

HPCLatAm: Towards the integration of the research communities on High Performance Computing in the Latinamerican Southern Cone

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Abstract

This article describes the main activities within the HPCLatAm initiative, which is devoted to the integration of the research communities on High Performance Computing in Latin American Southern Cone. A brief historical review about the recent development of the High Performance Computing research communities in Argentina, Chile, and Uruguay is presented, including information about present e-infrastructure. After that, the current activities of the HPCLatAm initiative are introduced, including the main highlights of the 2012 editions of the HPCLatAm Symposium, the HPC day, and the HPC School. Finally, the main ideas about the work lines needed to guarantee the success and impact of the HPCLatAm initiative are commented.

1 Introduction

During the last decades, High Performance Computing (HPC) has emerged as a fundamental discipline highly regarded in many scientific domains, especially in those posing very challenging problems that usually requires large computing resources to perform [1, 4].

The HPC term covers a wide range of topics, from those concerning the most powerful supercomputers in the world to any computer system larger than a regular desktop PC used for modeling and simulation. Notwithstanding, its application is broader than simply modeling and simulation, and covers large-scale data processing, real-time HPC and other applications that broaden day to day [13].

Over the past fifty years, modeling and simulation have come to complement theory and experiment as a key component of the scientific method. Meantime, the digital revolution of the past two decades has led to unprecedented demands for high-performance data-processing systems.

Much of the future developments in science and industry will surely rely on HPC simulations. HPC is an established and essential tool, and already has a major impact on industry and commerce, as well as in society. New applications are able to exploit HPC are constantly emerging. The benefits of HPC go beyond a positive return on investment. Improvements in healthcare, development of efficient transportation systems, quest for renewable and clean energy sources, and support to decision making through fast real-time simulations on live data in emergency response are examples of how HPC can have a major social impact.

HPC is indeed a key technology to increase competitiveness in science and industry. This fact is well understood by many countries (e.g. USA, China, Japan, and European Union), which invest several billion dollars a year in HPC.

There is a clear need to move beyond the current situation and join experts from industry (on both supply/services and user side), from the mathematical and physical sciences, and from computing sciences in interdisciplinary task forces to take a step forward. *No single community can do this alone: the only plan for success is a joint effort.*

In South America, HPC research and facilities have steadily developed in the last twenty years. Brazil has been the clear leader in research and use of HPC for decades, being the only Southamerican country ranking in the TOP500 list, since 1997. On the other hand, despite their differences in size and economy, Argentina, Chile, and Uruguay have been doing major efforts to build, consolidate, and grow their local HPC communities, since the mid 1990's.

This article presents an overview of the development of the HPC communities in Argentina, Chile, and Uruguay. After that, the HPCLatAm initiative, which aims at integrating the HPC research communities in the Latinamerican Southern Cone, is described. The perspectives about the integration of HPC communities in our region are presented, and brief conclusions are drawn.

2 HPC in Argentina, Chile, and Uruguay

This section shows an overview of the recent history in the development of HPC in Argentina, Chile, and Uruguay. The current state of infrastructure and adoption of this technology is also mentioned for each country.

2.1 HPC in Argentina

HPC development in Argentina can be tracked to mid 1990, when the first clusters were installed (e.g. in Centro Internacional de Métodos Numéricos en Ingeniería, Santa Fé, and Facultad de Ciencias Exactas y Naturales, Univ. de Buenos Aires). Since then, HPC has been increasingly adopted in all fields of science and engineering. During the last decade, two main projects have supported the consolidation of the HPC community: the Argentinian National Academic Network (Innova-Red) and the Argentinian National HPC System (SNCAD), which are described next.

2.1.1 The Argentinian NREN: Innova-Red

Innova-Red is a project of Innova-T, an NGO founded by CONICET (National Council for Science and Technology). The purpose of Innova-Red is to provide the educational and research community with the most modern means to perform tasks that require data transmission. Innova-Red allows the academic and scientific community of Argentina to connect and communicate with the international academic community and research centers worldwide. Innova-Red is part of RedCLARA and has been partner of e-Infrastructure projects EELA, EELA-2, and GISELA [3].

2.1.2 National HPC System

Argentina National HPC System (SNCAD) was created in 2010 as a joint initiative of Science Technology and Productive Innovation Ministry (MINCYT) and the Inter-agency Council of Science and Technology. Its goal is to build a National Interconnected Computing Service. Currently, it is engaged in developing a national network of HPC centers connected to Innova-Red, to meet the growing demand for science and technology community in the areas of storage, grid computing, high performance, visualization and other emerging technologies.

The general goals of the program are:

- to share the large computing facilities acquired using public funding;
- to foster open access, primary data and information visibility for the research paid with public funding;
- to promote the overall optimization of the Technological and Scientific National Complex;

- to improve the efficiency in the usage of the equipment and the quality of the services being done with them.

