SEVENTH FRAMEWORK PROGRAMME
Research Infrastructures

INFRA-2007-2.2.2.1 - Preparatory phase for 'Computer and Data Treatment' research infrastructures in the 2006 ESFRI Roadmap

PRACE

Partnership for Advanced Computing in Europe

Grant Agreement Number: RI-211528

D1.5
Final Report

Final

Version:	1.0
Author(s):	Thomas Eickermann, FZJ
Date:	27.06.2010

Project and Deliverable Information Sheet

PRACE Project	**Project Ref. №: RI-211528**	
	Project Title: Partnership for Advanced Computing in Europe	
	Project Web Site: http://www.prace-project.eu	
	Deliverable ID: < **D1.5**>	
	Deliverable Nature: < Final Report>	
	Deliverable Level: PU *	**Contractual Date of Delivery:** 30 / June / 2010
		Actual Date of Delivery: 30 / June / 2010
	EC Project Officer: Bernhard Fabianek	

* - The dissemination level are indicated as follows: **PU** – Public, **PP** – Restricted to other participants (including the Commission Services), **RE** – Restricted to a group specified by the consortium (including the Commission Services). **CO** – Confidential, only for members of the consortium (including the Commission Services).

Document Control Sheet

Document	**Title:** <**Final Report** >	
	ID: <**D1.5**>	
	Version: <27.06.2010>	**Status:** Final
	Available at: http://www.prace-project.eu	
	Software Tool: Microsoft Word 2003	
	File(s): D1.5-V1.0.doc	
Authorship	**Written by:**	Thomas Eickermann, FZJ
	Contributors:	Carlos Merida, BSC Ari Turunen, CSC Axel Berg, SARA Alan Simpson, EPCC Francois Robin, GENCI Herbert Huber, LRZ
	Reviewed by:	Mark Bull, EPCC Dietmar Erwin, FZJ
	Approved by:	Management Board/Technical Board

Document Status Sheet

Version	Date	Status	Comments
0.1	24/05/2010	Draft	Template with some pre-filled information from D1.4
0.2	13/06/2010	Draft	Included WP contributions
0.9	15/06/2010	Draft	Complete version for internal review
1.0	27/06/2010	Draft	Update based on internal review

Document Keywords and Abstract

Keywords:	PRACE, HPC, Research Infrastructure, Project Progress Report
Abstract:	This final report summarises the objectives, work performed, and achievements of the PRACE project. The mission of this Preparatory Phase project has been to prepare for the creation of a persistent pan-European HPC-service as a permanent Research Infrastructure as envisioned in the ESFRI Roadmap. The service will be provided by 3-5 superior centres that will form the Tier-0 level of the European HPC ecosystem.

Copyright notices

© 2010 PRACE Consortium Partners. All rights reserved. This document is a project document of the PRACE project. All contents are reserved by default and may not be disclosed to third parties without the written consent of the PRACE partners, except as mandated by the European Commission contract RI-211528 for reviewing and dissemination purposes.
All trademarks and other rights on third party products mentioned in this document are acknowledged as own by the respective holders.

Table of Contents

Project and Deliverable Information Sheet i
Document Control Sheet i
Document Status Sheet ii
Document Keywords and Abstract iii
Table of Contents v
List of Figures vi
List of Tables vi
References and Applicable Documents vi
List of Acronyms and Abbreviations vi
List of Project Partner short Names ix
Executive Summary 1
1 Introduction 2
2 PRACE Objectives – The case for a pan-European HPC service 2
3 Results and achievements of the project 4
3.1 WP1 – Management of the Contract 4
3.1.1 Project management and governance 4
3.1.2 Internal communication 6
3.1.3 Project Planning and Status 6
3.2 WP2 - Organisational concept of the Research Infrastructure 7
3.3 WP3 – Dissemination, outreach and training 11
3.4 WP4 – Distributed system management 16
3.5 WP5 – Deployment of the prototype systems 19
3.6 WP6 – Software enabling for Petaflop/s systems 21
3.7 WP7 – Petaflop/s systems for 2009/2010 23
3.8 WP8 – Future Petaflop/s computer technologies beyond 2010 27
4 Summary and Conclusions 30
4.1 Work performed and Main results 30
4.2 Socio-economic Impact 32
4.3 Conclusions 33
Annex 1: Gender Balance Activities 35
Annex 2: Use and Dissemination of Foreground 36
Dissemination 37
Cooperation 48

List of Figures

Figure 1: The envisioned European HPC ecosystem with 3-6 European centres forming its Tier-0 level... 2
Figure 2: Project Management Structure 5
Figure 3: The industry seminar in Amsterdam 31

List of Tables

Table 1: Members of the Management Board of the project. 5
Table 2: Members of the Technical Board, formed by the Work package leaders 5

References and Applicable Documents

[1] http://www.prace-project.eu

[2] http://www.hpcineuropetaskforce.eu/deliverables HET Peer Review

[3] ftp://ftp.cordis.europa.eu/pub/fp7/docs/project_reporting_en.pdf

Other references are the project Deliverables. Unless specified otherwise they are publicly available on the PRACE website at:
http://www.prace-project.eu/documents/public-deliverables-1/

List of Acronyms and Abbreviations

AHTP	Advanced HPC Technology Platform. To be created in this project as permanent groups to identify and work on future technologies for multi-petaflop/s systems.
AISBL	Association Internationale Sans But Lucrative ; an international non profit association under Belgian law.
BoF	Bird of Feathers session. Ad hoc session at conferences to solicit interest to work on specific topics.
BSCW	Basic Support for Cooperative Work is a web-based shared repository for documents.
CA	Consortium Agreement.
DEISA	Distributed European Infrastructure for Supercomputing Applications. EU project by leading national HPC centres.
DoW	Description of Work, the Annex I (or Technical Annex) of the Grant Agreement, describing the work plan of the PRACE project

EEF	European e-Infrastructure Forum
EGEE	Enabling Grids for E-sciencE; EU Grid project lead by CERN and successfully completed in 2004. Follow-up is EGEE-II.
EGI	European Grid Initiative, the future sustainable pan-European grid infrastructure (web.eu-egi.eu)
EGI_DS	EGI Design Study, project for the conceptual setup and operation of EGI.
EOI	Expression of Interest.
ePP-CC	European Preparatory phase Projects Coordination Committee
ESFRI	European Strategy Forum on Research Infrastructures; created roadmap for pan-European Research Infrastructure.
ERIC	European Research Infrastructure Consortium, a legal framework for Research Infrastructures, currently designed by the EC.
ETP	European technology Platform
F2F	Face-to-face meeting.
FPGA	Field Programmable Gate Array
GÉANT	Collaboration between National Research and Education Networks to build a multi-gigabit pan-European network, managed by DANTE. GÉANT2 is the follow-up as of 2004.
GPGPU	General Purpose GPU (Graphical Processing Unit)
HET	High Performance Computing in Europe Taskforce. Taskforce by representatives from European HPC community to shape the European HPC Research Infrastructure. Produced the scientific case and valuable groundwork for the PACE project.
HPC	High Performance Computing; Computing at a high performance level at any given time; often used synonym with Supercomputing.
HPC-Europa	Consortium of six leading (HPC) infrastructures and five centres of excellence providing transnational access; EU project.
ISC	International Supercomputing Conference; European equivalent to the US based SC0x conference. Held annually in Germany.
ITER	Joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. Also used as the name for the reactor.
LDAP	Lightweight Directory Access Protocol.
MB	Management Board, the top-level decision making body of PRACE.
MoU	Memorandum of Understanding.
MPP	Massively Parallel Processing.
NDA	Non-Disclosure Agreement. Typically signed between vendors and customers working together on products prior to their general availability or announcement.
PGAS	Partitioned Global Address Space – a new programming paradigm
PRACE	Partnership for Advanced Computing in Europe; Project Acronym.
PM	Project Manager.
PMO	Project Management Office.

PPC	Principal Partner Committee, the subgroup of the Principal Partners in the MB.
PR	Public Relations.
RI	Research Infrastructure.
SMP	Symmetric Multi-Processing.
Tier-0	Denotes the apex of a conceptual pyramid of HPC systems. In this context the Supercomputing Research Infrastructure would host the Tier-0 systems; national or topical HPC centres would constitute Tier-1.
TB	Technical Board, consisting of the Work Package leaders, including the PM.
TCO	Total Cost of Ownership. Includes the costs (personnel, power, cooling, maintenance, ...) in addition to the purchase cost of a system.
UNICORE	Uniform Interface to Computing Resources. Grid software for seamless access to distributed resources.

List of Project Partner short Names

FZJ	Forschungszentrum Juelich GmbH, Germany
USTUTT-HLRS	Universitaet Stuttgart – HLRS, Germany
BADW-LRZ	Leibniz-Rechenzentrum der Bayerischen Akademie der Wissenschaften, Germany
GENCI	Grand Equipement National de Calcul Intensif, France
EPSRC	Engineering and Physical Sciences Research Council, United Kingdom
BSC	Barcelona Supercomputing Center - Centro Nacional de Supercomputacion, Spain
CSC	CSC – IT Center for Science Ltd., Finland
ETHZ (CSCS)	Eidgenössische Technische Hochschule Zürich – CSCS, Switzerland
NCF	Netherlands Computing Facilities Foundation, The Netherlands
GUP	Institut fuer Graphische und Parallele Datenverarbeitung der Johannes Kepler Universitaet Linz, Austria
SNIC	Swedish National Infrastructure for Computing (within the Swedish Science Council), Sweden
CINECA	CINECA Consorzio Interuniversitario, Italy
PSNC	Poznan Supercomputing and Networking Center, Poland
SIGMA	UNINETT Sigma AS, Norway
GRNET	Greek Research and Technology Network, Greece
UC-LCA	Faculdade Ciencias e Tecnologia da Universidade de Coimbra, Portugal

Executive Summary

The PRACE project's mission has been to prepare for the creation of a persistent pan-European HPC-service, consisting of 3-5 centres, that will form the Tier-0 level of the European HPC ecosystem. This report describes the objectives, work performed, and achievements by the project. PRACE analysed options for, and took decisions on, its governance structure, the funding and usage model, and the peer review process.

It was agreed to establish the Research Infrastructure initially as an international non-profit organisation under Belgian law (AISBL) with its seat in Brussels. Based on these decisions the legal documents, i.e. the statutes and agreement for the initial period, were drafted and further elaborated into signature-ready versions.

Extensive dissemination and training activities have been conducted: three scientific conferences, two industrial seminars, and five code porting workshops have been organised. PRACE was also present at various HPC events, including ISC and SC conferences.

Six prototypes for potential Tier-0 systems to be procured in 2010 have been selected, installed and assessed in terms of their technical characteristics, performance and total cost of ownership.

An application benchmark suite representative of HPC usage in Europe has been created in 2008 and updated in 2009. The applications have been optimised and scaled on the prototypes. Performance analysis tools have been assessed, as well as advanced programming paradigms and languages.

A systems management and user environment software stack has been defined and later updated and deployed on the prototype systems, maintaining and enhancing compatibility with the respective DEISA stack, and thus providing a consistent environment throughout Tier-0 and Tier-1.

All elements needed for Tier-0 system procurements have been prepared and updated, taking into account the results from the technical work packages concerning user requirements, market analysis and architecture assessment, and completed by risk mitigation and procurement process templates.

Several prototypes for multi-petascale technology have been selected in a competitive internal process. The assessment of the technology and programmability of these systems has progressed well, although the delivery of some systems was delayed. STRATOS, the PRACE Advisory group for strategic technologies was created in late 2008 and since then has gained significant momentum. It now involves more than 80 HPC stakeholders, including vendors and academia, and has met several times, exchanging information and defining its vision and mission.

1 Introduction

This Deliverable summarises the achievements of the PRACE project. It contains the public textual material that is requested in the Guidelines Notes on Project Reporting [3] for the public parts of the compulsory Final Report, which will be submitted within 60 days after the end of the project. This structure of this document is oriented along the requirements of the compulsory Final Report.

The introductory Section 2 briefly states the objectives of the project. The organisation of the project into eight work packages and the work conducted and results achieved in these work packages are provided in Section 3. In Section 4, the results are summarised, conclusions are drawn and the potential impact and use of the results is elaborated.

Sections 2 to 4 correspond to the so-called "Publishable" part of the Project Final Report.

The gender balance activities are reported in Annex 1: Gender Balance Activities.

The material for the public part of the "Use and dissemination of foreground" part of the Project Final Report is provided in Annex 2: Use and Dissemination of Foreground.

2 PRACE Objectives – The case for a pan-European HPC service

Supercomputers are indispensable tools for solving the most challenging and complex scientific and technological problems through simulations. To remain internationally competitive, European scientists and engineers must be provided with leadership-class supercomputer systems. PRACE, the Partnership for Advanced Computing in Europe will create a persistent pan-European high performance computing (HPC) service and infrastructure. This infrastructure will be managed as a single European entity. European scientists and technologists will be able to access leadership supercomputers with capabilities equal to or better than those available in the USA, China and Japan. The service will comprise three to six world class leadership Tier-0 HPC centres strengthened by regional and national supercomputing centres working in tight collaboration through grid technologies. The infrastructure created by PRACE will form the top level of the European HPC ecosystem.

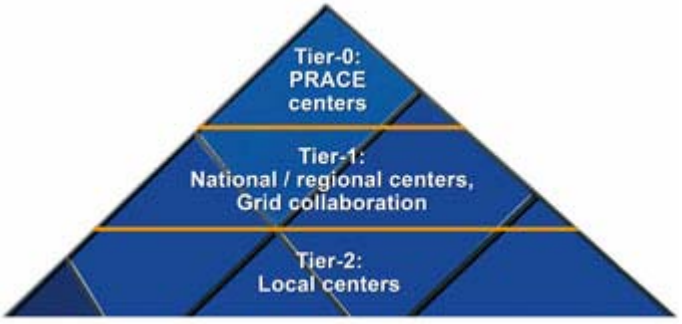

Figure 1: The envisioned European HPC ecosystem with 3-6 European centres forming its Tier-0 level

PRACE is a preparatory-phase project funded by the EU's 7th Framework Programme with the mission to prepare for a Tier-0 HPC service as a permanent European Research Infrastructure envisioned by the European Strategy Forum on Research Infrastructures (ESFRI). The overall objective is to complete all necessary preparations that will allow the community to progress to the construction phase at the end of the project.

These preparations comprise legal and administrative tasks, as well as accompanying technical work to prepare for the construction and production phases of the Research Infrastructure. The objectives of the legal and administrative tasks are:

- Selection of an appropriate legal form, the definition of its statutes and its governance in relation to the partners, the European Commission and the scientific users.
- Establishing funding strategies and usage models to ensure sustained funding.
- Defining a peer review process to support leading edge science and optimal use of the resources ensuring open, fair and unbiased access to the Research Infrastructure.
- Establishing links to the HPC ecosystem, including the national HPC infrastructures, Grid infrastructures such as EGI and potential user communities e.g. other ESFRI projects.
- Defining a consistent operational model across the distributed Tier-0 sites.
- Dissemination of project achievements; establishing and maintaining links with selected industries both as users of capability systems, technology providers, and creators of new technologies with HPC.
- Development of a comprehensive training programme for potential users.

The technical work is carried out with the following objectives

- Providing the tools for a consistent management of the Tier-0 systems and for the integration of the Tier-0 infrastructure into the European HPC ecosystem.
- Deployment of prototypes of leadership class systems at selected sites that are likely to become production level systems in 2009/2010.
- Porting, optimising, and petascaling selected applications to ready them for production on the Tier-0 systems, and creating a benchmark suite.
- Defining a consistent procurement strategy, an associated technical specification, selection criteria for the current and future generations of HPC services, and the requirements for the physical infrastructure to host Tier-0 systems.
- Starting a permanent process of technology evaluation to transform user requirements into specifications for future leadership-class systems. This process will last throughout the lifetime of the infrastructure and will be done in close relationship with vendors of components, systems, and software.

3 Results and achievements of the project

The project is organised in the following 8 work packages:

- WP1: Management of the Contract
- WP2: Organisational concept of the Research Infrastructure
- WP3: Dissemination, outreach and training
- WP4: Distributed system management
- WP5: Deployment of prototype systems
- WP6: Software enabling for Petaflop/s systems
- WP7: Petaflop/s systems for 2009/2010
- WP8: Future Petaflop/s computer technologies beyond 2010

The work and results in these work packages is described in the following sub-sections. A total of 81 Deliverables have been produced. Most of them are public reports that have already been made available (as preliminary reports where still subject to approval in the final project review) on the PRACE website: www.prace-project.eu. The following text makes extensive reference to these reports that can be downloaded freely, unless specified otherwise.

3.1 WP1 – Management of the Contract

3.1.1 Project management and governance

At the mid-term review on March 6, 2009, the reviewers rated the management of the project as excellent and the collaboration between the beneficiaries as effective. Therefore the project management and governance have been continued unchanged in the structures as set up in early 2008 and as documented in the Consortium Agreement (Figure 2).

The main decision making bodies in the project are the Management Board (MB– representatives of all Partners) and the Principal Partners Committee (PPC– representatives of the Principal Partners). The PPC decides on tasks that are essential for the definition, hosting, construction, funding or financing of the Tier-0 HPC infrastructure. The MB takes all other decisions of strategic importance. PPC and MB have face-to-face meetings every 2 months. These project meetings are organised jointly with PPC and MB meetings of the PRACE Initiative. To foster the involvement of the new members of the PRACE initiative in the overall process, their MB members are invited as permanent guests to the project MB meetings. They also have access to all project documentation, unless it is under NDA. These new members are currently Cyprus, Ireland, Serbia, Turkey, Bulgaria and the Czech Republic.

