Transforming Enterprise Ontologies into SBVR formalizations

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Abstract In 2007 the Object Management Group (OMG) adopted the Semantics of Business Vocabulary and Business Rules (SBVR) specification. The languages specified by this specification must be used to create business vocabularies and business rules of all kinds of business activities of all kinds of organizations. This paper describes and demonstrates how enterprise ontologies can be transformed into SBVR formalizations.
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1 Introduction

Recently more and more attention goes to domain ontologies which describe the concepts, relations and axioms for a specific domain instead of core (high-level, domain independent) ontologies which provide definitions for general-purpose terms. Well-known examples of domain ontologies are the Gene ontology and the Foundational Model of Anatomy. In this paper we focus on ontologies that have as domain of interest enterprises. Depending on by who the enterprise ontology is shared these kind ontologies can be interpreted in different ways. Enterprise ontologies (EO) describe the concepts, relations and axioms that are shared by different enterprises. These types of ontologies are in most cases developed in the context of conceptual modeling where they can be used as theoretical basis for an enterprise modeling language or can be directly used as a reference model (for an overview see [1]). A domain-specific enterprise ontology (DSEO) describes the concepts, relations and axioms that are shared by the people working in a specific enterprise. Recently different companies are investigating how general ontology engineering tools like for instance Protégé [1] or enterprise domain specific ontology tools like Collibra's Business Semantics Glossary[2] can ne used to create a shared repository of concepts, relations between concepts and axioms. For these enterprises the DSEO (or sometimes called business vocabulary) is considered as a knowledge management tool which helps them to capture the definition of the important enterprise concepts, their relations and axioms [2].

[1] http://protege.stanford.edu/
[2] http://www.collibra.com

It is clear that their exists a relationship between core ontologies, EO's and DSEO's [3]. The concepts of a core ontology are used to define the concepts of the EO, which in turn serves as a bridge between the core ontology and a DSEO. The operationalization of these relations depends on the context in which the ontologies are used. In ontology research the concepts of DSEO are defined as specializations of the concepts of EO which in turn are specialization of the concepts of the domain-independent ontology [4]. In conceptual modeling research the concepts of the domain independent ontology and the EO will be operationalized as meta concepts of a meta-model which in turn are instantiated by the enterprise-specific concepts of the DSEO which corresponds to an enterprise model. Both approaches are valid and the actual choice depends on the application in which these ontologies will be used.

In this paper we propose a third approach which uses the Semantics of Business Vocabulary and Business Rules (SBVR) [5] for representing the core, enterprise, and domain-specific enterprise ontologies and their relations. SBVR is not considered as better than using OWL or UML but as alternative, which has some benefits for specific applications. First in this research project we plan to use the DSEO as a business vocabulary and SBVR is put forward by OMG as a standard for representing business vocabularies. Second, SBVR was not only developed for creating vocabularies but also for rule specification which we believe is important in the context of enterprises where more and more people are interested in formal specification of business rules and their implementation in the daily operations of the enterprise. Finally we also believe that SBVR's ability to support high-order level abstraction and its specific focus on business people are important assets compared to other approaches which could make SBVR the standard language for representing both EO en DSEO.

The remaining of this paper is organized as follows. The next section provides some background about SBVR and compares it with languages that are currently used for formalizing ontologies. Section three demonstrates how SBVR can be used for the specification of an existing core ontology (i.e. the Unified Foundational Ontology), an existing enterprise ontology (i.e. the REA ontology), a DSEO for a car rental company and the relationships between the different ontologies. This section also discusses the benefits of using SBVR. Finally the paper ends with a conclusion and some future research directions.

