AN UPPER ONTOLOGY FOR ENTERPRISE PROCESS MODELLING

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Abstract: During last decades great expectations have been placed on Enterprise Modelling and Integration through ontologies. However, most of the existing proposals concentrate on an extensive set of enterprise concepts and definitions, making difficult for ontology engineers to distinguish only those of their interest. In this regard, this paper presents an approach towards a standard abstract framework for constructing Enterprise ontologies. The main aim of this approach is constructing an upper-level Ontology incorporating generic enterprise concepts and relations. The proposed ontology aims at becoming a starting point rather than being a predefined solution. Starting with this upper Ontology, business analysts can adapt and enhance in order to model enterprises of any type and sector.

1 INTRODUCTION

Enterprises in order to survive under the new competitive circumstances need to comprise flexible, interoperable structures, which provide coordination among their processes and facilitate the capitalization and reusability of enterprise knowledge.

Ontologies have promoted an innovative and lucrative approach to Enterprise Modelling. Their expressiveness in combination with their clarity and expansiveness, have resolved important problems, not resolved by classic modelling methods. (Gruber, 1991) However, most of the existing ontology-based frameworks concentrate and promote such an extensive set of enterprise concepts and definitions that it may be difficult for ontology engineers to distinguish and exploit only those of their interest. Ontologies can be used to support human or automated reasoning, they are a means of communication among people with diverse backgrounds, they offer a tool for efficient computation, they always offer a medium of human expression and they are easy to augment, extend and refine (Brewster and O'Hara, 2007)

Enterprise knowledge requires systematic modelling and integration in an effective and cohesive way. In this direction, this paper presents an approach, which aims mainly at the construction of an Upper Ontology for process flow modelling incorporating generic enterprise concepts and relations. This ontology does not pretend to provide a predefined solution but rather a starting point which can lead the ontology developer to adapt and enhance it for Process Modelling of any kind of enterprise. As expressed by (Poli, 1996) "An ontology is not a catalogue of the world, a taxonomy, a terminology or a list of objects, things or whatever else. If anything, an ontology is the general framework (i.e. structure) within which catalogues, taxonomies, terminologies may be given suitable organization."

During last decades "Ontologies" have entered the Computer Science Community. Ontologies represent a new technology direction towards the improvement of information systems and management. In particular, this paper focuses on the significant role of ontologies in business modelling, enterprise knowledge and information management.

A standard ontology - based enterprise modelling approach consists of three abstraction layers (INTEROP, 2004):

- The Upper Business Ontology layer comprises the generic meta-modelling concepts,
- The Application Ontology layer implements needed specialization of the upper entities and concepts in the application field, and
- The Lower Business Ontology layer implements specified instances – objects.

Regarding the structure of this paper, Section 2 presents the main work described in this paper,

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analyzes the organization, the design and the refinement of the suggested upper ontology; Finally Section 3 concludes.

2 THE PROPOSED UPPER ENTERPRISE ONTOLOGY

The goal of this section is to present the proposed approach, which pushes previous work in this domain one step further. The classic process modelling methodologies have adopted a workflow-minded approach, especially because of Enterprise Modelling Languages and Tools focus on control flow patterns. Only recently the weaknesses of a merely workflow-centric representation were pointed out by (van der Aalst and Pesic, 2006). Workflow-centric process representations are not very suitable for reaching the underlying knowledge level of business processes. The approach of the Upper Enterprise Ontology has been basically inspired from the Edinburgh Enterprise Ontology and other research projects and initiatives (e.g. Toronto Virtual Enterprise, TOVE Project). Nevertheless, the ontological approaches of these projects have not created models, which can be supported by current (workflow-centric) BPM tools and infrastructure (Hepp and Roman, 2007). The proposed approach aims at integrating a comprehensive conceptual metamodel of an enterprise in the actual executable workflows.