In cases where the process timeline has required MB decisions between the regular face-to-face meetings, the MB decisions have been made via email consultation and voting, a process which has proven to be efficient and effective.

Name	Institution	Country	Remark
Achim Bachem (Chair)	FZJ	Germany	PPC
Catherine Rivière	GENCI	France	PPC
Patrick Aerts	NCF	Netherlands	PPC
Francesc Subirada	BSC	Spain	PPC
Jane Nicholson	EPSRC	UK	PPC

Name	Institution	Country	Remark
Martin Polak	GUP	Austria	
Janne Ignatius	CSC	Finland	
Ioannis Liabotis	GRNET	Greece	
Sanzio Bassini	CINECA	Italy	
Jacko Koster	UNINETT	Norway	
Norbert Meyer	PSNC	Poland	
Pedro Alberto	UC-LCA	Portugal	
Ladina Gilly	CSCS	Switzerland	
Lennart Johnsson	KTH	Sweden	

Table 1: Members of the Management Board of the project.

Name	Institution	Country	WP number
Thomas Eickermann (Chair)	FZJ	Germany	1
Francesc Subirada	BSC	Spain	2
Ari Turunen	CSC	Finland	3
Peter Kunszt; Riccardo Murri/Axel Berg[1]	CSCS/NCF	Switzerland/Netherlands	4
Axel Berg	NCF	Netherlands	5
Mark Parsons	EPCC	UK	6
Francois Robin	GENCI	France	7
Herbert Huber	BADW-LRZ	Germany	8

Table 2: Members of the Technical Board, formed by the Work package leaders

The agenda of PPC and MB meetings are prepared by the Project Management Office (PMO) located in Juelich and headed by the PM. Typically, decision proposals on formal matters are prepared by the PMO, while decisions related to the project work plan are jointly prepared by the TB, the involved Work Packages and the PMO. The members of these boards are listed in Table 1 and Table 2.

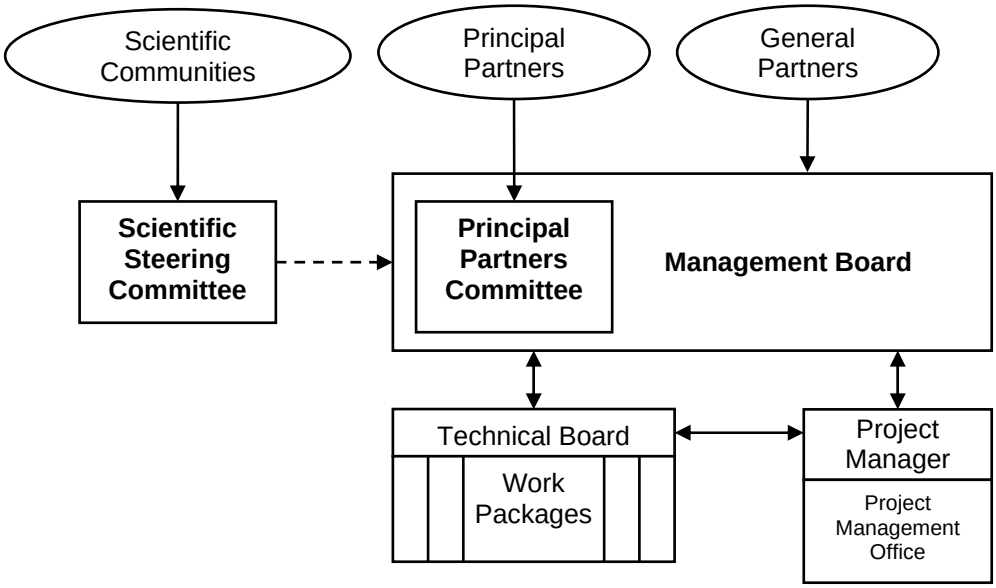

Figure 2: Project Management Structure

[1] After Riccardo Murri left CSCS at the end of 2009 Axel Berg assumed also responsibility for WP4.

Monitoring of project progress and partner performance

The project-internal reporting system, which requested monthly work package activity reports and quarterly financial reports from each partner (see Deliverable D1.2), has been updated based on the experience of the first year. The frequency of work package reports has been changed to quarterly to simplify the alignment with the financial reports. This has also contributed to further improvement in the quality of the reports.

The Project Management Office (PMO) uses these reports to monitor the overall progress within the work packages, to detect problems early on, and check the compliance of resource usage with the work plan of the project. The content and format of these reports have been documented in "Internal Reporting Guidelines". A summary is also forwarded to the work package leaders.

Management of milestones and deliverables, quality assurance

The project internal Quality Assurance process for the deliverables (responsible authors, two internal reviewers, fixed timelines, document templates and documented quality assurance process), has proven to be effective and efficient. It has facilitated the timely production of 81 Deliverables.

3.1.2 Internal communication

The project internal communication extensively uses email lists, a secure intranet, and electronic (telephone or video conference) as well as face-to-face meetings. These communication channels were established in the first month of the project.

All work packages, groups focussed on particular tasks, and the boards are having regular meetings, the frequency and nature (face-to-face or electronic) is adapted to their respective needs.

In addition to these board meetings, the Principal Partners have organised a series four of 1-2 day workshops to discuss questions of political scope. The representative of the General Partners participated in these workshops. Based on the work of the work packages, these workshops are used to prepare MB decisions. They have proven to be effective in accelerating the decision making process in the project. A similar meeting with participation of representatives of the Principal Partners' ministries took place on July 8, 2009. It was decisive for the later agreement on the temporary seat and legal form.

Meetings of the work packages are organized by the work package leader; meetings of the TB and the MB are prepared by the PMO.

3.1.3 Project Planning and Status

By the end of 2009, the project had reached the end of the planned project duration of 24 months and has achieved all of its overall objectives. The project had successful reviews in July 2008, December 2008, and March 2009. PRACE has completed the preparatory work for the construction and subsequent operation of the Tier-0 Research Infrastructure (RI), both in terms of legal and administrative tasks, as well as accompanying technical work. In a focused review on October 28th, 2009 the reviewers attested PRACE to have achieved "satisfactory progress" towards this.

The project has defined and implemented an internal selection process for two sets of prototypes during the project: a set of prototypes for potential production systems to be deployed in the short term (identified by WP7) and a set of prototype systems and components for future multi-petascale technologies (selected and evaluated by WP8). Since the acquisition of these

prototypes included significant reassignments of project budget, the processes and their results were assessed and approved by EC reviews in July and in December 2008 respectively and have been confirmed in two contract amendments.

Some prototype systems for future technologies were delivered later than expected due to reasons not under control of the project. These prototypes include – by definition – a significant risk that components or systems are delayed, do not meet the expectations or even do not become available at all. Therefore a continued assessment of these prototypes would provide additional insight into their technologies and thus relevant information for future procurements. Also porting and scaling the benchmark codes to more prototypes would further complete the picture of the suitability of different architectures for different applications.

A cost-neutral extension of the project was granted as part of the third contract amendment to conduct this work. The extension period was also used to maintain the significant momentum that PRACE has achieved in terms of relations to vendors (STRATOS), the continuous technology watch, the ecosystem relations (in particular to Tier-1 and user communities) and dissemination in general. This ensured that the project was active until the legal entity that will run and operate the infrastructure was actually in place. In detail, the work during the extension period from January to June 2010 (M24 – M30) to address the issues listed above has been the following:

- WP2: maintain and follow up on ecosystem contacts, in particular with Tier-1 and user communities.
- WP3: organize and conduct the DEISA-PRACE symposium in June 2010 in Barcelona jointly with DEISA, participate in ISC2009, including the PRACE award, and maintain the PRACE web-presence.
- WP4: establish a “security forum”, which is responsible for defining and implementing a consistent security policy in the Tier-0 infrastructure; provide support for distributed services such as user administration and peer review needed for the extended prototype usage of WP5 / WP6.
- WP5: provide support for an extended access programme to the prototype systems for external users; evaluation of the application benchmarks on more prototype platforms.
- WP6: port and petascale benchmark applications to more platforms including their integration into the benchmarking environment.
- WP7: maintain the general contacts with HPC systems vendors jointly with WP8 and prepare a follow-up event for the highly recognized International Workshop on HPC Centre Infrastructure.
- WP8: perform extended evaluation of the prototypes which were delivered late; continue the STRATOS activities to maintain the vendor relations.

In summary, the project has performed all preparatory work for the start of the implementation phase of the Research Infrastructure in 2010. Some fine-tuning and completion in the extension period has provided further benefit.

3.2 WP2 - Organisational concept of the Research Infrastructure

WP2 is responsible for preparing a comprehensive legal and administrative framework for the implementation phase of the Research Infrastructure, including the statutes for the new legal entity which will progressively incorporate what has been agreed on governance, funding, usage and peer review process. The crucial objective set has been to have signature ready contracts for

the new organisation, but the task structure of the work package covers many different organisational aspects:

- Task 2.1 Definition of the Legal Form of the Research Infrastructure
- Task 2.2 Definition of the Governance Structure
- Task 2.3 Specification of Funding and Usage strategies
- Task 2.4 Establishment of the Peer-Review Process
- Task 2.5 Establishing Links with the HPC Ecosystem
- Task 2.6 Development of the Operation Model
- Task 2.7 Selection of Prototypes and Production Systems

One aspect that became evident early in the project was the extremely close relationship between the tasks resulting in close coordination between the task leaders.

Task 2.1 Definition of the legal form for the Research Infrastructure

The appropriate legal form for the permanent Research Infrastructure has been defined based on the principles that the partners have agreed and taking into consideration the work done by ESFRI on legal forms for pan-European Research Infrastructures. Results were provided in three documents:

Report on options for a legal entity (D2.1.1) provides an overview of the available options for legal structure as well as a detailed analysis of the requirements for the PRACE legal form, along with documentation of the possible available international, European and national forms and a list of criteria which was used to choose the most appropriate form. The deliverable includes pre-requisites as well as a revised criteria list and scoring methods that narrow the field of options to ease the selection of a legal form.

A tender for legal services was published during 2009 to find a specialised firm that helped to analyse the legal forms and drawing the statutes. The public tender was first published in January 2009 and after several competition rounds; Bird & Bird was the selected firm of the contest.

Draft contract for the legal entity (D2.1.2, restricted) provides draft legal documents capturing agreed positions on key terms for the final statutes. The initial results of the work on the legal documents include the draft statutes, the agreement for the initial period and the draft intergovernmental convention. These drafts were consecutively refined until agreement on a final set of provisions on September 2009. Although the ERIC legal form was ranked as the most desirable one for PRACE, the delay on its regulation made it ineligible as the legal framework for PRACE.

Final signature ready contract for the legal entity (D2.1.3) provides a final set of signature-ready contracts for the legal entity (statutes and agreement for the initial period). These two documents constitute a significant part of the results of the different tasks in WP2, including financial, governance, and operational aspects, and with their formalization, the main objective of WP2, as initially set, was successfully accomplished. Upon selection of Portugal as a temporary legal seat, the legal documents were adapted to the specificities of the Portuguese law. In addition, the deliverable identified and provided details on the steps to be taken by each future member in order to formalize their incorporation.

Due to significant legal and financial risks involved in the dissolution of a Portuguese association, which would be part of a migration to a final seat, the decision on the legal seat was

revised later and Brussels was selected instead. The documents have been adapted to Belgian law after the finalization of D2.1.3.

Task 2.2 Definition of the Governance Structure

This task covers the work on codifying a governance structure of the legal entity of PRACE. It includes three documents showing results on the analysis at the different stages of the project:

Report on analysis of adequate governance structure (D2.2.1) shows the scaffold of what a good governance structure for PRACE should be. The document provides a definition of the governance scope, an analysis of the governance structures of various different but comparable research infrastructures and a brief initial suggestion for a structure.

First draft of governance structure (D2.2.2, restricted): Using the results provided in the previous deliverable, the draft governance document provides details of what are considered to be the necessary bodies and positions of the governance structure (including the HPC User Community), their mandates and an explanation of why they are considered to be necessary.

Governance document (D2.2.3): The structure defined has finally been adapted to the specific requirements of the Portuguese Association, and also the definition of the resolution rules of the different governing bodies. This adaptation takes into consideration the opinion of the national ministries and advice given by the specialised legal firm chosen, and also respects the concepts of effectiveness, accountability, participation and transparency that were set as key parameters for PRACE. The deliverable also includes the steps planed to populate the necessary bodies to govern the PRACE Association.

After the finalisation of this report, minor adjustments of the governance structure were necessary to adapt the structure to Belgian law (See Task 2.1).

Task 2.3 Specification of Funding and Usage strategies

This task focuses on the evaluation of funding strategies, on the definition of procurement of production systems and the definition of the modalities for the usage by scientists from different countries. This task produced the following:

Document on procurement strategy (D2.3.1, restricted): In this document, a definition of the strategy and process for procurement of prototype and production systems is provided.

Usage model document (D2.3.2, restricted): In this document three routes for allocating access to PRACE systems are proposed: Preparatory access to enable research groups to demonstrate the ability of a code to run, test out an approach, or trial an improvement to software; classic individual Project access; and Programme access under which a small number of large blocks of computing resource, to be allocated to major research teams or consortia who can manage the use of the time themselves. A mixed approach to awarding resources, with some allocations based on science and some allocated according to the partner's contribution is recommended. It is also proposed that a charge should be made for access by industry when the results of the work will not be made publicly available. A short access policy for PRACE prototypes is also recommended. This document was further revised to include the Service Level Agreements (SLAs) required.

Report on funding agreement (D2.3.3, restricted): This document suggests how to account for resources allocated to the organisation, identifies the budgets required for the organisation, and determines how this budget will be provided. In addition, the deliverable also provides a first

version of the budget requirements for the initial period of the RI, covering costs and funding sources, and determines how this budget will be provided.

Task 2.4 Establishment of the Peer-Review Process

This task focuses on the definition of the process, evaluation methods and criteria for the peer review mechanism, a crucial process for the success of the HPC policy. The task provided its results in two deliverables:

Initial report peer review process (D2.4.1): Aiming at developing an integrated but independent peer review system ensuring a one-stop-shop for user communities to access European HPC resources, a document establishing a general HPC policy was drafted. This deliverable builds on top of the HET peer review document and national policies. It defines a set of principles for the peer review process that PRACE will operate.

Peer review process document (D2.4.2): The usage model output and the preliminary outcomes for the peer review definition served as a reference for further refinement on peer review system. This final document defines the specifics of the process for peer review respecting the HET peer review structure as well as current best practices in HPC centres.

Task 2.5 Establishing Links with the HPC Ecosystem

PRACE is using a collaboration model to work with other national or topical centres and their user communities. The work done on establishing links with the ecosystem has had a positive effect on the relationship between WP2 and all of the other WPs including the technical ones. This task has focussed on establishing contacts with stakeholders in the European HPC ecosystem such as user communities, other research infrastructures, and the ESFRI projects. It has also allowed systematic documentation and follow-up of the contacts made by other WPs with e.g. system manufacturers, software developers, HPC and grid projects, funding bodies and European countries interested in joining PRACE. The work was reflected in two deliverables:

Analysis of HPC Ecosystem (D2.5.1): This document reports the results of an analysis of an assessment of collaboration and integration opportunities for PRACE.

Report on Links with HPC Ecosystem (D2.5.2): This other deliverable specifies the links established with actors in the ecosystem following the previous analysis.

Although this task did not have any formal deliverables due for the second year, it was active through different activities such as participation in the European RI Workshops and the ePP-CC workshops that took place twice during the year. This deliverable has been finally updated to register all the links established until the end of the project.

Task 2.6 Development of the Operation Model

In order to create a consistent operational model to provide the research community with a single, unique permanent infrastructure, the task leaders liaised heavily with the technical work packages. They also included the baseline assumptions (peer to peer, usage model) as well as other important points such as shared file systems, common user environment and minimal security levels to define an operational model.

A consistent operational model is required for PRACE to achieve its goals, in the face of evolving technologies and architectures, across multiple interconnected distributed sites. The

model must also allow a coherent ecosystem to be built, ensuring that PRACE Tier-0 systems are easy to use for users familiar with the other tiers of the European HPC environment. Results are:

Operational model analysis and initial specification (D2.6.1): This deliverable provides analysis and initial specifications for an operation model, and presents the result of an intensive questionnaire completed by European HPC centres.

Report on operational model (D2.6.2): This deliverable completes the previous specification providing further detail and defined the set of services to be delivered by the PRACE RI and how they will be delivered.

Task 2.7 Selection of Prototypes and Production Systems

This task focuses on documenting the process and rationale on the process for deciding the number and placement of prototype systems as well as the production systems. It is structured in four deliverables. Since these deliverables contain information that is related to procurements, they are restricted. However, most of the technical information that guided the decisions documented here is available in deliverables of work packages 6, 7, and 8:

Report on selection of first prototypes (D.2.7.1, restricted): This deliverable documents the Management Board decisions on prototype selection defining the set of criteria to consider in order to provide guidance to select the prototype machines to use in PRACE.

Final report on selection of prototypes (D2.7.2, restricted): This deliverable reports on the prototypes selected for the project. It includes both the candidates for potential Tier-0 production systems and of components and technologies for future multi-Petaflop/s systems.

Report on selection of first production systems (D2.7.3, restricted): This deliverable explains the available options for production systems including likely costs. It documents the steps taken to ensure that adequate funding will be available and in addition, it drafts the planned implementation phase for production systems.

Report on selection of next production systems (D2.7.4, restricted): Based on the findings of the technical work packages, a number of recommendations were issued, taking into account market and technology survey, sites assessment, infrastructure issues, etc. These results are reflected in this deliverable.

