Tokenization of Independent-View REA Components on the Blockchain

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"To be is to be the value of quantified variable." This is a famous quote of the philosopher Willard Van Orman Quine (1992) as reiterated and explained by John Sowa (2000, 52), a criterion to be used for admission of an ontological category into a representation scheme. In earlier work, Quine (1969, 23) had expressed this notion as "no entity without identity." In both philosophical cases, the import of the ideas is similar: It is difficult to represent and discuss a concept without providing a name for identifying the different individual instances of that concept.[1] As seen in Figure 1, this problem of able to name instances arises in a variety of knowledge representation fields, and the process of finding these names has come to be called "tokenization" in the blockchain environment.

For the REA ontology at MOF Level-2, "no entity without identity" means that a candidate class for a particular model (at MOF Level-1) must have an identifying attribute that can stand for the instances of that class at MOF Level-0. This means that all classes must be tokenized with attribute instances that are unique (every instance's value for that attribute is different from all other instance values). The requirement for an identifier is thus a representation constraint on an REA implementation.

In the normal ***trading partner*** view of REA (McCarthy 1982), this constraint is overcome with institutionalized naming schemes. For example:

- Economic **R**esources like inventory or cash are given unique tags, like product – number or account-number wholly under the control of the trading partner;
- Economic **E**vents are identified often with either document-numbers (like invoice# or advance-shipping-number) or with locally-unique timestamps; and

[1] Some of this text has been adopted directly from a work in progress by McCarthy, Geerts, and Gal (2017)

- Economic **A**gents are identified with controlled enumeration schemes (like employee#, customer#, vendor#).

Since traditional systems base their structures on discreet operations within a single enterprise, this can cause certain difficulties when firms attempted to integrate information systems across different trading communities and supply chains with an REA independent view (ISO 15944-4, 2007; 2015). Some conceptual adjustments will be required as the world starts to adapt to open-value networks and to REA implementations on the blockchain. As illustrated in Figure 3, *sales* and *purchases* are concepts that are not particularly useful in collaboration space as a sale to one enterprise is a purchase to another. As systems take on a more independent view, exchange terms (like *shipment* and *payment*) must replace the terms used within a trading partner. The REA model, which allowed for loosely coupled systems within one enterprise, must be expanded to an ontological structure that allows for sharing data across entire communities of systems (McCarthy, Geerts, & Gal, 2017).

The purpose of this presentation at VMBO is to explore in an interactive dialogue the possible sources for these new independent identifiers, including such ideas as crypto-identifiers for **a**gents, universal timestamps for **e**vents, and worldwide classification schemes for **r**esources. This new switch to universal and independent identifiers will allow REA to move closer to its stated goal of moving to the top of the accounting system interoperability spectrum (see Figure 6).

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Knowledge domain	Database theory	AI - artificial intelligence	Object oriented design	Mathematics	Semantic Web	Meta Object Facility (MOF)
a set of occurrences	Entity set	Type	Class	Intension	Universal	MOF M1
a single occurrence	Entity	Token	Object	Extension	Particular	MOF M0

Figure 1 -- Differentiating groups and instances in knowledge representation fields