Centers that are part of the SNCAD system are categorized either as *grid centers*, *computing centers* and *integral centers*. The main characteristics of each category are:

- *Grid centers*: must be part of the National Grid, should develop Grid middleware and Grid distributed applications, and must offer CPU time to the Grid community;
- *Computing centers*: must offer computing services to external researchers, and at least 20% of their resources should be allocated to users from outside the institution;
- *Integral centers*: must be part of the National Grid, must comply with the requirements to be a computing center, and at least 5% of their resources must be dedicated to Grid Computing.

MINCYT promotes the development of the associated centers through competitive funding calls. Nowadays, the associated centers are heavy users of computing power for a wide range of scientific fields, such as bioinformatics, computational fluid dynamics, and chemistry, among others (e.g. see [2, 7, 14]).

There are 14 centers associated to SNCAD: five of them fall into the Integral Center category, seven fall into the Computing Center category and two fall into the Grid Center Category. Their geographical distribution is shown in figure 1. The SNCAD is an active player in HPCLatAm initiative and supporting the last events, specially the HPC Schools. Further information about SNCAD can be found online at www.supercalculo.mincyt.gov.ar.

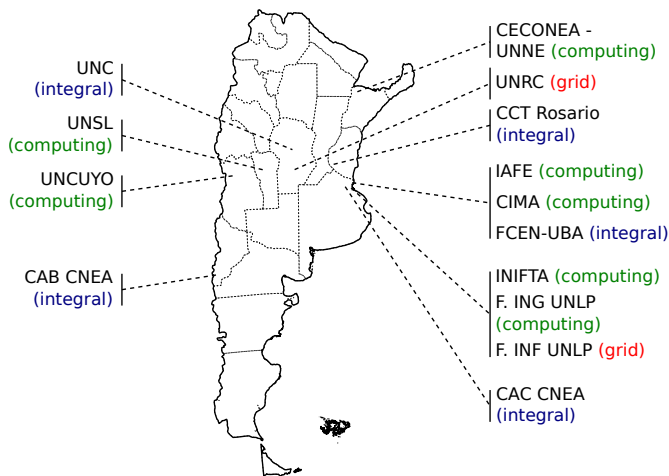


Figure 1. Centers associated to SNCAD

2.2 HPC in Chile

HPC is recent area of research in Chile, which was consolidated mainly by local efforts and two main national projects: CLGrid - Chilean Grid Initiative (for sharing available computer resources in academic institutions and for executing distributed scientific applications) and NLHPC - National Laboratory for HPC (an academic partnership for large-scale and data intensive research projects).

2.2.1 Some Historical Facts

In the Chilean academic sector, different research centers develop and apply HPC techniques to projects in different areas of science and engineering, like: bio-informatics, mining, astronomy, forestry, transport, telecommunications, meteorology. The main strengths of these centers are:

- High technical capacity for the construction of mathematical models and to design and implement high quality computing applications for complex problems.
- Low-cost development of solutions.
- Scientific-technological reliability.
- Established network of national and international cooperation.

With the arrival of long term resources for research, development, and innovation, these centers have grown significantly in both infrastructure and human resources. This development has allowed them to participate in engineering projects of great complexity, including the solving of critical problems for the economic development of Chile [5]. In 2005, the Center for Mathematical Modeling of the Univ. of Chile, proposed that Chilean universities and research centers develop a network of computational clusters. *CLGrid* allows the sharing of computer resources available in the academic institutions and the execution of distributed scientific applications.

The institutions participating in CLGrid are:

- Univ. de Chile, Center for Mathematical Modeling
- REUNA (National University Network)
- Univ. Católica del Norte
- Univ. de Concepción
- Univ. de la Frontera
- Univ. de la Serena
- Univ. Técnica Federico Santa María
- Dirección Meteorológica de Chile
- Univ. Adolfo Ibáñez
- Univ. Nacional Andrés Bello
- Univ. Austral de Chile
- Univ. del Bío Bío
- Univ. de Santiago
- Univ. de Valparaíso

The members of the CLGrid initiative carried out the following activities between 2006 and 2010:

1. Formation of international scientific cooperation networks with important HPC centers: PRAGMA, San Diego Supercomputing Center, Barcelona Supercomputing Center, Leibniz Supercomputing Centre.
2. Participation in European Community Projects: i) SCAT Scientific Computing and Advanced Training, 2006-2008; ii) EELA, EELA-2: e-infrastructure between Europe and Latin America, 2006-2010.
3. Participation in the Pan-American Advanced Studies Institute School Project “Scientific computing in the Americas: the challenge of massive parallelism”.
4. Implementation of test applications on CLGrid.
5. Organization of five CLGrid national workshops that included: talks by international experts, short training courses given by national and international experts in different subjects, presentations of scientific articles, presentations of thesis projects, talks by companies related to HPC, realization of coordination meetings.
6. Participation of some members of the CLGrid Initiative in the scientific committee of international conferences in Latin America in the field of HPC.

