



FP7 Support Action - European Exascale Software Initiative

DG Information Society and the unit e-Infrastructures



European initiatives, EC vision and funding

International Exascale Software Initiative, October 17-19, Hawaii

Overview of European Initiatives, focus on EESI, JY Berthou-*EESI project*

Exa-scale computing, software and simulation: Objective in FP7 ICT Call 7, P. Aerts-*EC*

Prace initiative, L. Johnson - *PRACE Management Board*

Characteristics of the EESI project



Coordination and support action – FP7/Infrastructures

www.eesi-project.eu

Coordinator: EDF R&D, Jean-Yves Berthou

Starting date : 1st of June 2010, for 18 months

Requested EC contribution : 640 000 €

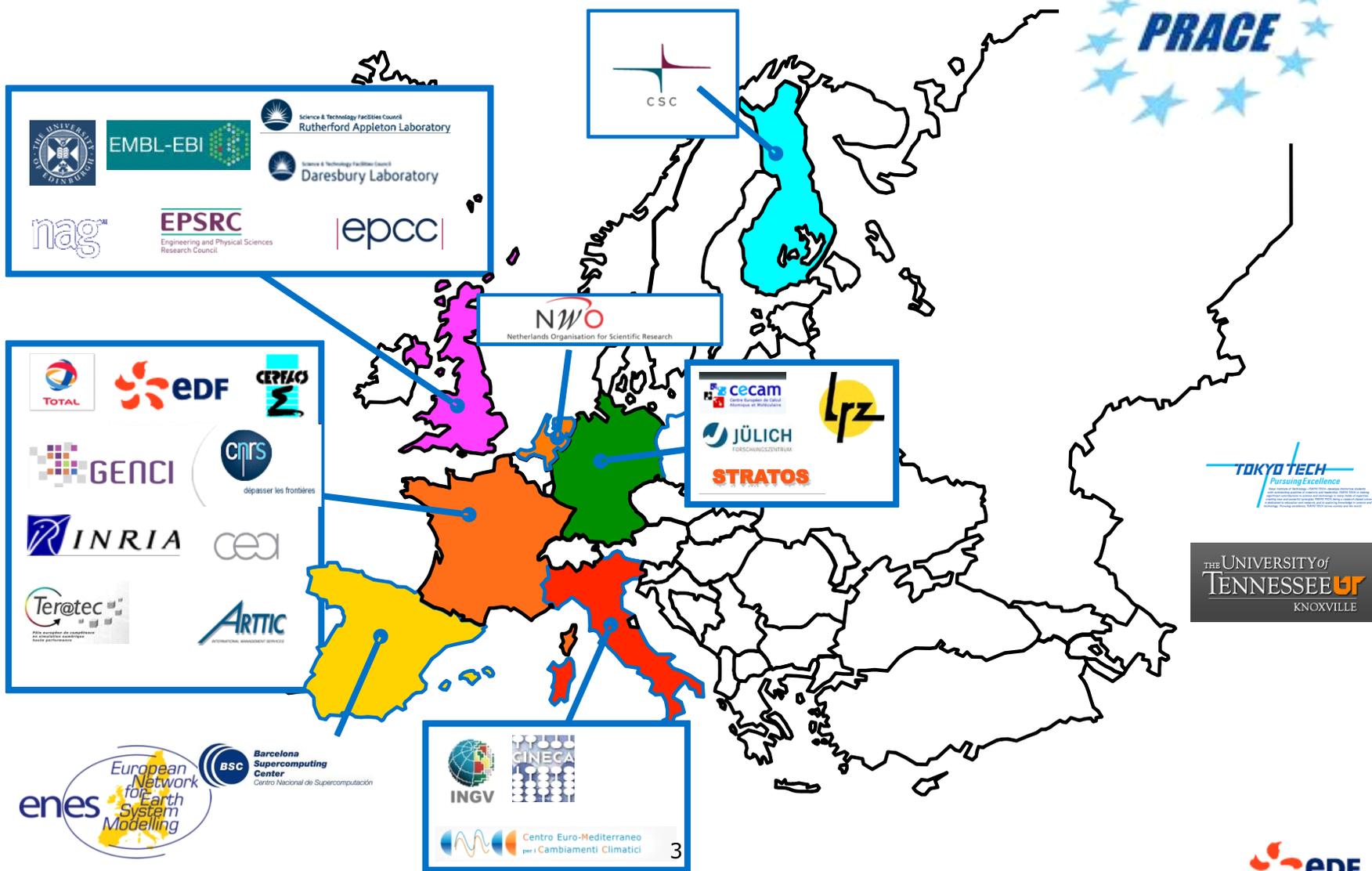
Consortium : 8 contractual partners:



