Knowledge Representation Through Ontology in a Management Support Systems Framework

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Some characteristics of the actual word are the geographic and temporal distribution of the activities. These characteristics entail a collaborative paradigm in many domains, e.g. business, education, which in turn requires a new management approach. Since this new management approach is a complex activity it is developed in a framework base that implies complex knowledge base development. To develop a complex knowledge base an ontological engineering can be used. In the present note an upper level ontology for the knowledge representation of support systems in a collaborative management framework is developed.
Keywords: *Knowledge Representation, Ontology, Management Support Systems.*

1 Introduction

The globalization, the Internet, the World Wide Web and the Information Society changed essentially the economy and business and also the computer sciences, in general, and the information systems, in particular. A new business environment was created by the e-commerce and the e-business and consequently the distributed and collaborative business, named by some author [13] Business Networking, appeared.

Usually, but not compulsory a collaborative system is a distributed one. Martin [10] defines a distributed system as *a network of computers (nodes), each having parts of network-wide data and functions, which work cooperatively to solve a problem* or as *distributed system is the process of aggregating the power of several computing entities to collaboratively run a single computational task in a transparent and coherent way, so that they appear as a single, centralized system*. These distributed systems generated new business models [9] that cause revision of companies' strategies, organization and their information systems [3, 13].

The collaborative systems form a new interdisciplinary research field, analogous with the cooperative systems, but if the first category corresponds to the horizontal structure, the second represents the vertical one [6].

In the literature are known many definitions for the collaborative systems, but one of the most simple is [2]: *a collaborative system is a collection of dynamic objects which communicate and cooperate for a common and partitioned target*. Many authors consider that collaborative systems are *complex information systems for a large area of activities based on sophisticated technological standards and on complex Internet, Intranet and Multimedia applications*[1].

2. A general framework for collaborative management systems

DARPA Intelligent Collaboration and Visualization Program [4] developed a general framework for the collaborative systems investigation. The authors applied the framework for different kind of problems and for collaborative project management [11]. Considering this framework and other developed framework for collaborative systems and also our own experience we developed a new general framework for collaborative systems that is organized on 5 tiers and 8 levels [12].

The main tiers of the general framework proposed are requirements, conceptual, logical, middleware and technological tier. Additionally some tiers are divided into two sub-tiers, the global (high level) and the local (low level) ones.

3. Ontologies

Before describing an ontological representation of knowledge in our framework we

[1] http://www.coopsys.com

present some definitions of ontologies.
One simple definition of ontology is Gruber's definition [8] *an ontology is an explicit specification of conceptualization* modified by Borst [1] in a *formal specification of a shared conceptualization.*
For our interests, definitions that are based on the process of building the ontology are important. In this respect we mention Schreiber's team definition [15]: o*ntology provides the means for describing explicitly at the conceptualization behind the knowledge represented in a knowledge base.* Another interesting definition is the definition provided by Swartout's team [16]: *an ontology is a hierachically structured set of terms for describing a domain that can be used as a skeleton foundation for a knowledge base.* A lexical ontology is defined as *a system of symbols that represents concepts coded in expressions of the natural language.* The most important ontology of this class is WordNet or EuroWordNet. The ontology engineering is *the task of designing, implementing and maintaining ontology based applications* [7, 5].
In [14] different ontology classifications are presented. One of them differentiates between un-formal and formal ontologies. Unformal ontologies are catalogs containing different undefined types or types defined only by natural language propositions while formal ontologies are collections of concepts' name, types and partial order relations between these types.
On the other hand the ontologies can be horizontally or vertically. Horizontal ontologies are used for different vertical spaces and can be used for different domains while vertical ontologies are used for domains organized in a vertical or pyramidal structure.

4. Knowledge representation through ontologies in the framework for collaborative management

In this section we will briefly describe an ontological representation of knowledge in our framework. The requirement tier contains the general objects that represent the group, tasks being performed by the group and the support required by the characteristics of the group. At this level we need to represent the group structure, the group process and different protocols and behavior issues. At the requirement tier we have four categories of objects [12]:

- work tasks that describes the main activities in the collaborative systems;
- transition tasks that assure the relation and links between the work tasks;
- social protocols that depend on the collaboration nature and contains some elements concerning the meeting conduct, communication standards, or awareness;
- group characteristics that depend on time, dimension, homogeneity, duration of the group, etc.

For this tier we can use a lexical ontology. On the other hand, here we have a horizontal ontology because the domains cover different domains of the discourse. Using a similar notation as Showa this ontology is represented in Figure 1.