3.3 WP3 – Dissemination, outreach and training

Work Package 3 (WP3) is responsible for the presentation of project results at conferences, the organization of PRACE events, as well as establishing a training program for potential PRACE research infrastructure users. It maintains the project's web presence, produces press releases, news bulletins, brochures, success stories, posters, web-based publications, events and training material. It also provides input to relevant European Commission initiated dissemination activities. In this context the project's dissemination messages also reflect its broader societal and economic impact.

The mission of WP3 is composed of the three following tasks:

- Task 3.1: Dissemination activities
- Task 3.2: Industry and business collaboration
- Task 3.3: Education and training program

The principal objectives for dissemination, outreach, and training in PRACE are dissemination to the major HPC stakeholders, the European scientific and research communities, research infrastructure organizations, universities and centres for higher education, and the general public, liaison with industrial and business partners as potential HPC users and the implementation of an education and training program for computational science aiming at scalable computing.

Task 3.1 Dissemination Activities

The dissemination activities were started immediately after the beginning of the project. In March 2008, WP3 produced the **Final plan for the use and dissemination of foreground (D3.1.1)**.

During the project duration 79 press releases and 8 newsletters were published. The number of press releases increased from 23 in 2008 to 41 in 2009 and 15 in the first half of 2010. They were sent to over 7,000 journalists around the world. The total number of PRACE related electronic articles and news items until the end of May 2010 was 1835 (481 until the end of November 2008).

The number of the web site visitors has also been increasing steadily – the total number of visitors as in the end of May 2010 was 201,160 visitors (97,493 unique visitors) since the launching of the website on March 19, 2008 (until December 2008, there had been 27,471 unique visitors). The number of the visitors has increased to over 10,000 visitors per month which means that the figure has doubled since 2008 (in the end of the year 2008 the number of visitors was around 5000 per month). These figures clearly show an increasing interest in PRACE.

Public web site for PRACE (D3.1.2): The PRACE website (http://www.prace-project.eu) contains general information about PRACE, includes all public deliverables, press releases, and other information such as general presentations. In an FAQ (Frequently Asked Question) section was introduced and a Job Bank was added to the website. The idea of the Job Bank is to promote HPC related jobs at the PRACE partner sites. A new section for the PRACE prototypes was introduced. Users can apply to use the PRACE prototypes using the information available at www.prace-project.eu/prototype-access. In addition, the training section was developed and over 48 hours of videos uploaded.

PRACE started collaboration with the Belief-II project (Bringing Europe's eLectronic Infrastructures to Expanding Frontiers). PRACE press releases and all other public PRACE digital material are available at the Belief Digital Library.

Dissemination package (D3.1.3): A variety of dissemination material that is disseminated at various events during the project has been created. The dissemination material, which is continuously updated, includes PRACE t-shirts, PRACE USB memory sticks with PRACE information, PRACE prototype posters, PRACE general poster, and PRACE brochures.

Proceedings of the first scientific conference (D3.1.6): PRACE arranged a scientific conference in Lyon on November 26. The conference was held in parallel with ICT 2008. The conference included a networking session entitled "Scientific Computing in the Petascale Regime: a European HPC Infrastructure" at ICT 2008 along with an evening session and dinner on the 26th. It was attended by over 40 participants from 16 countries. The themes of the scientific workshop were applications, architectures and training needs for Petascale computing. Participants received first-hand information outlining the current status of the PRACE project, including its progress with hardware infrastructure, software applications and training.

Proceedings of the second scientific conference (D3.1.7): DEISA, the Distributed European Infrastructure for Supercomputing Applications, and PRACE for the first time merged their annual science symposia into one big European HPC event: The DEISA PRACE Symposium 2009. This symposium took place from May 11 to May 13 in Amsterdam, and was hosted by SARA and NCF at the Royal Tropical Institute. DEISA PRACE Symposium 2009 attracted almost 200 participants from 22 countries.

The theme of this unique symposium was "HPC Infrastructures for Petascale Applications". The symposium was of major interest to a broad audience: from scientific users, HPC technology experts and vendors, government representatives and industry partners.

Speakers included representatives from the European Commission, government and funding agencies and research organisations from the USA, Japan, Australia, and Russia, complemented by speakers from different science communities.

The Third Scientific Conference: The DEISA PRACE Symposium 2010 was held for the second time as a big European HPC (High Performance Computing) event. The symposium featured speakers from different scientific communities as well as decision makers in science. The symposium was of major interest to a broad audience: from scientific users, HPC technology experts and vendors, government, EC representatives and industry partners. It gathered more than 130 participants from 23 countries and three continents. This symposium was held from May 10 to May 12 at Casa Milà, in Barcelona, and hosted by the Barcelona Supercomputing Center.

In addition to these conferences, WP3 organised booths and sessions at the International Supercomputing (ISC) in Dresden (2008) and Hamburg (2009, 2010), at the Supercomputing (SC) in Austin (2008) and Portland (2009). In total 19 further scientific events were attended and over 2,000 new contacts gained.

Task 3.2 Industry and business collaboration

The objective of this task is to liaise with industrial and business partners as potential HPC users. This was facilitated mainly through a series of industrial seminars, where PRACE presented itself and gathered requirements from industry.

The First Industrial Seminar (D3.2.1): The first PRACE seminar targeting European industry “Industrial Competitiveness: Europe goes HPC” was organised by GCS, GENCI and NCF in Amsterdam on September 3rd 2008. In depth discussions between speakers and audience about industrial needs and expectations regarding PRACE contributed to the success of the seminar. The First Industry Seminar was designed exclusively for CEO (Chief Executive Officer), CTO (Chief Technical Officer), CIO (Chief Information Officer) and R&D Managers, responsible for research and development infrastructures in business sectors that are likely to benefit from the use of future HPC infrastructure deployed by PRACE.

The first PRACE Industry Seminar attracted a total over 90 attendees from thirteen European countries representing 35 European companies covering a wide spectrum of industries.

The Second Industry Seminar (D3.2.2): The Second Industry Seminar was organized by GAUSS and GENCI with the sponsorship of Airbus, Grand Toulouse and Midi Pyrénées Region in Toulouse the 7–8th September 2009.

Around 103 attendees representing 57 companies attended this event. It was one year after the First Industry Seminar in Amsterdam – an opportunity for PRACE to meet again and intensify the contacts with the European industry community. It allowed PRACE to present the project,

and the attendees to discuss and exchange ideas about HPC in industry as a tool for increasing competitiveness and accelerating innovation.

Three parallel sessions gave an opportunity to gather industry's needs and expectations about PRACE and to elaborate how the project will build a pertinent European industrial HPC infrastructure. The conclusions concerning industrial requirements for HPC were documented in the final deliverable of this task: **Conclusion on collaboration with industry (D3.2.3)**.

Task 3.3 Education and training program

This task is in charge of implementing an education and training program for computational science aiming at scalable computing. This program consists of a series of seasonal schools and code porting workshops.

One of the most successful outcomes of the workshops organised by WP3 was the large collection of training material that is now freely available from within the PRACE training portal. In particular over forty-six hours of video content was captured to ensure that the HPC community at large is able to benefit from the expert instruction and knowledge transfer, on demand and at no cost.

Survey of HPC education and training needs (D3.3.1): To align the training program with users' needs, a survey among European HPC users was made. This report, which received an "excellent" at the EC Review, has steadily attracted interest all over the world. It has been requested to be a template not only in Hong Kong and North East Asia but also in the United States.

PRACE Summer School (D3.3.2): The PRACE Petascale Summer School (P2S2) was carried out by PDC, CSC and FZJ at the main campus of KTH in Stockholm during August 26th to 29th. The first two days focused on the Blue Gene/P in Jülich and the final two days focused on the Cray XT4 at CSC. It also included invited lecturers from WP6 and WP7. This four-day event of advanced training targeted students from research groups with the ambition of becoming users of future Petascale systems in Europe. The main goal was to give the participants hands-on experience on porting codes to massively parallel computers. The Summer school attracted 31 students from 16 different countries, including all PRACE countries at that time.

PRACE Winter School (D3.3.3): The PRACE Winter School was carried out by GRNET and CSCS in Athens, Greece, from February 10 to February 13 2009. The Winter School offered European users of High Performance Computing (HPC) a deep insight into current and future parallel programming techniques. Forty-eight participants from 18 European countries were selected from among 79 registrants to participate in this event, which was hosted by the Greek Research & Technology Network (GRNET), with the cooperation of the Aristotle University of Thessaloniki. Topics included MPI/OpenMP hybrid programming, multicore optimisations, Partitioned Global Address Space (PGAS) programming with Unified Parallel C (UPC), next-generation HPC programming with 'Chapel', and programming the novel IBM Cell system.

To enable students to also obtain practical experience with these techniques, access was provided during hands-on sessions to two PRACE prototype systems: The IBM POWER6 system at SARA in Amsterdam, The Netherlands, and the IBM Cell system at the BSC in Spain.

Code-porting and Optimisation Workshops (D3.3.4): WP3 organised five PRACE code-porting and scaling workshops and an additional GPGPU training. These workshops complete the PRACE HPC Training and Education programme, for the preparatory phase of the project, and significantly build upon the recommendations proposed within the PRACE HPC Training and Education survey.

The primary objective of these workshops was to provide participants with the necessary training, education and expertise to port and scale user applications to a broad spectrum of PRACE prototype petascale architectures, which may become resources within Europe's Tier-0 computing research infrastructure during the implementation phase of the PRACE project.

The workshops were hosted respectively by France, Finland, Switzerland, Spain, Poland and Sweden and attracted more than 120 participants from across Europe, Asia and North America. The workshops provided students with access to four PRACE prototype systems (Cray XT5, NEC SX-9, IBM BlueGene/P and IBM Cell) and the direct experience of over 10 invited speakers who are renowned experts in porting and scaling applications to these architectures.

The overwhelming response from the participants of these workshops was positive and it is imperative that the PRACE Training and Education programme is further supported to provide similar events in the future. Without the transfer of knowledge from porting and scaling experts, users of forthcoming Tier-0 computing resources will be inadequately prepared to exploit these valuable tools, in pushing the boundaries of European science and competing successfully within the global scientific community.

French PRACE GPGPU Training: The workshop was hosted at Ter@tec and CEA from April 27 to April 30, 2009, in Bruyères-le-Châtel, France. Twelve HPC experts from six PRACE countries received a deep insight into CUDA, a language for NVIDIA graphic cards, and to HMPP (Hybrid Multicore Parallel Programming) is a collection of tools, compilers and a runtime from CAPS enterprise that allows portable programming for various multi- and many-core architectures. The lectures were complemented by hands-on sessions on the GENCI-CEA PRACE prototype.

Finnish Workshop on Application Porting and Performance Tuning: The workshop was hosted at the HTC Keilaniemi Conference Centre during June 11-12, 2009, in Espoo, Finland, close to the CSC facilities. The programme for the workshop focused on a series of technical lectures presenting the porting, optimization and profiling techniques currently employed by PRACE researchers within WP6. These lectures included information on new programming models for petascale computing, numerical libraries and performance measurement tools. In addition, these lectures were complemented by a series of case studies, describing the application of these techniques and technologies on real applications.

Swiss Workshop on Cray XT5 Code Porting: The code-porting workshop was hosted at the Swiss National Supercomputing Centre, during July 13-15, 2009, in Manno, Switzerland. The focus of this three-day workshop was to provide students with advanced training and expertise in porting application codes to the Cray XT5 architecture; one of the PRACE prototype systems. The workshop comprised morning lectures and afternoon hands-on sessions with support from porting and optimization staff from Cray Inc.

Polish Workshop on NEC SX-9 and IBM BlueGene/P Code Porting: The Polish workshop was hosted at the Academic Computer Centre CYFRONET AGH during October 14–16, 2009, in Cracow, Poland, in association with the Cracow Grid Workshop 2009. The goal of this workshop was to provide students with leactures and hands-on experience with porting application codes to the IBM BlueGene/P (FZJ, Juelich) and NEC SX-9 (HLRS, Stuttgart) PRACE prototype systems.

Spanish Workshop on Cell and GPGPU Code Porting: The workshop was hosted at the North Campus, Technical University of Catalonia during the October 21–23, 2009, in Barcelona, Spain. The focus of this workshop was to provide students with advanced training in programming models and optimization techniques for Cell and GPGPU-based systems that comprise some of PRACE's prototype architectures. The workshop featured the OpenMP 3.0

programming model, application porting to Cell-based systems, and UPC, CUDA, and OpenCL or GPGPU systems.

Swedish Stream Computing Workshop: A workshop on stream computing was arranged on December 7–10, 2009 in Stockholm, Sweden at the KTH Royal Institute of Technology. It consisted of lectures and hands-on experiences in using OpenCL on state-of-the-art stream processors. The workshop also covered lectures on stream processor architectures and programming tools for stream processors and multi-core systems. Lectures reporting on successful use of stream processors in scientific applications were also presented. Contributions to the workshop were confirmed from AMD, NVIDIA, Stockholm University and Synective.

3.4 WP4 – Distributed system management

The aim of WP4 is to define the systems software stack for managing the distributed PRACE infrastructure and for providing access to users. Two main threads of activity have been closely intertwined within WP4's work, namely, the creation and enhancement of the distributed systems software stack, and the definition of the final specification for systems management on the PRACE Tier-0 systems.

WP4 organized its work throughout a series of face-to-face meetings, where the bulk of the work of selecting software and agreeing on configuration issues was done. The face-to-face meetings were complemented by weekly videoconferences and email discussions, to address the day-to-day work of deployment and discussing the technical details.

Requirement analysis for tier-0 systems management (D4.1.1): In order to capture the broadest range of requirements and constraints for the future management of a distributed Tier-0 system, an extensive survey, inquiring on all aspects of HPC systems technology (computational hardware and architecture, I/O and network capabilities, users management, systems software, etc.) has been prepared and sent to a number of potential future tier-0 site candidates. Persons responsible for these sites were asked to report on present practices and foreseen developments as well.
After collecting the answers and consolidating them into a single view of the PRACE HPC landscape, it appeared that no large difference was found between the distributed systems management aspects of a number of potential future Tier-0 systems and a number of present-day Tier-1 systems. A set of mandatory requirements was laid out, most of which can be already met with present-day solutions.

Deployment of software stack to all prototype sites and selected Tier-1 sites (D4.1.4, restricted): This final deliverable of Task 4.1 is closely related to D4.3 and is described in the respective paragraph below.

Deployment of enhanced solutions (D4.2.2): For the enhanced software stack (a successor to the **Evaluation report of existing solutions for the ecosystem integration (D4.2.1)**), the adoption of standards-compliant interfaces was a primary goal in this selection, especially to let the PRACE infrastructure interoperate with established actors in the HPC ecosystem. Interoperability with DEISA was particularly catered for, and the enhanced software stack uptakes new components from the ones that DEISA deploys in its production infrastructure. The enhanced software stack is also a step forward in providing a distributed systems management environment that can accommodate the daily operations needs of a production infrastructure. In particular, the D4.2.2 software stack includes:

- User administration system and accounting framework, initially adopted from DEISA. An outline of the modifications that need to be carried out for implementation in PRACE is provided. The system is set up so that it can adapt to both a distributed and a centralized administration model.
- Usage of RFT/GridFTP for data movement inside the PRACE prototypes network (which is the DEISA dedicated network, to which all PRACE prototypes are attached), and also as a means of interfacing with other infrastructures.
- Adoption of UNICORE6 as a user-friendly interface for job submission and monitoring.
- Software to distribute monitored systems information based on a draft distribution policy defined by WP4.

The path leading to this result had its start in a face-to-face meeting held during the PRACE "All-hands" at Juelich (February 11-13, 2009), with the main decisions being taken at a dedicated meeting hosted by CINECA in Bologna in April.

In order to have a clear picture of the status of the data management facilities, and the foreseeable development thereof, a survey was sent to PRACE sites, inquiring about the policies on data storage and the expansion plans. A further topic of the survey was the policies and capacities of the long-term archival storage. The outcome of the survey has been communicated to WP2 to help design the Operational and Usage model in D2.6.2.

For the selection of data transfer and management software, WP4 has examined the evaluations already carried out by DEISA of the SIMDAT, SRB/iRods and RFT/GridFTP software. An evaluation activity has been run to assess the SECTOR/UDT framework, which has concluded that it is not yet suited for production usage.

In order to define the availability of systems monitoring information, WP4 has prepared a list and classification of monitored information, and later run a survey, asking PRACE site representatives to share their views on what pieces of information should be made available to whom. The survey outcome has formed the basis of the recommendations on monitoring software and policies in D4.2.2.

Deployment of software stack to all prototype sites and selected Tier-1 sites (D4.1.4, restricted) and Specification document for PRACE systems management (D4.3, restricted): The last WP4 deliverables report on the final selection of software for distributed systems management, both on the actual deployment on the existing PRACE prototype infrastructure (D4.1.4) and as a specification for future deployment on the Tier-0 systems (D4.3). The software components of the final software stack are the same as those in the enhanced software stack (specified in D4.2.2): no software functionality was found missing, instead, WP4 has focused on tuning the configuration and the tools in view of future production use.

Indeed, during Summer and early Autumn 2009 an evaluation activity has been run, with the objectives of assessing the distributed systems management software stack from a users' perspective (i.e., exercise the systems just as an ordinary user of the PRACE infrastructure would have seen them). The evaluation task was able to test the functionality and performance of all the components of the software stack on most prototypes (depending on the installation status), and inject its feedback into the software configuration and selection process. Also, a comprehensive survey of the installation experiences of the distributed systems management software at PRACE prototype and Tier-1 sites was performed, which has been the basis for D4.1.4.