17 associated participants

11 contributing participants

EESI partners



EESI main goals



Build a European **vision and roadmap** to address the challenge of performing scientific computing on the new generation of computers which will provide **multi-Petaflop** performances in 2010 and **Exaflop** performances in 2020

- investigate how Europe is located, its strengths and weaknesses, in the overall international HPC landscape and competition
- identify priority actions
- identify the sources of competitiveness for Europe induced by the development of Peta/Exascale solutions and usages
- investigate and propose programs in education and training for the next generation of computational scientists
- identify and stimulate opportunities of worldwide collaborations

EESI main tasks



Coordination of the European participation in IESP

- *Make a thorough assessment of needs, issues and strategies*
- *Develop a coordinated software roadmap*
- *Provide a framework for organizing the software research community*
- *Engage and coordinate vendor community in crosscutting efforts*
- *Encourage and facilitate collaboration in education and training*

Cartography of existing HPC projects and initiatives in Europe, US and ASIA

Coordination of “disciplinary working groups” at the European level

- *Four groups “Application Grand Challenges”*
- *Four groups “Enabling technologies for Petaflop/Exaflop computing”*

Synthesis, dissemination and recommendation to the European Commission

Expected outputs



A **roadmap** and **set of recommendations** to the funding agencies shared by the European HPC community, on software - tools, methods and applications - to be developed for this new generation of supercomputers



- A detailed evaluation of how Europe is located, its strengths and weaknesses, in the overall international HPC landscape and competition
 - Are European stakeholders willing/able to build an exa-scale prototype/by when?
 - Actors/users/projects
 - Study "Development of a Supercomputing Strategy in Europe" by IDC (Final report in July 2010)
 - Study FISOFI4HPC (Infrastructures for High Parallel Codes): to be awarded (results Spring 2011 and June 2011)

EESI: European Commission Expectations



Are European stakeholders willing/able to build an exa-scale prototype/by when?

What is the broad picture in HPC world-wide? In particular, how European actors research, users, industry, vendors are positioned overall?

Are there new opportunities created from the transition from peta to exa-scale computing? What are the critical technologies that will be key to exploit these opportunities?

Do the development of these key technologies depend on the development of exa-scale prototypes?

In particular for Europe, should we aim for a new dawn of technological development in EU (hardware, system software, development environments), or rather concentrate in the application development and optimisation only?

International cooperation e.g. USA, Japan, China, Russia: why, when and on what to collaborate?

Assuming sufficient financial support, is there a real capability in Europe to try and develop exa-scale prototypes?

Whole prototypes or specific parts/layers? In which time range?

If the EU does not enter the race for exa-scale machines, would it be beneficial for Europe to support the technology and system suppliers' side? What are the most promising or critical technologies in which Europe can/will have a chance to become a front-runner?

Regarding extreme-HPC, how can eco-systems for researchers, technological development and users be created and supported?

What are in your view new challenges and new objectives appropriate for FP8? What is the best approach (i.e. in terms of funding instruments) to support the development of exa-scale machines?

What would be the supporting arguments to increase investment in exa-scale technologies?



- A European and international vision and roadmap
 - **Why** is exa-scale initiatives important? Who cares? Impact?
 - Scientific
 - Economic
 - **Social benefits**
 - Roadmap coherent with Vision: e.g. if Europe is ready to build an exa-scale prototype (vision):
 - **What**: Challenges? Gaps? Barriers? (not only technical)
 - **When/Who/Where/When/How much?**
 - in view of in the frame above:
 - Priority actions: strategy
 - Competitiveness (technology/apps)?/education-training

- Dissemination actions
 - Visibility of EESI: who is the potential target public?
 - R&D stakeholders
 - EC and national policy-makers
 - Society as a whole
- Identification of opportunities of worldwide collaborations
 - European position inside IESP: who's doing/deciding what?
 - Contribution to the international dialogs: mutual benefits!