In addition to the former activities, the methods and techniques of HPC have been incorporated into some under- and postgraduate programs, such as:

- *Univ. de Chile, Dept. of Mathematical Engineering:* i) Numerical Analysis: obligatory for the Mathematical Civil Engineering degree, reformulated in 2008 with a focus on scientific computing, and includes a scientific programming laboratory using Matlab and C language; ii) High Performance Calculation: this subject was created as an elective course for under- and postgraduates in 2007. It covers the following areas: supercomputing, multi-core architectures, shared and distributed memory programming, efficient implementation of algorithms, parallel computing. Additionally, an HPC laboratory is included in which applications are programmed for cluster computing.
- *Univ. de Chile, School of Science and Engineering:* i) Minor in Scientific Computing: includes a set of interdisciplinary subjects which provide a complementary formation to the specialization of the civil engineering degree. It considers obligatory and optional courses.
- *Univ. Santa María, Dept. of Informatics:* i) Parallel Computing: optional course for the Informatics Engineering degree and master degree in Informatics; ii) HPC Seminar: optional course of the master and doctorate degree in Informatics.
- *Univ. de la Frontera, Dept. of Mathematical Engineering:* i) Parallel Numerical Calculation: optional course for the Civil Mathematical Engineering degree; ii) In-

roduction to Parallel Computing: optional course for the doctorate in Mathematics and the master's degree in mathematical modeling.

- *Univ. Católica del Norte, Dept. of Systems and Computer Engineering*: i) HPC I: Parallel Computing Topics. Optional subject for the Computing Engineering degree. ii) HPC II: Grid Computing Topics. Optional subject for the Computing Engineering degree.

2.2.2 The National Laboratory for HPC

At the end of 2010, an association of Chilean universities proposed to create the National Laboratory for HPC (NLHPC): U. de Chile, U. Católica de Chile, U. Técnica Federico Santa María, U. de Santiago, U. de la Frontera, U. de Talca and U. Católica del Norte. The NLHPC is located within the Center for Mathematical Modeling in Facultad de Ciencias Físicas y Matemáticas (U. de Chile), a center of excellence with a long tradition in the management of large-scale collaborative projects.

The main goal of the NLHPC is to serve as a critical IT partner to large-scale and data intensive research projects based on HPC, by accomplish the following specific goals (see more information at www.nlhpc.cl):

1. Develop and support powerful and reliable computing and network resources, enabling national researchers to have access to HPC capacity, and solve computing- and data-intensive scientific problems.
2. Stimulate and participate in the creation of a national high-capacity network for the transmission of research data.
3. Use and explore innovative architectures and techniques to accelerate scientific computing.
4. Trigger new industrial initiatives in HPC, with special emphasis in those industries associated with the sectors identified as strategic to the Chilean economy, in particular the one on global services.
5. Provide insight into complex systems and advanced modeling needs through the scientific network created around the NLHPC.
6. Help educate the next generation of scientists and engineers proficient in the use of advanced computational tools and techniques.
7. Increase social awareness of the role of HPC in contemporary society and technological development.

Figure 2 shows the results of a survey about HPC resources utilization, answered by 300 researchers belonging to almost 50 research groups. The main areas of research that uses HPC are concentrated in some of the most computer power demanding applications worldwide: Molecular Simulations, Bioinformatics, Climate Research, Quantum Chemistry and Nanotechnology. These fields of application represent more than 50% of the total usage.

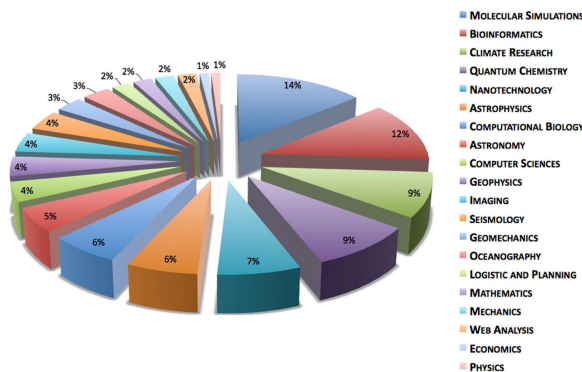


Figure 2. Research areas of usage for the NLHPC infrastructure

In addition to the access of HPC resources, one of the main long-term contributions of NLHPC will be its strong impact on education and training. The activities carried out in Chile during the last four years by the national scientific community in the area of HPC have been developed locally in each institution with a few number of coordination points: only one or two events which have been limited to seminars and CLGrid workshops.

Moreover, the education in the field of HPC has been restricted only to optional undergraduate courses in civil engineering requiring intensive calculations. Currently, there is no existing diploma or under- or postgraduate course dedicated to HPC. Therefore, we conclude that education and training in HPC in Chile is in an initial stage and has progressed as a response to local initiatives of some universities. We propose that HPC training activities evolve into a collection of coordinated training programs, supported by NLHPC, expecting to achieve the following results: i) update the requirements for HPC education and training of the Chilean scientific community; ii) develop a culture of efficient use of HPC techniques; and iii) educate under- and postgraduate students in HPC by means of courses in engineering careers, diplomas, and postgraduate programs, and the continuous learning of HPC technologies.

