SEVENTH FRAMEWORK PROGRAMME
Research Infrastructures

INFRA-2010-2.3.1 – First Implementation Phase of the European High Performance Computing (HPC) service PRACE

PRACE-1IP

PRACE First Implementation Project

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Funding scenarios for the PRACE infrastructure

Final

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Author(s): Sergio Bernardi, CINECA
Susie Douglas, EPSRC
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Authorship	**Written by:**	Sergio Bernardi, CINECA Susie Douglas, EPSRC
	Contributors:	Florian Berberich, FZJ Ana Bela Dias, NWO Eugene Griffith, BSC Jussi Heikonen, CSC Carlos Merida, BSC Nicolas Mignerey, GENCI Pascal Moussier, GENCI Katarzyna Pawlikowska, CSCS Georgi Prangov, NCSA Dominik Ulmer, CSCS
	Reviewed by:	Thomas Eickerman, FZJ Stephane Requena, GENCI
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References and Applicable Documents

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[2] D2.2.1 of PRACE-1IP, Evolution scenarios for PRACE operational and procurement model.
[3] http://www.prace-project.eu
[4] D2.3.2 of PRACE-PP, Usage Model Document (Resubmit).
[5] D2.2.2 of PRACE-1IP, Procedures for additional PRACE committees

List of Acronyms and Abbreviations

AISBL	Association Internationale Sans But Lucratif (Belgian legal form for an International association without lucrative purpose)
BSC	Barcelona Supercomputing Center (Spain)
CEA	Commissariat à l'Energie Atomique (represented in PRACE by GENCI, France)
CERN	European Organisation for Nuclear Research
CINECA	Consorzio Interuniversitario, the largest Italian computing centre (Italy)
CPU	Central Processing Unit
CSC	Finnish IT Centre for Science (Finland)
CSCS	The Swiss National Supercomputing Centre (represented in PRACE by ETHZ, Switzerland)
CSG	Centre Spatial Guyanais
DARPA	Defense Advanced Research Projects Agency
DEISA	Distributed European Infrastructure for Supercomputing Applications. EU project by leading national HPC centres.
EC	European Commission
EESI	European Exascale Software Initiative
EGI	European Grid Infrastructure
EGI-InSPIRE	EGI-Integrated Sustainable Pan-European Infrastructure for Researchers in Europe, European project associated with EGI
EoI	Expression of Interest
EPCC	Edinburg Parallel Computing Centre (represented in PRACE by EPSRC, United Kingdom)
EPSRC	The Engineering and Physical Sciences Research Council (United Kingdom)
ERA	European research Area
ERIC	European Research Infrastructure Consortium
ESA	European Space Agency
ESAC	European Space Astronomy Centre
ESFRI	European Strategy Forum on Research Infrastructures; created roadmap for pan-European Research Infrastructure.
ESOC	European Space Operations Centre
ESRF	European Synchrotron Radiation Facility
ESRIN	ESA Centre for Earth Observation
ESTEC	European Space Research and Technology Centre
ETHZ	Eidgenössische Technische Hochschule Zuerich, ETH Zurich (Switzerland)
EU	European Union
FZJ	Forschungszentrum Jülich (Germany)
GB	Giga (= 2^{30} ~ 10^9) Bytes (= 8 bits), also GByte
Gb/s	Giga (= 10^9) bits per second, also Gbit/s
GB/s	Giga (= 10^9) Bytes (= 8 bits) per second, also GByte/s
GCS	Gauss Centre for Supercomputing (Germany)
GDP	Gross Domestic Product
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.
GENCI	Grand Equipement National de Calcul Intensif (France)
GFlop/s	Giga (= 10^9) Floating point operations (usually in 64-bit, i.e. DP) per second, also GF/s
GHz	Giga (= 10^9) Hertz, frequency =10^9 periods or clock cycles per second
GigE	Gigabit Ethernet, also GbE