European Exascale Software Initiative AGENDA



JÜLICH FORSCHUNGSZENTRUM *Enabling technologies for Exaflop computing*

- Hardware roadmap, links with vendors
- Software eco-systems
- Numerical libraries, solvers and algorithms
- Scientific software engineering

Initial International workshop

Internal workshop: presentation of each working group results and roadmaps

Final conference: public presentation of project result

GENCI *Application Grand Challenges*

- Industrial and Engineering Applications (Transport, Energy)
- Weather, Climatology and Earth Sciences
- Fundamental Sciences (Chemistry, Physics)
- Life science, Health, BPM

Constitution of WG, Setup of guidelines, organisation modes

Initial cartography of existing HPC projects, initiatives in Europe, US and ASIA

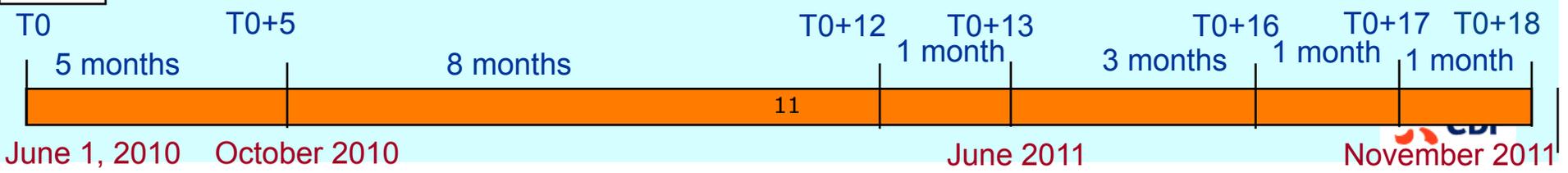


Synthesis of all contributions and production of a set of recommendations

Presentation of EESI results to the EC



Updated cartography of existing HPC projects, initiatives in Europe, US and ASIA



EESI Working Groups



 **Enabling technologies for Exaflop computing**

- Hardware roadmap, links with vendors
- Software eco-systems
- Numerical libraries, solvers and algorithms
- Scientific software engineering

 **Application Grand Challenges**

- Industrial and Engineering Applications (Transport, Energy)
- Weather, Climatology and Earth Sciences
- Fundamental Sciences (Chemistry, Physics)
- Life science, Health, BPM

*Constitution of WG,
Setup of guidelines,
organisation modes*

*First
disciplinary
workshop*

*Inter-disciplinary
workshop*

*Second
disciplinary
workshop*

*Working Group
Reports*



Initial cartography of existing HPC projects, initiatives in Europe, US and ASIA



■ Initiatives in Europe:

- Europe – Funding
- Europe – Collaborative Projects & Existing Initiatives
- National Initiatives in Europe

■ Initiatives worldwide:

- US Systems & Initiatives
- Japan Systems & Initiatives
- China Systems & Initiatives
- South Korea Systems & Initiatives
- India Systems & Initiatives



European Exascale Software Initiative



Investigation Report on Existing HPC Initiatives

CONTRACT NO EESI 261513
 INSTRUMENT CSA (Support and Collaborative Action)
 THEMATIC INFRASTRUCTURE

Due date of deliverable: 30.09.2010

Actual submission date: 29.09.2010

Publication date:

Start date of project: 1 JUNE 2010

Duration: 18 months

Name of lead contractor for this deliverable: EPSRC

Authors: Xu GUO (EPCC), Damien Lecarpentier (CSC), Per Oster (CSC), Mark Parsons (EPCC), Lorna Smith (EPCC)

Name of reviewers for this deliverable: Jean-Yves Berthou (EDF), Peter Michielse (NCF)

Abstract: This deliverable investigates large-scale HPC projects and initiatives around the globe with particular focus on Europe, Asia, and the US and trends concerning hardware, software, operation and support.

Revision JY Berthou, 28/09/2010

Project co-funded by the European Commission within the Seventh Framework Programme (FP7/2007-2013)		
Dissemination Level : PU		
PU	Public	X
PP	Restricted to other programme 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)	

Initial cartography of existing HPC projects, initiatives in Europe, US and ASIA



To conclude

A cartography to be updated and enlarged ...

- Geographically: Switzerland (HP2C initiatives, Blue Brain – EPFL ...), CERN, Russia, European Eastern and Mediterranean countries, South America, ...
- Scientific and technical fields: EESI WGs

... and shared with the IESP partners

A key point to enable the development of an international software stack for Exascale computing



Investigation Report on Existing HPC Initiatives

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Contact: l.smith@epcc.ed.ac.uk, Damien.Lecarpentier@csc.fi

Europe - Funding



- Exascale computing, software and simulation (FP7-ICT-2011-7 Objective ICT-2011.9.13)
- Computing Systems (FP7-ICT-2011-7 Objective ICT-2011.3.4)
- EU-Russia collaboration