2 Background

SBVR is a standard developed and adopted by the Object Management Group (OMG) in December 2007. The OMG specification defines the scope of the SBVR as follows: "this specification is applicable to the domain of business vocabularies and business rules of all kinds of business activities of all kinds of organizations. It is conceptualized optimally for business people rather than automated rules processing, and is designed to be used for business purposes, independent of information systems designs" [5]. SBVR is based on fact-oriented modeling languages like for instance Object Role Modeling (ORM) [6]. Fact-oriented languages are considered as an alternative for entity-relationship modeling or object-oriented modeling languages. The main characteristic of fact-oriented modeling languages is that it views the world as objects playing roles instead of viewing the word in terms of entities that have attributes and participate in relationships or viewing the word in terms of objects that encapsulate both data and behavior.

Linehan [7] stipulates that SBVR must be considered as language for specifying ontologies because it develops models that pass the 6 ontology criteria proposed by Atkinson [8]:

- an SBVR model describes domains in terms of concepts, properties of those concepts, constraints on those properties, and individuals
- An SBVR model corresponds to an explicit specification
- The SBVR model is machine readable
- SBVR is based on first order logic
- SBVR models are shared, accepted by a group
- SBVR models are intended to have an universal scope

Although SBVR seems an obvious choice for specifying ontologies, the use of SBVR has been limited. Both in practice and in research enterprise ontologies are either specified using a modeling language like ER or UML class diagram or using ontology languages like OWL. The fact-oriented background and some of the made design decisions are the main reason why we believe SBVR is an important alternative for specifying enterprise ontologies:

- Fact-oriented languages are closer to natural languages which make the models easier to verbalize and consequently easier to understand by business people. In SBVR this benefit is further exploited by incorporating Structured English as one of a possible formalization languages. This means that all vocabularies and rules can be represented using a small number of English structures and common words. In the context of this paper this means that both the EO and the DSEO ontology can be represented in a form that can be understood by business people and which can be transformed into a more formal specification that can be interpreted by computers. This characteristic is clearly a benefit compared to knowledge representation languages that are in most cases only understandable for people with some background in logics.
- SBVR is well suited for modeling constraints and rules. For instance compared to ER or UML class diagrams, ORM and consequently SBVR does not need an additional language for specifying more complex business rules [6]. This benefit has been further extended by the SBVR specification which contains the possibility to add rules (i.e. advice) that do not completely remove the degree of freedom. We believe that this mechanism can be useful for both EO and DSEO because it allows formally specifying business rules.
- Selecting SBVR instead of UML or OWL also depends on the kind of application the ontology will be used in. Like mentioned in the introduction a lot of enterprise ontology engineers use UML or ER for specifying their ontology as a kind of metamodel. Put differently a domain specific modeling language is developed that is based on the ontology. Consequently the ontology is tailed to a specific applica-

tion, namely enterprise modeling. Ontology representation languages are also developed to be used in a specific context. For instance OWL is developed in the context of the semantic web which means that it must support some specific functionalities which force the ontology engineer to take some specific design decisions. An SBVR specification captures the business vocabulary and business rules of all kinds of business activities of all kinds of organizations. It is designed to be used for business purposes, independent of information systems designs.

3 SBVR formalization of enterprise ontologies

The next four subsections will respectively demonstrate how SBVR can be used for the specification of an existing core ontology (i.e. the Unified Foundational Ontology), an existing enterprise ontology (i.e. the REA ontology), a DSEO for a car rental company and the relationships between the different ontologies.

3.1 SBVR formalization UFO

The Unified Foundational Ontology is a core ontology that has been developed by Guizzardi and is based on a number of theories from Formal Ontology, Philosophy of Language, Linguistics and Cognitive Psychology [9]. It is composed of three parts: UFO-A is an ontology of endurants, UFO-B is an ontology of events and UFO-C is an ontology of social entities. In the context of enterprise ontologies all three parts are relevant. Listing 1 represents a fragment of SBVR specification of the UFO ontology.

