Knowledge Sharing Using Product Life Cycle Management

Pham Cong Cuong[1], Alexandre Durupt[1], Nada Matta[2(✉)],
Benoit Eynard[1], and Guillaume Ducellier[2]

[1] University of Technology of Compiegne,
Compiegne, France
{phamcong,alexandre.durupt}@utc.fr
[2] University of Technology of Troyes,
Troyes, France
{nada.matta,guillaume.ducellier}@utt.fr

Abstract. Information Systems, used to share information, lead to the growth of heterogeneous data and then the dependencies between them. Thus, the links and dependencies among heterogeneous and distributed data are more and more complex during daily activities of users (engineers, etc.). Ontology is currently used to enhance the knowledge sharing and the data integration in many information systems. Our contribution is to propose a methodology to facilitate the exploitation (interrogation and sharing) of data in an organization.

Keywords: Knowledge sharing · PLM · Ontology

1 Introduction

Information Systems, used to share information, lead to the growth of heterogeneous data and then the dependencies between them. Thus, the links and dependencies among heterogeneous and distributed data are more and more complex during quotidian activities of users (engineers, etc.). The data exploitation (interrogation and sharing) has to be adapted to the context of large data and complex dependencies. To overcome this current inconvenience, more and more research works have investigated and studied the Semantic Web (SW) concepts and techniques, as well as their applications to improve the capabilities of PLM solutions in order to efficiently manage lifecycle data. Ontology is a key component of SW in which concepts and the relationships between concepts can be expressed in natural language and understandable by both of human and machine. Ontology is therefore used to enhance the knowledge sharing and the data integration in many actual information systems. Our contribution is to propose a methodology to facilitate the exploitation (interrogation and sharing) of data in an organization. Thus, the PLM domain is considered for industrial companies where the users are engineers. A global approach to construct an ontological model facilitating data exploitation is therefore illustrated from PLM context.

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2 Knowledge Sharing

Knowledge play an indispensable role in the long-term sustainability and success of organization. The need for processes that facilitate the creation, sharing and leveraging of individual and collective knowledge has emerged recently for this reason.

Knowledge sharing (KS) has been introduced as one of the major activities of knowledge management and some definitions of knowledge sharing can be found in the literature [4]. KS can be defined as activities of transferring or disseminating knowledge from one person, group or organization to another. The individuals initially create knowledge but it can be produced and held collectively. At the most basic level; knowledge sharing involves the process through which knowledge is transferred between a source and a recipient by using knowledge sharing techniques.

Information technology (IT) provides techniques to capture knowledge, categorize, search, extract content information and present it in more meaningful formats across multiple contexts of use. Some authors [5, 7, 8] have invested their efforts to construct platforms that enable knowledge sharing by using ITs. Sato et al. [5] used XML Linking Language (XLink) as a method of knowledge representation describing and proposed architecture for sharing that knowledge among users.

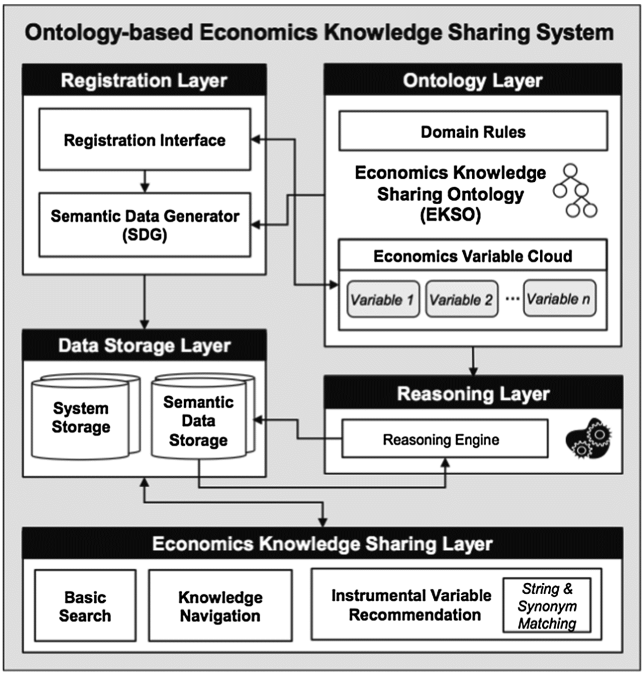

Fig. 1. Ontology-based economics knowledge sharing system architecture [7]. In this architecture, different levels are defined, related to the difference between data and knowledge. Ontology is enriched from data by generating semantic data related to ontology concepts. Reasoning engine is used when a data is searched. It allows to infer data using logic links between concepts.

