KNOWLEDGE SERVICES FOR DISTRIBUTED SERVICE INTEGRATION

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Key Objectives: Introduce a service-oriented approach to providing knowledge support for distributed computing, develop a generic knowledge service architecture to realise such an approach, apply this approach to design search and optimisation (Geodise) to enhance the design process and also for architecture validation.

Motivation for the work: While computing increasingly addresses collaboration, sharing and interaction that involve distributed services, there is a growing demand for knowledge services that provide underlying semantic support for such distributed services and also support the sharing and coordinated use of knowledge itself.

With the rapid development of distributed computing infrastructures such as Grid technologies [1] and web services, there is an increasing need for ontology and knowledge technologies to support service integration across distributed, heterogeneous, dynamic virtual organisations.

An ontology is an explicit, shared specification of a conceptualisation, which defines concepts and their relations in a specific domain. It provides a common vocabulary for describing resources and expertise within a domain and thus facilitates communication among people and distributed systems. Knowledge is the whole body of data and information that people bring to bear for practical use in action, to carry out tasks and create new information. Effective use, in particular, the sharing of knowledge among organisations within a domain will support faster decision-making, increase productivity and lower costs.

While advanced knowledge technologies [2] for knowledge management and metadata infrastructure [3] were being developed, it became evident that a fundamental infrastructure is essential to integrate various knowledge management tasks across the knowledge lifecycle, and also to allow knowledge sharing in a distributed environment. Here we propose and develop a service-oriented knowledge architecture as shown in Figure 1, which fits into the paradigm of the OGSA [4] and also the vision of the Semantic Grid [5].

In this framework, knowledge about a specific domain is acquired, modelled and saved in a knowledge warehouse containing ontologies and knowledge bases. A community knowledge portal is provided as an entrance point for users to provide, amend and use knowledge (with different levels of access control). The distinguishing feature of this architecture is that every activity relevant to the supply and consumption of knowledge is realised through various knowledge services implemented using web services. Therefore, knowledge services can be discovered, shared, and reused in distributed service integration over the Internet.

There are two categories of knowledge service within the architecture. One is concerned with knowledge management tasks such as knowledge providing, publishing and reuse. These knowledge services are intended to support the sharing of domain task-specific knowledge. The other type of knowledge services are centred on ontologies of a domain, providing semantic support for resource sharing and knowledge modelling.

The knowledge service architecture has been applied to a real application – the Grid-Enabled Optimisation and Design Search (Geodise) project [6], to build a state of the art knowledge-driven design tool based on the OGSA infrastructure. In the context of Geodise, knowledge management focuses on encapsulating and exploiting knowledge so that new designs can be developed more rapidly, and at a lower cost.

We have partially implemented this architecture following the lifecycle of knowledge management in Geodise. Knowledge acquisition (KA) has been carried out by interviewing domain experts and reading domain materials. The acquired knowledge is modelled as a number of aspect models with the PC PACK knowledge tools [7], which are then published in the form of a knowledge web (KW). Knowledge webs provide a means of knowledge publishing through which experts can continually update

knowledge, and users can obtain knowledge for their own use.

We have built ontologies for Geodise based on KA and KW using Protégé [8] and OilED [9], which include at present a user profile ontology and an ontology for design search and example, the user profile ontology has been used in Geodise authentication and authorisation mechanisms. Database services have exploited ontologies to generate database schema dynamically and thus ensure that all archived data is semantically enriched and consistent.

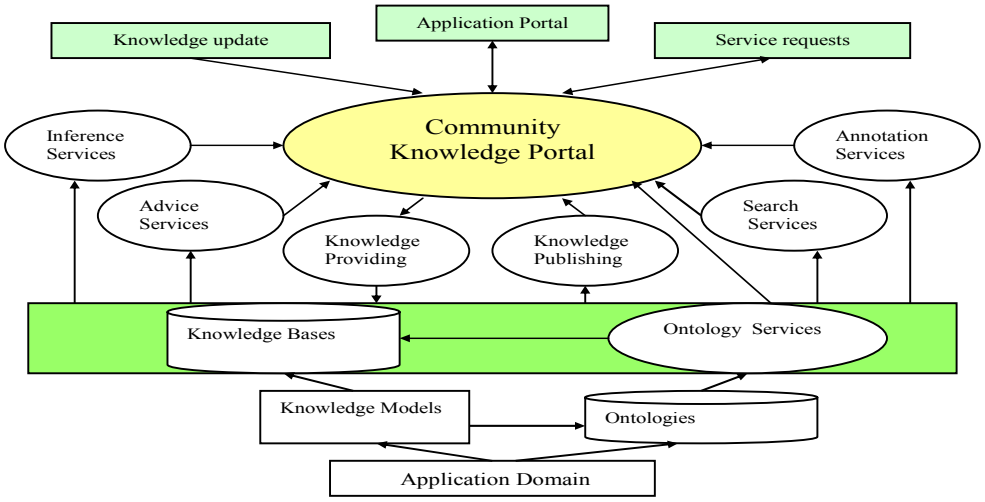

Figure1: Knowledge Service Architecture for Distributed Service Integration

optimisation. At this point we are in the position to provide knowledge services for Geodise.

As ontologies provide the conceptual backbone for knowledge management in Geodise, we have first developed an ontology service. This has been deployed using Apache Tomcat & Axis technologies. The service uses the emerging web ontology standard, DAML+OIL[10] as its underlying representation language. The service provides a Java API giving full access to a DAML+OIL model. The API is exposed through both a SOAP and a CGI interface for common ontological operations, such as subsumption checking, retrieving definitional information, navigating concept hierarchies, and retrieving lexical information.

We are currently developing annotation services [11] and advice services based on KW, ontologies and ontology services. In annotation, concepts from the ontology will be used to index resources such as optimisation logs. Queries against the ontology may then be used to retrieve information from these resources. Advice services focus on providing advice and knowledge support for decision-making by means of task-related knowledge bases and inference services.

The knowledge services developed have been successfully used by other Geodise services. For

The knowledge service architecture is flexible and extensible. Any function regarding knowledge can be inserted as a service. For example, a datamining service may be added later for automated knowledge acquisition and dynamic update of knowledge repositories.

Whilst this is an ongoing research project, many ideas are not fully implemented. However, initial results show that the approach to knowledge management and the architecture for exploiting knowledge in distributed service integration is viable and promising.

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