# VEGA-KG: A Way to the Knowledge Web

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**ABSTRACT**

This paper introduces a Knowledge Grid platform VEGA-KG that aims at uniformly sharing and managing knowledge resources across the Internet. The VEGA-KG includes two major components: a resource space model RSM and an operable knowledge browser. The RSM can uniformly organize information, knowledge and service resources in normal forms and provides local view and universal resource view for resource operations. The knowledge browser enables users to conveniently locate and manage resources by using a set of operations.

**Keywords**

Browser, Grid, Knowledge management, Knowledge sharing, Semantic Web, Web.

## 1. INTRODUCTION

In contrast to the rapid expansion of Web pages, the Internet users still lack of effective means to publish, organize, share and manage knowledge resources across the Internet. People have to be isolated with each other at the knowledge level to perform tasks from scratch by using their respective knowledge.

Knowledge management plays an important role in promoting innovation and productivity of organizations [1, 3, 4, 6, 10]. An Internet-based knowledge management should enable any user to store his/her knowledge at any time when he/she has generated some useful knowledge and to easily get the required knowledge from the knowledge repositories distributed on the Internet for solving encountered problems. In this way, knowledge resources on the Internet can be rapidly accumulated and evolved as the common knowledge assets of the whole Internet community with the expansion of the Internet users.

The Web Service, Semantic Web (http://www.semanticweb.org) and the Grid (http://www.gridforum.org) are three approaches towards the next-generation web. The Web Services refer to the applications that interact with each other using web standards such as WSDL, SOAP and UDDI. The current research on the Semantic Web focuses on ontology and the markup languages like XML, RDF and DAML [2]. A Grid can be regarded as an integrated platform that enables the controlled sharing of versatile resources. A generic Grid should have three characteristics: the network ability, the interoperability, the composition ability, and the semantic completeness [5]. A Grid itself can also be operated as a resource.

VEGA is a Grid project launched by the Chinese Academy of Sciences. It aims at four goals: Versatile service, Enabling intelligence, Global uniformity and Autonomous control.

## 2. VEGA-KG

VEGA-KG is the Knowledge Grid portion of the VEGA. It includes two major components: a uniform Resource Space Model RSM and an operable knowledge browser.

### 2.1 Resource Space Model RSM

The Resource Space Model RSM is for uniformly specifying information, knowledge, and service resources in an n-dimensional space. It has the following three distinguished characteristics:

1) *Normalized coordinate system*. The RSM provides three normal forms to normalize a resource space so as to guarantee the correctness of resource operations jus as the relational data model. The *first normal form* guarantees that there does not exist name duplication between coordinates at any dimension. The *second normal form* guarantees that any two coordinates are independent from each other. The *third normal form* guarantees that any two dimensions are orthogonal with each other. The theory includes fourteen conceptual definitions, seven characteristics and seven lemmas. We have proved that the join and disjoin operations keep the normal forms.
2) *Provide both the local view and the universal resource view*. The RSM enables users to choose to operate resources in either the local resource view or a universal resource view by joining different local resource spaces into one resource space.
3) *Support the management of the structured or semi-structured resources*. Templates are used to uniformly represent versatile resources. The templates are implemented by XML.

In the RSM, a resource operation language ROL is provided for uniformly operating resources, a set of criteria is set to help designers to design a good resource space, and a development method is provided to guide designers to develop a resource space.

The main difference between the RSM and the relational data model includes five aspects: the foundation, the managed objects, the data model, the normalization basis, the operation feature, and the interchange basis. Further investigation shows that the RSM is also suitable for managing relational tables.

The RSM can be used in many other application fields like digital library, UDDI, and component repositories [7, 8].

### 2.2 Knowledge Space

A *knowledge space* is a special case of the resource space, it has a three-dimensions: (*knowledge-level*, *knowledge-category*, *location*).

1) *Knowledge Level*. It includes four coordinates: *concept*, *axiom*, *rule*, and *method*. The conceptual level contains the basic concepts in form of noun or noun phrases together with their definitions. The axiom level contains the commonsense knowledge of knowledge categories. An axiom takes the form of a natural language statement or a mathematical equation that describes the relationship between concepts. The rule level contains the basic rules and principles of knowledge categories. A rule reflects the logical relationship between axioms. It takes the form as: *IF condition THEN conclusion*. The method level contains the problem-solving methods. A problem-solving method takes the form as the problem-solution pairs. The solution can be either a multi-step

problem-solving process or simply a one-step solution.

2) *Knowledge Category*. Knowledge category reflects the disciplines of the knowledge. This dimension includes several sub-categories, and each sub-category can further include several smaller sub-categories. A knowledge category together with its all-level sub-categories constitutes a *knowledge category hierarchy*. So coordinates of the knowledge-category axis are scalable because people usually concern knowledge across different knowledge levels. Except for the basic sub-categories, each coordinate of the horizontal axis can be drill-down onto a set of low-level coordinates, which can be then drill-down again or roll-up to its up-level coordinates. The top-level coordinates of the horizontal axis are the roots of all the knowledge category hierarchies.

3) *Location*. Universal Knowledge Location (UKL). The format of the UKL is: URL/[GroupName/]UserName/[attribute]/[x,y/]. The 'URL' is the Web site that the user can store knowledge. The 'GroupName' and the 'Username' are the name of the group or the person who contributes the knowledge. The 'attribute' can be either PRIVATE or PUBLIC, which respectively represents the private knowledge that the other people cannot get and the public knowledge that can be shared by the other people. The attribute can be default if it takes the PUBLIC value. "x, y" refers to the coordinates of the knowledge content, and the location refers to the whole knowledge grid in case of default.