Investigation Report on Existing HPC Initiatives

CONTRACT NO. FP7-2011-7-246490
INSTRUMENT ICT-2011-7-246490
Topic ICT-2011-7-246490-1-1
Date of publication 2012-03-01
Actual submission date 2011-10-10
Publication date 2012-03-01
Start date of project 1 JUNE 2010 Duration: 18 months
Name of coordinator for the activities: EESI
Address: No. 1010 SPICE, Cluster Lovénstråke (ECS), Post Office (ECS), Mark Parish (ECS), 1010 SPICE
Name of reviewer for this submission: Jean-Yves Berthou (EESI), Peter Madsen (EESI)
Abstract: This document investigates existing HPC centres and infrastructure for the sake of providing a baseline for the development of a new HPC centre, software, operation and support.

Page is included in the European Exascale Software Initiative (EESI) Research Programme (EESI-REP) (EESI)	
SI	Study
SI	Investigate the state of the art in the field of HPC infrastructure
SI	Investigate the state of the art in the field of HPC software
SI	Contribute to the development of the infrastructure for the EESI-REP (EESI)

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Exascale computing, software and simulation (FP7-ICT-2011-7 Objective ICT-2011.9.13)



Project name /call	Exascale computing, software and simulation (FP7-ICT-2011-7 Objective ICT-2011.9.13)
Short description/target	The objective is to develop a small number of advanced computing platforms with the potential for extreme performance (100 PFLOPS in 2014 with potential for exascale by 2020), as well as optimised application codes driven by the computational needs of science and engineering..
Url	ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2011-12_en.pdf
Funding source	European Commission
Budget	25 M€ (IP: 24M€ / CSA: 1M€)
Schedule	Projects funded for 2-3 years, starting in 2011-12. Deadline for applications: 18 January 2011

Computing Systems (FP7-ICT-2011-7 Objective ICT-2011.3.4)



Project name /call	Computing Systems (FP7-ICT-2011-7 Objective ICT-2011.3.4)
Short description/target	“The objective is to achieve breakthroughs in the transition to multi-core architectures across the whole computing spectrum: embedded computing, general-purpose computing (PC/servers) and high-performance computing (HPC).”
Url	ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/ict-wp-2011-12_en.pdf
Funding source	European Commission
Budget	45 M€ (STERP: 40M€ / NoE: 4M€ / CSA: 1 M€)
Schedule	Deadline for applications: 18 January 2011

EU-Russia collaboration



Project name /call	EU-Russia Research and Development cooperation (Objective ICT-2009.10.2)
Short description/target	The call focuses on programming models and runtime support, performance analysis tools for HPC, and optimisation, scalability and porting of codes.
Url	http://cordis.europa.eu/fp7/dc/index.cfm?fuseaction=UserSite.FP7DetailsCallPage&call_id=329
Funding source	European Commission and Russia
Budget	6 M€ (4 M€ EU + 2 M€ Russia).
Schedule	Deadline for applications: 12 November 2010

Europe – Collaborative Projects & Existing Initiatives



- Collaborative Projects
 - [The Partnership for Advanced Computing in Europe \(PRACE\)](#)
 - [Distributed European Infrastructure for Supercomputing Applications \(DEISA\)](#)
 - [European Exascale Software Initiative \(EESI\)](#)
 - [Progress towards Exascale Applications \(TEXT\)](#)
- Public-private partnerships and collaboration
 - [Exascale Innovation Center \(EIC\) – Germany](#)
 - [ExaCluster Laboratory \(ECL\) – Germany](#)
 - [EX@TEC – France](#)
 - [Flanders ExaScience Lab – Belgium](#)
 - [Exascale Stream Computing Collaboratory – Ireland](#)
 - [Exascale Technology Centre – UK](#)
 - [Promotion of Supercomputing Partnerships for European Compet and Technology – European \(PROSPECT\)](#)
 - [TERATEC – France](#)



Investigation Report on Existing HPC Initiatives

CONTRACT NO. EESI-2015-1
INSTRUMENT INFRASTRUCTURE
Topic(s) INFRASTRUCTURE

Due date of completion: 2018-2019
Actual completion date: 2018-2019
Publication date:

Start date of project: 1 JUNE 2015 Duration: 18 months
Name of coordinator for the initiative: PROSPECT
Address: No. 11010 (PROSPECT), Cluster Lonsdale (ECL), Parc Odeur (ECL), Mark Parkes (ECCI), Limerick (ECCI)

Name of initiator for this initiative: Jean-Yves Berthou (ECCI), Peter Mackenzie (ECCI)
Abstract: This initiative is investigating the state of HPC in Europe and identifying the gaps with potential. It aims to provide a comprehensive overview of the HPC landscape in Europe, including the state of the art, the needs of the community, and the potential for future development.

