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RESEARCH TRENDS IN KNOWLEDGE GRID

Summary: Among new solutions in sharing knowledge – grid processing seems to be one of the most promising. In the grid computing concept we find many advantages essential for business as well as for scientific groups that use large scale of knowledge resources. The aim of this paper is an investigation of the research areas that are essential for the knowledge grid discipline.

The paper is divided into four sections. In the first one an introduction to knowledge grid concepts is presented, in the next one a general model of KG is discussed. The third crucial part refers to the major research areas while the last one presents conclusions.

Key words: knowledge grid, grid computing, research areas.

1. Introduction

Undoubtedly among new solutions − that are able to support human beings in term of sharing knowledge − grid processing is one of the most promising. In the grid computing concept we find many advantages essential for business as well as for scientific groups that use large scale distributed information. The aim of this paper is an investigation of the research areas that are essential for the knowledge grid discipline. The paper is divided into four sections. In the first one an introduction to knowledge grid concepts is presented, in the next one a general model of KG is discussed. The third crucial part refers to the major research areas while the last one presents concluding remarks.

2. Genesis and definitions of knowledge grid

The inspiration for the knowledge grid came from the earlier defined grid computing (GC) idea. This approach was successfully implemented in database systems and, briefly speaking, GC consists in the usage of several computer platforms to serve some users in such a way that all resources (processors, software, networks, databases etc.) are integrated and available for them. An computer infrastructure created for this purpose can be optimised and managed from global or local point of view (compare: [Kourpas 2006]).

Discussing an essence of grid computing the following properties should be point out (compare: [Owoc, Walasiński 2006; Owoc 2008]):

- a grid as a basic infrastructure, that means computers are spread but connected creating certain a network with typical components: hardware, software, databases and communication capabilities (as it was stressed above). Therefore grid computing treats all mentioned resources holistically respecting flexibility of independent resource control,
- service-oriented of computing (so-called SOA) architecture as a basic platform, where a system architecture can be agreed with a superior model for building applications. There are specific standards applied in this environment: XML-based Web Services, Internet protocols and distribute objects. This allows for virtualization and provisioning of application resources.
- innovative character of the combination of technology; grid establishes a common perspective and method for managing, referencing and accessing the particular IT resources available in an enterprise.

Therefore the ultimate goal of grid computing is to allow the sharing of computing and data resources for a number of workloads and to enable collaboration both within and across organizations. In order to fulfill these assumptions suitable models (that are able to conform these features) should be defined. There are huge GC projects and standards where many companies are involved. Recently the term ***cloud computing*** became more popular but conceptually this idea is very similar to GC (see: Wikipedia).

Original definition of **knowledge grid** was introduced by Cantanaro and Talia (see: [Cantaro, Talia 2003]), which described this concept as … "a software system based on a set of services for knowledge discovery on the grid". Therefore KG in their solution enables the collaboration of knowledge centers using for example several data warehouses located in different company branches. According to their concepts KG services are organized in two hierarchical levels: the **Core** K-Grid and **High-level** K-Grid. The ***Knowledge Discovery Services*** and ***Resource Allocation and Execution Management Services*** are incorporated to the first one while the ***Data Access Service***, the ***Tools and Algorithms Access Service***, the ***Execution Plan Management Service*** and the ***Results Presentation Service*** to the second one. The whole idea has been implemented following essential (also as it was mentioned for GC) Service Oriented Architecture (SOA).

The second definition was proposed by H. Zhuge, which stated that KG … "is an intelligent and sustainable Internet application environment that enables people or virtual roles to effectively capture, coordinate, publish, understand, share and manage knowledge resources" (see: [Zhuge 2004]). Therefore KG should provide services to support innovation, problem solving and decision making in a distributed environment, which varies in scale and stability.

3. A general knowledge grid architecture

The Knowledge Grid as a new architecture is based on the existing methods and technologies such as the Grid, the Semantic Web, Web Services Peer-to-Peer, AI, proper data modelling, information processing technologies and system methodology (see: [Zhuge 2004 or Gil, Deelman, Blythe, Kesselman, Tangmunarunkit 2004]). A general context of this new architecture is depicted in fig. 1.

