VEGA Infrastructure for Resource Discovery in Grids

GONG YiLi (~), DONG FangPeng (~), LI Wei (~) and XU ZhiWei (~)
Institute of Computing Technology, The Chinese Academy of Sciences, Beijing 100080, P.R. China
E-mail: gongyili@ict.ac.cn
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Abstract Grids enable users to share and access large collections and various types of resources in wide areas, and how to locate resources in such dynamic, heterogeneous and autonomous distributed environments is a key and challenging issue. In this paper, a three-level decentralized and dynamic VEGA Infrastructure for Resource Discovery (VIRD) is proposed. In this architecture, every Border Grid Resource Name Server (BGRNS) or Grid Resource Name Server (GRNS) has its own local policies, governing information organization, management and searching. Changes in resource information are propagated dynamically among GRNS servers according to a link-state-like algorithm. A client can query its designated GRNS either recursively or iteratively. Optimizing techniques, such as shortcut, are adopted to make the dynamic framework more flexible and efficient. A simulator called SimVIRD is developed to verify the proposed architecture and algorithms. Experiment results indicate that this architecture could deliver good scalability and performance for grid resource discovery.

Keywords grid architecture, resource discovery, resource information propagation, Vega Grid

1 Introduction

A grid environment contains a large collection of different types of resource distributed in a wide area. These resources are owned and operated by various organizations with heterogeneous administrative policies. Resources can join and leave a grid at any time, and their status may change dynamically. Resource discovery, the problem of locating resources that satisfy users' requests efficiently and optimally, is an important and challenging issue in such a grid environment. A solution to the resource discovery problem must efficiently deal with scalability, dynamic changes, heterogeneity, and autonomous administration. In this paper, we will focus on the issues of scalability and dynamic change.

The Institute of Computing Technology is developing a number of integrated technologies and systems, jointly called VEGA Grid[1,2], to provide Versatile Service, Enabling Intelligence, Global Uniformity and Autonomous Control. This paper presents an approach to the grid resource discovery issue, called VEGA Infrastructure for Resource Discovery (VIRD). Our approach comprises a three-level architecture, a URN-based resource naming scheme, a two-level algorithm for propagating resource information changes, and two schemes for locating a resource recursively or iteratively.

The VIRD architecture is a three-level hierarchy: the top level is a backbone consisting of Border Grid Resource Name Servers (BGRNS); the second level consists of several domains and each domain consists of Grid Resource Name Servers (GRNS); the third level consists of all clients and resource providers. There is no central control in the VIRD. The backbone is responsible for inter-domain resource discovery. Within a domain, resource providers register themselves to GRNS servers, and clients acquire required resources through GRNS servers.

Some mechanisms are also proposed to adapt the VIRD to the dynamic characteristic of the grid. Resources are named as objects, i.e., attribution-value pairs. A link-state-like algorithm is used to update and propagate resource information quickly. A shortcut mechanism allows the topology of the GRNS servers to change dynamically.

We have developed a configurable, event-driven simulator called SimVIRD to verify our architecture and resource information propagation algorithm. Experiment results show that the viability of the VIRD approach depends largely on a metric called resource frequency, while being relatively insensitive to the size of a grid.

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The rest of this paper is organized as follows. Section 2 reviews existing work on resource discovery. Section 3 outlines the VIRD approach and explains its components and mechanisms in detail. Experiments with the SimVIRD are presented in Section 4. Section 5 offers the conclusions.

2 Related Work

There has been much work done in the field of resource discovery in grid environments.

The information service in Globus Project is MDS\textsuperscript{3,4}. First, the data representation in the directory service is globally uniform. In fact, every resource discovery and allocation system can have its own policies, and hence an identical information denotation would bring it some limitation and inconvenience. With the permission of a system-specific information organization, the system can optimize its database to improve convenience and achieve best storing and searching performance. Second, in the MDS architecture, information, along with information servers, is organized in the strictly tree-like topology with a comparatively fixed relationship; while the resource distribution may change dynamically. Third, generally, requests should be answered by remote servers storing the required resource information. If the information is locally available, the performance would be improved. Fourth, the directory service used is LDAP\textsuperscript{5}, which is designed for reading rather than writing, while in grid environments frequent changing may become a problem for this architecture.

The authors of [6] combine peer-to-peer technologies with grids and apply them to resource discovery. The P2P architecture is fully distributed and all the nodes are equivalent. But all request-forwarding algorithms they have proposed: random, experience-based plus random, best neighbor or experience-based plus best-neighbor, cannot change the plight that every node has little knowledge about the distribution of resources within the grid and their status. So, generally, they are less effective. In particular, when the types of requested resources are vast and the work set is very big, the miss rate increases because the past experience does not work.

[7] presents a grid resource discovery model based on the routing transferring method, in which all the routers are automatic and have no difference structurally, and the adopted algorithm is RIP-like distance vector routing algorithm. The problems of the algorithm will be discussed in detail in Subsection 3.2.2.1.

Next section will present our resource discovery framework in three main aspects: resource naming, resource information propagation and resource discovery, where several approaches that have been used by other distributed systems, e.g., IP routing systems, DNS, etc., are referenced.

3 The VIRD Approach

VIRD adopts a three-level hierarchy as shown in Fig.1: the top level is a backbone consisting of Border Grid Resource Name Servers (BGRNS); the second level has several domains and each domain consists of Grid Resource Name Servers (GRNS); and the third level consists of leaves which include all clients and resource providers.

- A Border Grid Resource Name Server (BGRNS) has connections to both the backbone and one or several domains, and exchanges information with them. When locating resources, BGRNS servers forward requests among domains and help to find out qualified resources.
- A Grid Resource Name Server (GRNS) dynamically collects information about resources registered to it, and spreads information to other GRNS servers. A GRNS receives requests from

![Fig.1. The three-level VIRD architecture: A backbone, domains and leaves.](image-url)