2.1 Organization

A prototype ontology has been initially elaborated, integrating, additionally, the main object-oriented principles (Ecker, Preis and Schneider, 1996):

- Class – defines the abstract characteristics of an entity including the entity's attributes (properties) and things that can or cannot do (methods, features).
- Instance – defines a particular instance of a class with concrete values of the class's characteristics.
- Inheritance – allows the hierarchy of classes. There can be a parent class and a lot of sub-classes to access the properties and features of their parent.
- Association – defines the relations between instances of classes (entities).
- Modularity – is a concept associated with the complexity of a model. Every complex model must be decomposed to simple, independent modules, which all together construct a more complicated.

2.2 Design

Core terms, concepts and their relationships are the most important components of an Enterprise Ontology.

Designing the suggested Upper Enterprise Ontology, six main domains of enterprise concepts have been identified. These meta-concepts can be utterly enhanced and used to incorporate the enterprise information and knowledge:*Actor* – refers to the active parts of enterprise. Actors can not only represent people involved actively in a business operation, but also they can be groups of people, such as internal departments of the organization or even external parties, for example other enterprises, government, institutions etc. In general, it concerns these entities, which interact actively within the enterprise processes in- or externally supplying a stimulus to the enterprise processing whether it is producing an event or performing an activity. Actors should, indeed, be categorized according to their roles, rights and tasks.

Business Object – refers to passive structures and objects of the enterprise, involved in enterprise activities and actions, i.e. resources, inputs, outputs, assistant material etc. They are usually entities that are accessed, used, transformed or generated from enterprise activities, or help, facilitate processes.

Process – refers to all the business operations, actions and activities inside the enterprise or with external parties. Within a process, Actors and Objects are involved. A Process, as a rule, needs someone to activate it, manage it or supervise it, inputs or resources to use but also usually produces outputs. However, there are also activities and processes triggered to start or end by a business event.

Event – represents actions and situations which can trigger, transform or terminate a Process. Events are generated and processed by Actors. Events are actions, which play important role at the beginning, at the end or even during enterprise processing.

Transition – meant to represent occasions in which the process flow tends to convergence or divergence. It is about entities that assist the parallel flow of sub-processes or represent the decision, among more than one process flow.

Connection – refers to the connections between the instances of the other ontology's classes represented in a business process model. It is decided that the object-oriented principle of

"association" should be incorporated to the Ontology as a separate class because of the significant information repository obtained. The main necessary properties of the Connection class are the connected entities and the orientation of the Connection. The Connection in a process flow can mean the correlation between relevant concepts or denote the sequence of a process flow.

The above mentioned entities have been identified as the meta – classes, which are indispensable in a business modelling framework. They have generic characteristics, attributes and features, which need to be moreover specialized so as to suit any type and kind of organization. Some of these attributes are represented below, in Table 1. Apparently, in different enterprise sectors or in different countries etc., to these generic characteristics others should be possibly added or these may be changed and adapted to the current conditions.

Table 1: Upper Classes' Attributes.

Actors
o Capabilities
o Role
o Secondary Authorities
Business Objects
o Type (e.g. In/Output, assistant medium)
Processes
o Goal
o Duration
o Priority
Events
o Goal
o Method
o Frequency

Moreover, the suggested Ontology incorporates conceptual relations - norms in the meaning of conventions and conditions adopted, as mentioned below, offering a set of tools and guidelines in order to use the ontology:

Inheritance – instantiation. The six classes, "Actor", "Business Object", "Process", "Event", "Transition" and "Connection" can be ancestors of new sub-classes, generated from the nature and the type of an enterprise or the complexity of the required business models. These classes but also the sub-classes, which inherit from them, can be instantiated in the same or different business models.

Association. Designing a business model, associating entities plays a significant role. There must be several axioms controlling the properties of the "Connection" Class and the constraints that this class should follow. Instances of the classes "Actor", Business Object", "Process", "Event" and "Transition" should be able to get associated or connected through a "Connection". For example, in the sales-model an "Accountant" -as Actor- should be the one that "Makes out" -as Process- the "Invoice" -as Business Object-. So, these three instances "Accountant", "Makes out", "Invoice" need to be connected. In the scope of the "association" meta-relation, there are constraints and rules about the potential connections. For instance, there is no meaning for two instances of the class "Business Object" to be connected to each other.