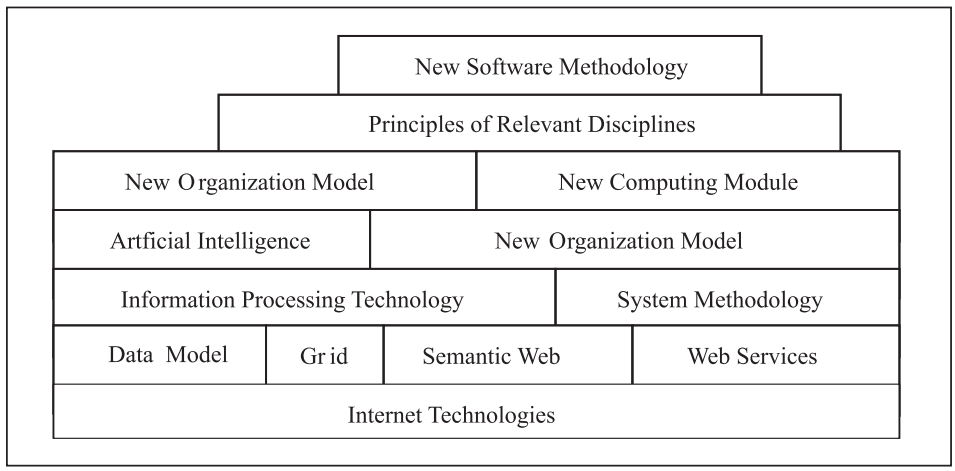

Fig. 1. Knowledge Grid Context

Source: [Zhuge 2004].

At the bottom level Internet technologies are the basic platform allowing for data resources exchange in the global dimension. The next layer consists of supporting solutions (eg. Mentioned earlier grid computing but also Web services including semantics and more universal data model. Integrating of the concerned components belongs to the next layer (eg. covering information processing technology and system's approach). In the middle knowledge grid supplemented by artificial intelligence methods create the core layer of the presented idea. This is a base for developing original solutions in terms of organizational and computing models. At the top of this concept new software methodology appears where the presented categories are regarded.

As a result we may define a knowledge management system (KMS) which is based on the knowledge grid architecture. Fig. 2 presents general concept of this approach.

Such system consists of the three-layer model (see: [Hengsham, Liquin 2005]):

- knowledge storage layer,
- knowledge services layer,
- knowledge grid application with interface for the end-user.

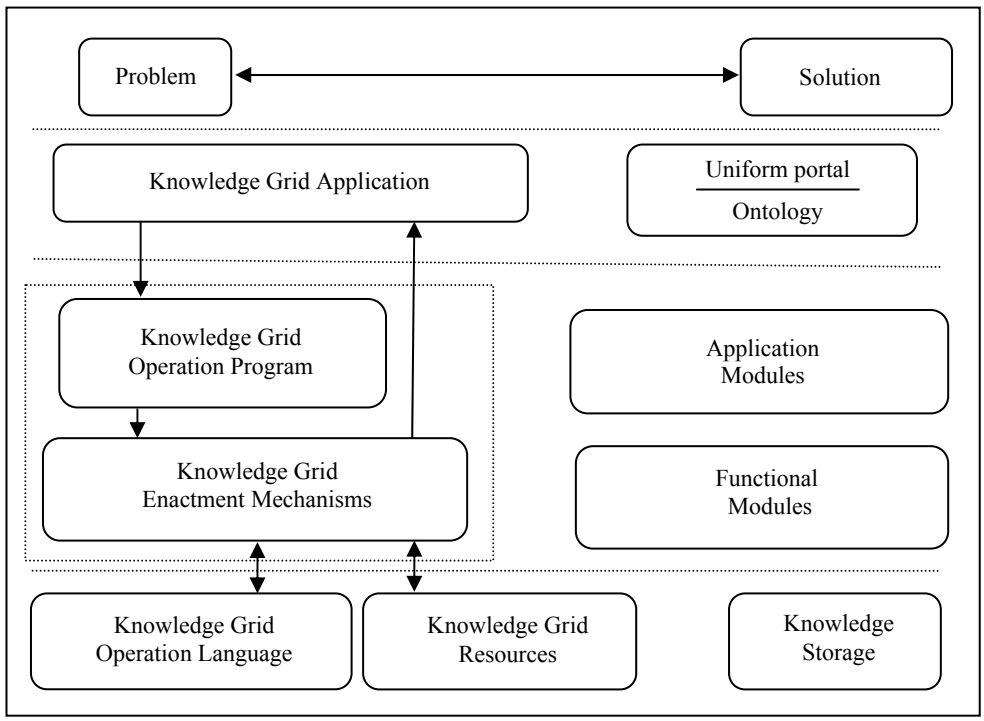

Fig. 2. Knowledge Management Systems using Grid Architecture

Source: own elaboration on [Hengshan, Liquin 2005].