Compatibility with DEISA has been a primary objective: it was explicitly ensured, in the interests of users and systems administrators, that the two HPC infrastructures are compatible down to the software level: users coming from DEISA will find a familiar environment in

PRACE, and systems administrators can more easily adapt their scripts from the DEISA machines to the PRACE systems.

The user administration and accounting system has been thoroughly revised and prepared for production use: a central PRACE LDAP server has been deployed at CEA (in anticipation of a similar server being run by - or on mandate of - the PRACE HQ) and the user database has been populated with all PRACE users from the 1st and 2nd prototype access call. With the currently deployed solution PRACE and DEISA share the same user administration system. A common LDAP schema has been agreed with DEISA (in a face-to-face meeting in Amsterdam, right after the DEISA technical meeting), and the DEISA user administration policies have been revised for use in PRACE. Negotiations are currently underway to produce a unified document that can accommodate user policies for both projects. Supporting scripts have been adapted by WP4 personnel at prototype sites, implementing the above mentioned policies. Discussions on data privacy and the possible legal implications of computer security have been fed back to WP2 and are now being formally tackled with the help of the legal firm AVA.

Besides user administration and accounting, several other services are now provided to PRACE users:

- The GSI-SSH "door nodes" provide interactive command-line access to the PRACE systems from the internet; these servers currently run at LRZ and SARA.
- The GridFTP "door node" provides an entry point to the PRACE infrastructure network for massive data transfer; this server currently runs at LRZ.
- The central UNICORE registry runs at FZJ (main instance) and CINECA (backup).
- The RFT server caters for unattended transfer of large data sets; LRZ runs this for PRACE.
- The central user LDAP database is run by CEA.

Finally, an important theme in D4.3 is the prospective support for Industrial users. A specific activity here was started with WP2 task 2.5 at the joint PRACE/DEISA Symposium in Amsterdam, and continued throughout the year; WP4 personnel also participated in the 2nd PRACE Industry Seminar in Toulouse. The conclusions of this work have been summarized in D4.3.

PRACE security forum: During the discussions and preparatory work on the WP4 "enhanced software stack", it became evident that even small differences in security policies can lead to long negotiations and delays in deciding and deploying a solution. Trust must be built among the participating centres; emergency procedures must be agreed upon; and a consensus must be reached about the concessions that local security policies have to make.

The decision has been taken to found a "PRACE security forum" in 2010, where experts and decision-makers from different sites meet and agree on a joint security policy. The initial objective of the security forum is to discuss and negotiate a joint PRACE security policy, to be implemented at all sites, that would enable the PRACE vision of uniform access to computing resources. Three key issues are closely interlinked and will be the main topic and result expected of the security forum: (1) a statement of minimal security requirements, that all PRACE sites are expected to abide to; (2) an agreed list of software and protocols that are considered robust and secure enough to implement these requirements; (3) a trust model that allows smooth interoperation of the distributed PRACE services.

The "PRACE security forum" will also advise on the participation of PRACE in international security organizations, and consult on security-sensitive policy documents (e.g., the "Acceptable Use Policy"). The "PRACE security forum" brings together:

- Security officers from PRACE service sites (i.e., all sites involved in PRACE operations: prototype sites and sites running auxiliary middleware services); it is important that the involved people have sufficient authority to negotiate security policies, and implement the decisions taken in the forum.
- Representatives of various WP's: WP2, WP4, and WP5.

A close collaboration with DEISA is being setup, which recently initiated a parallel initiative. A document has been produced that describes in detail the responsibilities, tasks and the organisation of the security forum.

3.5 WP5 – Deployment of the prototype systems

Work Package 5 (WP5) is central to the PRACE prototypes for potential Tier-0 systems, and focuses on the deployment and assessment of the prototype systems. The objective of WP5 is to install the selected prototype systems, test the integration and operation in close-to-production conditions, evaluate the capabilities of the systems and benchmark them with user applications.

The selected prototype systems are:

- IBM BlueGene/P at FZJ,
- IBM Power6 at SARA,
- Cray XT5 at CSC,
- IBM Cell/Power6 at BSC,
- NEC SX9/x86 system at HLRS,
- Intel Nehalem/Xeon IB cluster at CEA and FZJ.

In the first year (2008) of the project a start was made with the installation of the first prototype systems (**Installation report prototype systems (D5.1.2, restricted)**), as well as with preparations of the various technical benchmarks. The installation of two prototype systems, the IBM BlueGene/P at FZJ and IBM Power6 at SARA were completed in year 1, including writing the installation reports. In year 2 all of the remaining prototype systems were installed, and all technical assessments and application benchmarking were performed on all prototypes. The installation reports of the prototype systems Cray XT5 at CSC, IBM Cell/Power6 at BSC, the NEC SX9/x86 at HLRS, the Intel Nehalem at CEA and FZJ were completed, and are collected in an updated version of D5.1.2.

All prototypes have been available since their installation for access by the user community for porting and testing applications. With that, the prototypes served as the first 'real' PRACE distributed HPC infrastructure. Access to prototypes and support to external users has been continued until M30 of the project. This access programme has been well received by the scientific communities as a means to prepare their codes for the future Tier-0 infrastructure.

At the beginning of 2009 the technical assessment of the prototype systems (T5.2) and the evaluation of the communication and I/O infrastructure of the prototype systems (T5.3) were started. The approach taken is to provide quantitative data measured with synthetic benchmarks, provided by WP6, to characterise the performance of different properties of the prototypes in isolation. Where a synthetic benchmark is not available, such as investigating manageability of the system, an alternative method for obtaining quantitative and qualitative data is used. Most assessment activities provide information on scalability, but of course only up to the size of system available in the prototypes. This is particularly important, as these results will assist the decision on the suitability of a prototype as a Petaflop/s machine. The rules for benchmark runs are specified so that comparisons between results are more meaningful.

The technical evaluation (T5.2) included assessments of hardware performance, systems software performance, system balance, scalability, manageability, reliability and total cost of ownership (TCO) including infrastructure and data centre requirements. The evaluation of communication and I/O (T5.3) included assessments of message passing performance, internal system I/O performance and external I/O performance.

Technical assessments of all prototypes have been completed and reported in the **Technical assessment report of prototype systems (D5.2, restricted)** and the **Assessment report on communication and I/O infrastructure of prototype systems (D5.3, restricted).**

In close collaboration with WP6 the evaluation and benchmarking of user applications has been performed (T5.4). The applications used are those identified by WP6 as being representative of the current and future usage of major European HPC systems. The approach taken is to provide quantitative data measured with application benchmarks, provided by WP6, to characterise the performance of the prototype systems as a whole. In order to make meaningful comparisons between prototype systems with very distinct hardware architectures, a key feature of the approach is to measure the performance of applications on partitions of the different systems which have the same nominal peak floating point performance, rather than, say, the same number of cores or processing elements. The results of those benchmarks are reported in the **Report on the application benchmarking results of prototype systems (D5.4, restricted).**

In March 2009, the first versions of D5.2 and D5.3 were prepared and submitted. These documents are living documents and contained results from only the first two prototypes that were installed. Between M15 and M24 the assessments of the remaining prototypes have been performed after these prototypes became available. In December 2009, D5.2 and D5.3 have been updated to contain the results of the technical assessments of all prototypes.

At June 2009, a first version of D5.4 was provided. This document is also a living document and contained preliminary application benchmark results of a number of applications on a number of prototypes. Between June 2009 and June 2010 a large and continuous effort has been made to run more applications on more prototypes, and to re-run applications wherever applications had been improved. At December 2009 and at June 2010, D5.4 has been updated and finalised.

A consolidated report **Comparison and recommendations od Petaflop/s systems (D5.5, restricted)** has been produced at December 2009, where the most important and relevant results from the installation, technical assessments and benchmarking of the six prototype systems are compared. Where possible, recommendations for the selection of actual Petaflop/s systems are made.

In conclusion, the PRACE prototypes have provided an HPC infrastructure that has been available for all partners within PRACE. With that, it has stimulated and driven the gaining and sharing of knowledge and experiences among partners within the project. Equally important, with the deployment of the PRACE prototypes, a first real PRACE infrastructure became available for the user community. This has not only been important for the provision of an infrastructure for porting and testing purposes, but it has helped creating awareness of the PRACE project and the future PRACE infrastructure among the users.

The extensive benchmarking of the deployed prototype systems and the results obtained prove that through the used benchmarks and the created benchmark templates detailed insight in a large number of important characteristics of systems and architectures can be obtained. Moreover, it has been shown that useful comparisons among different systems and architectures can be made using these benchmarks. This not only validates the created set of benchmarks and benchmark templates, but also provides an important set of reference material for the assessment of systems in the near future. With that, these results will be very helpful for the selection of near-future Petaflop/s systems.

This work also showed that early access to new systems and architectures is important for testing and assessing technology under close to production conditions, both from the system management side as well as from the application side for porting and scaling. Running synthetic benchmarks has been very useful in learning about the characteristics of the various systems, as well as optimizing configurations and settings of the systems for better performance and stability.

3.6 WP6 – Software enabling for Petaflop/s systems

Work Package 6 (WP6) is responsible for understanding the software requirements for future Petaflop scale supercomputers in Europe. Its primary goal is: to identify and understand the software libraries, tools, benchmarks and skills required by users to ensure that their application can use a Petaflop/s system productively and efficiently. WP6 is the largest of the PRACE technical work packages and involves all of the PRACE partners.

For the first year of the project, the goal was to produce an initial representative benchmark suite (**Report on available performance analysis and benchmark tools, representative Benchmark (D6.3.1)**) to assess Petaflop/s systems. During the second year, these applications were ported to the prototypes selected by WP7. Significant effort was spent optimising and petascaling these applications before they were used in WP5 to help evaluate the prototypes. This work was written up in best-practice guides for petascaling and optimisation (**Report on approaches to petascaling (D6.4**) and **Report on porting and optimisation of applications (D6.5)**) .

One of the major challenges in producing this benchmark suite was to ensure that it was representative of the likely usage of European Petaflop/s systems. To ensure this, we carried out a series of surveys in 2008; results from these surveys were detailed in the relevant deliverables.

1. *System Survey:* We surveyed more than 20 major HPC systems throughout Europe to understand how they were used and what were their major application codes **(Identification and categorisation of applications and initial benchmark suite (D6.1))** As well as including most of the largest HPC systems in Europe, this survey also included key HPC systems from all but two of the countries participating in PRACE.
2. *Applications Survey:* For each of the major applications identified in the System survey, we carried out an in-depth survey of their scientific and technical categories (D6.1). The survey data was used to produce an overall utilisation matrix characterised by scientific area and algorithm.
3. *User Survey:* A survey was also sent to the Top 10 users in each PRACE country, as identified by WP3. This survey included questions about the user, usage patterns, HPC infrastructure, upcoming algorithms and general comments about future petascale systems. Almost 70 responses were received and analysed for the **Final report on application requirements (D6.2.2).**

Together, these surveys provided an excellent picture of current and future European HPC usage from a variety of perspectives. This information allowed us to identify a set of applications for the initial benchmark suite that covered the major scientific and algorithmic areas, which were widely used across Europe and which were representative of likely usage of European Petaflop/s systems. At the EC review in March 2009, the reviewers recommended to revisit the initial benchmark suite to ensure that all applications have the potential to scale into the Petaflop/s regime. Choosing representative applications ensures that a number of applications relevant to European science are ready to exploit petascale systems and helps inform the user community about which applications and algorithms will or will not scale readily to petascale systems.

However, we recognise that the applications are used to help evaluate the PRACE prototypes and are likely to be used in the procurement of future petascale systems. For these purposes, it is important that applications scale well on at least some of the architectures.

WP6 performed a set of scaling runs for all the benchmark applications, primarily for WP5. We decided also to use this data to ensure that each benchmark application scales well on at least one of the prototypes. If an application did not scale, we considered substituting it with an application from a similar scientific area which scaled better; a similar process was applied to applications with licensing problems. This process identified three applications (VASP, ECHAM5 and SIESTA) which were to be replaced with scalable applications with straightforward licensing requirements. The replacements identified were: Quantum_Espresso, WRF and Octopus, respectively. Extensions to the pool of applications were also sought in the areas of earth science and engineering, for industrial relevance. For an application to qualify, we used the same criteria as for the replacement of the codes. Two applications (ELMER and SPECFEM3D) were added to the benchmark suite.

The representative applications were the focus for the second year of WP6 and for the extension period. Task 6.3 ported these to the prototypes and produces an integrated benchmark suite. Tasks 6.4 and 6.5 were responsible for Petascaling and Optimisation of these applications, respectively. To ensure that effort was used effectively, we decided to split the work by application benchmark, rather than by task. For each of the benchmark applications, we identified a Benchmark Code Owner (BCO) who is responsible for: identifying appropriate data sets; integrating the application into the benchmark suite; porting the application to the appropriate prototypes; improving the application's performance by optimisation and scaling The results of this work were twofold: a set of applications ready for the initial production systems and guides to best practice for scaling and optimisation. The applications benchmarks were integrated into a benchmark suite and acceptance tests were defined and performed. Additionally, we also carried out investigations into synthetic benchmarks, performance analysis tools and the performance of novel languages on key kernels. More detailed reports on the active tasks and deliverables can be found below.

- T6.3 was responsible for finalising the contents of the PRACE Applications Benchmark Suite (PABS). To allow ease of use of the applications itself, all benchmark codes were integrated into a benchmark framework. The contents of a synthetic benchmark suite was defined by WP6; actual testing has taken place in the framework of WP5 to assess the prototypes. T6.3 also investigated performance analysis tools, with a focus on practical usage on large numbers of cores. Several combinations of tool-application-prototype have been tested to get insight into their behaviour (reported in the **Final benchmark suite (D6.3.2)**).
- For Task T6.4, the PABS applications were petascaled and the experience gained during this process has been documented in deliverable **Report on approaches to Petascaling (D6.4)**. This data was collected by sending a report template, to the people involved, asking for best practices, lessons learned, bottlenecks etc. for petascaling.
- Task 6.5 focused on porting and optimising the applications in PABS; the results of this effort are reported in the **Report on porting and optimisation of applications (D6.5)**. The applications were ported, on average, to three prototype systems. For optimisation, it proved essential to tune the options and parameters used when compiling and running a code, for example, the choice of numerical libraries and compiler options. A tool was developed for studying optimal compiler options and platform-specific recommendations were produced. Source level optimisations that improved computational throughput were also investigated.

- The activity in Task 6.6 was mainly focused on deliverable **Report on petascale software libraries and programming models (D6.6)**. A survey and analysis of the new upcoming programming models and languages suitable for petascale applications was issued, trying to identify gaps and opportunities provided in terms of performance and efficiency, and benefits for parallelism. This was followed by a specific experimental activity to implement selected software kernels, representative of the PRACE applications, to test and evaluate 12 different advanced parallel programming paradigms and languages, selected from the survey. This activity allowed for the first time a wide comparative evaluation of the performance and programmability of new programming paradigms and languages. Some work in this task has been done in cooperation with WP8 in order to better address and analyse the suitability of the selected programming models for petascaling.

During the extension period, the main focus of WP6 was in porting the applications benchmarks to more of the prototypes and ensuring that additional acceptance tests were completed. Particular emphasis was given to prototypes which had a smaller number of applications already ported by the end of 2009 (usually because these were installed later, e.g., NEC x86 cluster and Cray XT5 with Shanghai CPUs) and for the new applications added in 2009. The enhanced porting matrix was reported in an updated version of the **Final benchmark suite (D6.3.2)** and the performance results were reported in an updated version of D5.4. In addition, some of the results from D6.6 (e.g., on PGAS languages and models for programming accelerators) were presented in a joint workshop with WP8 (see Section 3.8).

In summary, WP6 has defined a benchmark suite (PABS) that contains scalable applications representative of likely usage of European petascale systems, and have ensured that these applications are ready to exploit such systems. PABS has been integrated into a coherent environment and the acceptance tests defined and performed demonstrate both correctness and usability. We collected applications performance data on all of the WP7/WP5 prototypes and this data was used by WP5 to help to evaluate the prototypes. The reports on the technical work on these applications have documented experiences, best-practices, and problems encountered while enabling applications and the deliverables collate common best practices on porting, optimisation and scaling for petascale systems. WP6 has also collaborated with WP8 on evaluating novel languages and programming models and with WP5 on evaluating the prototypes. Overall, WP6 has involved the collaboration of technical experts from all the PRACE partners to prepare a wide range of European HPC applications for petascale systems and to produce best-practice guides which are a valuable resource for the European HPC user community.

3.7 WP7 – Petaflop/s systems for 2009/2010

Work Package 7 (WP7) is in charge of a set of tasks necessary for preparing the initial deployment of the PRACE infrastructure in 2009/2010. This includes the preparation of different technical or procedural elements useful for the future procurement of the supercomputers, as well as the synthesis of information needed for strategic decisions and directions (supporting the MB and also the future management structure of the RI). In addition to this, like other technical PRACE Work Packages, WP7 is preparing the organization of the future RI by setting up the processes and the network of experts that will be the basis of a sustainable RI at a practical level.

Most of the WP7 tasks contribute to all of these goals. More precisely, the planning of a supercomputer installation is typically organised as a process with several different phases. WP7 addresses the different phases through the activities of its 6 tasks:

1. understand the users needs and their applications requirements (Task 2);

2. assess how the foreseeable market can best satisfy these requirements (Task 1);
3. deploy prototypes to get a practical understanding of promising architectures and technologies and assess them more precisely (Task 1 for the selection of prototypes);
4. analyse possible risks and organize a strategy for minimizing them and their consequences (Task 4);
5. prepare the elements for starting a procurement including technical specifications (Task 5), installation specifications (Task 3) and a detailed procurement process (Task 6).