Project funded by the European Union under the Horizon 2020 Research Programme (101019141)	
AC	Study
AF	Feasibility study of a programme to enhance the competitiveness of the European Union
AE	Research to create a programme to enhance the competitiveness of the European Union
AG	Conducting a study for the purposes of the investigation into the competitiveness of the European Union

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The Partnership for Advanced Computing in Europe (PRACE)



Research Infrastructure name	Partnership for Advanced Computing in Europe (PRACE)
Short description /target	Build a world-class high-performance computing capability and strengthen Europe's scientific and industrial competitiveness. On the longer term (2019) Exaflop computing power will be targeted by PRACE
Partners involved	20 partners
Url	www.prace-ri.eu
Funding source	PRACE members, European Commission
Schedule	PRACE Preparatory Phase: January 2008 – June 2010 PRACE First Implementation Phase: July 2010- June 2012 PRACE Second Implementation Phase: 2011- 2013 planed
Budget	PRACE 1IP: 28 M€ (20 M€ EC contribution) Additional 400 M€ from hosting partners for five years

Distributed European Infrastructure for Supercomputing Applications (DEISA)



Project name	Distributed European Infrastructure for Supercomputing Applications (DEISA)
Short description/target	Provide a pan-european HPC infrastructure for Supercomputing applications.
Partners involved	11 partners
Url	http://www.deisa.eu/
Funding source	European Commission, DEISA partners
Schedule	2002 – 2011 (DEISA2 from May 2008 – May 2010)
Budget	DEISA2: 18.7M€

European Exascale Software Initiative (EESI)



Project name	European Exascale Software Initiative (EESI)
Short description/target	Build a European Software Exascale Roadmap
Partners involved	8 contractual partners and 17 associate partners
Url	http://www.eesi-project.eu/
Funding source	European Commission, EESI partners
Schedule	2010 – 2011
Budget	0,64 M€

Progress towards Exascale Applications (TEXT)



Project name	Towards EXascale ApplicaTions (TEXT)
Short description/target	TEXT is an EC funded research project into new parallel programming models, in particular StarSs, aiming at scaling real-world applications to Exascale performance level.
Organisations involved	(BSC) – (coordinator) High Performance Computing Center (HLRS) - Forschungszentrum Julich (FZJ) – EPCC at the of – Foundation for research and Technology (FORTH) – of – Université de Pau – Universitat Jaume I – IBM Zurich ()
Contact person	Jesús Labartata (BSC), Technical manager of the project. (jesus.labarta@bsc.es)
Funding source	EC and partners
Project duration	24 months, starting June 2010
Budget	3,5 M€ with an EC contribution of 2,47 M€ (call infra 2010-1-2-2)

Exascale Innovation Center (EIC) – Germany



Project name	(EIC)
Short description/target	Public-private collaboration to develop hardware and software required to approach Exascale computing
Organisations involved	FZJ, IBM
Schedule	2010-2019

ExaCluster Laboratory (ECL) – Germany



Project name	ExaCluster Laboratory (ECL)
Short description /target	Public-private collaboration to develop key technologies, tools and methods to power multi Petaflop and Exaflop machines, focusing on the scalability and resilience of those systems
Organisations involved	FZG, Intel, ParTec
Schedule	Multi-year agreement

EX@TEC – France



Project name	Ex@tec
Short description/target	Public-private collaboration to develop hardware and software required to approach exascale computing
Organisations involved	CEA, GENCI, UVSQ, INTEL
Schedule	2010-2015

Flanders ExaScience Lab – Belgium



Project name	ExaScience Lab
Short description/target	Public-private collaboration to develop software to run on Intel-based future exascale computer systems.
Organisations involved	Intel Corporation, Imec, and five Flemish Universities (University of Antwerp, Ghent University, Hasselt University, Katholieke Universiteit Leuven and Vrije Universiteit Brussel)
Schedule	2010-2015

Exascale Stream Computing Collaboratory

– Ireland



Project name	Exascale Stream Computing Collaboratory
Short description/ target	Public-private collaboration to develop computing architectures and technologies that overcome current limitations of dealing with the massive volumes of real-time data and analysis.
Organisations involved	IBM, Trinity College Dublin (TCD), Tyndall National Institute in Cork, National University of Ireland Galway (NUIG), University College Cork (UCC) and IRCSET, the Irish Research Council for Science, Engineering and Technology

