Blockchain Enterprise Ontologies: TOVE and DEMO

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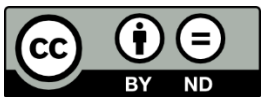

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Enterprise ontology for blockchain transactions includes datalogical, infological and essential levels. OntoClean (Guarino 1998) developed by Nicola Guarino and Chris Welty (Guarino and Welty 2000) analyzes ontologies based on formal, domain-independent properties (metaproperties), being the first attempt to formalize the notion of ontological analysis for computer systems. The notions are extracted from the philosophical ontology. In the semantic web, a property is a binary relationship, with a subtle distinction between ownership and class. Thus, a metaproperty is a property of a property or a class.

Identity for the ontologies of computer systems includes conceptual modeling of the database, especially those that expose the existence or at least the need to represent other entities. In OntoClean, identity criteria are associated with, or carried by a class whose instances are identified in the same way, called *sortal*. Identification criteria and sortals are intuitively designed to respond to the linguistic way of associating identity with certain classes.

The design of ontology can be done when there is a basic understanding of the blockchain analysis. Blockchain comes in three forms: public, private or hybrid. (Buterin 2015) Blockchain ontology should also refer to the operations and business processes of potential adopters. Enterprise ontology provides a collection of relevant terms and definitions of natural language. Examples of frameworks for enterprise ontology are TOVE, EO and DEMO. (Kruijff and Weigand 2017)

TOVE, the acronym of the *TOronto Virtual Enterprise* project, is a project for an ontological framework for enterprise integration based and tailored for enterprise modeling. (Totland 1997) The initial objectives of the project were: (Fox 1992)

Creating a distributed representation or an ontology of the enterprise that every agent in the distributed enterprise can understand and use

- Defining the meaning of all descriptions or semantics
- Implementing semantics into a set of axioms that will allow TOVE to automatically answer to many "common sense" questions about the enterprise, and
- Defining a symbol system to represent a concept in a graphical context.

The project develops a set of integrated ontologies for modeling enterprises. Ted Williams states that it is "multi-level, spanning conceptual, generic and applications layers. The generic and

applications layers all also stratified and composed of micro theories spanning, for example, activities, time, resources, constraints, etc.” (Williams 2000)

Fox et al. presented TOVE enterprise models as a second-generation knowledge engineering approach. An approach to first generation knowledge engineering "is extracting rules from experts, while second generation is ontology engineering: They develop comprehensive ontologies for all the aspects of an organization they find necessary (necessity is decided based on competency requirements to the model, i.e., what are the questions the model will have to answer, either by ordinary look-up or by deduction). The background of TOVE is clearly knowledge engineering and to some degree Computer Integrated Manufacturing." (Fox 1992)

A business modeling methodology for transactions and the analysis and representation of business processes that provide a coherent understanding of communication, information, action and organization was developed in the 1980s by Jan Dietz and is inspired by the perspective language/action introduced in the field of computer science and computer systems design by Fernando Flores and Terry Winograd in the 1980s: (Flores et al. 1988) Design and Engineering Methodology for Organizations (DEMO). (J. L. G. Dietz 2001)

DEMO is based on explicitly specified principles characterized by a rigid modeling methodology (Van Nuffel, Mulder, and Van Kervel 2009) and focuses on building and operating a system rather than on functional behavior. It underlines the importance of choosing the most effective level of abstraction to establish a separation of problems. (Nian and Chuen 2015) DEMO has proven to be a useful methodology to formalize systems that are ambiguous, inconsistent or incomplete, especially when it comes to reducing the complexity of modeling (Wang, Albani, and Barjis 2011) enterprise ontology. (Kruijff and Weigand 2017)

The methodology provides a coherent understanding of communication, information, action and organization, and is based on the following principles: (J. Dietz 1996)

- An organization consists of people with authority and responsibility to act and negotiate.
- Information systems and business processes design leads to uniformity.
- The models should be understandable for everyone interested.
- Information needs to match their users.

This concept has proven to be a new paradigm for the design of information systems, highlighting what people do while communicating, reality through language, and how communication brings a coordination of their activities. (Dignum and Dietz 1997)

DEMO is related to the Natural Language Information Analysis Method (NIAM) developed by Shir Nijssen (Aaldijk and Vermeulen 2001) and Object Role Modeling (ORM) (J. L. G. Dietz and Halpin 2004).

The ontological model of an enterprise in DEMO consists of an integrated set of four layout models, each with a specific vision of the enterprise:

- Construction Model (CM): composition, environment, interaction structure and interstriction structure
- Process Model (PM): the state space and the transition space of its coordinating world
- Action Model (AM): a set of action rules; and
- Factual Model (FM): the state space and the transition space of its production world

An important development in the history of databases was the separation of implementation options from the conceptual model of the database (principle of data independence). A similar separation is very necessary for the blockchain domain. An axiom of distinction of enterprise ontology can be adopted as an ontological basis for this separation. (Kruijff and Weigand 2017)

Enterprise ontology distinguishes three basic human abilities: performa (bringing new things through communication), informa (content aspects of communication and information) and forma (aspects of the form of communication and information). (J. L. G. Dietz 2006)

Following the three abilities, we distinguish three ontological layers: (Kruijff and Weigand 2017) datalogical (describes blockchain transactions at the technical level in terms of blocks and code), an infological abstraction (to describe blockchain transactions as the effect of an open (immutable) register system), and essential (to describe the economic significance of infological transactions). The datalogical level is the level of data structures and data manipulation, using taxonomies identified in the cryptocurrency, (Glaser and Bezzenberger 2015) blockchain research (Christidis and Devetsikiotis 2016) and blockchain technologies and cloud providers. (Gray 2016)

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