He used the peer-to-peer technology to help users to better understand how to reuse existing knowledge on computer networks. Zhang et al. [8] tried to re-define knowledge resources in the network by object-oriented thinking and proposed three-layer knowledge sharing model. By using technologies on Web 2.0, a knowledge-sharing system is built on the Internet, allows the knowledge acquisition, sharing, extension and retrieving. Several knowledge-sharing systems use ontologies, which are defined as an explicit formal specification of a shared conceptualization [2]. For instance, Yoo et al. [7] proposed a system based on ontology expressing economics knowledge and Semantic Web technologies. Figure 1 presents the architecture of this system that consists of five layers: registration, ontology, data storage, reasoning and economic knowledge sharing. Users can register economics knowledge pertaining to a certain economics paper. They define then the metadata and the relationships between notions discussed in the paper. According ontology model, the system transforms this knowledge into semantic data in a machine-understandable format. Two functions: basic search and knowledge navigation were implemented.

OntoShare [1] is another ontology-based knowledge sharing system, in which, as users contribute information to the community, a knowledge resource annotated with metadata is created by using ontologies that have been defined using Resources Description Framework Schema (RDFS) and populated using RDF.

Before proposing our approach that uses ontology to share knowledge in PLM, let us describe main problem of sharing information in PLM.

3 Information Sharing in PLM

The Product Lifecycle Management (PLM) systems integrate constantly all the information produced throughout all phases of a product's lifecycle to everyone in an organization at every level (managerial, technical…) [6].

Some key advantages of PLM systems can be noted [3]:

- Establishing an effective PLM system reduces the enormous data resources to a coherent data flow, avoids redundancies and heterogeneities.
- PLM enables the collaboration through distributed and virtual/extended enterprises (workflow and process management, communication and notifications, secure data exchange…)
- PLM permits the product structure and its evolution management during different steps and track-performed modifications tracking.
- PLM is a mature solution to tackle the heterogeneity, growth and complexity of the data and its processing methods as well as some of the traceability and confidentiality issues.

So, PLM system brings together: Products, service, activities, processes, people, skills, data, knowledge, procedures and standards…. It aims to provide the right information for the right people at the right time. It provides an efficient solution to handle the complex and heterogeneous data resources and a mature method to track the evolution and modification of these data.

However, along with these advantages, it also exists some issues:

- Lack of strong stakeholders, ICT tools as well as a common standard between PLM systems causes data integrity problems and limits the access to and sharing of product information and knowledge distributed,
- Another issue of PLM community is the increasing of need for product lifecycle knowledge capitalization and reuse in order to reduce time and cost.
- Database exploitation requires a good understanding of database structure as well as data model especially in the context where the data is heterogeneous and the links and dependencies among data are complex.

To answer these problems, we aim to use ontology to enhance knowledge sharing in PLM. The difficulties in data exploitation and technical information in PLM systems come from the low-level of data model representation, the increasing of the complexity of links and dependencies among heterogeneous data. To exploit data from database, it requires a deep understanding of data model and the dependencies between these data. Ontology promises an efficient solution to enable the sharing this understanding. The data model and the complex relationships could be also presented obviously, visually and easily to perceive by using ontology.

4 Our Approach to Share Knowledge in PLM

The main problem in information management is to manage the evolution of data and links between information. Each user introduces his own view when he/she adds a new data. So, information search based on database becomes complex. Otherwise, knowledge engineering techniques as shown before provide techniques, which help from one side to respect the logic of a user and from another side to share knowledge. We propose to use knowledge sharing techniques based on ontology and inference engine in order to help in data management in PLM (Fig. 2). In fact, ontologies must be

