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Editorial

Semantics, Resource and Grid

Abstract

The future interconnection environment will be a platform-independent *Virtual Grid* consisting of requirements, roles and resources. With machine-understandable semantics, a resource can actively and dynamically cluster relevant resources to provide on-demand services by understanding requirements and functions each other. Versatile resources are encapsulated to provide services in the form of single semantic image by using the uniform resource model. A resource can intelligently assist people to accomplish complex tasks and solve problems by participating versatile resource flow cycles through virtual roles to use proper knowledge, information, and computing resources. From this Virtual Grid point of view, this paper conceptualizes the Social Grid, Semantic Resource Grid and Knowledge Grid, then points out the key research issues of the future interconnection environment.
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Keywords: Grid; Knowledge Grid; Resource; Semantic Grid; Social Grid

1. Introduction

The rapid development of IT has profoundly influenced human society, and the development of the society further requests new technologies. The relational database theory is a milestone in the history of information sharing and management. It has generated three Turing Award winners, a related software industry and has affected the world for 40 years. The Internet is another milestone. It has formed unprecedented social and economical influence. However, its current application platform (Web) cannot meet the needs of fast expanding applications. Research and development on new interconnection environment will form profound influence on society, economy, technology and science.

The *Semantic Web* is an effort to improve the current Web by making Web resources "machine-understandable" because current Web resources do not reflect machine-understandable semantics [2,5]. Efforts to realize computer-mediated knowledge sharing were made in AI field such as the Knowledge Interchange Format (KIF, http://logic.stanford.edu/kif/) and the Open Knowledge Base Connectivity (OKBC, http://www.ai.sri.com/∼okbc/). The XML-based markup languages like RDF (http://www.w3c.org/RDF) and ontology mechanisms have become the major means for establishing the platform-irrelevant machine-understandable basis in the Internet age. However, we should pay attention to balance the machine-understandable semantics and the human-understandable semantics when we make effort to improve the machine-understandable semantic representation approach.

The *Web Service* aims at providing an open platform for the development, deployment, interaction, and management of globally distributed e-services based on Web standards like UDDI. The *Grid* is a technology that enables distributed computing resources to be shared, managed, coordinated, and controlled. The resources could be machines, networks, data, and any types of devices. Its ideal is that any compatible device could be plugged anywhere onto the Grid and be guaranteed the required services regardless of their locations just as the power grid [3]. The Open Grid Service Architecture (OGSA) has absorbed the features of the Web Services [4].

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The Web Intelligence is to improve the current web by using the artificial intelligence and information processing technologies like text mining and knowledge discovery [6]. The Semantic Grid is to incorporate the advantages of the Grid, Semantic Web and Web Service (http://www.semanticgrid.org).

2. Social Grid

Human society has experienced the evolution from low to high social systems for thousands of years. The advanced social system in the information age will be a "Social Grid" that works according to social and economic rules and laws. In the Social Grid, people enjoy and provide services through versatile flow cycles like control flows, material flows, energy flows, information flows and knowledge flows. People can communicate and learn knowledge from each other through mutual understandable semantics.

An artificial interconnection environment is effective only when it can work harmoniously with the Social Grids. For example, an effective e-business environment requires harmonious cooperation among information flows, knowledge flows, material flows, e-services, and social services. The e-services belong to the e-business platforms. The material flows and social services belong to the society. The information flows and knowledge flows belong to both the society and the platforms. Proper semantic representation establishes the mutual understanding bridge between the Social Grid and the artificial interconnection environment.

The future artificial interconnection environment should harmoniously work and evolve together with the evolution of the Social Grid.

3. Semantic Resource Grid

The Semantic Resource Grid is for realizing effective resource sharing and management (http://www2002.org/CDROM/poster/53.pdf).

At the high level, the Semantic Resource Grid is a "world" of requirements, roles and services. Services are provided by the resources implemented on the basis of uniform resource model [7]. Services can actively find and advertise requirements. People can play the role of service and enjoy services provided by others. Requirements and services are organized into different federations that belong to different communities. Some services play the broker role that is responsible for dynamically integrating services to meet the needs of versatile requirements.

At the low level, the Semantic Resource Grid normally organizes and operates resources by means of *single semantic image*, i.e., versatile resources are mapped into a single semantic space to obtain common understandings. The single semantic image can be realized by certain semantic relationships like the orthogonal classification semantics and the semantic link networks established above resources. The normalization theory guarantees the correctness and effectiveness of resource operations [8]. The Semantic Resource Grid requires a semantic browser that enables not only people but also services to understand the semantics of resources being browsed, carry out resource operation and reasoning, explain the display, and estimate future browsing result.

The current efforts towards the next-generation web provide multiple candidate techniques and implementation platforms for the Semantic Resource Grid. The Grid is not the only platform for realizing the Semantic Resource Grid, but the Semantic Resource Grid should absorb the ideas of the Grid.

4. Knowledge Grid

Fran Berman pointed out the challenge of extracting knowledge from terabytes and mentioned that the function of the Knowledge Grid is: "to synthesize knowledge from data by means of mining and reference, and to enable search engines to make references, answer questions, and to draw conclusions from masses of data" [1]. The China Knowledge Grid Research Group developed an experimental Knowledge Grid system and published it online in late 2001, meanwhile, they proposed the multi-dimensional resource space model, resource operation language, knowledge browser as well as the concept of Service Grid (http://kg.ict.ac.cn).