Listing 1: SBVR specification UFO ontology

```
Kind
  Definition:     A Substantial universal which can be
                  uniquely identified and which contains
                  properties that are essential to all its
                  individuals.
  Concept Type:   object type
  Source:         UFO-A
Role
  Definition:     A Substantial Universal which can be
                  uniquely identified and which contains
                  properties that are never essential to
                  all its individuals.
  Concept Type:   object type
  Source:         UFO-A
Event
  Definition:     A Universal composed of temporal parts
  Concept Type:   object type
  Source:         UFO-B
Agent
```

```
  Definition:     A Substantial Universal that creates
                  actions, perceives events and to which
                  we can ascribe an intentional moment
  Concept Type:   object type
  Source:         UFO-C
Object
  Definition:     A Substantial Universal unable to per-
                  ceive events or to have intentional mo-
                  ments
  Concept Type:   object type
  Source:         UFO-C
```

3.2 SBVR specification REA ontology

The last 20 years different EO ontologies have been developed and formalized in different ways. In most cases EO have been formalized using a conceptual modeling language. For instance both the REA ontology and the E3-value ontology have been formalized using UML class diagrams. Transforming a UML class diagram into SBVR is not straightforward but is described in detail by [10] who have automated the transformation from UML class diagrams to SVBR a using a model transformation language.

Listing 2 represents a fragment of the SBVR specification of the REA ontology which was developed using the UML class diagram included in [1] as starting point. Most of the transformations from UML to SBVR are straightforward: classes are transformed in object types and relations in fact types. Listing 2 also demonstrates the simple incorporation of the EO axioms in the SBVR specification.

Listing 2: SBVR specification of REA ontology

```
economic resource
  Definition:     An economic resource possesses economic
                  value and is under the control of a nat-
                  ural or legal person.
  Concept Type:   object type
economic event
  Definition:     A change in the value of an economic
                  resource
  Concept Type:   object type
economic agent
  Definition:     An individual or organization capable of
                  having control over economic resources,
                  and transferring or receiving the con-
                  trol to or from other individuals or
                  organizations.
  Concept Type:   object type
economic event affects economic resource
```

```
  Concept Type:   fact Type
  Necessity:      Each economic event must affect at least
                  one economic resource
  Necessity:      Each economic resource must be affected
                  by at least one increment economic event
                  and at least one decrement economic
                  event
inside economic agent and outside economic agent partici-
pate in economic event
  Concept Type:   fact type
  Necessity:      Each economic event must be participated
                  by at least one inside economic agent
                  and at least one outside economic agent
increment economic event has a dual decrement economic
event
  Concept Type:   fact type
  Necessity:      Each increment economic event must have
                  at least one dual decrement economic
                  event
  Necessity:      Each decrement economic event must have
                  at least one dual increment economic
                  event
```

3.3 SBVR specification of Car Rental Vocabulary

The DSEO that is used in this demonstration is not developed by us but is a fragment of the EU-Rent vocabulary that is used as an example in the SBVR specification.

Listing 3: Fragment SBVR EU-Rent ontology

```
rented car
  Definition:     rental car that is assigned to a Rental
  Concept Type:   Object type
rental charge commitment:
  Definition:     commitment by a renter specifying that
                  an estimated amount will be charged.
  Concept Type:   Object type
rental car movement commitment
  Definition:     commitment with a renter specifying use
                  of some car of a car group for a rental
                  period and a car movement
  Concept Type:   Object type
renter
  Definition:     driver contractually responsible for a
                  rental
```

```
  Concept Type:   Object type
renter is responsible for rental
  Concept Type:   Fact Type
rental car is assigned to rental
  Concept Type:   Fact Type
```

3.4 SBVR specification of ontology relations

In SBVR the relation between the concepts of the core ontology, the EO and the DSEO concepts can be incorporated by means of high-order types which can be used to define concept types whose instances are also types. Higher-order types are included in SBVR by adding a special kind of fact type which is called "categorization fact type" and which allows to create categorization concept types. In order to remain some of the useful properties of first-order logic (e.g. completeness) SBVR adopts the Henkin semantics which means that the domain of the categorization types must be set. For instance if we want to indicate in the DSEO ontology that carpart and car are both economic resources which is a concept that is defined in the EO, two steps need to be performed. On the one hand carpart and car will be defined as a specialization of economic resource. On the other hand carpart and car will be also defined as instances of the economic resource categorization, which is defined using the categorization fact type. This approach is represented in listing 4 for the relation between UFO Kinds and the REA Economic Resource ontology, and in Listing 5 for the relation between the REA Economic Resource and EU-rent Car and CarPart concepts and the EU Car Rent ontology.