2.3 HPC in Uruguay

The HPC research in Uruguay started in the 1990's at the Numerical Computing Center (Centro de Cálculo, CeCal), Facultad de Ingeniería, Univ. de la República (UdelaR).

UdelaR is the lone public university and the leading higher education and research institution in Uruguay. It is public, independent, and co-governed by their professors, students, and alumni. Currently, UdelaR has about 120.000 students (3.6% of the country population, the largest relative registration for a single institution in Latin America).

2.3.1 The HPC research group at CeCal, UdelaR

The HPC research group at CeCal was created in 1993, with the main objectives of performing research and teaching activities in the areas of parallel computing, computer networks and distributed systems, and its application for solving complex engineering problems. Initially, the group was created with a small number of three members, only one of them having completed postgraduate (M.Sc.) education.

The first years of HPC research at CeCal were mainly focused on learning the concepts about the field, and working on topic related with the interests of the original members: computational fluid dynamics, geoinformatics, and data analysis. The first HPC infrastructure in the country was built in 1994-1997: a network of workstations with Bull Scala (RS-6000) shared-memory symmetric multiprocessors connected using a FDDI LAN at 100Mbps.

The first applications developed using the new HPC infrastructure at CeCal were a distributed shallow water model using domain decomposition, applied to the study of astronomic and storm tidal currents on Río de la Plata [6], and a global climate model for climate forecast in Uruguay.

The group also designed the first HPC course at UdelaR, to present the concepts of applied parallel and distributed computing, and instructing students and researchers from different areas to use HPC techniques to develop efficient implementations for solving hard problems. It was approved as curricular and postgraduate course in 1994.

Both graduate/postgraduate formation in HPC topics were encouraged by the group. In 1995-1998 two members completed a M.Sc. and a Ph.D, and new members joined the group in 1996-1998. Several research projects were carried out, most of them involving joint works with other research groups in UdelaR or foreign institutions.

After five years of promising start, the HPC group was temporary dissolved in 1998-2000. All HPC group members left, and only one student remained at the new "CeCal group" within the Computer Science Institute. After that critical shaking, the main priority was to re-build the group from scratch, making special emphasis on postgraduate education and on joint works with other research groups.

From 2000 to 2013, the new HPC research group at CeCal was developed trying to achieve three main goals: i) consolidate the HPC course as the main instrument to disseminate the research area by introducing students and researchers the basic concepts of applied parallel and distributed computing; ii) provide to other research groups (inside and outside our Faculty) the knowledge and the service to help them developing or improving the execution of applications with high computing demand; iii) extend the staff working in this area of research, allowing facing more challenging problems, new areas of research, and publishing the results in international conferences and journals.

The first M.Sc. graduation for a new HPC group member

was completed in 2004, and two more followed in 2006-2007. Two Ph.D. were obtained in 2010-2011. Currently, the HPC group has two Ph.D. (two more expected for 2013-2015), one M.Sc. (one more expected for 2014), and four postgraduate students. We have published more than 30 articles in peer-reviewed international journals, and more than 100 articles in international conferences.

From 2006, the group have tackled the research line on scheduling on heterogeneous computing systems. Several scheduling methods were proposed and published in journal articles on this topic (e.g. [10, 9, 11]). In 2007, the HPC group worked on a joint project to design and build the first cluster facility at Facultad de Ingeniería, for executing numerical simulations to study free surface flows [12]. This was an important milestone toward the construction of a larger HPC infrastructure for UdelaR (see next subsection).

In 2009-2012, the HPC group at CeCal participated in the development of the Europe-Latin America grid infrastructure built in the EELA, EELA-2, and GISELA projects [3]. This research group contributed with the development of applications (DigiClima Grid [16], GA-DPPM, caff3D.mb, and ME-MLS), three of them already implemented and migrated to the GISELA Scientific Gateway. Recently, it started to work with the cloud computing paradigm, specifically by using the new cloud-friendly Ourgrid platform, and by studying the scheduling of applications and virtual machines in cloud infrastructures.

Nowadays, the list of international cooperations of the HPC group at CeCal includes several research groups from Latin America and Europe, including groups from Argentina, Brazil, Chile, France, Mexico, Luxembourg, and Spain, among others. Several joint works have been and also are currently developed with those foreign partners.

From a retrospective view, in the last 20 years, the HPC group at CeCal was able to strengthen its position and progressively accomplish the three main objectives:

1. the HPC course is firmly consolidated: uninterruptedly offered for 19 years, it is valid as graduate and postgraduate course on Computer Science, Engineering, Physics, Applied Fluid Mechanics, and Mathematics;
2. a laboratory for research on parallel computing is available, allowing the execution of highly demanding applications over several infrastructures: clusters, shared-memory multiprocessors, GPU platforms, grid, volunteer-based, and cloud computing environments;
3. the research staff increased, allowing the group to diversify the studying areas and face several application domains for parallel computing (working in own projects, or in joint projects with other departments, institutions, and foreign research groups), and offer the services of numerical modeling, high performance execution and code parallelization.

