

# Preface

For more than a decade, the development of grid computing was driven by scientific applications. The need to solve large-scale, increasingly complex problems motivated research on grids systems. Many interesting problems have been solved with the help of grids, for instance, the nug30 Quadratic Assignment Problem.

This challenging optimization problem was posed in 1968 and requires, given a set of  $n$  facilities, a set of  $n$  locations, a distance specified for each pair of locations, and a flow (weight) specified for each pair of facilities (e.g., the amount of supplies transported between the two facilities), assigning all 30 facilities to the 30 different locations with the goal of minimizing the sum of the distances multiplied by the corresponding flows.

Despite its apparent simplicity, the problem is NP-Hard, and the number of possible assignments is extremely large, so that even if you could check a trillion assignments per second, this process would take over 100 times the age of the universe. However, once the algorithms and software necessary to tackle the previously unsolved problem on a computational grid were developed, solving the problem required nearly a week, with a computational endeavor involving more than 1,000 computational resources working simultaneously at eight institutions geographically distributed in different parts of the world.

The FightAIDS@Home project, which is based on the volunteered computing power of the World Community Grid, aims at testing candidate compounds against the variations (or “mutants”) of HIV that can arise and cause drug resistance.

During November 2009, the project identified several fragments as new candidates for a novel binding site on the peripheral surface of HIV protease. These fragments docked well against the “exo site” and in vitro studies (i.e., “wet lab” experiments in test tubes) will assess their potencies. If these wet lab experiments produce promising results, then these fragments could form the foundation for the development of “allosteric inhibitors” of HIV protease (i.e., “flexibility wedges” that can disrupt the conformational changes that HIV protease must undergo in order to function). These allosteric inhibitors could represent a totally new class of anti-AIDS compounds.

These two examples clearly explain why scientists are now routinely supported in their research by grid infrastructures. But what about business and casual users?

Although projects such as BEinGRID have reported some successful business experiments that may profit from execution in grid environments, it appears that there is not a general business case for the grid. However, recent advances in virtualization techniques, coupled with the increased Internet bandwidth now available, led in 2007 to the concept of cloud computing. The emergence of this new paradigm is mainly based on its simplicity and the affordable price for seamless access to both computational and storage resources.

Virtualization enables cloud computing, providing the ability to run legacy applications on older operating systems, creation of a single system image starting from an heterogeneous collection of machines such as those traditionally found in grid environments, and faster job migration within different virtual machines running on the same hardware. For grid and cloud computing, virtualization is the key for provisioning and fair resource allocation. From the security point of view, since virtual machines run isolated in their sandboxes, this provides an additional protection against malicious or faulty codes.

Clouds provide access to inexpensive hardware and storage resources through very simple APIs, and are based on a pay-per-use model, so that renting these resources is usually much cheaper than acquiring dedicated new ones. Moreover, people are becoming comfortable with storing their data remotely in a cloud environment. Therefore, clouds are being increasingly used by scientists, small and medium sized enterprises, and casual users.

Grids, clouds, and virtualization are exciting technologies that are going to become prominent in the next few years; we expect a wide proliferation in their use, especially clouds since these distributed computing facilities are already accessible at a reasonable cost to many potential users. We also expect grids and clouds to play an ever increasing role in the field of scientific research. It is therefore necessary a thorough understanding of principles and techniques of these fields, and the main aim of this book is to foster awareness of the essential ideas by exploring current and future developments in the area.

The idea of writing this book dates back to the highly successful Grids, Clouds and Virtualization Workshop that we organized in conjunction with the 4th International Conference on Grid and Pervasive Computing (GPC 2009) held in Geneva, 4–8 May 2009. We were contacted by Mr. Wayne Wheeler of Springer, and, after an insightful discussion, we agreed to serve as the editors for the book. Indeed, it is virtually impossible for a single person to write a book covering all of the important aspects of grids, clouds, and virtualization while maintaining the required depth, consistency, and appeal.

We invited many well-known and internationally recognized experts, asking them to contribute their expertise. The book delves into details of grids, clouds, and virtualization, guiding the reader through a collection of chapters dealing with key topics. The bibliography rather than being exhaustive, covers essential reference material. The aim is to avoid an encyclopedic approach since we believe that an attempt to cover everything will instead fail to convey any useful information to the interested readers, an audience including researchers actively involved in the field, undergraduate and graduate students, system designers and programmers, and IT policy makers.

The book may serve both as an introduction and as a technical reference. Our desire and hope is that it will be useful to many people familiarizing with the subject and will contribute to new advances in the field.

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