separable, we can define delivery of online IP (as rights without things) and of the rental of a thing (as things without ownership rights). A more complete breakdown of what makes up a delivery is explored in Hruby and Scheller [12].

Based on this work, delivery (the discharging of some commitment) may be specified in terms of things (possession), rights (of which ownership embodies several kinds) and availability, the latter relating to a specific kind of service in which some state of the world is made available. This latter may also include insurance, where the insurance policy is framed in terms of 'making whole' the policy holder.

4   A Combined Ontology and Application Architecture

If we define an ontology based on the above observations, this may consist of three basic sets of semantically primitive building blocks: offerings (or affordances) i.e. pre-sale conditional commitments; agreements or contracts (including those that embody more typical transactions) and the delivery end of transactions in which the commitments that start their life (REA Event) when the contract is formally entered into, each come to an end by being discharged, as the delivery of some pre-defined combination of possession, title and availability.

The terms for the supply chain by which goods are delivered may also be defined in these terms, being a set of transactions in which the 'seller' is the logistics operator (truck, shipping etc.), the delivery is formally specified in terms of possession only, with detailed possession specification terms (Free on Board, Cost, Insurance and Freight etc.) such that possession but not ownership make up the delivery terms.

Finally, anything that can be specified can be committed to and any delivery that can be matched to some specification, can be deemed to have been adequately delivered and the commitment discharged.

Each such commitment can be registered on a distributed ledger for the purposes of unambiguously and non-repudiably defining what was offered, what was agreed to and what was delivered.

A modular ontology based on these three sets of concepts (offering, contract and delivery) can also be used to specify and design smart contracts across the business space of economic exchanges, for goods, services and available facilities, including IP and other kinds of rights.

5   Conclusions

We elevated the abstractions that make up the REA ontology, to cover not only transactions but any kinds of commitment and the agreements that make use of these. By introducing the notion of a 'conditional commitment' we are additionally able to define a full range of scenarios in which agreements may be entered into, opening up the possibility of modeling novel and future economic scenarios including those that make use of distributed ledger technology. Segregating the nature of the discharging of a commitment (e.g. delivery) in terms of possession of things, rights (including those rights that define ownership) and availability, it is possible to model a whole range of scenarios in the value chain, including supply chains and service provision.

This appears to validate the assumption that in defining the semantics of economic activities in the most semantically primitive or abstract terms possible, it is possible to use these abstractions as a sort of domain-independent 'domain specific language' – a seeming contradiction in terms but really describing the ability to use the design techniques used in more typical DSLs, to create a wide range of mutually consistent and interoperable conceptual ontologies.

Ontologies created from this DSL-like platform may be used in the creation of applications, including smart contract applications for use in distributed ledger

environments, to make use of the immutable nature of distributed ledgers to define commitments entered into and to determine when these may be considered to have been discharged.

Further explorations of this work would provide a detailed set of models for supply chains and assist in supply chain integration. These may also open up possibilities for improved trade finance, in terms of letters of credit and similar arrangements. In addition, the nature of insurance (including for supply chain logistics activities) should be describable using the same set of primitives. This is a future direction to explore further in this work.

Another future direction to explore is in creating ontological definitions of the process or workflow that makes up an REA 'Event', such that these may be linked to program behaviors as well as to measurements or readings in Internet of Things (IoT) devices such as RFID readers.

References

1. FIBO Foundations specification, http://www.omg.org/spec/EDMC-FIBO/FND/Current. Last accessed 18 Feb 2021
2. The Semantic Shed, www.semanticshed.org. Last accessed 18 Feb 2021
3. Securities and related financial instruments — Classification of financial instruments (CFI) code, https://www.iso.org/standard/73564.html. Last accessed 18 Feb 2021
4. ISO/IEC: Information technology — Business Operational View — Part 4: Business transaction scenarios — Accounting and economic ontology. ISO/IEC 15944-4:2007 (2007)
5. Bennett, M.: Adopting and Extending REA Terms in the Financial Industry Business Ontology: A Case Study. VMBO (2014)
6. Bennett, M., Gillmore, M., Nehmer, R.: Claims Debt and Equity in REA with FIBO Extensions. The Semantic Shed (2018). http://www.semantic-shed.org/docs/ClaimsDebtAndEquityInREAWithFIBOExtensions.docx. Last accessed 18 Feb 2021
7. Bennett, M., Expressing Contracts and Equity using REA Semantics. VMBO (2020)
8. Porello, P., Guizzardi, G., Sales, T. P., Amaral, G.: A Core Ontology for Economic Exchanges. In: Dobbie G., Frank U., Kappel G., Liddle S.W., Mayr H.C. (eds) Conceptual Modeling. ER 2020. Lecture Notes in Computer Science, vol 12400. Springer, Cham. (2020). https://doi.org/10.1007/978-3-030-62522-1_27
9. Alter, S.: The work system method for understanding information systems and information system research. Communications of the Association for Information Systems 2002;9:90-104 (2002)
10. Grönroos, C.: Service Management and Marketing: A Customer Relationship Approach. Chichester: John Wiley (2000)
11. Industrial Ontology Foundation Product Service System Working Group minutes, https://docs.google.com/document/d/1THJTl0p2pIdzlanApSQJdga3dDL-qx4RRlf8X_uErhY. Last accessed 18 Feb 2021
12. Hruby, P., Scheller, C. V.: Augmenting Value Stream Mapping by Possession, Ownership and Availability. In: Proceedings of 14th International Workshop on Value Modelling and Business Ontologies, vol 2574. (2020)