Chapter XIII

The Grid for Nature–Inspired Computing and Complex Simulations

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ABSTRACT

This chapter deals with the usage of grid technologies for nature-inspired algorithms and complex simulations. After shortly introducing the grid and its technological state of the art, some features are pointed out in order to set the boundaries of the applicability of such new technology to the matters of interest. Then two paragraphs show some possible usages of grid technologies. The first one introduces the master-worker paradigm as a conceptual and technological scheme that helps in solving issues related to dynamic optimisation via nature-inspired algorithms and in exploring the parameters space of complex simulations. The following paragraph concerns two other points: the possibility to distribute agents of agent-based simulations using multi-agent systems; and the boundaries, architectures, and advantages in distributing parts of complex simulations which are heavy from the computational point of view. The chapter, as a whole, acts as a guide presenting applicative ideas and tools to exploit grid technological solutions for the considered purposes.

INTRODUCTION

Among the many novelties developed in ICT, the *grid* has emerged as one of the most radical and promising, aiming to modify the established standards in computing.

The basic idea of the grid is, as well known, the possibility to develop and implement a widespread network of computing services, easily accessible from anywhere, taking as a model the structure of power grids for distributing electricity. In such kind of information infra-

structure, it should not be relevant where the computing power is geographically located and computing therefore becomes a commodity.

The grid is a new paradigm that makes possible already known computing paradigms such as parallel and distributed computing in a more general framework based on common standards and on grid services.[1] Such services are not just useful for performing better computations in terms of time, but also to share any kind of resources (for instance databases and scientific tools) among any kind of virtual organisation.

While the social and organisational impact of the new concepts implied by the grid (in particular the transformation of computing in a commodity) are still to be explored and they actually belong more to possible future scenarios than to real ones, it is worth noting the state of the art of the technologies developed in the field.

Since the main ideas of the grid have been presented to the scientific community, a decade characterised by many research projects has passed away and it is nowadays possible to exploit the first elements of such infrastructure: many grids have been developed by different scientific communities, and a considerable amount of software is available to develop new grids and services.

Thus, grid computing is not a dream but something real, though it is worth adding that the usage of the grid is nowadays not *easy*. In fact, referring to the current issues in exploiting the new technology, the actual phase of development and evolution must be carefully considered: after less than a decade of development, the technology is not usable by every potential end user because of the software available, which is mainly middleware that must be managed by professionals.

But even if the problem of easiness of usage does not affect every potential user (e.g., institutions and organizations where computing departments have human resources with the needed skills), other issues are now preventing the fast diffusion of the grid, mainly its lack of standards and the few fields for which it has been used and thus for which it has shown its sound advantages. These issues are nowadays considered critical and in fact new standards, such as the open grid services architecture—OGSA (Foster, Kesselman, Nick, & Tuecke, 2002; Foster, Kesselman, & Tuecke, 2004) and the open grid services infrastructure—OGSI (Tuecke et al., 2003), and many new projects are under fast development and diffusion.

This chapter considers both available technologies and already started projects, but it is not a generic introduction on the theme[2]: it deals with possible usages of the technology on specific topics.

In fact, while grid technologies can be applied in every field of research and for any kind of purpose characterised by the need of an intensive usage of computing power, here the focus is on the exploitation of the tool in the overlapping fields of nature-inspired computing and complexity, aiming to answer research and organisational questions.

Considering such kind of aim, it is worth underlining how the mentioned fields of research are overlapping and closely connected, and moreover how they call for contributions from several other research fields, from distributed artificial intelligence to operational research.

Moreover, another important issue should be considered: grid technologies, even if thought and designed to radically modify the computing paradigm for all possible kinds of purpose, have been mainly developed and applied in some fields which are intrinsically different from the ones we are talking about.

For instance, the largest part of projects, software, infrastructure, and research funds

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