WP7 also provides information for preparing future strategic decisions, in particular:

- cost estimates, expected level of performances of the most powerful systems in the world around 2010 (Task 1);
- architectures most likely to fulfil user requirements (Task 2);
- analysis of possible installation sites (Task 3).

Given the dependence of other WPs on WP7 results, all tasks produced preliminary results and deliverables in 2008 that were updated and refined in 2009. This section focuses on the final results achieved mostly in 2009. The extension period 2010 was mainly devoted to update and maintain vendor contacts and to prepare a follow-up event for

These activities have led, in accordance with the Project Plan, to producing results in March 2009 (Pre-qualification questionnaire (D7.6.2): procurement procedures), in June (Final assessment of Petaflop/s systems to be installed in 2009/2010 (D7.1.3): macroscopic analysis of market, costs, requirements and architectures, restricted), one in November (D7.5.2 technical requirements) and another two by the end of December (Evaluation criteria and acceptance tests (D7.6.3): procurement elements and Final Risk Register (D7.4.2, restricted)).

Moreover, WP7 contributed to the organization of the first European Workshop on HPC centre infrastructures held in Lugano in September 2009. A PRACE closed session, organized and chaired by WP7, was the occasion of gathering updated information on the status of large infrastructures in Europe and to foster exchange of information between PRACE partners' sites.

The major achievements and findings of WP7 can be summarized as follows:

- vendors contacts, which further contribute to building a widespread recognition of PRACE;
- market and technology watch, continuing in close collaboration with WP8;
- a new HPC architectures classification, which has then been used to build blocks of technical specifications;
- applications requirements and its mapping to the HPC architectures using input from the evaluation of prototypes (WP5);
- continuing survey of petascale projects worldwide, so as to orientate PRACE choices and sizing of systems for 2010;
- cost analysis and first elements of TCO for different possible equipment scenarios;
- contribution to first European Workshop on HPC centre infrastructures and organization of a PRACE closed session during this workshop;
- regular participation to WP8 events to discuss the future missions of STRATOS, some of which will continue WP7/WP8 joint activities;
- desirable technical requirements for petascale systems;
- risk analysis taking into account the progress of the project and studying in more detail mitigation strategies and their impact;
- completion of the set of building blocks for procurement processes.

In detail the six tasks of work package 7 produced the following results:

Task 7.1 Survey of technologies, architectures and vendors for Petaflop/s systems to be delivered in 2009/2010

Final assessment of Petaflop/s systems to be installed in 2009/2010 (D7.1.3, restricted): This document summarises the final results of Task 7.1. It provides:

- Cost estimates for one Petaflop/s peak systems in 2010 on a TCO basis (total cost of ownership). As in previous estimates, the cost varies significantly with the architecture of the system (in the range of 50 to 200 M€); in all cases, the running cost is similar to the cost of the supercomputer and the two major elements of the running cost are electricity and maintenance.
- A worldwide analysis of the most powerful supercomputers likely to be in operation in 2010/2011. This analysis shows that the future RI should target performances exceeding 1 Petaflop/s (peak) in 2010 to have a system in the 5 or 10 most powerful systems in the world.
- An update of the HPC architectures classification and how applications requirements can relate to architecture options.
- Recommendations for the first production systems.

In 2010, general contacts with vendors have been maintained jointly with WP8. A series of meetings has been organised during ISC'10 in Hamburg, 30 May-3 June 2010. The WP7 meetings series covers most of the list of main HPC vendors PRACE has identified.

Task 7.2 Translation of user requirements into architecture and configuration specifications

This task worked with WP6 to develop D7.1.3 to report an updated analysis of desirable architectures on the basis of the PRACE benchmark set. This analysis showed that general-purpose architectures (MPP and clusters) are still the most likely to satisfy applications requirements in the short to medium term. Further work of Task 2, refining the previous work using input from the experience on prototypes (WP5), was included in D7.5.2 (see below).

Task 7.3 Installation requirements for Petaflop/s systems

Report on installation requirements and availability at European sites (D7.3, restricted): This deliverable provides a detailed survey of existing and planned large facilities in Europe and a list of requirements for installing Petaflop/s (peak) systems in 2010. The survey showed that the spectrum of building infrastructure of the PRACE partners can cover all requirements expected for future petascale systems. All Principal Partners and one General Partner site fall into this category. It confirms that most of the sites have the possibility to adapt their infrastructure according to requirements for medium or long-term future systems. The PRACE portfolio of computer centres is well suited not only for 2010-2012 but also for technology developments beyond this time window.

Furthermore, this task worked on the preparation and the organization of a HPC Infrastructure Workshop that was held in Lugano in September 2009. This workshop followed the internal

PRACE October 2008 meeting on this topic, but was open to a selection of non-PRACE sites with international visibility, as well as to invited IT equipment providers and data centres engineering experts. The purpose was to get a combined vision of how to optimize the design and operation of large HPC centres hosting petascale machines. This event, complemented by a PRACE closed session, was a great success with more than 50 participants. This event aims at becoming an annual reference workshop in Europe. The next workshop is planned to be organized in France in autumn 2010. This *2nd European Workshop on HPC Centre Infrastructures* (http://www-hpc.cea.fr/en/events/Workshop-HPC-2010.htm) will be held in Dourdan near Paris October 6-8, 2010. Organised by CEA with a CEA-CSCS-BAdW/LRZ Programme Committee, it will comprise a half-day closed PRACE session after 2 days of sessions open to the global community of HPC infrastructures (beyond the scope of PRACE partners, mostly from Europe and the USA). Upon invitation only, around 70 participants are expected, for presentations, discussions and exchanges on energy production, energy efficiency, electrical, technical and IT equipment and construction issues. This event has mostly been prepared between January and June of 2010.

Task 7.4 Risk Assessment

Final risk register (D7.4.2, restricted): This document describes the final risk register for PRACE, covering both technical risks and organisational risks (in part contributed by WP2). This deliverable is an update of the **Initial risk register (D7.4.1, restricted)**, taking into account the progress of the project and studying in more detail mitigation strategies and their impact.

Task 7.5 Drafting of technical requirements

Technical requirement for the second Petaflop/s system(s) in 2009/2010 (D7.5.2, restricted): This deliverable is an update of the **Technical requirement for the first Petaflop/s system(s) in 2009/2010 (D7.5.1, restricted)**. It provides final technical specifications, organized as a "toolbox" which can be used for different types of supercomputer configurations in a flexible way. Based on input from PRACE prototypes (WP7 and WP8) and on the experience of the PRACE partners, D7.5.2 proposes desirable parameters for the set of most promising architectures, including:

- homogeneous clusters (with two different sets of parameters depending on the size of the node);
- heterogeneous clusters;
- massively parallel systems (with two different sets of parameters depending on the node size).

D7.5.2 contains a lot of other information useful for preparing technical requirements for a procurement, including a checklist of typical technical requirements used in HPC procurements, assuming that site specific procurements are free to select those requirements that are relevant and add meaningful values for the type of system being procured.

Task 7.6 Procurement process template

This task produced:

Procurement strategy (D7.6.1): This document contains a survey of common practices for supercomputer procurements in Europe and described the different possible options for PRACE future procurements.

Pre-qualification questionnaire (D7.6.2): In some procurement situations, it may indeed be useful to have a two-step process, first checking the ability of vendors to address the foreseen specifications. Such a preliminary selection may save time and effort for the rest of the procurement, focusing on real issues only with the vendors that are technically and financially capable to answer the petascale full technical requirements.

Evaluation criteria and acceptance tests (D7.6.3): This deliverable gives an overview of best practices in the evaluation of Pre-Qualification Questionnaires, of responses to technical requirements presented in deliverable D7.5.2 and of the performance of benchmarks discussed in deliverable D6.2.2; the assessment of risks discussed in deliverable D7.4.2; and the overall evaluation of responses from vendors covering financial, corporate, technical and non-technical factors. This deliverable comments on how the evaluation and assessment should vary depending on the architecture (novel architecture or general purpose system).

3.8 WP8 – Future Petaflop/s computer technologies beyond 2010

Work Package 8 (WP8) deals with the evaluation, the development, and the active initiation of research on "Future Petaflop/s computer technologies beyond 2010". WP8 aims at fostering HPC development in Europe and involving European industry. WP8 focused both on the assessment of new technologies through prototypes and research activities and the start-up of STRATOS, the "PRACE Advisory group for Strategic Technologies, a vehicle to give industrial partners the possibility to engage with PRACE to develop and optimize hard- and software to the needs of the European Tier-0 centres and their users.

STRATOS

On December 16, 2008, the STRATOS MoU was signed by 12 PRACE partners and PROSPECT e.V. (www.prospect-hpc.eu), a consortium of HPC stakeholders from academia and industry. To start up the collaboration, a first joint STRATOS, PROSPECT and Ter@tec (www.teratec.fr) meeting was held on February 11, 2009. The main topics of the agenda were introductory presentations of STRATOS, PROSPECT and Ter@tec, initial ideas for the STRATOS long-term work plan and several presentations on energy-aware high-performance computing. Ter@tec, a French based consortium of Hardware/Software vendors, industrial HPC users and academic institutes acceded to the STRATOS MoU and became an official partner in March. Since then several STRATOS meetings have been held. Their focus ranged from collecting input from industrial European HPC users and European Communities on their needs for multi-petascale computing to latest developments on highly energy-efficient systems and data-centre infrastructure. Three STRATOS working groups have been formed: "Exascale Software", "Technology Watch" and "Green-IT and HPC Leadership resources". Meanwhile EPCC, STFC and SARA have also joined STRATOS.

WP8 prototypes & research activities

The work on the WP8 prototypes has been manyfold. Several prototypes have been chosen to assess the performance and programmability of hardware accelerators as well as their energy-efficiency. A detailed evaluation of the performance and productivity of languages for hardware accelerators as well as PGAS languages has been performed as a joint effort between the "Software" WP (WP6) and WP8. This fruitful collaboration has ensured that members from both work packages have a deep understanding of the requirements from both sides. Besides the

prototypes, several research activities have been carried out complementing the technical assessment of new and emerging technologies.

The following hardware, software and research activities have been assessed:

- Systems
  - CINES and LRZ have jointly evaluated a hybrid system architecture containing thin nodes, fat nodes and compute accelerators with a shared file system with components from SGI, nVIDIA and ClearSpeed.
  - NCF has assessed a system composed of ClearSpeed/PetaPath accelerator boards together with the ClearSpeed programming language Cn.
  - FZJ has extended the communication capabilities of their Cell-based QPACE system, to test the suitability for a wider range of applications.
- Software
  - CEA has studied the performance of GPUs using the CAPS hybrid multicore parallel programming (HMPP) workbench on nVIDIA Tesla.
  - LRZ assessed code and performance portability of the RapidMind multicore development platform across architectures (Cell, Tesla & Nehalem-EP).
  - BSC has evaluated the different implementations of their Superscalar programming model: CellSs, GPUSs, ClearSpeedSs and SMPSs.
  - CSCS evaluated the ease of use of the PGAS programming model by using the Cray Compiler Environment for UPC and CAF.
  - CSC studied the maturity of OpenCL and performance improvements for multi-GPU programming on NVIDIA Tesla and AMD Firestream cards.
  - EPCC evaluated the HARWEST Compiling Environment for developing programs on their FPGA-based supercomputer “Maxwell”.
- Tools
  - BSC performed in-depths analysis and performance prediction for full PRACE application codes to show the capabilities of their tools Paraver and Dimemas.
- Components
  - CINECA evaluated the performance of I/O and the Lustre file system and assessed the advantages of SSD technology for metadata handling.
  - LRZ evaluated the ease of use of the new Many Intel Core (MIC) architecture for HPC specific workloads.
- Energy efficiency
  - SNIC-KTH studied the achievable energy efficiency of commodity parts and commodity interconnects for cost efficiency and a minimal impact on the programming model.
  - PSNC and STFC have jointly assessed the power efficiency of different hardware solutions together with the power consumption profile of HPC servers.

The rich collection of WP8 results has been reported in several deliverables, with the **Final technical report and architectural proposal (D8.3.2)** being the public available compendium of results from prototype evaluations, research activities and a discursive collection of technology evolutions and revolutions necessary to scale systems to multi-Petaflop/s or even further to Exascale.

Events

WP8 jointly organized three so-called "Technology Watch" meetings between PRACE WP7/8 members and industry representatives. The focus of the first workshop mid 2008 in Paris, France was on processor technologies and included discussions under NDA about the future of hardware accelerators. The second workshop was held in Garching, Germany in late 2008. It covered the areas of network and interconnect technologies and storage and file systems. The third workshop was held in Barcelona in Spring 2009 and focused on memory subsystems and batch-queuing resource managers.

WP7 and WP8 jointly organized the first "Infrastructure workshop" in Lugano, Switzerland in 2009. This highly successful event covered all relevant topics needed to design energy-efficient datacenter infrastructure. WP8 also actively contributed to the organization of the second European workshop on supercomputing centre infrastructure which will be held on October 6th to 8th, 2010 in Dourdan, France.

In March 2010, during the PRACE extension phase, WP6 and WP8 jointly organized an open workshop on "New Languages & Future Technology Prototypes" at Garching, Germany. The workshop was dedicated to the results of the evaluation of new languages for HPC and the prototypes and research activities of the "Future Technology" work package. Topics included hybrid programming, PGAS and the DARPA HPCS languages, GPGPUs, Cell and Clearspeed accelerators and their programming models, FPGAs, performance prediction and energy efficiency. Eighteen speakers from nine European countries presented fifteen languages, five hardware prototypes and two research activities. The talks provided a comprehensive overview of key results and some additional information e.g. on the latest compiler updates. More than sixty attendees got a deep insight in the state-of-the-art on hardware accelerator programming, had the opportunity to ask questions and to directly discuss with PRACE experts. A booklet which contains all presentations and some additional material has been produced and is available from the PRACE website.

4 Summary and Conclusions

4.1 Work performed and Main results

During two and a half years PRACE has raised significant awareness about its mission to create a persistent Pan-European HPC service of the highest performance level and is well recognised as the major HPC project in Europe. PRACE has completed its work plan and has achieved all milestones in both the legal and administrative tasks, and the technical work.

Legal and administrative tasks

The tasks of selecting a suitable legal form and its governance structure, and the definition of a funding and usage model are closely interlinked and form the very centre of the task. After a thorough analysis of the available options, taking into account existing European Research Infrastructures, proposals for the legal form and a draft governance structure for PRACE have been derived. Negotiations involving representatives from the national ministries have lead to the agreement to establish the PRACE Research Infrastructure initially as an International Non-profit Association under Belgian law (AISBL) located in Brussels, Belgium. Signature-ready contracts for this association have been prepared. In these, the statutes define in detail the objectives of the Infrastructure and its governance, through the necessary bodies and their mandates, and the roles and responsibilities of the membership. The pan-European peer review system for PRACE is also laid out in the statutes. It is based on the principle “the best systems for the best science” and takes into account the results of the HET group and an analysis of national HPC peer review systems.

An Agreement for the Initial Period contains all provisions needed for the smooth start-up of the Infrastructure in 2010. In the initial phase, the HPC service will be based on coordinated national procurements. The legal entity will then evolve into a more tightly integrated structure. The four Principal Partner (called hosting members in the PRACE AISBL) countries Germany, France, Spain and Italy have already now made binding commitments to contribute Tier-0 resources each with a value of € 100 Million in the next five years; The Netherlands will follow later in 2010.

With the creation of the PRACE AISBL on April 23 in Brussels, the PRACE Preparatory Phase project has reached its ultimate goal. The AISBL currently has 20 members representing the 14 countries that participated in the PRACE project and 6 additional countries (Bulgaria, Cyprus, Czech Republic, Ireland, Serbia, and Turkey) that have joined the PRACE Initiative since the project started in 2008.

The process for the procurement of the production systems of the future Research Infrastructure has been defined. It is based on best practices of the PRACE partners, also taking into account lessons learned from recent major European and international procurements.

An analysis of the HPC ecosystem has been performed that identifies key stakeholders at all levels including funding, policy makers, resource providers and potential users. PRACE has addressed these priority stakeholders individually to involve them in the process. PRACE is a founding member of the European e-Infrastructure Forum, which strives for interoperation of European e-Infrastructure. There is a close cooperation with DEISA at the technical level, synchronizing the work and sharing results among the projects; the main areas of collaboration are benchmarking, distributed system management, and joint dissemination and outreach activities.

Figure 3: The industry seminar in Amsterdam

PRACE has also undertaken extensive dissemination and outreach activities. A web-presence has been established at www.prace-project.eu. This web site is a central point of public information about all activities within the project. It is complemented by active dissemination channels such as press releases, news-feeds, a quarterly newsletter and contributions to the most relevant HPC conferences. PRACE had booths at ISC 2008 in June in Dresden, at SC08 in Austin, at ICT 2008 in Lyon in November, at ISC 2009 in June in Hamburg, at SC09 in Portland, at ISC 2010 in June in Hamburg and contributed to the technical programmes of these events. A Summer School and a Winter School on Petascaling were organised in Stockholm in August 2008 and in Athens in March 2009 respectively, five code porting workshops in Espoo, Manno, Cracow, Barcelona, and Stockholm, and two Industrial Seminars in Amsterdam in September 2008 and in Toulouse in September 2009. The first DEISA-PRACE symposium in May 2009 in Amsterdam was jointly organised with DEISA and attracted about 200 participants from all over the world and was followed by the second DEISA-PRACE symposium in May 10 in Barcelona. To ensure a smooth transition, the preparations for the next events that will be organised by the 1st Implementation Phase project (PRACE-1IP) have already been started.