Exascale Technology Centre – UK



Project name	Exascale Technology Centre
Short description/ target	Public-private collaboration to investigate the challenge of delivering an Exaflop within the next decade.
Organisations involved	Cray Inc and EPCC, The
Schedule	2010-2012

Promotion of Supercomputing Partnerships for European Competitiveness and Technology (PROSPECT)



Project name	Promotion of Supercomputing Partnerships for European Competitiveness and Technology (PROSPECT) - http://www.prospect-hpc.eu/
Short description/ target	Create projects concerning the main objective to develop hardware and application and system software components as well as related operating and programming concepts for Peta- and multi-Petaflop systems as a contribution to the PRACE-project.
Organisations involved	FZJ, LRZ, BSC, CSC, Deutscher Wetterdienst, BULL, ClusterVision, DDN, Intel, NumaScale, Partec, T'System, HLRS, EuroTeh, Mellanox, EPCC, NanoSoslitice, ENAE, DELL, IBM, SUN, SuperMicro, Univ. Heidelberg , HP, Tech. Univ. Chemnitz
Schedule	Started in 2007

Ter@tec & Ter@tec Campus



Project name	TER@TEC and Ter@tec Campus
Short description/ target	<p>Ter@tec Campus/Technopolis: 13 000 m2 of offices and labs dedicated to Simulation and High Performance Computing, close to the TGCC (Very Large Computing Center), will host more than 1000 people</p> <p>TER@TEC: Non-profit association for promoting HPC which links industrial companies, users and providers, and major R&D centers, public and private:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Participate in the emergence and setting up of joint collaborative R&D projects, <input type="checkbox"/> Facilitate the access to state-of-the-art processing facilities among the most powerful in the world <input type="checkbox"/> Contribute to the development of the requisite skills and competences through training, seminars, conferences and lectures
Organisations involved	Major players in the HPC industry (manufacturers, publishers, suppliers of service), collaborative laboratories Industry & Research (Intel Corp, Bull-CEA, ...), an incubator and nursery hotel companies, some Services Platforms (hardware, software and services), a HPC European Training Institute
Schedule	Started in ?

National Initiatives in Europe



Investigation Report on Existing HPC Initiatives

CONTRACT NO: 825 2001
PROJECT NAME: Exascale Software Initiative
START DATE: 2018-01-01
END DATE: 2020-12-31
Version: 1.0

NO	NAME	STATUS
1
2
3
4

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Germany



HPC stakeholders:

- ❑ Funding bodies: federal and state level with advice from the Wissenschaftsrat (WR).
- ❑ **Gauss Centre for Supercomputing (GCS, created in 2006)** : collaboration between FZJ, the Leibniz-Rechenzentrum (LRZ) and the Höchstleistungsrechenzentrum Stuttgart (HLRS)
- ❑ **PROSPECT, Promotion of Supercomputing Partnerships for European Competitiveness and Technology" (PROSPECT)**: launched in 2007 by FZJ, LRZ and BSC, aside of the PRACE project, <http://www.prospect-hpc.eu>
- ❑ **Munich Computational Sciences Centre (MCSC)**: foster joint research developments in the field of computational sciences, management of huge data repositories and HPC
- ❑ **HLRS**, debis Systemhaus GmbH, debis-sfr and Porsche: formed a company to provide access to supercomputers for research and industry.
- ❑ The Munich Centre of Advanced Computing (MAC)
- ❑ **ExaCluster Laboratory (ECL) – Germany**
- ❑ JÜLICH SUPERCOMPUTING CENTRE (JSC) (<http://www.fz-juelich.de/jsc/simlabs>)
- ❑ January 2010 call from the German federal government (?Meuro) for “HPC Software for Scalable Computers” to improve the scalability of applications
- ❑ KONWIHR, competence Network for Technical and Scientific High Performance Computing in Bavaria



Germany



Computing facilities:

Academia:

- ❑ GCS: 400 M€ national project PetaGCS (2010 – 2016), establish 3 Petaflop supercomputers at FZJ, LRZ, HLRS
- ❑ FZJ: 1PF, IBM BG/P, 300 TF BULL Sun Constellation
- ❑ DKRZ - Deutsches Klimarechenzentrum : 150 TF IBM Power 575
- ❑ HLRN: 2x120 TF, SGI Altix ICE
- ❑ Max-Planck-Gesellschaft: 128 TF IBM Power 575

Industry:

- ❑ IT Service Provider: 120 TF, HP Cluster
- ❑ 9 systems 50-70 TF, 480 TF cumulated