### 2.3 Knowledge Browser

Knowledge browser is an easy-to-use and operable browser, with is responsible for: 1) locating knowledge resources in knowledge space by determining its coordinates, 2) selecting suitable operations and setting the parameters, 3) delivering the operation to the execution engine, and 4) receiving and showing the operation results. The coordinates are determined by selecting the coordinate hierarchy on the left portion of the interface and by choosing the proper rectangle on the middle portion as shown in Figure 1.

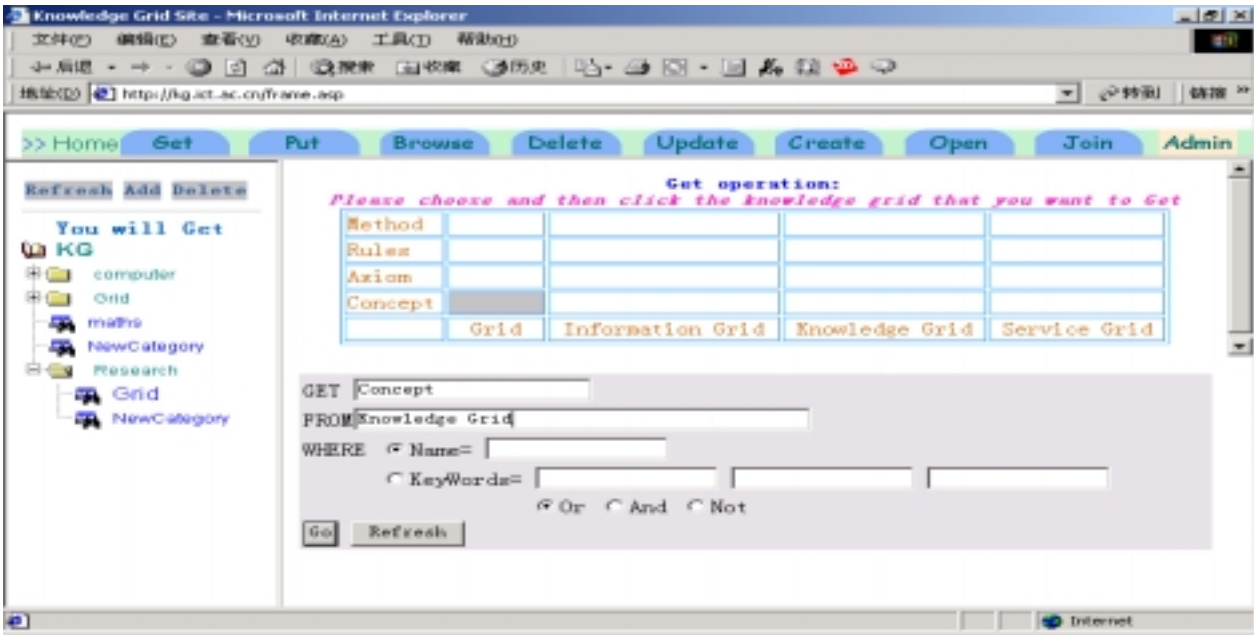


Figure 1. The operable knowledge browser of the VEGA-KG.

The browser provides a set of basic operations as shown in the top portion of the interface. Users can click the proper operation button, fill in the parameters in the operation template shown in the bottom portion, and then submit the operation. The execution engine is responsible for explaining the operation according to the ROL, executing the operation, and carrying out reasoning according to the typed links defined between resources. The execution results are returned to the browser.

## 3. SUMMARY

The VEGA-KG is an effort towards a knowledge web, which provides the Internet users the platform to effectively share and manage knowledge resources across the Internet. Different from the other Grid model, VEGA-KG is based on the resource space model RSM and the Semantic Web. The Semantic Web enables knowledge resources to be machine-understandable so as to support intelligent services. The RSM enables resources to be normally organized and correctly operated. The first version of the VEGA-KG has been implemented, and is available for use at http://kg.ict.ac.cn.

Ongoing work is to develop a Process Grid that is above the Knowledge Grid and can manage versatile processes on the web based on the proposed resource space model and the workflow technology [9].

## 4. ACKNOWLEDGEMENTS

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## 5. REFERENCES

1. R.Dieng, Knowledge Management and the Internet, IEEE Intelligent Systems, May/June, 2000, pp.14-17.
2. M.Klein, XML, RDF, and Relatives, IEEE Internet Computing, March/April, 2001, pp.26-28.
3. P.Martin and P.W.Eklund, Knowledge Retrieval and the World Wide Web, IEEE Intelligent Systems, May/June, pp. 18-25, 2000.
4. H.Zhuge, J.Ma, and X.Shi, Analogy and Abstract in Cognitive Space: A Software Process Model, Information and Software Technology, vol.39, pp.463-468, 1997.
5. H.Zhuge, A Knowledge Grid Model and Platform for Global Knowledge Sharing, Expert Systems with Applications, vol.22, no.4, 2002.
6. H.Zhuge, A Knowledge Flow Model for Peer-to-Peer Team Knowledge Sharing and Management, Expert Systems with Applications, vol.23, no.1, 2002.
7. H.Zhuge, A Problem-oriented and Rule-based Component Repository, Journal of Systems and Software, vol.50, pp. 201-208, 2000.
8. H.Zhuge, Inheritance Rules for Flexible Model Retrieval, Decision Support Systems, vol.22, No.4, pp.379-390, 1998.
9. H.Zhuge, T.YCheung, and H.K.Pung, A Timed Workflow Process Model, Journal of Systems and Software, vol.55, pp.231-243, 2001.
10. H.Zhuge and X. Shi, Communication Cost of Cognitive Co-operation for Team Development, Journal of Systems and Software, vol.57, issue 3, pp.227-233, 2001.