By definition, Knowledge Grid is an intelligent interconnection environment that enables people or virtual roles to effectively capture, publish, share, and manage explicit knowledge resources as well as provide on-demand knowledge services to support people or services to carry out innovation, cooperative teamwork, problem-solving and decision making. It adopts the current techniques and standards and evolves with the progress of all the efforts towards the next-generation web. The Semantic Web is the understanding basis of the Knowledge Grid.

Besides the knowledge operations for appending, maintaining and retrieving knowledge, a Knowledge Grid provides the following two kinds of services:

(1) *Knowledge services*, which provide users with useful and relatively complete knowledge for solving problems. The knowledge service consists of two processes: *knowledge provision process*, during which the intelligent interface helps users to easily understand and learn knowledge; and a *knowledge logistic process*, during which the Knowledge Grid will gather useful knowledge from the right knowledge portals and push them to the right person based on some evaluation and optimization models.
(2) *Solution services*, which provide users with solutions to the problems because users may not be interested in or may not need to obtain the detailed knowledge on solving the problems. The intelligent engine (can be either domain specific or domain independent like the web search engine) is required to find the solution by making use of the knowledge logistic process.

5. About the papers in this special issue

This special issue includes 10 papers reporting the latest progress of research and practice relevant to the Semantic Grid and Knowledge Grid. These papers come from Australia, China, Russia, and UK. They are selected from 20 submissions and have experienced two-round review. Although research on Semantic Grid and Knowledge Grid is in its early stage, these papers have made significant progress.

The four papers following this editorial are mainly on semantic description and semantic-based service model. The paper "SGrid: A Service Oriented Model for the Semantic Grid" presents a Semantic Grid Service model. The authors report the implementation of a Web Services wrapper generator for automatically wrapping legacy codes as Web services. The paper "Predicate-Ordered Logic for Knowledge Representation on the Web" presents a logic framework for knowledge representation. It is an effort to establish the theoretical foundation for ontology languages. The paper "An Ontology-based Grid Service Discovery Matchmaking Framework" proposes a matchmaking framework based on a well-defined ontology and describes a matchmaking mechanism. Matching between semantic descriptions is the key issue of service discovery. The paper "Extending RDF in Distributed Knowledge-Intensive Applications" presents a network management knowledge model and distributed workflow system process ontology. The authors suggest the approach to apply the RDF to reengineer data integration solutions in different knowledge-intensive areas.

The next four papers are on semantic-based knowledge management in interconnection environment and relevant applications. Effective research document sharing is an important part of e-science. The paper "Semantic-Profile-based Document Logistics for Cooperative Research" presents an approach for realizing effective research document sharing in cooperative research teams through constructing semantic-profiles and implementing document logistics based on the Knowledge Grid platform. The paper "Knowledge Logistics in Information Grid Environment" proposes a "knowledge source network" approach and its multi-agent-based architecture and describes the relevant prototype. The paper "HyO-XTM: A Set of Hyper-graph Operations on XML Topic Map towards Knowledge Management" presents a set of Hyper-graph operations to manage the distributed knowledge resources based on the XTM hyper-graph model to realize knowledge management in Semantic Web environment. The paper "A Fuzzy Collaborative Assessment Approach for Knowledge Grid" proposes a Knowledge Grid assessment approach by incorporating the subjective and objective assessment strategies. The approach can help the developers improve the performance of Knowledge Grid and assist users to select the best Knowledge Grid to obtain proper knowledge services.

Access control is important in realizing the secure Grid environment. The last paper is on the theory for realizing access control in Semantic Grid environment. The authors report the relevant practice in China.

6. Key research issues

This special issue has not yet addressed the following topics that will play the key role in future interconnection environment:

(1) *Normalization*, how to normalize the semantic space so that people or services can efficiently and correctly operate resources according to semantics [8].
(2) *Dynamic clustering*, how to enable services to efficiently, dynamically and intelligently gather together according to the understanding of requirement [7].
(3) *Harmonious evolution*, how to enable services and knowledge to automatically evolve with respect to the evolution of the social requirements [9].
(4) *Coordination between multiple semantic layers*, how to coordinate multiple semantic layers like commonsense, process and logical semantics. Such coordination is important in understanding complex semantics.
(5) *Coupling between resources*, how to coordinate versatile resources so as to raise the effectiveness of using resources. Semantic information is the main source of knowledge, and knowledge is the basis for understanding semantic information. Semantic information provides the basis for specifying, selecting, and integrating services, and the execution of services also need the support of knowledge and information resources.
(6) *Intelligent knowledge/semantic browser*, how to best display the machine-understandable semantics and explain the display. Different from the current Web browser, it enables users to operate resources according to semantics.

7. Summary

The future interconnection environment will be a platform-independent Virtual Grid that evolves harmoniously with the society. The semantics and versatile resources are its fundamental elements. We should pay enough attention to the social factors, adopt the existing principles and rules of relevant fields, and keep updated with the development of these fields when carrying out research and development on the future interconnection environment.

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