Listing 4: Relation UFO and REA

```
kind is categorized by kind category
  Concept Type:   categorization fact type
  Necessity:      Each kind is categorized by exactly one
                  kind category
kind category
  Definition:     Concept that specializes the concept
                  kind
  Concept Type:   categorization type
Economic Resource
  Concept Type:   kind category
```

Listing 5: Relation REA and EU-rent

```
economic resource is categorized by economic resource
category
  Concept Type:   categorization fact type
  Necessity:      Each economic resource is categorized by
                  exactly one economic resource category
economic resource category
```

```
  Definition:     Concept that specializes the concept
                  economic resource
  Concept Type:   categorization type
Car
  Concept Type:   economic resource category
```

4 Conclusion

The main contribution of this paper is demonstrating the use of SBVR for formalizing a core ontology, an Enterprise Ontology, a enterprise-specific ontology and their relations. Different future research directions are important. In this paper the approach was only demonstrated using a laboratory case but in the near future we will use the same approach for the development of enterprise ontology for a specific company. The provided feedback will used to further improve the method. The use of a realistic business case must also further demonstrate the flexibility of our approach. Finally we also need to demonstrate that the enterprise ontology that is specified using SBVR can be used in real implementations. For instance currently we are investigating how the developed SBVR enterprise ontology can be incorporated in requirements engineering techniques like BPMN and Communication Analysis.

References

1. Gailly, F., Poels, G.: Ontology-driven Business Modelling: Improving the Conceptual Representation of the REA-ontology. In: Parent, C., Schewe, K.-Di., Storey, V.C., and Thalheim, B. (eds.) Conceptual Modeling 2007. pp. 407–422. Springer, Auckland, New Zealand (2007).
2. Bera, P., Burton-Jones, A., Wand, Y.: GUIDELINES FOR DESIGNING VISUAL ONTOLOGIES TO SUPPORT KNOWLEDGE IDENTIFICATION. Mis Quarterly. 35, 883–908 (2011).
3. Van Heijst, G., Schreiber, G., Wielinga, B.: Using explicit ontologies in KBS development. International Journal of Human-Computer Studies. 46, 183–292 (1997).
4. Guarino, N.: Formal Ontology and Information Systems. International Conference on Formal ontology in Information Systems (FOIS'98). pp. 3–15. IOS Press, Trento, Italy (1998).
5. OMG: Semantics of Business Vocabulary and Business Rules (SBVR), v1.0, (2008).
6. Halpin, T.: Information modeling and relational databases : from conceptual analysis to logical design. Morgan Kaufman Publishers, San Francisco (2001).
7. Linehan, M.H.: Ontologies and Rules in Business Models. EDOC Conference Workshop, 2007. EDOC '07. Eleventh International IEEE. pp. 149–156 (2007).
8. Atkinson, C.: Models versus Ontologies - What's the Difference and where does it Matter? October. 1–16 (2006).
9. Guizzardi, G., Wagner, G.: Using the Unified Foundational Ontology (UFO) as a Foundation for General Conceptual Modeling Languages. In: Poli, R., Seibt, J., Healy, M., and Kameas, A. (eds.) Theory and Application of Ontologies. Springer, Berlin (2010).
10. Cabot, J., Pau, R., Raventos, R.: From UML/OCL to SBVR specifications: A challenging transformation. Information Systems. 35, 417–440 (2010).