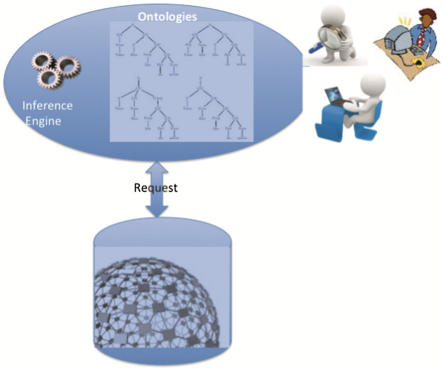

Fig. 2. Architecture of knowledge sharing in PLM. Inference engine can be used when a user ask for data from PLM. It follow ontologies in order to generate several links between data. The system can then transform these links in a data request which is used for database.

defined to represent user views. Ontologies' low-level concepts have to be linked to data in database, or unless respect the variable name of these data. An inference engine can help to build a data request and generate links using the propagation of relations between concepts. We present in the following an example of this work for researcher working in bio-imaging (GIN) lab.

4.1 Building Ontology in GIN Lab

To ensure a concrete view, we started our work by interviewing some scientists in a research institute where the complexity, variety, heterogeneity and growth of data resources have been handled by using PLM solutions. The goal of this interview is to identify the real needs of researchers, the difficulties in manipulating with information system during daily activities. In fact, most of scientists have difficulties in data querying and they almost cannot accomplish this task without helps of database technicians. For this reason, a visual, dynamic query interface that contains contents non-technician and user-proper, is required and acts an important role in system. Furthermore, as showed in the Fig. 3, the knowledge sharing process in bio-imaging GIN Laboratory initiates by data querying from PLM database through this query interface. Providing an efficient interface therefore becomes crucial and essential.

We define an ontology corresponding of the use logic of information in database. Information belongs to three major categories: **Tools**, **Data**, and **Process** (Fig. 4). Several relations exist between these concepts like **Use, Follow** and **Provide** (Fig. 5).

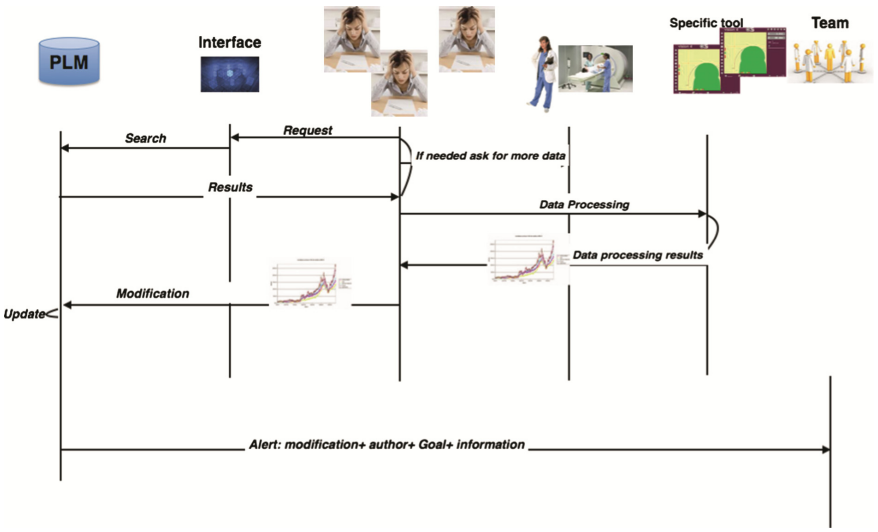

Fig. 3. Knowledge sharing in Bio-Imaging GIN Lab.

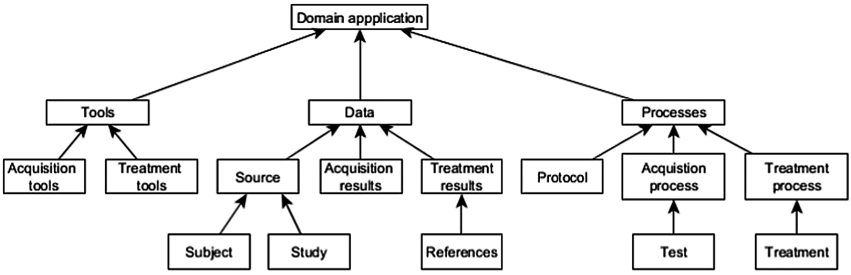

Fig. 4. Conceptual tree of ontology. Three main concepts are used "Tools", "Data" and "Process". These concepts are manipulated in different ways: in acquisition, treatment, or results.

