

Chapter 1.8

Architectural Elements of Resource Sharing Networks

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ABSTRACT

This chapter first presents taxonomies on approaches for resource allocation across resource sharing networks such as Grids. It then examines existing systems and classifies them under their architectures, operational models, support for the life-cycle of virtual organisations, and resource control techniques. Resource sharing networks have been established and used for various scientific applications over the last decade. The early ideas of Grid computing have foreseen a global and scalable network that would provide users with resources on demand. In spite of the extensive literature on resource allocation and scheduling across organisational boundaries, these resource sharing networks mostly work in isolation, thus contrasting with the original idea of Grid computing. Several efforts have been made towards providing architectures, mechanisms, policies and standards that may enable resource allocation across Grids. A survey and classification of these systems are relevant for the understanding of different approaches utilised for connecting resources across organisations and virtualisation techniques. In addition, a classification also sets the ground for future work on inter-operation of Grids.

INTRODUCTION

Since the formulation of the early ideas on meta-computing (Smarr & Catlett, 1992), several research activities have focused on mechanisms to connect worldwide distributed resources. Advances in distributed computing have enabled the

creation of Grid-based resource sharing networks such as TeraGrid (Catlett, Beckman, Skow, & Foster, 2006) and Open Science Grid (2005). These networks, composed of multiple resource providers, enable collaborative work and sharing of resources such as computers, storage devices and network links among groups of individuals and organisations. These collaborations, widely known as Virtual Organisations (VOs) (Foster,

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Kesselman, & Tuecke, 2001), require resources from multiple computing sites. In this chapter we focus on networks established by organisations to share computing resources.

Despite the extensive literature on resource allocation and scheduling across organisational boundaries (Butt, Zhang, & Hu, 2003; Grimme, Lepping, & Papaspyrou, 2008; Iosup, Epema, Tannenbaum, Farrellee, & Livny, 2007; Ranjan, Rahman, & Buyya, 2008; Fu, Chase, Chun, Schwab, & Vahdat, 2003; Irwin et al., 2006; Peterson, Muir, Roscoe, & Klingaman, 2006; Ramakrishnan et al., 2006; Huang, Casanova, & Chien, 2006), existing resource sharing networks mostly work in isolation and with different utilisation levels (Assunção, Buyya, & Venugopal, 2008; Iosup et al., 2007), thus contrasting with the original idea of Grid computing (Foster et al., 2001). The early ideas of Grid computing have foreseen a global and scalable network that would provide users with resources on demand.

We have previously demonstrated that there can exist benefits for Grids to share resources with one another such as reducing the costs incurred by over-provisioning (Assunção & Buyya, in press). Hence, it is relevant to survey and classify existing work on mechanisms that can be used to interconnect resources from multiple Grids. A survey and classification of these systems are important in order to understand the different approaches utilised for connecting resources across organisations and to set the ground for future work on inter-operation of resource sharing networks, such as Grids. Taxonomies on resource management systems for resource sharing networks have been proposed (Iosup et al., 2007; Grit, 2005). Buyya et al. (2000) and Iosup et al. (2007) have described the architectures used by meta-scheduler systems and how jobs are directed to the resources where they execute. Grit (2005) has classified the roles of intermediate parties, such as brokers, in resource allocation for virtual computing environments.

This chapter extends existing taxonomies, thus making the following contributions:

- It examines additional systems and classifies them under a larger property spectrum namely resource control techniques, scheduling considering virtual organisations and arrangements for resource sharing.
- It provides classifications and a survey of work on resource allocation and scheduling across organisations, such as centralised scheduling, meta-scheduling and resource brokering in Grid computing. This survey aims to show different approaches to federate organisations in a resource sharing network and to allocate resources to its users. We also present a mapping of the surveyed systems against the proposed classifications.

BACKGROUND

Several of the organisational models followed by existing Grids are based on the idea of VOs. The VO scenario is characterised by resource providers offering different shares of resources to different VOs via some kind of agreement or contract; these shares are further aggregated and allocated to users and groups within each VO. The life-cycle of a VO can be divided into four distinct phases namely creation, operation, maintenance, and dissolution. During the creation phase, an organisation looks for collaborators and then selects a list of potential partners to start the VO. The operation phase is concerned with resource management, task distribution, and usage policy enforcement (Wasson & Humphrey, 2003; Dumitrescu & Foster, 2004). The maintenance phase deals with the adaptation of the VO, such as allocation of additional resources according to its users' demands. The VO dissolution involves legal and economic issues such as determining the success or failure of the VO, intellectual property and revocation of access and usage privileges.

The problem of managing resources within VOs in Grid computing is further complicated

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