2.3.2 The Cluster FING HPC infrastructure

Cluster FING [8] is the infrastructure for high performance scientific computing located at Engineering Faculty. It is publicly available for all research groups at Udelar and its foreign partners. The cluster was built in 2009, with initial funds from the Sectorial Committee for Scientific Research, UdelaR, with the main goal of instrumenting a computing platform to efficiently tackle complex scientific problems.

The Cluster FING is operational since March 2009. The platform is self-managed and self-funded by the contribution from the research projects that use the infrastructure.

Initially built using only nine computing servers having 72 processing cores, nowadays the Cluster FING infrastructure has 1428 processing cores (468 CPU cores and 960 GPU cores), accounting for a theoretical peak performance of about 4500 GFLOPS (4.5×10^{12} floating point operations per second), by a great margin *the largest computing power available in the country*.

At May, 2013, the Cluster FING has completed more than 2.9 million hours of effective computing time (see the evolution in Figure 3). The main indicators about the Cluster FING infrastructure are presented in Table 1.

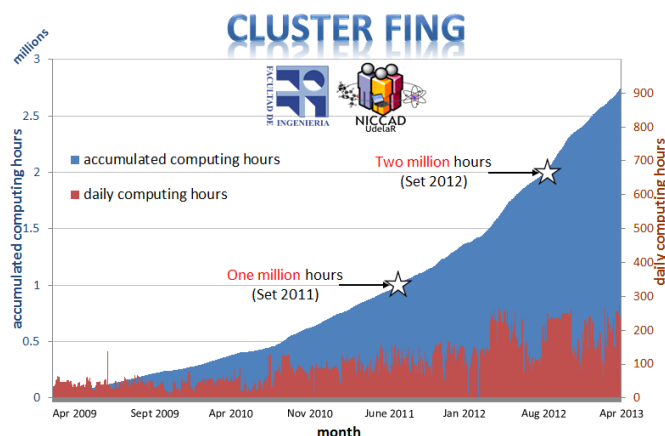


Figure 3. Evolution of effective computing hours in the Cluster FING infrastructure

indicator	value (May, 2013)
number of users	> 150, from six countries
total computing time	> 2.900.000 hours (~ 332 years)
academic research projects	> 35
posgraduate thesis	> 30 M.Sc., > 15 Ph.D.
research groups	25
courses and graduate projects	> 100
consultancy projects	9
articles published	> 150

Table 1. Cluster FING indicators (May 2013)

More information about the Cluster FING infrastructure is available at www.fing.edu.uy/cluster

2.3.3 The High Performance Scientific Computing Interdisciplinary Group (NICCAD)

NICCAD (Núcleo Interdisciplinario de Computación Científica de Alto Desempeño) is a multidisciplinary association of twenty-three research groups working on mathematical models and computational models applied to solve complex scientific problems using HPC techniques.

NICCAD was created in 2010, and it gathers research groups from three institutions from UdelaR: Faculty of Science, Faculty of Engineering, and Faculty of Chemistry, and also a research group from Institut Pasteur Montevideo.

The main goals of NICCAD are: i) to promote the interdisciplinary and multidisciplinary research on efficient methods for solving complex scientific problems; ii) to work toward integrating researchers from diverse disciplines to create an integrated vision of scientific HPC techniques; iii) to perform teaching activities on applied mathematics, numerical models, simulation, and HPC; iv) to disseminate the use of HPC techniques and infrastructures (clusters, distributed/volunteer computing, grid, and cloud).

The main areas for NICCAD research groups include:

- Computational fluid dynamics
- Climate research and forecast
- Combinatorial optimization
- Theoretical and computational chemistry
- Planetary geophysics
- Computational physics
- Biomolecular simulations
- Wind energy and renewable energies
- Systems biology
- Networks, robotics, and artificial intelligence
- Energetic converters simulation
- Electric energy systems planning
- Bioinformatics

Since 2010, the NICCAD group has been actively involved in interdisciplinary research projects and joint publications (e.g. [15],[16]), and also in organizing the main activities related to HPC in Uruguay and the region, including HPC formation and scientific events:

- graduate and posgraduate courses, 2011-2013;
- *National HPC Symposium*, editions 2010, 2011, 2012;
- *PEDECIBA Interdisciplinary Event*, in October 2012;
- *HPCLatAm Symposium*, editions 2011, 2012, 2013;
- *STIC-AmSud Scientific Meeting: High performance scientific computing in cluster, grid, and cloud computing systems*: 20 talks and 15 speakers from 7 countries, in November 2012;

- *Workshop on Soft Computing Techniques in Cluster and Grid Computing Systems* within the International Conference on P2P, Parallel, Grid, Cloud and Internet Computing, editions 2012 and 2013.

More information about NICCAD is available at www.fing.edu.uy/grupos/niccad.