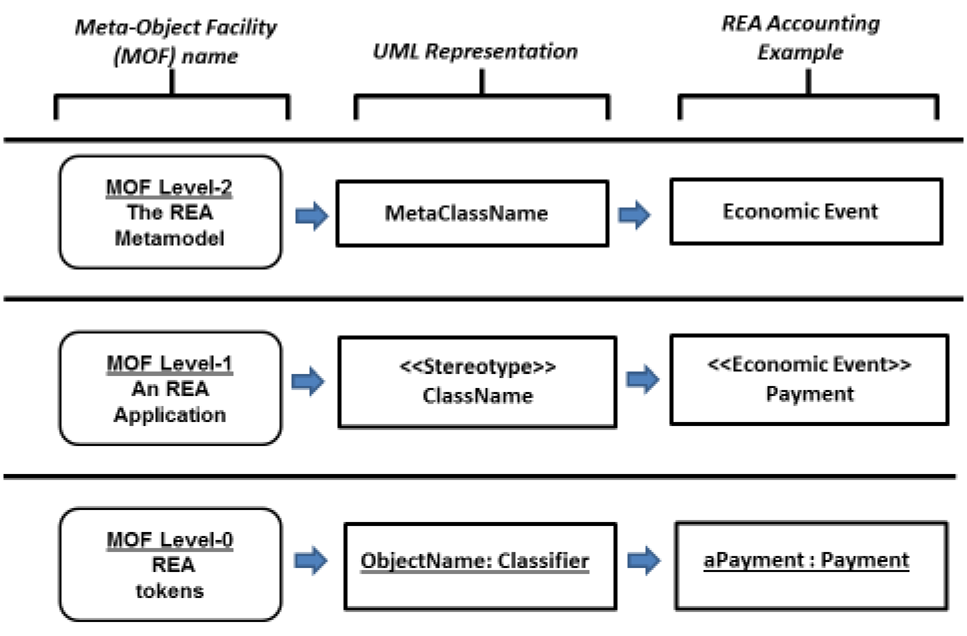
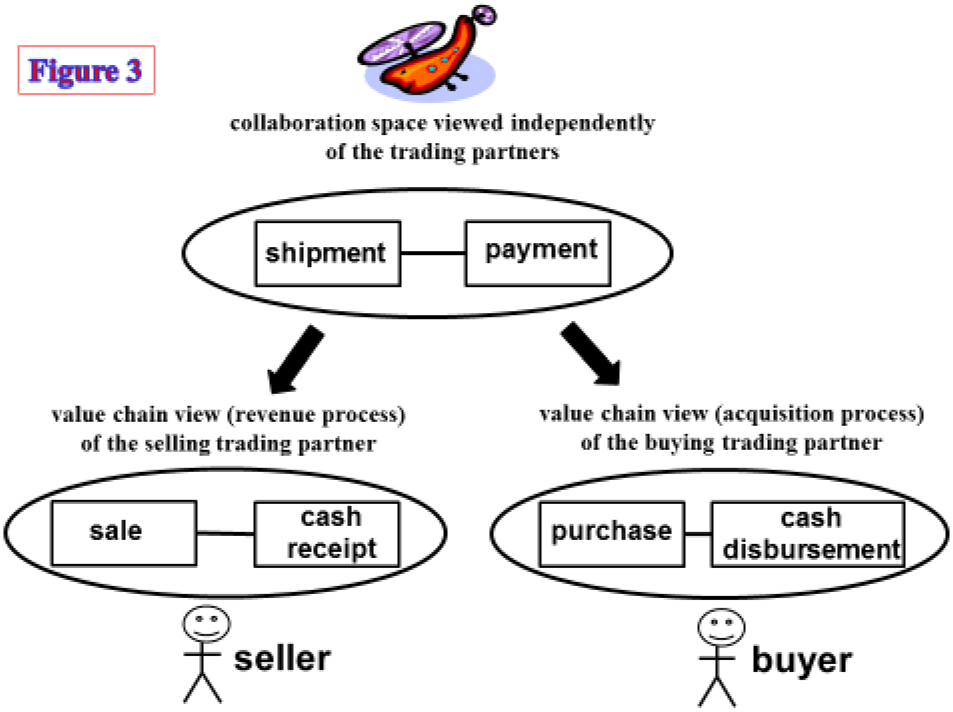
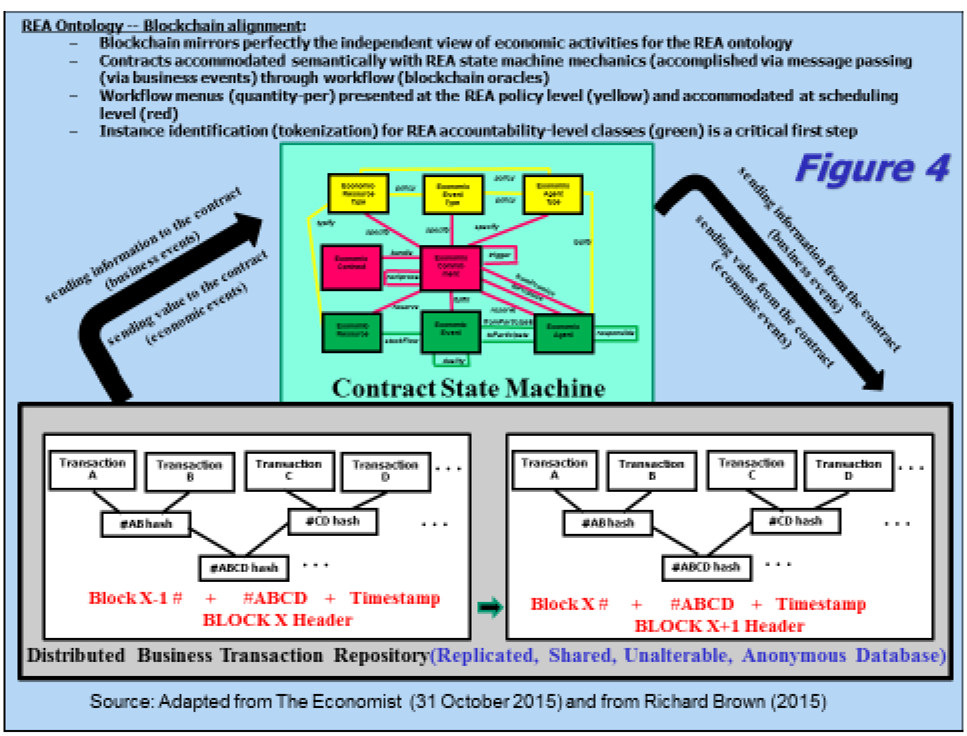