Modularity. Business processes are often complex, which make difficult their models design and representation. For this reason, modularity of business models is essential for ontology engineers and users. The Suggested Upper Enterprise Ontology integrates modularity and decomposition of Processes, thus the sub-processes can be represented as "black boxes" simplifying the design of more sophisticated processes. For example, in the Buying-model should exist a process of "Arrange Payment". This process can be represented in another process model in details. In this way, there can be a general business model, for example Buying-model, which comprises all the necessary sub-processes as activities in it; however, anyone can gather details in specified models of every activity of them, represented as a distinct process.

In the following figure (Figure 1) the potential anatomy of an enhanced version of the suggested Upper Enterprise Ontology is represented.

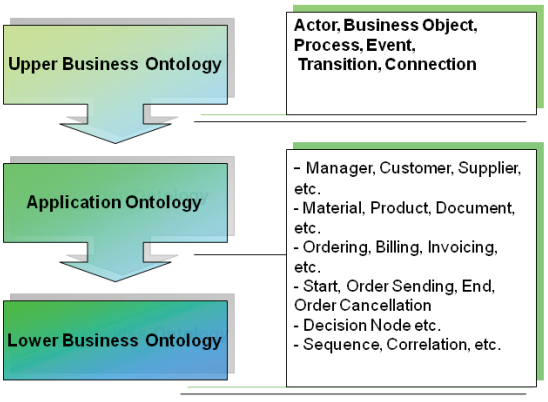

Figure 1: Upper Enterprise Ontology's essential and enhanced layers.

2.3 Refinement

In order to make the potential use of the Suggested Ontology explicit an example of enhancing the

ontological class hierarchy is presented hereafter. This enhanced Ontology will be able to represent several processes of a small or medium- sized enterprise through properly defined and comprehensive business models. This refinement is represented in Figure 2.

The six generic classes are refined to more specialized classes and this refinement continues to lower levels, for example the class of "Order Cancellation" is a refinement and inherits from the class "Ending Event" and the last is a sub-class of the meta - class "Event".

The definition and explanation of all these sub-classes is beyond the purpose of the proposed ontology because this would lead towards an undesired direction, i.e. a large ontology with an extensive and complex set of terms and definitions. The main objective of the presented approach is to define explicitly generic concepts and the relationships between them.

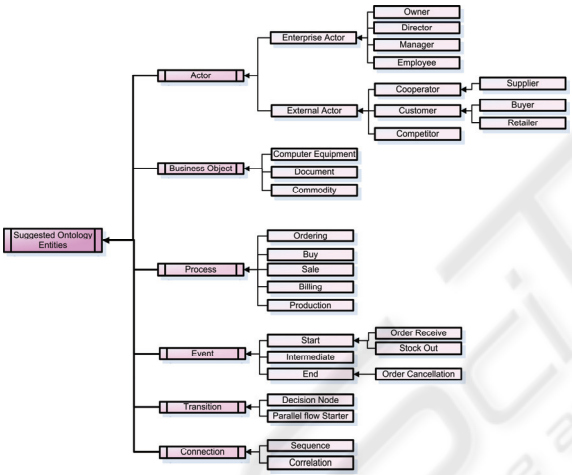

Figure 2: A refined version of Upper Enterprise Ontology.

3 CONCLUSIONS

In this paper a methodological approach towards the construction of a generic upper-level Ontology has been sought. The Ontology will be able to be used as an initial modelling set of entities for modelling different types of Enterprise Ontologies. The proposed ontology can be enhanced, refined and used in different sectors and enterprise environments.

It can be used by already existing enterprise modelling methods and environments. More specifically, a business-model description language can make use the Suggested Ontology as a medium to generate and represent formal business models. Furthermore, a business modelling software tool, based on the suggested Upper Enterprise Ontology, could lead enterprises to design, present, compare and improve their business models in a simplistic and comprehensive way and through these models to monitor and revise their processes and their strategy. Accordingly, the second step of work is to refine and improve the Upper Ontology, in order to be used by a new-developed software tool, which will support Application and Lower Business Ontologies construction, models designing, and semantic reasoning based on the predefined meta-concepts and principles of the Suggested Ontology. Therefore, working in the direction of implementing such a software application, which will be presented next, has already started.

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