3 The HPCLatAm initiative

HPCLatAm main goal is to stimulate and facilitate a wider usage and adoption of HPC techniques across the public and private sector in order to propel productivity, innovation and competitiveness in Latin America. The main motivation for the initiative is to gather the young but growing community of scientist and practitioners of high performance and scientific computing in Latin America.

HPCLatAm has also focused efforts in human resources formation (graduate and posgraduate courses) and collaborations for developing joint projects.

A Steering Committee, whose members are researchers from five different countries (Argentina, Brazil, Chile, Spain, and Uruguay) from both academy and industry, coordinates and directs the main activities within the initiative.

The main event within HPCLatAm is the HPCLatAm Symposium, which was/is held yearly in:

- 2008: Córdoba, Argentina
- 2009: Mar del Plata, Argentina
- 2010: Buenos Aires, Argentina
- 2011: Córdoba, Argentina
- 2012: Buenos Aires, Argentina (first solo event)
- 2013: Mendoza, Argentina (to be held)
- 2014: Valparaíso, Chile (to be held)

The HPCLatAm Symposium aims to bring together researchers, developers, and users of HPC to discuss new ideas, experiences, and problems; while promoting research and diffusion in HPC techniques on clusters, grids, and distributed systems in Latin America. It featured invited talks from academy and industry, full-paper sessions, and presentation sessions, presenting mature work and new ideas in HPC applied in research and industrial applications. The five editions of the HPCLatAm Symposium have proved that the HPC community in the region is steadily growing.

3.1 The V HPCLatAm Symposium, 2012

The 2012 meeting was the most successful edition of the HPCLatAm Symposium up to now. It was held in Buenos Aires, Argentina, from July 24 to July 26, 2012.

The V HPCLatAm Symposium included:

- more than 80 assistants !!

- 4 keynote speakers, including Foster (Argonne National Laboratory, Univ. of Chicago, USA) and Mateo Valero (Barcelona Supercomputing Center, Spain)
- 3 full paper sessions: *High performance scientific computing*, *GPU computing*, and *Applications*
- 14 students posters and 21 presentations
- 34 paper submissions, from 7 countries
- Technical program committee: 21 researchers, from 7 countries. Reviewer committee: 41 researchers, from 12 countries. Acceptance rate (full papers): 32%
- more than 5000 visits from 60 countries to the conference website <http://hpc2012.hpclatam.org>.

Figure 4 summarizes the number of papers submitted and accepted in the HPCLatAm Symposium (2008 to 2012).

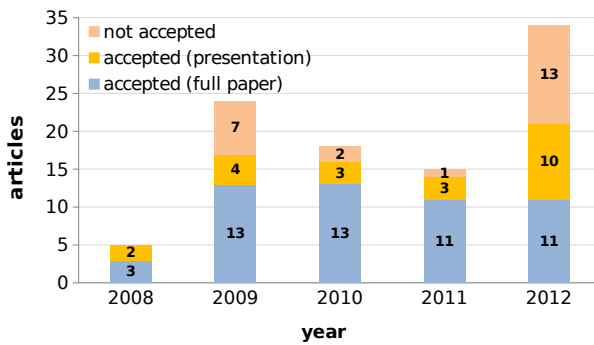


Figure 4. Papers submitted to /accepted in the HPCLatAm Symposium, editions I to V (2008-2012)

3.2 The HPC School, ECAR 2012

ECAR (Escuela de Computación de Alto Rendimiento) was the main activity for student formation and training within HPCLatAm in 2012. A total number of 65 students from five countries assisted to eight courses, organized in two tracks: *Foundations* and *Applications*.

The track Foundations introduced the current techniques for HPC programming, including the courses (professors):

- Distributed memory programming (MPI) (P. Mininni, Univ. de Buenos Aires, Argentina).
- Shared memory programming - OpenMP (G. Hernández, Univ. de Valparaíso, Chile)
- Shared memory programming - pthreads (S. Nesmachnow and G. Ares, Univ. de la República, Uruguay).

The track Applications introduced the main HPC tools and applications used nowadays in several research areas, as well as advanced HPC topics, including the courses:

- Meshless numerical methods (L. González, Univ. Politécnica de Madrid, Spain)
- HPC in bioinformatics (A. Roitberg, Univ. de Florida, USA; A. Turjanski and M. Martí, Univ. de Buenos Aires, Argentina)
- Visualization (J. Hernando, Univ. Politécnica de Madrid, Madrid, Spain)
- Other models for parallel computing (A. Cristal, Barcelona Supercomputing Center, Spain)
- GPGPU computing (N. Wolovick and C. Bederián, Univ. Nacional de Córdoba, Argentina)

ECAR 2012 was organized paying special attention to human resources formation in both HPC and scientific computing. Graduate and postgraduate students received scholarships and funding help to assist ECAR 2012. The teaching staff gathered experts from five countries.

3.3 The HPC Day, 2012

The HPC Day was held within the Argentinian Symposium on Informatics and Operations Research, in La Plata 2012. It was another forum to bring together researchers, developers, and users of HPC to discuss the ideas and experiences of scientist and practitioners of HPC in Latin America. It featured invited talks, mainly from industry, presenting works and ideas about the application of HPC, and round-table meetings for the exchange and dissemination of new ideas, techniques, and research in HPC.