France



HPC stakeholders:

- ❑ ANR (*National Research Agency*) : national funding body for research (66 Meuros since 2005 for HPC)
- ❑ GENCI: national HPC strategy for academic research, funds and coordinates HPC facilities at CNRS/IDRIS, CEA and French Univ./CINES. French representative in PRACE, funded the second PRACE Tier0 system, operated by CEA in the TGCC (Très Grand Centre de Calcul) near Paris
- ❑ CEA – Military Applications
- ❑ INRIA, The Joint Laboratory for Petascale Computing. The Joint Laboratory is based at Illinois and includes researchers from INRIA, Illinois' Center for Extreme-Scale Computation and the National Center for Supercomputing Applications.
- ❑ **TER@TEC**: Non-profit association for promoting HPC which links industrial companies, users and providers, and major R&D centers, public and private
- ❑ Industry: CCRT and companies such as Total, EDF, Airbus



France



Computing facilities:

Academia/Gov.:

- ❑ CEA/DAM: TERA 100 BullX supercomputer, 1 PF sustained (oct. 2010), 63 TF TERA 10 BULL Bull Novascale
- ❑ GENCI: 267 TF SGI Altix (CINES), 140 TF IBM BG/P(IDRIS), 67 IBM Power (IDRIS), 103 TF+192TF hybrid BULL system (CCRT) biggest academic hybrid cluster in Europe
 - ✓ Planed 2011 : GENCI 1,6 PF BULLX machine, installed at TGCC, first French PRACE Tier0 system
- ❑ CEA/CCRT: 40 TF BULL Novascale, 65 TF Bull Novascale
- ❑ Gov: 247 TF, HP Cluster Plat.

Industry:

- ❑ Airbus: 100 TF in France (HP POD) and some TF in Germany
- ❑ Total: 220 TF + 256 TF hybrid SGI Altix (biggest industrial hybrid cluster in Europe)
- ❑ EDF: 350 TF installed in 2010, 1.2 PF planed in 2012.
 - ✓ 2010: 200 TF IBM IDataPlex, 110 TF BG/P, 22 TF BG/L, 25 TF HP Cluster
- ❑ Gaming, Financial inst., distribution, Communication: 12 systems, 40-80 TF, 800 TF total installed.



Italy



HPC stakeholders:

- ❑ Funding body: Ministry for Education, 35 Meuro in 2009 for HPC
- ❑ CINECA (created in 1969, Bologna): operated by a consortium of 43 Italian Universities, National Research Council, OGS(Oceanography and Experimental Geophysics), Ministry for Education, Ministry of University and Research.
- ❑ HPC Centre on Climate Change (CMCC): Eu Mediterranean Centre for Climate Change



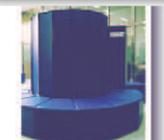
Computing facilities:

- ❑ CINECA:
 - ✓ 2010: 100 TF, IBM SP6
 - ✓ 2011: 500 TF, Idataplex IBM+GPCPU
 - ✓ 2012: xPF in 2012, IBM BG/Q
- ❑ CMCC: 30 TF in 2010



The history

- 1966: CDC 6600
 - 1978: CDC 7600
 - 1988: Cray X-MP / 48
 - 1990: Cray Y-MP / 4.64
 - IBM 3090 600 VF
 - 1993: Cray C-90 / 3128
 - 1994: Cray T3E 64
 - IBM SP2 32
 - 1996: Cray T3E 128
 - 1998: Cray T3E 128
 - 1998: Cray T3E 206
 - SGI Origin 16
 - 1999: Cray T3E 206
 - SGI Origin 64
 - IBM SP Power 3 16
 - 2000: Cray T3E 306
 - SGI Origin 128
 - IBM SP Power 3 128
 - 2002: IBM SP4 612
 - SGI Origin 128
 - 2004: IBM CLX Xeon 1084
 - 2006: IBM SP6 612
 - 2007: IBM BCX AMD 9120
 - 2008: IBM SP6
- 1st SC in Italy
 - 1st Vector Sc
 - 1st parallel system in Italy
 - 1st MPP system in Italy
 - 1 TeraFlops
 - 10 TeraFlops
 - 100 TeraFlops





Spain



HPC stakeholders:

- ❑ Ministry of Science and Innovation (MICINN), Generalitat de Catalunya and the Technical University of Catalunya, Ministry of Education and Science
- ❑ Ministry of Education and Science: funding body through program *Consolider – Ingenio*.
- ❑ Barcelona Supercomputing Center (BSC): Spanish National HPC centre since 2007, will host the tier-0 PRACE Spanish computer. Manage joint collaborations with industry (IBM, Microsoft).

