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European actions for High-Performance Computing: PRACE, DEISA and HPC-Europa

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Summary. — Between e-Infrastructures, ESFRI has identified in FP7 High-Performance Computing a strategic priority for Europe. In order to have the highest return from the associated massive economical and political commitment, HPC resources must be exploited at the highest level. Their access must be effective and capillary, their services must allow more and more people to use the resources, regardless their geographical location. Projects like PRACE, DEISA and HPC-Europa have been supported by the EU to cope with such issues providing the best solutions for the European research community.

PACS 07.05.Bx – Computer systems: hardware, operating systems, computer languages, and utilities.

1. – Introduction

Building a world-class pan-European High Performance Computing (HPC) Service is a highly ambitious undertaking that involves governments, funding agencies, centres capable to host and manage the supercomputers, and the scientific and industrial user communities with leading edge applications. In contrast to Research Infrastructures that focus on a single scientific instrument an HPC Infrastructure has two unique characteristics: supercomputers serve all scientific disciplines and high-end (hereafter tier-0) supercomputers have a fast (typically, three years) depreciation cycle since they address leading edge services.

This requires a periodic renewal of the systems and a continuous upgrade of the infrastructure. Furthermore, novel architectures and system designs are continuously created by the vendors for leadership systems. Finally, at any given time a number of different systems are available each of them serving a particular application spectrum best.

This fact mandates a distributed Pan-European Research Infrastructure, since no single site can host all the necessary systems because of floor space, power, and cooling demands.

In the last years, the European Commission has strongly supported the path toward such infrastructure, funding a few core projects with the goal of designing, implementing

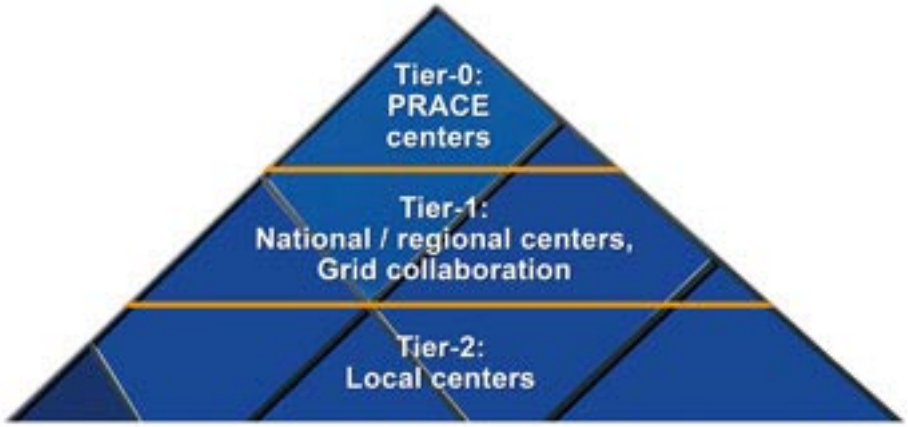

Fig. 1. – The pyramid model promoted by PRACE.

and deploying it, creating, at the same time, the awareness, the skills and the competencies necessary for its optimal exploitation.

CINECA is involved in all these projects, namely PRACE, DEISA (and its follow-up DEISA2) and HPC-Europa (and its follow-up HPCE2), representing the bridge between the national HPC reality, in particular for scientific research, and the corresponding continental framework and the new services becoming progressively available.

2. – PRACE

PRACE, the Partnership for Advanced Computing in Europe (`http://www.prace-project.eu/`), has the goal of preparing the creation of a persistent pan-European High-Performance Computing (HPC) Service and Infrastructure. This infrastructure will be managed as a single European entity. In other words, the partnership will become a unique entity of the pan-European HPC ecosystem. European scientists and technologists will be provided with world-class supercomputers with capabilities comparable to the largest systems available worldwide. The service will comprise three to five superior HPC centers strengthened by regional and national supercomputing centers. The infrastructure will be complemented with network and grid access, and the services required to enable applications. These include development of parallel application software expertise, packages, and data handling. It will build on the partners experience and use concepts and services from EC-funded projects such as GEANT2 and DEISA (see next section).

The European model of a sustainable high-performance ecosystem promoted by PRACE consists of a small number of supercomputer centres offering computing service at the highest performance level; national and regional centres with supercomputers offering the performance to run most of the advanced computing; and the local computing centres in universities, research labs or in other organizations strengthening software development and researchers competence in computational science. This results in the pyramid architecture sketched in fig. 1.

PRACE is now focussed in studying the implications of the persistency and sustainability of such infrastructure. This implies the implementations of a continuous evalu-

ation and procurement process of the tier-0 systems, the deploy of prototype systems, the build-up of structured relationships with vendors to gather strategic information in advance, the set-up of a governance and a management system and the set-up of enabling actions on scientific applications for future tier-0 systems.

In parallel, using the results of these activities PRACE will prepare the deployment of Petafop/s system in 2009/2010 to be installed in a few tier-0 sites. CINECA has recently joined the lists of candidate sites for hosting tier-0 systems and has scheduled the deploy of its tier-0 system in the 2011/2012 time frame.

