RESEARCH ON SPATIAL INFORMATION/KNOWLEDGE RESOURCE ORGANIZATION IN GRID ENVIRONMENT

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ABSTRACT:

Following the advancement of spatial acquisition technologies, more and more spatial data/information has been collected by the integrated ground-air spatial information collection system. Spatial information is geographically distributed in various locations and belongs to different organizations with a rapid increment in the aspects such as scale and complexity. We have unprecedented challenge of increment of spatial information/knowledge resources today. Grid technology is a new revolutionary technology aimed to solve resources sharing on the web. Grid technology is not only a new technology, but also is a new thought. The emergence of grid technology provides a new approach to spatial knowledge automatic acquisition and sharing. This paper studies this new technology in spatial information/knowledge sharing. In this paper, complex network theory, spatial resource management and organization characteristics, and spatial resource model are discussed. A spatial resource management and organization model is also proposed in the paper.

1. INTRODUCTION

With the advent of new century, the technology-driven effect to spatial information science has become strong and strong. Following internet technology, grid technology is another new revolutionary technology. More and more spatial data/information have been collected by the integrated ground-air spatial information collection system, and spatial information is geographically distributed in various locations and belongs to different organizations with a rapid increment in the aspects such as scale and complexity. Therefore, we face unprecedented increasing demand of spatial information process capability and spatial information/knowledge resource sharing than before. How to access useful resource from bulky and distributing spatial information, and eliminate "Information Isolated Island and Knowledge Isolated Island" and to achieve information and knowledge sharing and application is a challenged task.

Grid technology is series of new technologies and establishment which has built on the internet to implement cooperative resource sharing in the dynamitic and widely distributed virtual organization, and to solve scientific and engineering problems. Researches based on grid have become new forward position in spatial information science (*e.g.* I. Foster and C. kesselman, 1999, 2004; Berman F, Fox G and Hey T, 2003; J. Joseph, C. Fellenstein, 2003). Aim to solve spatial resource sharing, this paper introduces this new technology in spatial resource management and organization.

In grid environment, resource refers to all the entities which can be request to access by users. Spatial resource refers to spatial data/information and spatial knowledge resource aggregation in grid environment. The complexity of spatial resources primarily reflects in the distribution of spatial resources, heterogeneous, the mass etc. The essence of spatial information/knowledge resource management in spatial information/knowledge grid is to make spatial information/knowledge resource to the maximum effectiveness. Spatial information/knowledge production and application must be compatible with the resources management and organization strategy.

2. SMALL WORLD, SCALE FREE NETWORK AND SPATIAL RESOURCE ORGANIZATION IN GIRD ENVIRONMENT

In the recent twenty years, Internet scale has grown exponentially, and has become a global coverage of the ultra-large-scale information network. In the future, such large-scale network environment, heterogeneity and mobility of spatial information/knowledge resources have been enhanced. The correct description of the current Internet network and spatial resource distribution characteristics undoubtedly plays a vital role in spatial resource organization in grid environment.

In the past 40 years, scientists are accustomed to regard all the complex networks as a random network. In recent years, following advancement of computer data storage capacity and data process ability and establishment of large-scale database, people regain the characteristics of real internet from its characteristics, and found that the real rules of the network is neither simple regular network, nor is random network, but shows certain laws. In 1998, several American scientists studied a series of complex systems, such as the Internet's behaviour and characteristics; found a number of complex networks have two basic characteristics, small scale-free topology and the small world（*e.g.*Watts D J,1998, 2004; Barabasi AL and Albert R., 1999).

From the structure of the Internet, its performance by the group, clustering and small world network model features. spatial resources interested to the public is very focused, which is mostly concentrated in some distribution nodes, and have a

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huge amount of resources to visit sites in the network in a star-burst pattern, the power law reveals that connections of different resources is polarization: most of the resource nodes' connections are not many, but a very small number of nodes' connections is far beyond conventional.

Compared with other network modes, scale-free network model takes the two characteristics into account. The first is growth characteristics: the size of network is constantly expanding, for example, there are many new resources joint to the World Wide Web every day. Priority of connection: that is, new resource nodes are inclined to connect to those nodes which have higher connectivity. This growth and priorities of internet is the inevitable trend of network evolution. The growth of network reflects the development trend of information society, and the priority connectivity reflects the characteristics in the network evolution.