Computing facilities:

- ❑ BSC:
 - ✓ 2010, 94 TF installed
 - ✓ >2012 : Spanish PRACE system, around 10 PF (new Data center, 20 MW/5MW for HPC)



UK



HPC stakeholders:

- ❑ Funding bodies: Research Councils UK (especially EPSRC, STFC, NERC and BBSRC)
EPSRC call for HPC Software Development projects (August 2010), to enable HPC science and engineering (3.5 M£)
- ❑ EPCC, STFC and NAG: national service support for high performance computing
 - ✓ EPCC, University of Edinburgh operates HECToR (systems and consultancy)
 - ✓ STFC: Hartree Centre, a new computational sciences institute for the UK
 - ✓ NAG: Computational Science and Engineering (CSE) Support Service (training, code optimization) for HECToR, all UK academia and industry
- ❑ European Centre for Medium-Range Weather Forecasts (ECMWF)
- ❑ Atomic Weapons Establishment (AWE)
- ❑ Oxford e-Research Centre: HPC/Numerical Algorithms roadmap for the UK

Computing facilities

- ❑ HECToR (funded by EPSRC, NERC and BBSRC operated by EPCC): 374 TF (Cray XT6->XE6), 200 TF (Cray XT4)
 - ✓ 2011: upgrade between 600 and 900 TFLOPS
- ❑ ECMWF: 2x150 TF (IBM Power 575)
- ❑ United Kingdom Meteorological Office: 2x66 TF (IBM P6)
- ❑ Atomic Weapons Establishment (AWE): 2x35 TF (BULL Bullx)
- ❑ University of Southampton: 72 TF (IBM IDataPlex)
- ❑ Food industry, Financial institutions, IT Service provider: 30 systems between 30TF to 70 TF peak, for a total of 1,5 PF



The Netherlands



HPC stakeholders:

- ❑ National Computing Facilities foundation (NCF), responsible for promoting and coordinating the use of the Netherlands' HPC and grid resources and academic supercomputing policy – annual regular budget around 7 Meuro
- ❑ SARA: Dutch national supercomputing center (funded partly by NCF)
- ❑ ASTRON and Univ. Groningen: Lofar project (correlation of the received radio signals in the Lofar array of receivers in the Netherlands and neighboring countries)
- ❑ BiG Grid project: national grid project for e-science, invests in compute clusters, large storage facilities, network facilities to access the systems and large backup facilities (30 Meuro). Managed by NCF, national sub-atomic physics laboratory Nikhef and the bioinformatics community NBIC. Part of CERN LHC Tier-1 infrastructure

Computing facilities:

- ❑ SARA: 65 TF IBM Power6-based and tier-1 capabilities (large memory and I/O bandwidth, scalability projects (Compute Challenges, Scalability Awards)
- ❑ SARA: 20 TF Dell quad-core compute cluster
- ❑ ASTRON and Univ. Groningen: 35 TF IBM BlueGene/P, 33 TF ClusterVision Cluster



Finland



HPC stakeholders:

- Finnish Funding Agency for Technology and Innovation (TEKES) and Academy of Finland.
- CSC – IT Center for Science: Finnish national HPC centre
- MASI project (2005-2009): modelling and simulation methods, 26.3 M€

Computing facilities:

- CSC – IT Center for Science: 102 TF CRAY, 34 TF HP cluster
- 2012, new data center in Kajaani (Northern Finland)

<http://www.csc.fi/english/csc/news/news/data>



Russia



HPC stakeholders:

- ❑ Supercomputing Consortium of Russian Universities (*Dec 23, 2008*) : Moscow State University, Niznij Novgorod State University, Tomsk State University, South-Ural State University.

Primary goal of the Consortium: Supercomputing Education



- ❑ Supercomputing Education project, 2010-2012, \$8M, General, funded by the "Commission for Modernization and Technological Development of Russia's Economy", General Chair of the commission "D.Medvedev, President of Russian Federation"
 1. 2010 – 5 centers in 5 Federal Districts of Russia, network of university centers (science&education) on supercomputing technologies (SCT)
 2. Development of methodological environment for supercomputing education
 3. Implementation of programs for teaching, advanced training and retraining on SCT
 4. Integration of education and fundamental and applied research.
Cooperation between education, research and industry.
 5. **International collaboration** on supercomputing education.
 6. Dissemination information within society about achievements of the supercomputing education project. PR-activities.