3. – DEISA

DEISA (Distributed European Infrastructure for Supercomputer Applications - `http://www.deisa.eu`) is a consortium of eleven major national supercomputing centres in Europe. The involved sites are FZJ-Julich, LRZ, HLRS and RZG Garching (Germany), ECMWF and EPCC (UK), IDRIS-CNRS (France), CSC (Finland), CINECA (Italy), BSC (Spain) and SARA (The Netherlands). The partners in this project consider it their mission and their responsibility to provide visionary leadership in the area of high-performance computing in Europe. Therefore, the consortium decided to create and operate a distributed petascale supercomputing facility, whose integrated power has reached several hundreds of teraflops in 2008. The principal objective of this Integrated Infrastructure Initiative (I3 - `http://cordis.europa.eu/infrastructures/home.html`) is to advance computational science in leading scientific and industrial disciplines by deploying an innovative Grid-empowered infrastructure to enhance and reinforce High-Performance Computing in Europe. This super-cluster with appropriate software and with dedicated high-speed networks, represents a way open, in the immediate future, for innovative and creative thinking that enhances the impact of existing infrastructures (see fig. 2). It is assumed that this approach will provide answers to a number very demanding requirements arising from the scientific community. The DEISA infrastructure is based on the tight coupling of homogeneous (with respect to architecture and system software) national supercomputers, to provide a distributed supercomputing platform operating in multi-cluster mode. The production capability of the distributed platform provides a substantial European added value to the existing national infrastructures.

Leading scientists across Europe are exploiting the bundled supercomputing power and the related global data management infrastructures in a coherent and comfortable way. A special focus is set on grand-challenge applications from key scientific areas like material sciences, climate research, astrophysics, life sciences and fusion-oriented energy research. Since 2005, the focus has been enhanced by defining the DEISA Extreme Computing Initiative (DECI, `http://www.deisa.eu/science/deci`, see also sect. **3**). The DEISA research infrastructure is also open, under certain conditions, to users of non-member organisations.

DEISA is collaborating with a large number of projects or institutions in Europe. The first priority has been cooperation with other EU funded infrastructure projects in HPC (HPC-Europa, `http://www.hpc-europa.org/`) or Grid computing (EGEE, `http://www.eu-egee.org/`). DEISA also deploys very close collaborations with other projects emerging in the R&D area in particular.

The United States are also deploying a technology-driven, grid-empowered infrastructure, TeraGrid (`http://www.teragrid.org/`). In this project, five computing systems across the country are integrated to form a unique, single-system platform using very high-bandwidth, dedicated networks to guarantee highest performance. DEISA can be

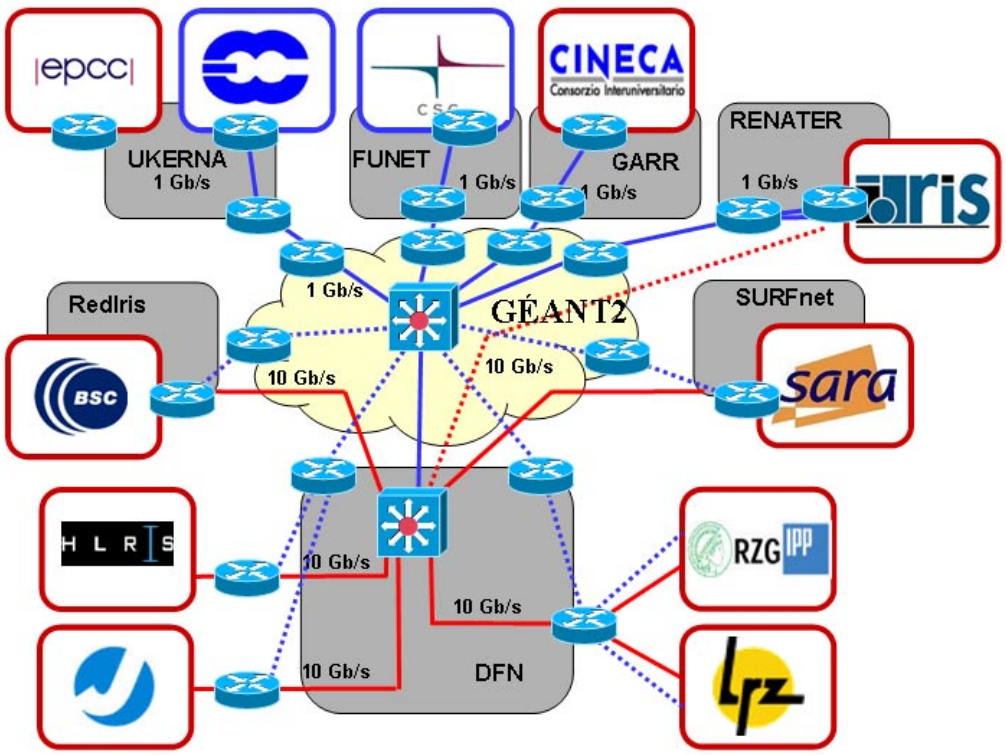

Fig. 2. – The DEISA HPC Grid with the continental filesystem.

seen as the European counterpart to TeraGrid. Though implementation strategies are not identical, close collaboration with TeraGrid is ongoing.

4. – HPC-Europa

If PRACE addresses the design and the management of the European HPC infrastructure and DEISA provides its technological implementation, HPC-Europa (`http://www.hpc-europa.eu/`) enables the access to the European HPC facilities and promotes the diffusion of the know-how and the exchange of competencies and skills.

The main goal of HPC-Europa is the support to Transnational Access, that is to enable researchers from all over Europe to visit a participating research institute, to carry out a collaborative visit of several months and to gain access to some of the most advanced European High-Performance Computing facilities, having consultancy and support provided by experienced staff.

Over the four years lifespan of the action, HPC-Europa is providing HPC service, specialist support, scientific tutoring and collaboration opportunities to more than 1000 European researchers, a very large community of users, providing them with more than 22 million of CPU hours of computing time.

An interesting side-outcome of the project results to be the design, implementation and adoption of an effective and efficient model for reviewing and selection of researchers

and HPC-based research projects that could be proposed to, and exploited by the next generation petascale facility in Europe and beyond and, in particular, by PRACE. Such model, once validated by the European E-Infrastructures community, could represent a possible subject of discussion even with extra-European centers and projects working in the field.