Technical work

One focus of the technical work in PRACE has been gathering information to inform important decisions regarding the type, performance, costs, and hosting of the future Petaflop/s production systems and the prototypes of these systems. The analysis of the application requirements and the survey of available and promising future technologies matching these requirements have lead to a selection of two sets of prototype systems that cover the most relevant architectures and technologies: a set of prototypes for production systems for 2009/2010 has been selected and approved in an EC review in July 2008. The selected systems are – in full or part – (i) IBM Blue Gene/P at FZJ, (ii) IBM Power6 at SARA, (iii) Cray XT5 at CSC, a joint proposal with CSCS, (iv) IBM Cell/Power6 at BSC, (v) NEC SX9/x86 at HLRS, and (vi) Intel Nehalem/Infiniband cluster at FZJ/CEA.

A second set of prototype systems and components for future multi-petascale technologies beyond 2010 has been selected and approved by the EC in a review in December 2008. The selected prototypes are (i) IBM Cell+FPGA at FZJ, (ii) RapidMind development platform / LRZ, (iii) SGI UV+GPUs / ICE2+Clearspeed at LRZ and CINES, (iv) TESLA-Server at CEA, (v) Virtex FPGAs on IBM HS21 at EPCC, (vi) Cray prototype compiler at CSCS, (vii) ClearSpeed at SARA, (viii) a novel HP I/O subsystem at CINECA, and (ix) a AMD Istanbul + QDR IB based cluster at KTH. An open, fair and transparent process, including external reviewers, was conducted for the prototype selection. The prototypes are assessed for their suitability for Petaflop/s production systems through an analysis of their various technical and performance characteristics.

The application benchmark suite used for this has been created to be representative of the likely usage of European Petaflop/s systems. It is based on three surveys carried out by PRACE: a survey of major application codes on European HPC systems, an in-depth survey of the identified applications, leading to a utilisation matrix providing information about HPC resource usage by scientific domain and algorithm. This activity was complemented by a survey about usage patterns, future plans and expectations of the top 10 users in all PRACE countries. During the optimisation and scaling of the suite, three codes have been replaced to ensure that all

applications will be able to exploit the Petaflop/s production systems. Furthermore the benchmark suite is used for assessing the prototype systems, new programming paradigms, languages and tools and finally in the procurement process for the Petaflop/s production systems.

The requirements for Tier-0 systems management and integration with the ecosystem, in particular the Tier-1 systems, have been analysed based on experience and expectations of potential Tier-0 sites and existing Tier-1 infrastructures. A uniform user environment, using standardised authentication and data-transfer mechanisms has been defined and deployed on the prototype systems. A close cooperation has been established with DEISA as a major provider of distributed HPC systems management solutions. It has lead to a consistent environment throughout Tier-0 and Tier-1.

Additional work has been completed to inform the decisions on the first Tier-0 production systems and sites. This includes an analysis of possible host sites and installation requirements, an estimation of the Total Cost of Ownership (TCO) of systems for different deployment scenarios and, finally, a survey of petascale projects outside Europe, to orientate PRACE choices and sizing of systems for 2009/2010. This work and the analysis has led to the prototype selection in 2008 and has been repeated and updated in 2009 to incorporate new developments.

As a complement to the work that is aimed at the procurement, construction and operation phases of HPC services in 2009/2010, an equally important activity is devoted to the evaluation and active initiation of research on future multi-petascale technologies beyond 2010. STRATOS[2], the PRACE advisory group for **str**ategic **t**echn**o**logie**s**, has been created as the main vehicle to foster the development of components and technologies for future multi-petascale systems. Within STRATOS, partners from PRACE and industrial consortia, including more than 80 organisations, co-operate on the specification and developments of such components. The STRATOS MoU was signed in December 2008 by 12 PRACE partners and the consortia PROSPECT and Ter@Tec. Its long-term work plan comprises joint activities on Exascale Software, and Green-IT and HPC Leadership resources.

4.2 Socio-economic Impact

To remain internationally competitive in science and in industrial development Europe needs leadership class HPC resources and services. The overall objective of the PRACE project was to prepare the implementation of a world-class HPC service for European researchers and engineers as a permanent Research Infrastructure that will provide these resources and services. It will be instrumental for Europe to take a leading role in addressing grand challenges such as climate change, sustainable energy supply,and the ageing society with the help of Supercomputer simulations. As stated in FP7 Work Programme 2010, it *will thereby contribute to the technological development capacity and to the scientific performance and attractiveness of the European Research Area*.

The full impact of the project will become apparent when the persistent Research Infrastructure is in operation and reliably available and the science and technology it enables and supports produce results. Nevertheless, already now at the end of the preparatory phase, PRACE has created a significant socio-economic impact:

Intra-European cooperation on the strategic level: In PRACE, European countries which have so far acted mainly as competitors in the area of HPC, have joined their financial and intellectual capacities to provide an added value on the European level as well as for research and development in their own countries. In the Principal Partner countries, PRACE has

[2] Originally called AHTP in the Technical Annex

mobilised 400 Million € of funding for the Tier-0 infrastructure that is provided in addition to existing national programmes. This pan-European approach has been so compelling and attractive that six additional countries have joined the PRACE Initiative during the project life-time and are now members of the Research Infrastructure. A further proof for the coordinative effect of PRACE is that it has stimulated the formation of regional clusters in outer regions of Europe, such as LinkSCEEM-2 (Eastern Mediterranean) or HP-SEE (South East Europe) with the intention to contribute to PRACE on the same level as the larger economies.

Intra-European cooperation of the HPC service providers: PRACE facilitated the transition from competition to cooperation mode among the European HPC centres, which is an achievement per se. It has lead to an exchange of best practices and expertise in all aspects of HPC service provisioning among leading European centres, ranging from procurements, infrastructure, operation and management, user support, and peer review to algorithms, code development and HPC technology. These have been documented and are not only serving as a model for the PRACE Tier-0 centres, but also for new national and topical centres especially in the new member states.

Intra-European cooperation in science and engineering: PRACE as a provider of European-level HPC resources and services will serve as a centre of attraction and nucleus of cooperation also for scientific communities. Community-specific support will be a key instrument to foster this, e.g. through the training programme already started. The huge interest to participate in the establishment of the PRACE Scientific Steering Committee already gives evidence of the high awareness of Europe's Computational Scientists. In a workshop in Jülich in June 2010, supported by PRACE, but organised independently by the scientists, about 40 leading scientists from different European countries and difference scientific disciples met and agreed on a set of representatives that will be responsible for the scientific steering of PRACE.

European HPC industry: In the USA, Japan and now also in China, developing the HPC industry is part of a national policy to achieve a leadership position in science and engineering. While currently there is no comparable strategy in Europe, a number of European companies are successful in designing and manufacturing HPC products, from components to system integration and software. Through its foreseen combined buying power as well as its HPC competence, PRACE has already now raised significant interest among European and international HPC vendors and technology providers. This has been leveraged to create a framework for information exchange and cooperation between PRACE and the HPC industry through STRATOS. This structure will eventually foster the further development of a European HPC industry.

4.3 Conclusions

At the end of the PRACE project, all of the elements needed to migrate from the preparatory phase to the implementation, construction, and operation phase of the European HPC service as a permanent Research Infrastructure are available. In particular, the following elements have been delivered:

- A signature-ready contract for the Research Infrastructure legal entity
- A governance structure for this legal entity
- Secured funding for the construction and operation, and a usage model
- A single European peer review process that ensures open, fair and unbiased access
- A consistent operational model for the distributed Tier-0 sites
- Well established links to the HPC ecosystem with a focus on the Tier-1 level

The technical work has lead to

- A first production Petaflop/s systems ready to start providing the Tier-0 HPC service to the European research communities
- A common middleware and software stack for the Tier-0 systems, interoperable with the Tier-1 systems
- A well defined procurement process for European Tier-0 systems
- A benchmark suite to be used in these procurements
- A permanent process of technology evaluation and development that is institutionalized in STRATOS.

As a result of this successful work, the PRACE Research Infrastructure has been established on April 23, 2010 as an international non-profit association under Belgian law (AISBL) in Brussels. On June 9, the inauguration of the PRACE Research Infrastructure has been celebrated in Barcelona in the presence of the high-level representatives of the Spanish and Catalan governments – including the president of Catalunia – and the European Commission. On the same day, the PRACE Council has held its constituting meeting and elected Prof. Achim Bachem (FZJ) as its chair and Sergi Girona (BSC) as Chair of the Board of Directors.

On June 14, an SSC Establishment Workshop, organised by 6 independent representatives of the European scientific communities, chaired by Prof. Richard Kenway, has nominated the candidates for the PRACE Scientific Steering Committee (SSC) for approval at the next Council meeting. With the Council, the BoD, and the SSC in place, PRACE has implemented the main bodies of the governance structure that was developed in the project.

Already on May 10, a first call for Early Access to the first Tier-0 system has been published. This system is the IBM BlueGene/P installed at the GCS-member Jülich Supercomputing Centre, ranked as the number 1 system in Europe and number 5 world-wide in the June 2010 TOP500 list. Sixty five proposals have been submitted by Principal Investigators from 16 European countries in response to the Early Access Call, requesting a total of 1.47 billion core hours – almost 5 times the available amount of 328 million core hours for this call. This clearly demonstrates the huge demand for capability HPC resources all over Europe and the awareness that PRACE has raised among European computational scientists. The first regular call was published on June 15, offering 360 million core hours. It is the first of a planned sequence of bi-annual calls of the same size. It is foreseen that in autumn 2011 the next PRACE Tier-0 system, to be installed in France, will be fully available for PRACE.

As these achievements demonstrate, the PRACE preparatory phase project was tremendously successful in enabling and preparing the implementation of the PRACE pan-European High Performance Computing Research Infrastructure and service.

Annex 1: Gender Balance Activities

The under-representation of women in science, engineering and technology is an issue both for the research community and the individuals. This is partly true also for the area of High Performance Computing and Computational Science. This project recognises that increasing women participation will ultimately lead to an improvement in research culture, policy and practice. This is therefore already a priority of each of the participant institutions which are 'equal opportunities' employers. All of them are taking active measures to raise the number of female researchers, such as gender equality programs and encouragement of female applications to apply for staff positions at all levels. Where monitored, these activities show significant success. Examples are an increase of female researchers at FZJ from 9% to 15% between 1998 and 2005 or from 2 to 8 (out of about 40) employees at ETHZ between 2003 and 2007. Furthermore, EPSRC's participation in this project is led by women, as well as GENCI's which is represented by its female CEO. Other partners already have a relatively high percentage of female employees, e.g. 25% at BADW-LRZ and 22% at CSC. In France, the Irene Joliot Curie award, rewarding outstanding achievements by women in science and engineering, is the best known aspect for a proactive governmental policy for gender equality and the promotion of women in Science.

In addition to these individual actions, PRACE is contributing in the promotion of gender equality in the field of the project through the following means:

- Encouraging women's participation in the project both as researchers and within the project's management bodies. The success of this is proven by a good representation of women in responsible positions:
  - Two out of six members of the Principal Partners Committee are female.
  - The Management Board has another female member.
  - Two work packages are co-lead by women: WP3 and WP8.

  It should be mentioned that 2 of these have been appointed during the project and have replaced men that originally held these leading positions.
- Ensuring that the organisational concept of the Research Infrastructure that is developed in WP2 is fully compliant with gender equality, including the peer review process.
- Encouraging women to participate in the education and training program set up in WP3 to advance their academic careers. This is now beginning to yield fruit. While there was only one female attendee of the summer school in 2008, there were six women out of 48 participants at the Winter School on 2009.

Annex 2: Use and Dissemination of Foreground

The main objective of the PRACE project has been the preparation of the implementation of the permanent pan-European PRACE Research Infrastructure. Therefore, the major part of the foreground created serves directly this purpose and is being used to enable and support the establishment of this RI. Since the members of the RI include all project partners, the documentation of the project results in its 81 deliverables has essentially been sufficient for this purpose. The key results and their usage by the RI are:

- An analysis of possible legal forms, appropriate governance structures, resulting in a recommendation and draft contracts have prepared the decisions and implementation of this decisions through the establishment of the PRACE AISBL in Brussels.
- The analysis of best practices for Peer Review and the proposal for the PRACE Peer Review system deduced from it is now being implemented by the PRACE RI.
- The analysis of HPC training needs in Europe has lead to the creation of an extensive training programme which will now be continued by the RI.
- The analysis of requirements for the (technical) management of the distributed Tier-0 infrastructure has lead to a specification and prototypical implementation of systems management solutions and a user environment, which will now be implemented by the RI.
- The results of the prototype assessment, user and application requirement analysis, technology surveys, installation requirements, procurement processes have lead to recommendations that have been used to guide the procurement plan of the PRACE RI.
- The representative PRACE benchmark suite will be used for the Tier-0 procurements of the PRACE RI members.
- The work on application enabling optimisation and scaling has created knowledge about application and library properties and optimisation techniques that has been documented and will be exploited heavily in the user and community support of the PRACE RI.
- The assessment of future hardware and software technologies has provided important insight into vendor roadmaps and developments to educate PRACE's mid-term procurement plans.
- STRATOS will serve as a collaboration platform between the PRACE RI and HPC vendors and technology providers.

Apart from this direct use by the RI, this foreground is also of interest for other parties. PRACE is actively promoting its usage. The extensive dissemination activities, which are listed in detail in the next sub-sections, have raised a significant interest in PRACE results. Important examples for this are

- The results concerning the legal, organisational, and financial structure are discussed with and disseminated to other ESFRI preparatory phase projects through the ePPCC (European Preparatory Phase Coordination Committee). Since PRACE is one of the first major ESFRI projects to move to the Implementation Phase, the interest in its results is high. It should be mentioned that there is also significant interest from other countries such as Japan in the European concept of RIs and the Pyramid model of HPC provisioning. This will be exploited to establish closer contacts and collaborations with such countries.

- The know-how in HPC application enabling and scaling, new programming paradigms and languages, programming of new architectures, etc. is shared with actual and future HPC users and software developers on all levels of the European HPC ecosystem, but with a focus on the high end, represented by PRACE.
- While many results related to new and future technologies have been achieved under NDA and cannot be disseminated outside PRACE, the parts that are not restricted have been published in a report and are disseminated actively in presentations at conferences.

The following two subsections list in more detail the activities to promote the use of foreground created by PRACE, namely the *Dissemination* to a broader audience and the *Cooperation* with other stakeholders in the HPC ecosystem.

Dissemination

The main targets of dissemination are the major HPC stakeholders, the European scientific and research communities, research infrastructure organisations, universities and centres for higher education, and the general public. The project has liaised with industrial and business partners as potential HPC users as well as implemented an education and training program for computational science aimed at scalable computing.

High Performance Computing and Networking is getting more and more important and beneficial for science and industry. Thus communication of HPC related information to potential users and the public is an increasingly important aspect of science. Unfortunately, the general public is not sufficiently aware of how computational methods have improved research. This is partly due the lack of communication resources in the supercomputing community, and partly because the communication has been traditionally handled by specialists whose primary target audience has been other specialists. The result is that the benefits of computational science are not widely acknowledged and even understood.

However, there is a constant and increasing demand for the popularised material aimed at funders, decision makers and new potential customers in industry. The importance of communications is stated in Regulation (EC) No 2321/2002 of the European Parliament and of the Council concerning the rules for the participation of undertakings, research centres and universities in, and for the dissemination of research results. Dissemination of research is as important as the generation of research, and it is crucial to understand and address the challenges to knowledge dissemination in order to have a fully effective R&D strategy.

Communicators can be the bridge between academia and industry, aiming at technology transfer. In this context the dissemination of the key results also reflects the broader societal and economic impact. PRACE strives to further enhance communication with the broader scientific community as well as with policy and decision makers, and the public at large.

During the project 79 press releases and 8 newsletters were published. The number of press releases increased from 23 in 2008 to 41 in 2009 and 15 in the first half of 2010. They were sent to over 7,000 journalists around the world.

The total number of PRACE related electronic articles and news items until the end of May 2010 was 1835 (481 until the end of November 2008).

The number of the web site visitors has also been increasing steadily – the total number of visitors as in the end of May 2010 was 201,160 visitors (97,493 unique visitors) since the launching of the website on March 19, 2008 (until December 2008, there had been 27,471 unique visitors). The number of the visitors has increased to over 10 000 visitors per month

which means that the figure has doubled since 2008 (in the end of the year 2008 the number of visitors was around 5000 per month).

The following paragraphs contain a list of PRACE-related presentations, and events organised or attended by PRACE during the reporting period.