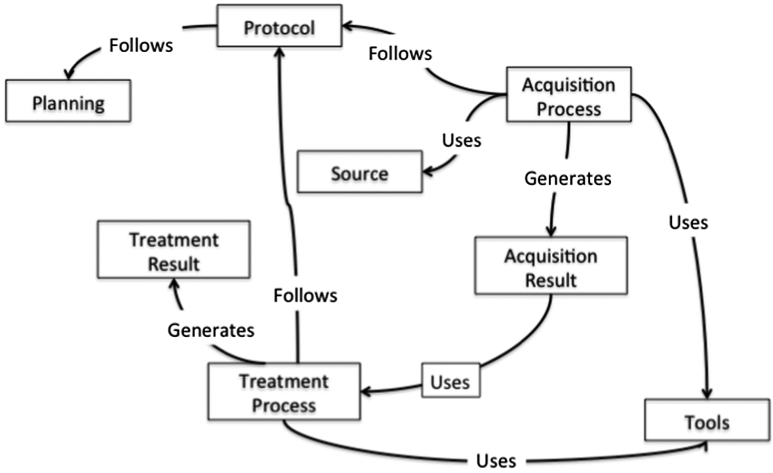

Fig. 5. Conceptual graph of ontology. Data acquisition follows different protocol in order to acquire information from several sources. Acquisition results are then manipulated in treatments, respecting protocols in order to provide results.

4.2 Ontology Based Querying Interface

By using ontology tree and ontology graph, ontology-based graph query interface helps users to make a query more easily. By using the ontology tree and ontology graph, users can understand the relationships among concepts and directly choose query parameters. Users also can choose a query in query history to re-execute, modify or complete it. When a user completes his query, our system does as following

1. Identifying nodes links, following relations in ontologies.
2. Generating an output query in a format understandable and executable by Query Processor, XQuery Engine for example.
3. Executing the output query on PLM data file (.xml or .json format).
4. Results are then visualized as a graph and data in the Interface query.

5 Conclusion and Perspective

In this paper, we presented a knowledge sharing solution using PLM, based on ontology and semantic web studies. A general approach for ontological model construction and an ontology-base query interface then is presented as a solution to tackle the difficulties in querying PLM database. A use case in BioImaging domain has been also used to illustrate the abilities of our proposed interface. As future work we will focus on the test of proposed query interface with various queries sets (in BioImaging domain) and the case study of engineering design (in PLM). The ontology tree and ontology graph must be also developed to cover all concepts in BioImaging domain. Ontology will be implemented in semantic web language (RDF, SPARQL) in order to use inference engine for information search. We plan to test different inference engine for this aim.

References

1. Davies, J., Duke, A., Stonkus, A.: Ontoshare: using ontologies for knowledge sharing
2. Fensel, D., van Harmelen, F., Horrocks, I., McGuinness, D.L., Patel-Schneider, P.F.: OIL: an ontology infrastructure for the semantic web. IEEE Intell. Syst. **16**(2), 38–45 (2001)
3. Eynard, B., Gallet, T., Nowak, P., Roucoules, L.: UML based specifications of PDM product structure and workflow. Comput. Ind. **55**(3), 301–316 (2004)
4. Hendriks, P.: Why share knowledge? The influence of ICT on the motivation for knowledge sharing. Knowl. Process Manage. **6**(2), 91–100 (1999)
5. Sato, H., Otomo, K., Masuo, T.. A knowledge sharing system using XML Linking Language and peer-to-peer technology. In: IEEE Xplore, pp. 26–27 (2002)
6. Sudarsan, R., Fenves, S.J., Sriram, R.D., Wang, F.: A product information modeling framework for product lifecycle management. Comput. Aided Des. **37**(13), 1399–1411 (2005)
7. Yoo, D., No, S.: Ontology-based economics knowledge sharing system. Expert Syst. Appl. **41**(4), 1331–1341 (2014)
8. Zhang, J., Liu, Y., Xiao, Y.: Internet knowledge-sharing system based on object-oriented. IEEE Xplore **1**, 239–243 (2008)