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Review

Resource discovery mechanisms in grid systems: A survey

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ABSTRACT

Grid computing systems provide a vast amount of computing resources from multiple administrative domains to reach a main objective. One of the most important challenges in these systems is to discover appropriate resource in networks. In this paper we survey the resource discovery mechanisms which have been used in Grid computing systems so far. We classify the resource discovery mechanisms into five main categories: Centralized, Decentralized, Peer to Peer, Hierarchical, and Agent based. We reviewed the major development in these five categories and outlined new challenges. This survey paper also provides a discussion of differences between considered mechanisms in terms of scalability, dynamicity, reliability and queries' attributes as well as directions for future research.

Contents

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1. Introduction

The term "Grid" was coined in the mid 1990s offering access to a vast collection of heterogeneous resources as a single, unified resource to solve large-scale computing and data intensive problems for advanced science and engineering (Balasangameshwara and Raju, 2012; Erdil, 2012; Ian Foster and Kesselman, 1999; Siva Sathya and Syam Babu, 2010). Some examples of Grid computing systems are NASA IPG (Johnston et al., 1999), the World Wide Grid,[1] HealthGrid (Naseer and Stergioulas, 2010), and Selenium-Grid.[2] After almost 20 years of development, Grid computing has made many varieties, such as computational Grid which denotes systems that have higher aggregated computational capacity available for single applications; data Grid which provides an infrastructure for synthesizing new information from data repositories such as digital libraries or data warehouses that are distributed in a wide area network; information Grid which is the integration of information across heterogeneous data sources; service Grid which provides services that cannot be provided by any single machine; wireless Grid which enables wireless and mobile users to share computing resources, services, and information (Moreno-Vozmediano, 2009); A multimedia Grid which provides an infrastructure for real-time multimedia applications and cloud computing (Krauter et al., 2002).

The Grid architecture adopts a layered structure that corresponds to the Internet protocol architecture (Fig. 1). The Grid architecture consists of four layers: fabric, connectivity, collective and application layer. The fabric layer in this structure refers to a set of resources or devices, including computers, storage systems, networks, and various types of computer-controlled instruments and devices. The Connectivity layer defines core communication and authentication protocols required for Grid-specific network transactions (Foster et al., 2001). The Resource layer is built on Connectivity layer communication and authentication protocols to define protocols for the secure negotiation, initiation, monitoring, control, accounting, and payment of sharing operations on individual resources (Foster et al., 2001). Above the resource and connectivity layers, the collective layer contains protocols, services, and APIs that implement interactions across collections of resources, therefore collective layer coordinates multiple resources (Wang et al., 2009) that provide facilities to access some useful services such as resource discovery and management. The final layer in Grid architecture is the application layer which comprises the user applications (Foster et al., 2001).

In Grid, there are many types of resources such as computers, cluster of computers, online tools, storage space, data, and applications (Iamnitchi and Foster, 2001) which are widely distributed and heterogeneous in comparison to traditional and cluster systems. Resource discovery is one of the essential challenges in Grid, which discovers appropriate resources based on the requested task. There are certain factors that make the resource discovery problem difficult to solve. These factors are the huge number of resources, distributed ownership, heterogeneity of resources, resource failure, reliability, dynamicity and resource evolution (Hameurlain et al., 2010). These factors are essential criteria for designing a good resource discovery mechanism.

In this paper, we divided most of the introduced resource discovery algorithms into five main categories, centralized, decentralized, peer to peer, hierarchical, and agent-based. This paper provides a survey on resource and service discovery mechanisms in Grid systems and compares the differences between mentioned mechanisms and describes several popular resource discovery mechanisms. Also a taxonomy to differentiate between considered mechanisms is provided.

The rest of this paper is structured as follows. The basic concepts and terminologies are provided in the next section. Section 3 discusses resource discovery mechanisms in Grid system and categorizes them. Section 4 presents the taxonomy and comparison of proposed mechanisms. Section 5 maps out some open issues. Finally Section 5 concludes this paper.

2. Basic concepts and related terminologies

This section introduces the basic concepts and related terminologies which are used in this paper. We explain the following concepts and terminologies:

Scalability: scalability is one of the important issues for designing resource discovery mechanisms. It defines the ability of a resource discovery mechanism to handle a growing amount of Grid systems with predefined level of efficiency.

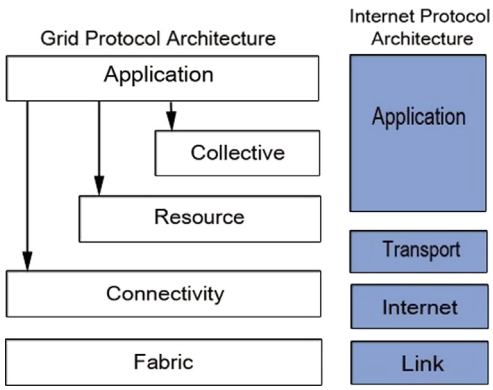

Fig. 1. Grid architecture compared with internet architecture (Ian Foster et al., 2001).

[1] http://www.buyya.com/ecogrid/wwg/.
[2] www.selenium-grid.seleniumhq.org.