The project has created a public web site (www.prace-project.eu) as the central element of the dissemination activities of the project. All information published by and about PRACE is also accessible via this web site. In detail, the web presence provides:

- A introduction to the project, its objectives and activities that has been prepared for the interested public
- Public documents such as PR material, newsletters, presentations, and public deliverables. Unless specified otherwise, the deliverables referenced in this document can be downloaded from this website.
- Press releases, events, news and articles about PRACE
- An entry point for applications to prototype access
- HPC training material
- FAQ and Job Bank

PRACE has released eight newsletters and the following press releases:

- PRACE-Partnership for Advanced Computing in Europe launched in January (9.1.2008)
- Starting a European Research Infrastructure (30.1.2008)
- Architectures of future PRACE Petascale systems are taking shape (14.5.2008)
- PRACE hosts Petascale Summer School in Sweden (21.5.2008)
- DEISA2 engaging for a European HPC Ecosystem (23.5.2008)
- Two new countries joined PRACE (3.6.2008)
- PRACE hosts a BoF session at ISC'08 (12.6.2008)
- PRACE awards prize for outstanding scientific paper at ISC’08 (12.6.2008)
- Europe’s High-Performance Computing (HPC) training and education needs revealed in comprehensive survey (15.7.2008)
- First candidate applications for PRACE Petaflop/s systems identified (17.7.2008)
- PRACE selected promising architectures (1.9.2008)
- 1st PRACE Industry Seminar greatly successful (19.09.2008)
- PRACE investigated application requirements (13.10.2008)
- PRACE hosts scientific workshop during ICT 2008 (15.10.2008)
- PRACE arranges Winter School in February 2009 in Athens (31.10.2008)
- PRACE looks forward to SC08 (30.10.2008)
- Cyprus joins the PRACE initiative (18.11.2008)
- Pictures from the PRACE booth at SC08! (18.11.2008)
- Presentations from PRACE scientific workshop available (1.12.2008)
- Reminder: PRACE Award 2009 (15.01.2009)
- PRACE Part of Zero-In Magazine - Call for Papers Open (03.02.2009)
- Serbia joins the PRACE initiative (13.02.2009)
- PRACE held All Hands Meeting in Jülich, Germany, February 12-13, 2009 (16.02.2009)
- PRACE hosts highly successful Winter School (25.02.2009)
- HPC Infrastructures for Petascale Applications – DEISA PRACE Symposium 2009 (25.02.2009)

- A new world record in Go established by PRACE prototype and French software (02.03.2009)
- PRACE to implement STRATOS – a Permanent Research Platform (24.03.2009)
- PRACE evaluates Technologies for Future Multi-Petaflop/s Systems (30.03.2009)
- Call for Proposals for PRACE Prototype testing (09.04.2009)
- PRACE Award 2009 Winner Announced (22.04.2009)
- CSC and CSCS Arrange Two PRACE Code-Porting Workshops (23.04.2009)
- PRACE in the latest GridBriefing (06.05.2009)
- Presentations from the DEISA PRACE Symposium available (14.05.2009)
- PRACE hosted a Seminar on CUDA and HMPP (18.05.2009)
- DEISA PRACE Symposium 2009 attracted almost 200 participants from more than 20 countries and four continents (22.05.2009)
- PRACE, the Partnership for Advanced Computing in Europe, takes an active role at ISC'09, Hamburg, Germany on June 23-26, 2009 (01.06.2009)
- PRACE part of La Recherche magazine (26.06.2009)
- PRACE organises an industry seminar for potential European High Performance Computing users (26.06.2009)
- Presentations and pictures from ISC'09 (29.06.2009)
- First projects granted access to the PRACE Prototype systems - 4.4 Million Core hours to 3 projects (22.07.2009)
- BSC arranges a PRACE code porting and optimization workshop (11.08.2009)
- PRACE HPC Training Video Material Available (4.09.2009)
- Bulgaria and Czech Republic joined PRACE (9.09.2009)
- ACC CYFRONET AGH organises PRACE code porting workshop in Cracow, Poland (17.09.2009)
- Lisbon selected as the First PRACE Headquarters Location (24.09.2009)
- European industry went HPC with PRACE in Toulouse (1.10.2009)
- Six Projects granted Access to the PRACE Prototype Systems - 4.5 Million Core Hours (15.10.2009)
- Italy became a PRACE Principal Partner (20.10.2009)
- Supercomputer Experts met at the First European Workshop on HPC Centre Infrastructures (4.11.2009)
- PRACE Stream Computing Workshop to be held in Stockholm (5.11.2009)
- PRACE at SC09 (12.11.2009)
- PRACE is Ready for Implementation: Applications ported (16.11.2009)
- PRACE is Ready for Implementation (16.11.2009)
- PRACE Prototype the Greenest Supercomputer on Earth (19.11.2009)
- PRACE Task Leader Tim Stitt wins HPC Open Education Cup 2008-2009 (24.11.2009)
- PRACE Award 2010: Call for Papers has Started (3.12.2009)
- New PRACE training material available - 48 hours videos and 69 presentations 15.12.2009
- New call for Proposals for PRACE Prototype testing 17.12.2009

- PRACE Benchmark Suite Finalised 15.02.2010
- PRACE to establish a Scientific Steering Committee 23.02.2010
- PRACE evaluated additional prototypes for next generation architectures 26.02.2010
- DEISA PRACE Symposium 2010 in Barcelona: Exciting Computational Science and Future HPC Technologies 05.03.2010
- PRACE granted over 4.3 Million Core Hours to PRACE Prototype Systems 16.03.2010
- PRACE held a Workshop on New Languages and Future Technology Prototypes 18.03.2010
- Nine PRACE Prototypes are Available for Testing 19.03.2010
- PRACE Award 2010 Winners Announced 19.04.2010
- Announcement: PRACE SSC Workshop postponed due to the Volcanic Ash Cloud 19.04.2010
- First PRACE Petaflop/s System Ready for European Researchers: Early Access Call Open 10.05.2010
- Presentations from DEISA PRACE Symposium 2010 available 17.05.2010
- Get up-to-date with PRACE at ISC'10 20.05.2010
- DEISA PRACE Symposium 2010 attracted Participants from 23 Countries 28.05.2010
- Presentations from ISC'10 available 01.06.2010
- PRACE Research Infrastructure inaugurated: World-class Supercomputing Service for European Science 09.06.2010
- PRACE calls for One Year Project Grants on Europe's fastest Computer 15.06.2010

The following list contains PRACE related presentations and publications given or initiated by members of the consortium:

- **First Hellasgrid User forum, Athens,** Greece, January 10-11, 2008:
  - F. Karayannis: speech about PRACE
- **3rd EGEE User Forum,** Clermont Ferrand, France, February 11-14, 2008:
  - P. Öster: The PRACE project (presentation)
  - Information booth with the PRACE roll-up and the first version of PRACE brochure (translated also in French).
- **HP HPC Executive Forum**, Divonne, France, February 14, 2008:
  - K. Koski: Building the European High-Performance Computing Ecosystem (presentation)
- **Inauguration of JUGENE – the IBM Bluegene/P system,** Juelich, Germany, February 22, 2008:
  - PRACE was highlighted as an important endeavor for Europe by Jürgen Rüttgers, Prime Minister of the State of Northrhine-Westphalia and Thomas Rachel, Parliamentary State Secretary of the Federal Ministry of Education Research.
- **CEBIT 2008,** Hannover, Germany, March 3-9, 2008:
  - Supercomputing in Juelich was presented at CEBIT 2008 in Hannover together with IBM. Chancellor Mrs. Merkel visited the IBM booth where Thomas Lippert presented JUGENE and PRACE.
- **4th Intel EMEA HPC Roundtable**, Munich, Germany, March 21-22, 2008:
  - LRZ: PRACE panel discussion organized
- **Expert Discussion** (between University of Alberta and German Universities and HPC centres), Berlin, Germany, April 14, 2008:
  - Th. Eickermann: representing PRACE (round-table discussion)
- **ZKI-AK Supercomputing**, Duesseldorf, Germany, April 17-18, 2008:
  - N. Attig: PRACE and GCS (presentation)

- **Deisa Symposium,** Edinburgh, UK, April 28-29, 2008:
  - Th. Eickermann: PRACE – An overview (presentation)
- **PARA 2008,** NTNU, Trondheim, Norway, May 13-16, 2008:
  - M. Kupczyk, N. Meyer: HPC and Grid computing. The new value for the pan-European scientific community (presentation)
  - Uninett: Attending as sponsor at PARA08, disseminate PRACE material on booth
  - K. Koski: Case CSC Finland in building the European HPC Ecosystem (invited presentation)
- **NOTUR 2008**, Tromso, Norway, June 3-5, 2008:
  - Uninett: arranged NOTUR2008 and disseminates PRACE material, posters, flyers, brochures
- **Ter@tec symposium 2008**, Evry, France, June 3-4, 2008:
  - A. Bachem: The European Projects (invited presentation)
  - Th. Lippert: Petasclae Computing (presentation)
  - GENCI: PRACE poster and brochures
- **Cray User Group meeting**, Helsinki, Finland, May, 3-7:
  - CSCS and CSC: organized a PRACE BoF session, distributed brochures.
  - T. Stitt: A Compiler Performance Study on the Cray XT Architecture Exploiting Catamount and Compute Node Linux (CNL) Compute Nodes (presentation)
  - K. Koski: Petaflop Computing in the European HPC Ecosystem (presentation)
- **Bavarian Academy of Sciences and Humanities**, Munich, Germany, May, 9:
  - A.Bode: Petaflops-Supercomputer: Von der Architektur zur Programmierung
- **IBERGRID 2008**, Porto, Portugal, May 12-14:
  - UC-LCA: booth promoting UC-LCA and PRACE
- **Science policy seminar of the Finnish Ministry of Education,** Helsinki, Finland, May 15, 2008:
  - A. Bachem: The impact of e-Infrastructures for Science and Innovation in Europe (presentation)
- **Baltic Grid-II kick-off meeting**, Vilnius, Lithuania, May 13 – 15, 2008:
  - PDC: Distribution of PRACE promotional material
- **SERI,** Versailles, France, June 5-7, 2008:
  - PRACE Poster on German booth (Florian Berberich)
- **Computer Networks '2008 Conference**, Zakopane, Poland, June 17-20, 2008:
  - A. Kwiecien: **Projekt PRACE – zaawansowana usługa HPC dla Eu-ropy (**presentation)
- **SGIUG Conference**, Los Angeles, USA, June 9-12, 2008:
  - PSNC: PRACE - Partnership for Advanced Computing in Europe (presentation)
- **HPC 2008 workshop**, Cetraro, Italy, June 30 – July 4, 2008:
  - G. Erbacci: A HPC infrastructure at the service of Scientific Research in Italy
- **Simulating the future using 1 million cores and beyond' EDF Workshop**, Tremblay/Paris, France, September 22-24, 2008::
  - D.Emerson: Petaflop Computing: Challenges, Expectations and Reality for CFD
- **Lower Silesian Science Festival**, Wroclaw, Poland, September 19-22, 2008:
  - PSNC: Introduction to PRACE
- **Electronic Structure Calculations in Materials Modeling** (60-year anniversary seminar of professor Risto Nieminen), HUT Espoo, Finland, October 3, 2008:
  - CSC**:** Building a HPC Ecosystem in Europe
- **ICT BIO 2008**, Brussels, October 23-24, 2008:
  - Th. Eickermann: PRACE – A Petaflop Computing Research Infrastructure for European Scientists and Engineers

- **ICHEC Annual seminar**, Dublin, Ireland, October 30, 2008:
  - CSC: Building the European HPC Ecosystem
- **Code_Saturne Users' Club**, Chatou France, December 1-2, 2008:
  - STFC: presentation about Code_Saturne in PRACE
- **ECRI 2008**, Versailles, France, December 9-10, 2008:
  - A.Bachem: PRACE – A High Performance Computing Service for Europe
- **JSC End of year Colloqium**, Jülich, Germany, December 18, 2008:
  - Th. Eickermann: PRACE – Petaflops for Europe
- Focussed presentations of PRACE to specific potential user groups or companies in 2008:
  - GENCI: to **ARCELOR – MITTAL R&D**, Saint Denis, France
  - GENCI: **Société Générale**, La Défense, France
- **CIRA seminar**: Lyon, France, January 6, 2009
  - P. Michielse (NCF): Petaflop systems and performance evaluation (presentation)
- **OGF25 / EGEE User Forum**, Catania, Italy, March 2-6, 2009:
  - L. Johnsson (KTH): PRACE overview (presentation in session "Evolvement of US and European HPC Infrastructures")
  - Discussions with user communities and infrastructure providers
  - PRACE dissemination material was available at the event.
- **Polish Railways in UE – new perspectives**: Jelenia Góra, Poland, March, 18-20 2009
  - PRACE covered in presentation on computational and network services/infrastructures in Europe (in Polish)
- **Scientific POWER Meeting**, Mazurian Lakes, Poland, March 26-28, 2009:
  - PRACE took part in the poster session of this event.
- **24th Forum ORAP**, Lille, France, March 26, 2009:
  - D. Erwin (FZJ): PRACE – A Mid-Term Update (presentation)
- **eStrategies | Projects Magazine**: March 2009
  - T. Eickermann (FZJ): Europe to lead in high-end computing infrastructure (article)
- **First International Conference on Parallel, Distributed and Grid Computing for Engineering**: Pecs, Hungary, April, 6-8, 2009
  - D.R. Emerson (STFC): Engineering at the Edge: Challenges for Petaflop Computing and Computational Fluid Dynamics (presentation)
- **IESP Workshop**: Santa Fe, NM, USA, April 7-8, 2009
- P. Michielse (NCF): Application Analysis and Porting in the PRACE Project (**presentation** and white-paper)
- **NAFEMS NORDIC Seminar: Multi-Disciplinary Simulation in Engineering Analysis**, Helsinki, Finland, April, 21-22, 2009:
  - PRACE had a joint exhibition booth with CSC and EGI, the European Grid Initiative.
  - A PRACE presentation was given at CSC for interested participants
  - A tour to see the PRACE prototype Loviatar was arranged.
- **Intel Round Table**: Garching, Germany, April 22-23, 2009
  - H. Huber (LRZ): presentation on PRACE WP8 and STRATOS
- **NOTUR2009**, Trondheim, Norway, May 18-20, 2009:
  - A.v. Alfthan (CSC): PRACE - Software enabling for Petaflop/s systems (presentation)
  - PRACE dissemination material was available at the event
- **ScicomP 15**, Barcelona, Spain, May 18-22:

    - PRACE dissemination material was distributed in the conference kit for the event participants
- **Inauguration of the first European Petaflop/s system in Juelich,** Juelich, Germany, May 26, 2009:
    - PRACE was highlighted as an important endeavour for Europe by Dr. Jürgen Rüttgers, Prime Minister of the State of North Rhine-Westphalia and Prof. Dr. Annette Schavan, Federal Minister for Education and Research of Germany.
- I**WOMP09**: Dresden, Germany, June 3-5, 2009
    - M. Bull, et al. (EPCC): A Microbenchmark Suite for Mixed-mode OpenMP/MPI (presentation)
- **SERI 2009:** Paris, France, June 3-5, 2009
    - PRACE featured as one of two topics at the FZJ booth (F. Berberich)
- **HPDC 2009**, Munich, Germany, June 11-13, 2009
    - PRACE booth (LRZ) and Poster (CSC)
- **NSC'09**, Linköping, (Sweden) October 13-14, 2009.
    - PRACE presentations and dissemination material was available
- **GÉANT Symposium,** Vienna, Austria, September 9, 2009
    - T. Eickermann (FZJ): PRACE – A preview to the European HPC Service
- **HECToR Distributed CSE Support Technical Meeting**, Oxford, UK, September 23-24, 2009
    - Z.Shang (STFC): Porting and Optimisation of Code_Saturne
- **NEERI 09**, Helsinki, Finland, September 30 - October 2, 2009
    - PRACE presentations and dissemination material were available
- **ICNSP 09**, Lisbon, Portugal, October 609, 2009
    - P. Alberto (UC-LCA): PRACE - Partnership for Advanced Computing in Europe
- **LinkSCEEM Conference**, Paphos, Cyprus, October 6-8, 2009
    - N. Attig (FZJ): The PRACE project
    - T. Stitt (CSCS): An Introduction to Parallel Programming
- **IDC HPC User Forum,** Stuttgart, Germany, October 5, 2009
    - T.Eickermann (FZJ): PRACE – Project Update
- **Bio IT World Conference & Expo 09**, Hannover, Germany, October 6-8, 2009
    - T.Eickermann (FZJ): PRACE – Preparing for a European HPC Service
- **IDC HPC User Forum,** Lausanne, Switzerland, October 8-9, 2009
    - T.Eickermann (FZJ): PRACE – Project Update
- **BELIEF II**. Johannesburg, South Africa 7.-9.December
    - Ari Turunen : General presentation of PRACE and its dissemination.
- **International Journal of High Performance Computing Applications,** Vol. 23, No. 4, 369-373 (2009):
    - P. Michielse (NCF): Application Analysis and Porting in the PRACE Project
- **Club des Utilisateurs de Code_Saturne Meeting**. Paris, France, December 7-8, 2009
    - A. Sutherland (STFC): Presentation on Code_Saturne work
- **4TH INTERNATIONAL CONFERENCE OF NUMERICAL MODELING OF SPACE PLASMA FLOWS (ASTRONUM 2009), Astronomical Society of the Pacific (ASP) Conference Series,** Vol. 429 (July 2010), Ed. Nikolai V. Pogorelov, 29 June – 3 July, 2009 @ Chamonix, France, Print ISBN: 978-1-58381-738-4, e-book ISBN: 978-1-58381-739-1
    - Ari Turunen, Jean-Philippe Nominé, François Robin, Dietmar Erwin, Herbert Huber, Axel Berg, Riccardo Murri, Alan Simpson
      PRACE: Partnership for Advanced Computing in Europe - Preparation of a Petascale Supercomputing Infrastructure for European Scientists

The following list gives an overview of events organised by PRACE, either standalone, or in conjunction with or as part of a larger conference.

