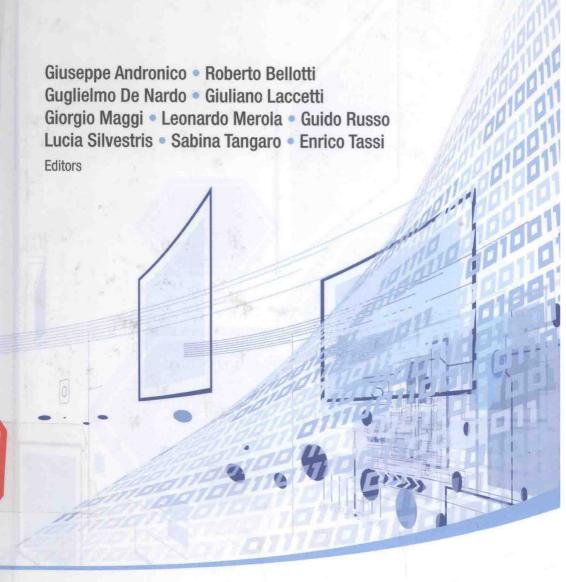
High Performance Scientific Computing Using Distributed Infrastructures

Results and Scientific Applications Derived from the Italian PON ReCaS Project





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Foreword

Started in October 2011 and completed in summer 2015, the ReCaS project was funded by the Italian Ministry of Research and Education (MIUR) through the Italian national *Programma Operativo Nazionale* (National Operational Programme, PON) for "Research and Competitiveness" (PON R&C) 2007–2013 Call 254 Action I "support for structural changes and scientific & technological improvement for a transition towards a knowledge economy" for the development and enhancement of a distributed computing infrastructure of Grid/Cloud type over the four EU "Convergence" regions in Southern Italy: Campania, Puglia, Sicily, and Calabria.

The acronym ReCaS stands for "Rete di Calcolo per SuperB e altre applicazioni" (Computing network for SuperB and other applications). The SuperB was a Istituto Nazionale Fisica Nucleare (INFN) project for a new accelerator in the Rome area that has been cancelled by the Italian government due to budget limitations. Now ReCaS is a computing network infrastructure in Southern Italy devoted to scientific and non-scientific applications within the vision of a common European infrastructure for computing, storage, and network.

The actuators are the University of Naples Federico II, the University of Bari Aldo Moro and the Italian National Institute of Nuclear Physics (INFN) with its "sections" in Naples, Bari, Catania, and Cosenza. In Catania and Cosenza sites, there are fundamental operational synergies with the University of Catania and the University of Calabria, respectively.

A lot of experience in the context of previous PON 2000-2006 program, INFN and UE grid projects, has been fully exploited, e.g., SCoPE project in Naples, PI2S2 in Catania.

The main objective of the project is a better integration of the various initiatives already present in Southern Italy, carried out by research and academic institutions, including INFN and Universities. High throughput computing (HTC) and high performance computing (HPC), big data preservation in the medium and long term, need a national infrastructure federated between the various actors in Italy in order to be internationally competitive and integrated in a European Grid/Cloud infrastructure.

As an outcome of the ReCaS project, the present book is published by the World Scientific Publishing and it includes contributions from all the people who used (or collaborate to its maintenance) the ReCaS computing and storage resources for scientific and technological research activities from different scientific domains and applications, e.g., Materials Science and Technology, Aerospace Science and Technology, Mathematics and Computer Science, Chemistry, Life Science, and so on.

All the contributions are organized in different Sections: the first Section collects contributions describing the infrastructure in all its parts (from the hardware description to the policies used for user recruitment and support); the second one collects the contributions which are an overview on the type of applications using the ReCaS infrastructure. Each of the remaining sections collects contributions from a specific scientific/technological domain: Physical Science, Life Science, Engineering, Earth Science, Computer and Computational Science. In the "Physical Science" section there are contributions from the High Energy Physics domain related with the ATLAS, ALICE and The Belle II experiments. In the same section, contributions related with astronomical studies (the KM3Net experiment) and research on non-commutative geometry are also presented. The "Life Science" section includes contributions related to a new approach for the Study of Melanogenesis, the study of the structure of chromosomes in the nucleus of cells and the use of neural network to model complex biological phenomena. In the "Engineering" section are presented contributions from different engineering fields of interest: the building responses to an earthquake event; the computational simulation of rheology processes; the "in silico" analysis of architectures for the naval and aerospace worlds. In the "Earth Science" section, two contributions are present: the first one discusses results about the numerical simulation of seismic ground motion during the 2009 L'Aquila earthquake, the second one describes the results of the first section related with a new numerical approach for simulation of subsurface hydrological processes. Finally, the "Computer and Computational Science" section collects a first contribution related with a Scalability Analysis of Variational Data Assimilation Algorithms on Hybrid Architectures. All the other contributions in this section are related with the development of tools for the management, monitoring and use of the ReCaS infrastructure resources.

All of the above papers address original research and design and maintenance in the broad field of the HPC systems and environments and several science fields. We collected them with the aim to prepare a volume that could serve as resource for education, information, and reference to professors, researchers, graduate students and the more general HPC community. The editors would like to express their gratitude to the referees for their dedication and expert work in reviewing these papers. Last but not least, we are grateful to all authors for their contributions. We hope that readers will enjoy this volume as much as we enjoyed preparing it.

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> Naples September 2016

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