The knowledge storage layer corresponds almost exactly to the knowledge database. The knowledge is stored and can be recovered from there. This layer's function is to provide secure access to the knowledge resources for knowledge workers in a business organisation. Its functions involve syntactic analysis, searching, inquiring and extending knowledge bases.

The most important tasks for the Knowledge Grid support of knowledge management would be purchasing knowledge units and optimizing the storage, navigation and distribution of entities of knowledge in databases.

The knowledge services layer supplies one view of heterogeneous knowledge sources and software systems, together with suitable software for knowledge discovery and reduction of redundant information. Furthermore, knowledge in this layer is used to improve query precision preciseness and to explain results to the end-user (compare: [Durman, Owoc 2008]).

The processes, which help to intelligently eliminate, create and discover organisational knowledge, happen in the middle layer. The aforementioned knowledge service layer will, therefore, be of most interest from the paper’s goal perspective.

4. Research areas of knowledge grid

The presented earlier KG ideas and an architecture are formulated initially therefore research projects in this domain are very hot and promising. Taking into account known concepts of KG as well as organized and planned conferences the following research streams seem to be reasonable [Cantaro, Talia 2003; Zhuge 2004; Konogaya 2006; GridConf]:

- **Theories and Methods for Supporting Knowledge Management**. One can stress at least the core phases of knowledge management: gathering, representation and sharing knowledge. Thanks to the Knowledge Grid, it will be possible to effectively capture and conveniently publish knowledge in a machine-processable form that could be understood directly, or following a simple transformation, by humans.
- **Ontology and Semantic Aspects of Knowledge Grid**. Nevertheless of KG application area there are huge of problems with common understanding of the whole concept; domain terminology, interpretation of interrelationships, principles and references to other disciplines.
- **Knowledge Grid in Different Organizations**. Propagation and management of knowledge within a virtual organization is one of the suggested hot topics. There are problems how implement KG in global organizations and on the other hand what kind of information infrastructure could be effective in case of hybrid and multilevel companies.
- **Knowledge Grid and Effectiveness of Knowledge Management** (KM). Taking into consideration particular KM phases: organization, evaluation, and improvement we are looking for efficient tools and techniques in order to support the whole cycle. The Knowledge Grid should be able to eliminate redundant knowledge and improve knowledge so that the amount of useful knowledge can be increased. It should be also able to create new knowledge from existing well-represented knowledge, from case histories, and from raw knowledge materials like texts.
- **Knowledge Integration in the Grid Architecture**. One of the promising features of the presented approach is gathering information and knowledge pieces from many sources. For example integrating knowledge resources could support analogies, problem solving, and scientific discovery so standards in this area are welcome.

The itemised areas cover majority of the potential problems that can be observed in the presented approach. Gradually solving these quests should decide about the superiority of this intelligent architecture over other types of knowledge management system's architectures, allowed building a much more efficient, intelligent system for a knowledge based organization.

5. Conclusions

The Knowledge Grid environment (individuals, communities) sees the presented concept as a very promising solution in the future but still many research problems should be solved. The basic findings can be formulated from the paper in the following way:

1) knowledge grid as a new approach to manage knowledge from different sources should be more effective comparing to the previous solutions,

2) the new architecture for KG is necessary (based on SOA) includes many layers responsible for the particular services,

3) the trial of investigation research problems in the KG allowed for diversification of particular areas covering fundamental as well as arising from crossing knowledge grid with other disciplines.

KG is still relatively new concept therefore we may expect dynamical development of the research in this domain.

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TRENDY BADAWCZE W KONCEPCJI WIEDZY SIECIOWEJ

Streszczenie: Przetwarzanie sieciowe wydaje się jednym z bardziej obiecujących rozwiązań w zakresie dzielenia się wiedzą w społeczeństwie informacyjnym. W ramach tej koncepcji można odnaleźć szereg udogodnień wręcz rewolucjonizujących dostęp do informacji rozproszonej zarówno dla ośrodków reprezentujących szeroko rozumiany biznes, jak i ośrodków naukowo-badawczych. Celem artykułu jest przedstawienie kierunków badawczych istotnych w ramach koncepcji wiedzy sieciowej.

W części pierwszej artykułu przedstawiono założenia i model charakterystyczny dla wiedzy sieciowej. Część zasadnicza artykułu zawiera dyskusję dotyczącą obszarów badawczych charakterystycznych dla wiedzy sieciowej. Część końcowa zawiera wnioski dotyczące stanu aktualnego, a także perspektywy dalszych badań.