Figure 2 – REA Use in the Meta-Object Facility (MOF)

Figure 3


collaboration space viewed independently
of the trading partners
shipment
payment
value chain view (revenue process)
of the selling trading partner
value chain view (acquisition process)
of the buying trading partner
sale
cash receipt
purchase
cash disbursement
seller
buyer


REA Ontology -- Blockchain alignment:
– Blockchain mirrors perfectly the independent view of economic activities for the REA ontology
– Contracts accommodated semantically with REA state machine mechanics (accomplished via message passing (via business events) through workflow (blockchain oracles)
– Workflow menus (quantity-per) presented at the REA policy level (yellow) and accommodated at scheduling level (red)
– Instance identification (tokenization) for REA accountability-level classes (green) is a critical first step
Figure 4
sending information to the contract
(business events)
sending value to the contract
(economic events)
sending information from the contract
(business events)
sending value from the contract
(economic events)
Contract State Machine
Transaction A
Transaction B
Transaction C
Transaction D
#AB hash
#CD hash
#ABCD hash
Block X-1 # + #ABCD + Timestamp
BLOCK X Header
Block X # + #ABCD + Timestamp
BLOCK X+1 Header
Distributed Business Transaction Repository (Replicated, Shared, Unalterable, Anonymous Database)
Source: Adapted from The Economist (31 October 2015) and from Richard Brown (2015)

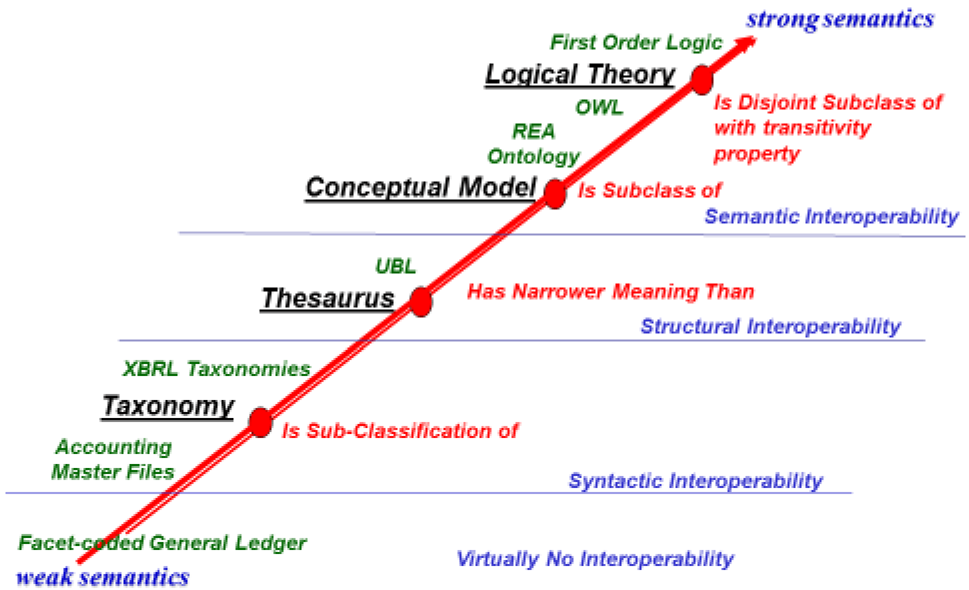


Figure 5 -- Accounting Interoperability Spectrum

(adapted by authors to accounting from original ideas of Leo Obrst)