The core thought of grid computing is to make resource on the web easy to use, ubiquitous and building the greatest exchange and sharing information network in our society. For spatial information/knowledge resource sharing and effectively use on the web, the scale-free and small world characteristics of internet has given us new inspiration. At present, social development and sustained economic growth put a huge demand to spatial information/knowledge resources. By ground -air integration spatial-time information acquisition system, there are more and more spatial data/information resources for human increasing or accumulating at a rapidly accelerating rate. Various communication technology advancement and communication network bandwidth increment, and large-capacity storage devices growing bring opportunities to spatial resource sharing and use. In this case, we must design a new mechanism for spatial information/knowledge resource sharing based on grid technology. In this new frame, we should fully take spatial resource characteristics on the web into account to organize resources rationality to raise the utilization rate of resources, especially in the vast information resources distributed storage space, content-targeted, information retrieval, data distribution and information filtering, data mining and knowledge discovery, and so on. Only in this way, can we be easily to achieve spatial information/knowledge resources sharing and utilization, and to provide spatial resources initiative, continuously available to users.

3. RESOURCE MANAGEMENT AND ORGANIZATION CHARACTERISTICS

The traditional data model and resource management and organizational model are derived from centralized system, and these models are difficult to competent to the dynamic, large-scale, distribution and complex spatial information / knowledge resources organization and management in grid environment. We believe that spatial information / knowledge resources management and organization have the following features in the grid environment:

Sharing: resources on the grid are the geographic distribution, but they can be fully shared. That is, any resources are available to users on the grid. Resource sharing is the purpose of grid technology, there is no true grid without resource sharing. To resolve resource sharing is the issue of grid technology. The meaning of this sharing here is very extensive. Spatial information/knowledge grid takes resource sharing as the main goal. According to the users demand, users can securely access heterogeneous information / knowledge resources on the grid without concerning its specific location. Distribution is merely physical characteristics of spatial resource, and sharing is logic characteristics of spatial information/knowledge resource to be achieved in grid environment.

Collaboration: resource collaboration is based on interconnection in grid environment, including the use of resources due to different users at any time and space, access and other differences arising from the consultations, and also including the combination of resources. Spatial information/knowledge grid is a collaborative working platform for the worldwide users and researchers. Spatial resource collaboration emphasizes on spatial services combination and job scheduling to solve spatial resource sharing.

Openness: same as internet, grid is also an open information carrier. As spatial resource sharing grid environment, spatial information grid is a very open environment. Any person may visit at any time, any space and access to information / knowledge resources. In fact, because of the existence of intellectual property rights protection, security and confidentiality of knowledge, and other restrictions, this openness is limited to person who may easily access to the authorized resources. Adopted a uniform standard agreement, users can access various spatial information / knowledge resources.

Stability: stability is the fundamentality of spatial information/knowledge resource management and organization in grid environment, and guarantees to efficient utilization of spatial resources. As spatial information/knowledge resources can be freely to join and leave on grid, so the availability of spatial resources is dynamic with time changes, each spatial resource contributed to the grid users is changing. Stability stresses on equality and cooperative management pattern for spatial resource management and organization in grid environment, grid resources or grid services is not only linked to each other, but also is independence. Any failure of resources or services will not affect the overall grid performance.

Virtuality: virtuality of spatial information/knowledge resource management embodies spatial information/knowledge virtualization. Heterogeneous transparency is achieved through virtualization (shielding spatial information/knowledge resource types), and location transparency (unknown resource access) and access transparency (resource access without consultation) are also achieved.

4. SPATIAL INFORMATION/KNOWLEDGE RESOURCE MODEL DESIGN

The essential of grid technology is to complete a task through the sharing resources of geographical distribution autonomy system. Therefore, how to overcome the heterogeneity of these resources and to provide scalable, dynamic and interoperable support is very important, and such is spatial information/knowledge resource management and organization to complete the function in grid environment. According to the roles of functions, there are three roles of spatial resource management in spatial information/knowledge grid; spatial resource providers, spatial resource users and spatial resource management and organization systems.