Some interesting common lines of work for our countries were established: the science vice-ministers from Brazil and Argentina had a meeting to review the common agenda. The Argentinean Director of International Relationship of the Science Ministry established some goals to be met to foster the collaboration.

As a result of the HPC-Day, a letter of intention was signed between the assistants, showing the great compromise of carrying the idea of integrating the HPC communities to each local government.

The contacts between local governments in Argentina, Brazil, Chile, and Uruguay are currently under development. The main goal of the HPCLatAm initiative is to sign a formal regional agreement between governments that allows students, researchers and practitioners in HPC and related areas to fully participate in HPC formation, training, and dissemination activities in our region, as well as to promote joint research projects in HPC by means of specific bi-lateral or multi-lateral funding.

3.4 Upcoming and related events

The upcoming and related events promoted by the HPCLatAm initiative in 2013 include the ECAR 2013, the

VI HPCLatAm Symposium, and the HPC-Day 2013. The main details for each activity are presented next.

ECAR 2013, Mendoza, Argentina, July 2013. More than 120 students applied for a place in one of the three courses offered at ECAR 2013. The courses includes both classes and practical hands-on sessions on relevant HPC topics:

- MPI/OpenMP (S. Nesmachnow, Univ. de la República, Uruguay; G. Hernández, Univ. de Valparaíso, Chile)
- GPGPU (M. Ujaldón, Univ. de Málaga, Spain)
- Cloud Computing (J.L. Vázquez Poletti, Univ. Complutense de Madrid, Spain)

The courses will be complemented with three workshops about HPC applications and related research lines:

- Computational Mechanics (M. Vázquez, Barcelona Supercomputing Center, Spain).
- Molecular Dynamics (M. del Pópolo, Univ. Nacional de Cuyo and CONICET, Argentina).
- Scientific Applications (L. Barba, Boston Univ., USA).

The SNCAD will support more than 40 students from Argentina, whom will receive full financial support to assist to ECAR 2013. Students from Uruguay, Chile, and Mexico will also receive funds for assisting to ECAR 2013, from local agencies and joint projects. This participation will render this school a key event for the formation of specialized human resources in HPC field in the region.

VI HPCLatAm Symposium, Mendoza, Argentina, July 2013. The 2013 edition of the HPCLatAm Symposium is again showing the interest of the scientific community in HPC field: 26 contributions have been received, from six countries, which are under review right now. The Symposium will feature invited talks from Academia and Industry and presentations in a wide range of topics: GPGPU, Algorithms, Cloud and Grid Computing. An audience of about 80 – 100 assistants is expected.

HPC-day 2013, Córdoba, Argentina, September 2013. HPC-Day is becoming a key event to contribute to the consolidation of the HPC community. In 2013, the HPC-Day will be held within the Argentinian Symposium on Informatics and Operations Research, as part of the celebration for the 400 years since the foundation of Univ. Nacional de Córdoba. The 2013 edition of the HPC-Day event will include two main activities:

- Breakfast meeting with business leaders: the HPC-Day will include to short talks and presentations to generate collaborations between academia and industry, as a way to try to bring the gap between them.
- HPC policies meeting: the HPC-Day will bring together key decision makers of IT field in government from Argentina and the region, looking to strength the regional collaborations and coordinate efforts in HPC.

4 Perspectives

From the first time since its creation in 2008, the HPCLatAm Symposium will be moving out of Argentina for the VII edition to be held in Valparaíso, Chile in 2014. Furthermore, we plan to integrate the HPCLatAm Symposium with CLCAR (Conferencia Latinoamericana de Computación de Alto Rendimiento), our counterpart in Mesoamérica, for the 2014 edition of both meetings.

The Joint HPCLatAm-CLCAR meeting is intended to be a large conference gathering all Latin America HPC research communities, and it will also include a school with courses in basic and applied topics of HPC. The school is a key initiative that will produce the following impacts:

- The increase of use and sharing of the HPC resources available in Latin-American.
- The development of a culture of efficient use of the techniques and methods of HPC as a tool to study real system models found in science, engineering and industry.
- The introduction of classical techniques and new HPC technologies (hardware systems, programming models, languages, libraries, etc.) to a new generation of students.
- The creation of a network of people which will enable further mid-term collaboration in Latin America.

We plan to celebrate these joint meetings yearly or maybe biyearly on alternate locations between South America and Mesoamerica for years to come.

Another initiative that will foster the HPC activities in LA in the long term should be the implementation of continuous education programs for under- and postgraduate students, doctorate and post doctorate graduates, engineers and scientists. For example, implementing courses in engineering and scientific careers, diplomas and postgraduate programs. We can affirm that a strong HPC training and education system considering the specific objectives indicated, designed in a way that responds to the needs of the national and regional scientific community will have significant impact in productivity, measured in:

- Publications and participation in conferences.
- Basic and applied research projects that use HPC methods and techniques.
- National and international scientific collaboration.
- Theses that use HPC methods to study complex systems that emerges from science, engineering and industry.

