Ontology Services for the Virtual Enterprise

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ABSTRACT

The efficient and effective aggregation of various web resources (applications & data services) for particular industrial needs and their transformation into useful information and products will be a main driver in web evolution. The use of metadata and ontologies to describe these resources could simplify and structure the systematic building of applications through the composition and reuse of software and data components, proper use of QoS requirements, Virtual Organisation (VO) logic etc. This position paper presents a design of ontology services for the virtual enterprise. The application is suitable for the Architecture, Engineering and Construction (AEC) sector, where the particular intention is to improve the use of AEC services on the web, offering to a domain expert a reference model for the different kind of engineering tasks, methodologies and software available to solve a given AEC problem. This approach also takes into account the AEC innovation (knowledge management) life cycle.

Categories and Subject Descriptors

D.3.5 [**Information Systems**]: Information Storage and Retrieval – *Online Information Services*

General Terms

Design

Keywords

Ontology, Dynamic Virtual Organisation, Product Life Cycle.

1. INTRODUCTION

In this paper, we present a part of the InteliGrid architecture [1], namely, the Ontology Services, which are currently at development process. The InteliGrid platform is being built with the purpose to support Dynamic Virtual Organizations (DVOs), that collaborate on the design, production and maintenance of complex products. Such DVOs are typical for industries with long and dynamically changing supply chains like automotive and aerospace. Perhaps the most complex DVOs are in the domain of Architecture, Engineering and Construction (AEC). The innovation life cycle in the AEC sector is typically fragmented, and this often results in a lot of misconception and miscommunication among the different stakeholders and their supporting information systems involved, all having their own understanding and view on activities, results and mechanisms in AEC processes. Therefore, shared understanding of same business concepts may improve the use of the various software and information systems, which is essential for efficient and effective collaboration within the DVO.

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2. REQUIREMENTS

In the AEC sector as well as in other sectors there exists a need to offer services that enable the production, management, and offering of quality information related to complex products and business processes. In particular, the entities engaged in production of complex products face several requirements:

- Virtual organisation logic has to be respected as well as the Quality of Service requirements,
- Commitment to an engineering ontology is essential for shared understanding of the business concepts,
- Heterogeneous resources of the DVO should be registered with the engineering ontology,
- Mechanisms should be provided for validation of the applications and data services,
- Ability to use complex, structured, product model databases in a secure way is needed,
- Ability to track provenance, and
- Ability to reuse Data/Workflows/Processes.

3. EXPLOITABLE METADATA

To achieve the aforementioned requirements we considered different kinds of exploitable metadata:

- metadata generated during the execution of various services (usually log files). These metadata can be used for monitoring and could also be used to track provenance.
- metadata about the availability, cost of services i.e. QoS requirements and conceptual models concerning the VO logic. These metadata can be used e.g. for composition of business workflows (e.g. by using BPEL4WS [2]).
- metadata describing web services. The main purpose of these metadata is the publication, discovery and composition of services. It can be expressed by means of the Web Ontology Language for Web Services (OWL-S), which contains constructs to commit the web services to the engineering ontology.

- metadata about the data. The use of such metadata would enable data-level interoperability between the various AEC services.

4. ONTOLOGY SERVICES

In the context of the InteliGrid system the Ontology Services (see Figure 1) are designed to deal with the heterogeneity of resources (minor, but, important differences in data models, data storage formats etc), the DVO logic, the composition of services in complex problem solving scenarios, and finally for provenance tracking.

To achieve interoperation of the different resources, consensual ontology and mapping rules between the general ontology and each specific one are used. For the AEC domain we use a general ontology called Industry Foundation Classes (IFC) [3], which has been built to promote interoperability within collaborative construction environments. The product is the "centre of the Universe" for engineering data management. The processes create and maintain it, and the knowledge is collected to improve processes and product. In light of its central role, the importance of openly available product data representations is obvious. Consequently, the IAI [3] (standardisation organisation in the domain of AEC/FM) have made considerable investments in the development of product model standards defining the data structures to describe various industry products (e.g. buildings, off-shore structures etc). The analysis of the semantics across the heterogeneous AEC resources enables the development of adaptive mechanisms that can organise those resources according to their contents and interdependencies.

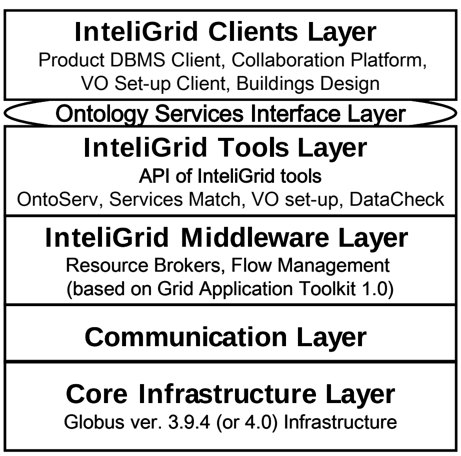

Figure 1. High level architecture of the InteliGrid Ontology Services.

5. WORKING MODEL

In this section we shortly describe the working model of the InteliGrid framework (see Figure 1). The main actors involved in the full process are:

Clients are making queries by using specific XML based query language. Clients are: already existing application that represents a collaboration platform, building design and structural analysis clients, and a well-known database client for product models.

The Ontology Services are being implemented by using the Jena API [4]. They were split into several modules: "OntoServ" supporting generic operations with ontologies; "Services Match" enabling the discovery of services by means of search in a database; "VO Set-up" dealing with security, privacy and QoS requirements that comprise the VO logic; "DataCheck" dealing with the consistency of the data model. The "DataCheck" uses a proprietary reasoner and a corresponding product model database.

In the lower layers of the architecture, we use stateful web services, which are such services that have state that can be querried outside a particular interaction. Critical underpinning of web services is the gradually growing set of specifications in the Web Service Interoperability Profiles. WS-I+ adds minimum additional capabilities to WS-I to allow development of grid services [5]. Those additional capabilities are: BPEL4WS for workflow, WS-Addressing for virtualization and richness of messaging, WS-ReliableMessaging/Reliability to provide basis for fault tolerance. WS-RF uses rich metadata to define stateful interactions between services. So, a grid service is a web service that provides a set of well-defined interfaces that follow specific conventions. The interfaces address discovery, dynamic service creation, lifetime management, notification, and manageability.

We have implemented a mock-up prototype of the InteliGrid framework achieving good results with the basic "OntoServ" module.

6. CONCLUSIONS

In this paper we have presented a proposal of an architecture for the management of resources in a flexible and dynamic virtual organisation in the sector of Architecture, Engineering and Construction. This proposal is based on the latest developments in stateful web services. It is expected that the architecture is useful for those types of Virtual Organisations, where there are not so many transactions in a very short time period and when the state of the services has to be maintained over longer period of time.

7. ACKNOWLEDGMENTS

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