Resource providers: responsible for monitoring the status of resources and publicize resource status by regular form, and provide accessible spatial information/knowledge resource via grid services. These services have definitive access interface and agreement, explicit access semantic, and rationally deploy in the spatial information/knowledge management systems to the resource users.

Resource users: spatial information/knowledge users or application programs search the needed services through spatial information/knowledge management and organization systems, and make contractual relationship with resource provider by resource matching process to use corresponding services.

Spatial resource management and organization system: to provide description information of spatial information/knowledge resource and management and organization functions, and has a public access address and access agreements for space information / knowledge resources and users to access. Spatial resource organization is to solve how to organize spatial resource formally for users and application services to operate various resources effectively and correctly according to corresponding semantic to improve resource utilization efficiency. Resource standardized organization may be achieved through spatial resource model.

Spatial information/knowledge resources in different nodes can be regarded as a three-dimension space in grid environment, including spatial resource types, spatial resource levels and location coordinates, in which spatial resource types and levels can determine spatial resource content, and location coordinates can determine resource storage location（*e.g.* H.Zhuge, 2004). Only standardized organize spatial resources reasonably in grid environment, can we be more effectively achieve the goal of global distribution of spatial resource sharing and management.

5. SPATIAL RESOURCE MODEL OF SPATIAL INFORMATION/KNOWLEDGE RESOURCES

Spatial resource model of spatial information/knowledge resources is a knowledge-centric recourse management model based on grid technology, which is designed for the solution to the conflicts between spatial information/knowledge resources demand and utilization. From the point view of small-world and scale-free characteristics of complex network and the three topology properties (Power-law Distribution, Hierarchy, Rich-Club) of internet（*e.g.* Siganos G et al.2003; Sharad Jaiswal et al.2004; Shi Zhou and Raul J. Mondragon, 2004), we should learn something for spatial resource model of spatial information/knowledge.

Spatial information/knowledge production, management and application should have the correspondence information/knowledge resource organization and management strategy. Obviously, it is unreasonable that there is only one top level node in the grid environment, which take charge the others nodes, for any low level resource change may incur information update of the top level management node (*e.g.* Liu, 2004). There are many technologies which can be benefit to this problem（*e.g.* Diego Calvanese et al.,2004; Beng Chin Ooi et al.,2004; Z. Li et al.,2004). For example, P2P technology and agent technology maybe play some roles the spatial information/knowledge resource organization and management in the future. We bring forward virtual and dynamic hierarchical multi-layer resource organization and management strategy. Based on the thought of MLW (Multi-Local Worlds), the model regards the multi-local worlds as logic units in the gird environment, also as virtual areas. In the virtual areas, we take the nodes which have high congregation degree as super centre node, when any resource joins the internet, the resource node will priority search the nearest centre node, and joins to the correspondent virtual areas to form nature small world and power law properties. Using this property, the centre node would take charge of the management of resources in the network area. Such a network area is called as DAS (Domain Autonomy System). The nodes can join and leave the domain dynamically. The fine-grained services of data and knowledge resource are firstly provided in the local area autonomy system, and then considered in other area autonomy systems through coarse-grained service if the local area autonomy system can't meet the demand. Various DAS forms as a tree: there is a root node, several middle layers DAS, and series of leaves nodes. The nodes have peer relationships if there exist the same layers. In this way, it is convenience for the safe management and inherited right for the level nodes.

6. CONCLUSION

Grid technology is not only a new technology, but also is a new thought. The emergence of grid technology provides a new approach to spatial knowledge automatic acquisition and sharing. Spatial Information/Knowledge Grid is being developed on top of the existing Grid technology which can coordinate different spatial information resources to complete different tasks and applications (*e.g.* Y. W. Luo et. 2003; K. T. He et al., 2004). We must establish correspondence resource management and organization strategy and resource model. Spatial resource model plays an important role in spatial information/knowledge grid environment, in which users can present all kinds of requests for spatial information/knowledge resource and its process, and Spatial Information/Knowledge Grid can joint distributed spatial data, computing, network and software resources to cooperate and accomplish different users' requests.

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