Joint projects are another building block for the successful integration of HPC communities. Some of the interesting joint projects involving scientific groups in HPCLatAm from different countries include:

1. *Digi-Clima Grid*: Semi-automatic processing for historical graphical rain intensity records using grid computing (Univ. de la República, Uruguay and Univ. Federal de Campina Grande, Brazil).
2. *SEHLOC*: Scheduling evaluation in heterogeneous computing systems with hwloc (Univ. de la República, Uruguay, Univ. de San Luis, Argentina, and INRIA Bourdeaux, France).
3. *PERMARE*: Adaptive deployment of MapReduce-based applications over pervasive and desktop grid infrastructures (Univ. de la República, Uruguay, Univ. de Santa María, Brazil, Univ. de Rennes Champagne-Ardenne, France, Univ. Paris I, France).
4. *OurSched*: Scheduling and discovering policies in the Ourgrid middleware (Univ. de la República, Uruguay, Univ. de Buenos Aires, and Univ. Federal de Campina Grande, Brazil).
5. *Computational Fluid Dynamics and advances in the age of “petascale computing”* (Univ. Politécnica de Madrid, Spain, Univ. de São Paulo, Brazil and Univ. de Buenos Aires, Argentina).
6. *Models and Experimental Studies of Rock Impacts on Safety Devices* (Univ. Santa María, Chile, Univ. de Valparaíso, Chile, and Laboratoire Central des Ponts et Chaussées, France).

In addition, several research groups in HPCLatAm are participating in the Interamerican Network for Supercomputing (Red Interamericana de Supercómputo, RISC). The RISC project aims at deepening strategic R&D cooperation between Europe (EU) and Latin America (LA) in the field of HPC by building a multinational and multi-stakeholder community. RISC will identify common needs, research issues and opportunities for cooperative R&D on HPC between EU and LA in the transition to multi-core architectures across the computing spectrum and relevant programming paradigms, algorithms and modeling approaches, thus setting the basis for the formulation of a global strategy for future research. At the end of the project, we expect a fully functioning network focusing on activities to support and to promote coordination of the HPC and Computational Science research between EU and LA.

The initial RISC partners are:

1. Barcelona Supercomputing Center, Spain
2. Univ. de Buenos Aires, Argentina
3. Univ. de Chile, Chile
4. Univ. Politécnica de Madrid, Spain
5. Fundação Coordenação de Projetos Pesquisas e Estudos Tecnológicos, Brazil
6. Univ. de Coimbra, Portugal
7. Consorzio Interuniversitario Cineca, Italy
8. Univ. Veracruzana, Mexico
9. Univ. Autónoma de Manizales, Colombia
10. Reseau Menon E.E.I.G., Belgium

Several other groups and institutions are associated partners to the RISC project, including Centro de Bioinformática y Biología Computacional de Colombia, Univ. de Caldas, Univ. Tecnológica de Bolívar (Colombia); Univ. de Sonora, CINVESTAT (México); Unidad de Supercomputación y Cálculo Científico from Univ. Industrial de Santander (Colombia); NICCAD from Univ. de la República (Uruguay); Centro de Cálculo Científico from Univ. de Los Andes (Venezuela).

One of the key funding programs in the near future is the Horizon 2020 from the European Commission. In this long-term program, Information and Communication Technologies plays a fundamental and transversal role. It is expected that international cooperation will be supported in this program (similar to RISC project). Although, a new and interesting call is worth to be mentioned: EU-Brazil Research and Development Cooperation in Advanced Cyber Infrastructure, including Cloud Computing, High Performance Computing and Experimental Platforms, with an expected joint budget of 7M€.

5 Conclusions

In the last ten years, important and sustainable efforts were carried in Argentina, Chile, and Uruguay to acquire the knowledge and expertise in these fields, recognizing its importance as a key tool for science, technology and innovation. These efforts have been materialized in research and innovation projects, organization of international conferences and schools, inclusion of courses and seminars in scientific and technological careers, among others.

The HPCLatAm initiative represent a new step to foster the collaboration in the region and disseminate the methods, techniques and applications of the HPC field.

The events and meetings organized by the HPCLatAm initiative since 2008 have been continuously having an increasing impact and also gathering the attention at different levels, from international experts to local industry and government. The organized school in 2012 attracted the attention of under- and postgraduate students, many of them received full scholarships to assist to the two weeks duration event. The courses were delivered by international experts in a wide range of topics: from foundations of parallel computing to scientific applications.

Some international projects have contributed to the initial development of HPC community in the region: EELA, EELA-2, GISELA, and RISC supported the integration of the community between Europe and Latin America. In this line of work, the HPCLatAm initiative has been contributing to the consolidation and integration of the HPC communities in South America, and its main objective is to continue to foster the integration in all Latin America.

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