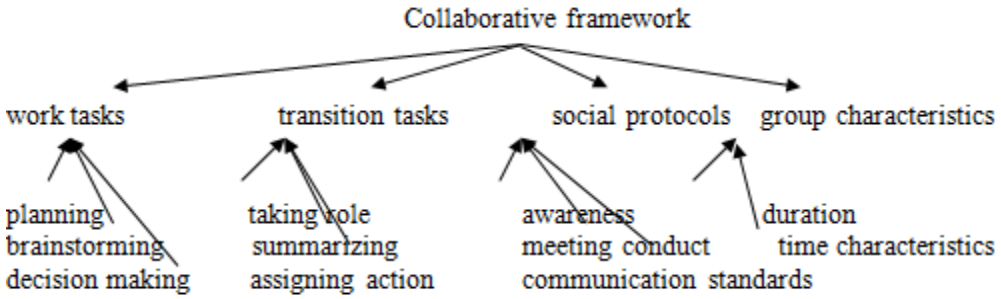


Fig.1. Partial view of taxonomy of framework ontology

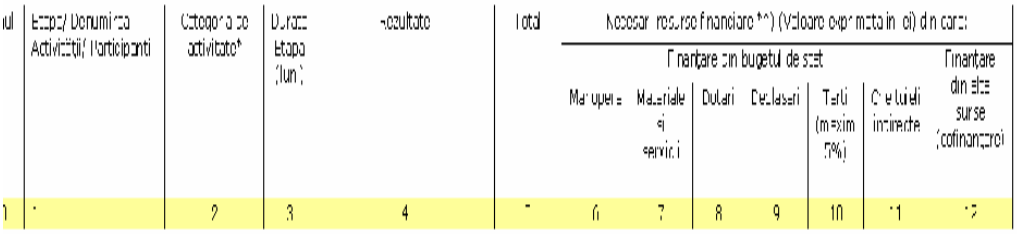
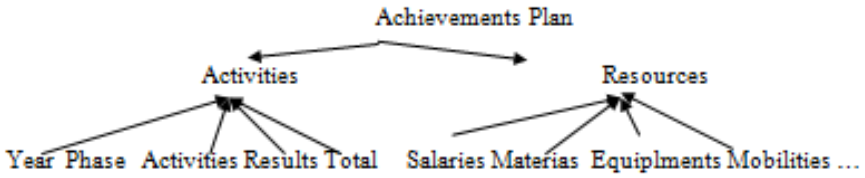
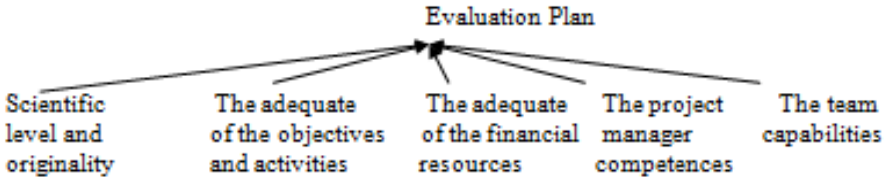


Fig.2. Achievements plan table header

The Shova's lattice to represent the upper-level ontology of the requirement level is:



For Evaluation Plan we have the lattice:



We also can use more precise ontologies, as for example, *SUMO* (Suggested Upper Merged Ontology), which can be mapped to WordNet, *Cyc* that is an AI project to assemble a comprehensive ontology and database for common sense knowledge, with the goal of enabling AI applications to perform human-like reasoning, *CIDOC CRM* (*Conceptual Reference Model)*, which provides a formal and extensible ontology for cultural heritage information (currently an ISO Draft International Standard (ISO/DIS 21127)) or GOLD that is an ontology for descriptive linguistics that can be mapped over SUMO.

The conceptual tier represents the image of the requirement tier objects and relations by conceptualization. At this tier, the functionality necessary to support different requirements is described. More exactly, the work and transition tasks, social protocols, and group characteristics from the requirement tier are detailed. Different scenarios are illustrated, at this tier.

The main images of the sections from the requirement tier are [12]:

- conceptual images of the work tasks concern work, supports for object types, object manipulations, object management;
- images of transition tasks from requirement tier are: collaboration coordination, collaboration planning capabilities, locator capabilities;
- for the social protocols we have: awareness indicators, meeting conduct, communication.

This tier can be represented as the requirement tier.

The authors developed also an ontology based on Faceted Horn First Order Predicate Logic (HFOPL) that describes very well Showa's top level ontology [14].

The middleware tier contains different types of services that can be used in developing CSCW (Computer Support Collaborative Work Systems). We note only that for markup ontologies we can use many languages like OWL (Ontology Web Language) for example, which is a markup language used for publishing and sharing data on the Internet that was specified by World Wide Web Consortium (W3C).

One of the most important application domains of this framework is the collaborative project management [11]. The high level ontology is formed in this case by two catego-

ries, the collaborative design and monitoring. We will briefly describe the design phases. In the Partnership Research Projects, the requirements are generally specified by the requirement specifications[2]. In Romania, these projects are managed by The National Commission of the Programs Management (CNMP)[3]. The requirements are specified by guideline of proposal, by the template of the Achievements plan (illustrated in Figure 2)[4] and by the guideline of evaluators (evaluation plan).

These lattices constitute prototypes for the conceptual level. Using these prototypes, at the conceptual level, the Achievement Plan will be detailed for all temporal phases and all partners. This will complete the ontology. The instance of this template will be the Project Plan. The evaluators will establish if the plan will be accepted or not by a metric (p, T, C) where C is the class of accepted projects, T is the prototype and p is the concrete project.

5. Conclusion

Knowledge representation by ontologies and ontological engineering are intensively studied lately. A second extensively studied problem is the collaborative support systems for management. Finally, the application of frameworks to design and build complex systems is also a big issue. At the intersection of these three fields a new research domain is emerging.

6. Acknowledgment

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[2] http://www.neh.gov/grants/guidelines/collaborative.html
[3] http://www.cnmp.ro:8083/pncdi2/pprogram4
[4] The image represents the header of real Achievements plan (in Romanian).