- **ISC 2008**, Dresden, Germany, June 16-20, 2008:
  - CSC and HLRS: PRACE booth
  - **Conference Session: The European HPC Projects PRACE, PROSPECT and TALOS chaired by F. Subirada**
  - A. Bachem: PRACE: An Initiative for the Future European Supercomputing Infrastructure (presentation)
  - **Birds-of-a-Feather Session: Building the HPC Ecosystem** organised and chaired by K. Koski, including presentations from K.Koski, H. Lederer (RZG/DEISA), and R. Pennington, NCSA.
  - PRACE award for an outstanding paper on petascaling
  - A. Bachem: Participation in a press conference
- **PRACE Petascale Summer School** at KTH, Stockholm, Sweden, August 26-29, 2008:
  - W.Frings: The Blue Gene/P at Jülich, Introduction, Case Study & Optimization
  - M. Bull, J. Hill, A. Simpson: A Survey of HPC Usage in Europe and the PRACE Benchmark Suite
  - S. von Alfthan: Advanced MPI
  - T. Oppelstrup : Introduction to GPU programming
  - Hybrid Programming
  - S. von Alfthan: Introduction Hybrid Programming ()
  - M. Bull, M. Piotrowski: Mixed Mode Programming: A Case Study on an IBM Power5 Cluster
  - P. Manninen: Lecture and lab works (Performance Measurements Tools and Techniques)
  - A. van der Steen: Towards Petaflop systems
  - J.P. Nominé: PRACE WP7 Prototypes - Qiuck Overview
- **Industrial Competitiveness: Europe goes HPC,** Amsterdam, The Netherlands, September 3, 2008:
  - P. Aerts (NCF), "Seminar Opening", 3 September, Amsterdam, the Netherlands (
  - A. Bachem (Forschungszentrum Jülich, PRACE Coordinator), "PRACE - Europe goes HPC"
  - J.F. Hamelin (EDF): "HPC in Energy: Getting ready for Petaflop capacities and beyond, a utility perspective"
  - J. G. San Luis (Repsol): "The Kaleidoscope Project: Breaking the Sound Barrier in Seismic Imaging"
  - F. Robin (CEA/GENCI): "HPC Trends"
  - H.J. Van den Herik (Tilburg University)
  - T. Lippert, (Forschungszentrum Jülich): "Results and Lessons Learnt"
  - Organised by PRACE, presentations by P. Aerts, A. Bachem, F. Robin, T. Lippert (PRACE), J.F. Hamelin (EDF), J.G. San Luis (Repsol), H.J. Van den Herik (Tilburg University)
- **SC08**, Austin, USA, November 17-20, 2008:
  - FZJ and CSC: PRACE booth, including a "treasure hunt", where participants had to visit the booths of all PRACE partners.
  - Th. Eickermann: PRACE presentation at the FZJ booth in a Grid session
- **ICT 2008**, Lyon, France, November, 25-27
  - CSC and CSCS: PRACE booth

  - PRACE First scientific conference: ICT session “Scientific Computing in the Petascale Regime: a European HPC Infrastructure” complemented by an eveing session.
    - K. Koski: ICT infrastructure for science: virtualising global research
    - K. Koski: HPC Ecosystem
    - J.-P. Nomine: PRACE Prototypes Approach towards a pan-European Petascale Computing Infrastructure
    - M. Araya: Development of a Seismic Imaging Tools (BSIT) on Cell Architecture (BSC)
    - S. Bernardi, F. Garofalo: HPC-Europa and HPC-Europa2 transnational access selection: a possible model for Tier-0 access
    - T. Eickermann: The PRACE Infrastructure. How European researchers can use the infrastructure
    - T. Stitt: Towards a European HPC Training and Education Infrastructure for Petascale Computing
    - R. Fonseca: Full Scale Kinetic Modelling of Laboratory and Astrophysical Plasmas with Petascale Systems (Instituto Superior Tecnico and ISCTE, Lisbon, Portugal)

- **PRACE Petascale Winter School,** Athens, Greece, February 10-13 2009:
  - B. Fabianek (EC): High-Performance Computing in Europe - A view from the European Commission
  - J. Donners (SARA): Introduction to the POWER6 system
  - P. Korosoglou (AUTH): Current Parallel Programming Concepts
  - C. Bekas (IBM): Introduction to Parallel Computing: The Message Passing, Shared Memory and Hybrid paradigms
  - Hands-on Session: MPI, OpenMP and their Hybrid (J. Donners, SARA)
  - Hands-on Session: MPI, OpenMP and their Hybrid (P. Korosoglou, AUTH & C. Bekas, IBM)
  - W. Jalby (Univ. de Versailles): Unicore/Pipeline Optimization
  - M. Ferraras (UPC): Introduction to PGAS Programming
  - W. Jalby (Univ. de Versailles): Multicore Optimizations
  - W. Jalby (Univ. de Versailles): Memory Hierarchy Optimizations
  - M. Ferraras (UPC): Tutorial: Introduction to the PGAS Programming Paradigm with UPC
  - M. Ferraras (UPC): Tutorial 2: Introduction to the PGAS Programming Paradigm with UPC
  - B. Chamberlain (Cray): Chapel Background and Base Language
  - B. Chamberlain (Cray): Task Parallel Features in Chapel
  - B. Chamberlain (Cray): Data Parallel Features in Chapel
  - B. Chamberlain (Cray): Locality, Status and Future Directions
  - Hands-on: Programming, Compiling and Executing Chapel Programs (B. Chamberlain, Cray, T. Stitt, CSCS-ETHZ)
  - G. Carteni (BSC): Introduction to CELL + MariCel Prototype Presentation
  - J. Caubet, IBM): Programming with the IBM SDK, OpenMP for CELL
  - Programming the CELL with CellSs, Rosa Badia, BSC (pdf)
  - Hands-On Session: Programming the CELL with the IBM SDK, CellSs and MPI, (J. Caubet, BSC, R. Badia, BSC)
- **First STRATOS & Ter@tec meeting**: Juelich, Germany, February 11, 2009:
  - Project presentations and brainstorming on STRATOS work plan
- **Second STRATOS meeting**: Garching, Germany, April 2, 2009:

  - Discussion on STRATOS long-term work plan
- **Code Porting Workshop: CUDA and HMPP**, Bruyères-le-Châtel, France, April 27-30, 2009:
  - Two-day workshop jointly organised with Ter@tec.
- **DEISA/PRACE-symposium**: Amsterdam, The Netherlands, May 11-13, 2009
  - The second PRACE scientific event, jointly organised with DEISA comprised a programme with 30 presentations from funding agencies, HPC infrastructure projects, and HPC users (see section 3.3 for details). Four presentations were given by PRACE:
  - A. Bachem (FZJ): PRACE - On the way to a Persistent European High-End Computing Service (presentation)
  - A.v.d. Steen (NCF): Directions in HPC Technology (presentation)
  - M. Bull (EPCC): A Survey of HPC Systems and Application in Europe (presentation)
  - T. Stitt (CSCS): Towards a European HPC Training and Education Infrastructure for Petascale Computing (presentation)
- **PRACE workshop on application porting and performance tuning**, Helsinki, Finland, June 11-12, 2009:
  - The lectures covered new programming models suited for future petaflops supercomputers, issues involved in selecting and using numerical libraries and best-practices learned from tuning and porting three scientific applications. Finally an introduction to two important performance measurement tools, Scalaca and Paraver, was given.
- **ISC 2009**, Hamburg, Germany, June 23-26, 2009:
  - Second PRACE award for an outstanding scientific paper submitted to ISC by European students or young scientists on petascaling (presented by A. Bachem)
  - Networking session PRACE: HPC for scientific breakthroughs on June 24
    - T. Eickermann: PRACE - High End Computing Service for Europe (presentation)
    - T. Lippert: Ab initio Determination of Light Hadron Masses (presentation)
    - S. Girona: Opportunities and Challenges of Novel Architectures for HPC (presentation)
    - S. Wesner: Hybrid HPC in Industrial Applications (presentation)
    - S. Bassini: Towards a Petascale Infrastructure based on the Effective Deployment of Blue Gene Q (presentation)
  - PRACE Exhibition booth (no. 730)
- **PRACE Cray XT5 Code-Porting Workshop,** Lugano, Switzerland, July 13-15, 2009:
  - The focus of this three-day workshop was to provide students with advanced training and expertise in porting application codes to the Cray XT5 architecture. The workshop comprised morning lectures and afternoon hands-on sessions.
- **First European Workshop on HPC Centre Infrastructures**, Origlio, Switzerland, September 2-4, 2009
  - The goal of the first European HPC Infrastructure Workshop was to initiate an exchange of knowledge and experiences in this area. 55 experts came together to discuss topics such as building design, facility management and operation, energy efficiency, cooling technologies and computer cooling designs. Speakers from APC, ASHRAE, Bull, CEA, Cray, CSCS, EYP, Green Grid, IBM, Intel, NCSA, RZ Integral, SGI, SUN, the University of Illinois and the Uptime Institute shaped this event with presentations of high technical quality
    The workshop was organised by CSCS, CEA, and LRZ.
- **Second Industry Seminar,** Toulouse, France, September 7-8, 2009:

  - follow-up event to the first Industry seminar. Prepared by GENCI and FZJ.
  - Programme
    - C. Riviere: Seminar Opening
    - A. Bachem: PRACE – Europe goes HPC
    - P. Cohen: Toulouse's Mayor welcome
    - J.M. Thomas (CEO, VP Airbus): Aerospace Valley Aerospace Industry
    - T. Koschnick (Züricher Kantonalbank): HPC in Finance: A field report
    - F. Christel (BMW): HPC in the Automotive Industry: Virtual Prototyping at BMW Group
    - A. Turunen: PRACE Dissemination, Outreach and Training
    - R. Murri: Distributed System Management
    - M. Parsons: Software Enabling for Petaflop/s systems
    - I. Christadler: Future Petaflop/s Computer Technologies beyond 2010
    - Parallel sessions chaired by:
      - B. Fabianek (EC-INFSO): Organisation and Business Models
      - T. Eickermann: Network and Security
      - G. Lecina (Dassault-Systems), S. Requena: Training and user Support in Relation with ISVs
    - R. Pesseau (CTO, Free Field Technologies): HPC Usage on Acoustics Modeling
    - C. Chauvez (CTO, Prospect FS Ltd): HPC Usage in Energu Modeling
    - A. Lichnewsky, R. Murri, T. Stitt: Conclusions from Parallel Sessions
    - F. Subirada: Wrap-Up
- **PRACE Workshop on NEC SX-9 and BlueGene/P Code Porting**, Cracow, Poland, October 14-16, 2009:
  - The first day of the workshop focused on introductory lectures to the prototype systems while the second and third days concentrated solely on "hands-on" code-porting and optimisation exercises
- **PRACE Workshop on Cell and GPGPU Code Porting,** Barcelona, October 21-23, 2009:
  - The first day of the workshop focused on the OpenMP 3.0 programming model. The second day focused on application porting to CELL-based systems. The third and final day focused on UPC, and the CUDA and OpenCL programming models for GPGPU systems
- **SC09,** Portland, USA, Nov. 2009:
  - FZJ and CSC: PRACE Exhibition booth (no. 2973), jointly with DEISA; including a "treasure hunt", where participants had to visit the booths of all PRACE partners
  - T. Eickermann: PRACE – HPC for European Science (Fujitsu User Meeting FISUM09, November 15)
  - BoF session "European HPC and Grid Infrastructures" jointly organised with DEISA and EGI, November 17
  - T. Eickermann: PRACE the Tier-0 HPC Infrastructure for European Science (presentation on European HPC and Grid Infrastructures BoF)
- **PRACE workshop on Stream Computing**, Stockholm, Sweden, December 7-10, 2009:
  - The workshop offered an introduction to OpenCL and stream/GPU programming. It consisted of lectures and hands-on experiences in using OpenCL on state-of-the-art stream processors. The workshop also covered lectures on stream processor architectures and programming tools for stream processors and multi-core systems.
- **Second DEISA/PRACE-symposium**: Barcelona, Spain, May 10-12, 2010

  - The third PRACE scientific event, jointly organised with DEISA comprised a programme with 25 presentations from funding agencies, HPC infrastructure projects, and HPC users. Four presentations were given by PRACE:
  - T. Eickermann: PRACE Implementation Phase (presentation)
  - J. Labarta: Programming models and tools (presentation)
  - A.B. Dias: Access to PRACE systems (presentation)
  - H. Huber: Emerging and future technologies (presentation)
- **ISC'2010**, Hamburg, Germany, May 30 – June 3, 2010:
  - Third PRACE award for an outstanding scientific paper submitted to ISC by European students or young scientists on petascaling (presented by L. Johnsson)
  - Networking session PRACE: HPC for scientific breakthroughs on June 1
    - T. Eickermann: News from the PRACE Research Infrastructure: Status and next Steps (presentation)
    - A. Berg: Comparison of PRACE prototypes and benchmark (presentation)
    - I. Christadler: Evaluating performance and productivity of new HPC programming languages (presentation)
    - T.Downes (DCU and DIAS, Ireland, PRACE User): A PRACE user experience: Massively parallel simulations of astrophysical turbulence (presentation)
    - A.B. Dias: PRACE HPC access (presentation)
  - PRACE Exhibition booth (no. 125)

Cooperation

Establishing and maintaining connections with the main players in the HPC ecosystem is a crucial activity for PRACE. An analysis of the ecosystem has been performed and documented in deliverable D2.5.1. Deliverable D2.5.2 provides more details and also reports on initial contacts to the stakeholders that are of high priority for PRACE:

- **Providers of HPC services**
  After Cyprus, Ireland, Turkey and Serbia, which had joined the PRACE initiative in 2008, Bulgaria and the Czech Republic signed the MoU in 2009. Russia has indicated its interest to cooperate with PRACE and representatives of the Moscow State University and the Russian Academy of Science have attended PRACE events such as the DEISA-race symposium and the second industry seminar.
- **Related European projects**
  The close cooperation with DEISA has been continued through uptake and exchange of technology, through joint dissemination activities (DEISA PRACE Symposium, a DEISA representation at the PRACE booth at SC09), and on future planning. PRACE and DEISA are mutually represented in their respective management bodies (MB, EceCom). The informal contacts with EGI, EGEE, and DEISA at the ICT 2008 in Lyon have lead to the formation of a European e-Infrastructure Forum (EEF), which meets regularly to exchange information and discuss principles and practices to create synergies for distributed infrastructures. Currently, PRACE, DEISA. EGI, EGEE, DEISA, GEANT, and Terena are members of this group. It is expected that e.g. a future data infrastructure will also join the forum. At the recent EEF meetings at the EGEE'09 conference and the SC09, first steps towards a work plan have been made as well as joint activities to address the ESFRI communities. Furthermore Norbert Meyer (PSNC) is a permanent observer in the EGI_DS Management Board.

- **Networking infrastructure providers**
  See previous item.
- **System manufacturers**
  The main interface for PRACE to cooperate with HPC industry is STRATOS, which has initiated a number of activities (see Section 3.8). Further contacts are resulting from the prototyping activities.
- **Software vendors and the software developing academic community**
  Contacts are based on the same channels as system manufacturers, and on the work of WP6 on tools and libraries. ISV relations have also been on the agenda of the second industrial seminar.
- **End user communities**
  The creation of the Scientific Steering Committee and the Access Committee is almost completed. On June 14, 2010, a workshop with about 40 participants, hosted at FZJ, has being organised by a Programme Committee (PC) of six independent representatives of different scientific communities, chaired by Prof. Richard Kenway. The result of this workshop was a list of initial SSC members, subject to approval in the next meeting of the PRACE AISBL Council. This process has been designed by PRACE to be fully driven by the communities and to be independent from the PRACE partners. Communities that had provided LoS for PRACE have been suggested for invitation to the PC and were represented at the workshop. Several channels are utilised to address the other ESFRI projects (letters offering information and discussion being sent, meetings between ESFRI projects organised by the EC). Furthermore, ESFRI projects have been contacted through the EEF (see item 'Related European projects' above)
- **Funding bodies**
  All partners have been in close contact with their national governments to inform them and get their advice for the preparation of the contract for the legal entity. This has lead enable PRACE to prepare signature-ready contracts within the foreseen timeline.
- **Policy setting organisations**
  Contacts to e-IRG and ESFRI in particular through Leif Laaksonen's (CSC) direct participation. A constant connection and interaction with EU DG INFSO is taking place through the project coordinator.

Furthermore, PRACE has participated in several events targeted to coordination of European projects or efforts or to disseminate the PRACE objectives on a policy setting level:

- ePP-CC meetings in Brussels on February 6, 2009: F. Berberich,, D. Erwin, K. Schwemmer (FZJ) and E. Griffiths (BSC) participate in discussions on organisational and legal aspects of future RIs. Since then, this group has held bi-monthly meetings via telephone or face-to-face, in which F. Berberich participates regularly.
- OGF25, Catania, Italy, March 2-6, 2009: L. Johnsson (KTH) participates as member of the OGF Advisory Committee.
- OGF27, Banff, Alberta, Canada, October 12-15, 2009: L. Johnsson (KTH) participates as member of the OGF Advisory Committee.
- e-IRG: L. Laaksonen (CSC) participates as chair in various workshops and delegates meetings.
- Information Event on the 7th Call for proposals under the e-Infrastructures Activity of the 'Capacities' Specific Programme, FP7, Brussels, Belgium, June 18, 2009: T. Eickermann participated and presented plans for the first construction phase project
- Second FP7 ICT Coordinators Day on Project Management, Brussels, Belgium June, 10, 2009: F. Berberich, participated and took the opportunity to network with other RI projects.

- Four face-to-face meetings of the European e-Infrastructure Forum EEF:
  - OGF25 in Catania, Italy on March 3, 2009,
  - DEISA PRACE Symposium in Amsterdam, The Netherlands on May 13, 2009,
  - EGEE'09 Conference in Barcelona, Spain, on September 21, 2009,
  - SC09 in Portland, Oregon, USA, on November 17, 2009.
  - Additional meetings are conducted via telephone as needed, typically on a monthly basis.

- EU Concertation meeting, Brussels, Belgium, October 12-13, 2009
  - T. Eickermann: PRACE addressing needs of ESFRI communities (participation in a panel discussion)
  - T. Eickermann: Governance of the PRACE RI (participation in a panel discussion)