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 PRACE project.
HPC	High Performance Computing; Computing at a high performance level at any given time; often used synonym with Supercomputing
HQ	Head Quarter
INCITE	Innovative and Novel Computational Impact on Theory and Experiment, US Department of Energy Leadership Computing
IO	International Organisation
ITER	International Thermonuclear Experimental
JRC	Joint Research Center
JSC	Jülich Supercomputing Centre (FZJ, Germany)
KTH	Kungliga Tekniska Högskolan (represented in PRACE by SNIC, Sweden)
LLNL	Laurence Livermore National Laboratory, Livermore, California (USA)
LRZ	Leibniz Supercomputing Centre (Garching, Germany)
MB	Mega (= 2^{20} ~ 10^6) Bytes (= 8 bits), also MByte
MB/s	Mega (= 10^6) Bytes (= 8 bits) per second, also MByte/s
MFlop/s	Mega (= 10^6) Floating point operations (usually in 64-bit, i.e. DP) per second, also MF/s
MoU	Memorandum of Understanding.
NWO	De Nederlandse Organisatie voor Wetenschappelijk Onderzoek (Netherlands)
PRACE	Partnership for Advanced Computing in Europe; Project Acronym
PRACE AISBL	PRACE Association International Sans But Lucratif
PRACE-PP	Partnership for Advanced Computing in Europe, Preparatory Phase project
PRACE-1IP	Partnership for Advanced Computing in Europe, first Implementation Phase project
PSNC	Poznan Supercomputing and Networking Centre (Poland)
RI	Research Infrastructure
SARA	Stichting Academisch Rekencentrum Amsterdam (Netherlands)
SNIC	Swedish National Infrastructure for Computing (Sweden)
STFC	Science and Technology Facilities Council (represented in PRACE by EPSRC, United Kingdom)
STRATOS	PRACE advisory group for STRAtegic TechnOlogieS
TB	Tera (= 240 ~ 1012) Bytes (= 8 bits), also TByte
TCO	Total Cost of Ownership. Includes the costs (personnel, power, cooling, maintenance, ...) in addition to the purchase cost of a system.
TFlop/s	Tera (= 1012) Floating-point operations (usually in 64-bit, i.e. DP) per second, also TF/s
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
VAT	Value Added Tax
XSEDE	Extreme Science and Engineering Discovery Environment

Executive Summary

The present PRACE funding model is based on two strands. The first is a flat cash contribution that all members pay for the sustainability of the organization in terms of basic office operations (like office space, staff wages, general accounting and taxes). The second is an in-kind contribution which is defined in terms of computing resources and associated services. The amount of this in-kind contribution has been agreed to be 100M€ per Hosting Member for the initial period of five years. This model is known as the Cycles model and the operation is based on the provision of computing hours by the Hosting Members.

An important aspect to take into account for any future funding model is the long term perspective for the sustainability of PRACE. Members must discuss and decide upon the evolution of the funding model that will be put in place and implement it, prior to the end date of the initial period in April 2015. Therefore, this is an urgent action for PRACE AISBL and the PRACE Office to consider.

For an analysis of what the PRACE funding model should be, it is important to explore what other existing research infrastructures have implemented in terms of models and practices and what could be the pros and cons for PRACE.

Clearly all the examples studied show different characteristics and solutions for the structure of the financial contributions and the enforcement of the *juste retour* principle.

The structure of the financial contributions is generally based on two approaches:

- GDP
- Share of usage of the resources (pay per use)

Before undertaking analysis of the potential funding models, it was essential to establish some principles that should be present in any funding model that could be used for PRACE in the future.

The principles can be seen as the strategic guidelines to take into consideration for the selection of a suitable model for providing a route towards long-term financial stability and sustainability.

Nine principles have been established (see section 3.1):

- Meeting the mission of PRACE
- Legality
- Sustainability
- Fairness to partners within PRACE
- Transparency
- Meeting user needs
- Flexibility
- Acceptability to the AISBL
- Ability to bring to a close

The current funding model is analysed within the context of these principles in order to assess the merit in the current arrangement. The analysis has been then performed in three different scenarios that might be considered options for PRACE evolution:

- Central Organisation - One system
- Central Organisation - Many systems

- Loosely coupled distributed organisation

A summary table is presented at the end of the document where the characteristics of the above options are compared to provide a global overview.

1 Introduction

This deliverable is the second of two deliverables concerning the evolution of the financial model of the association. The first deliverable D2.3.1 [1] of PRACE-1IP focussed on the analysis of funding various activities through in-kind contributions. This deliverable analysed the characteristics, metrics and different models of in-kind funding.

D2.3.2 aims to propose and analyse different funding scenarios for contributions from member countries, external sources (EC), services and activities. D2.3.2 relates also to the work done in D2.2.1 [2] of PRACE-1IP concerning the evolution of the operational model where the issue of funding sustainability has been highlighted.

An important aspect to take into account is the long term perspective for the sustainability of PRACE. This is not a secondary goal given that the present model will expire in 2015. The objective of the work in this deliverable is to provide feasible and realistic options for the evolution of the financial models for PRACE in order to achieve a sustainable funding process for the long term.

In the Section 1, the background of the present funding model is given together with legal and political constraints, and other related issues.

Section 2 provides the analysis of the funding practices and financial models adopted by a selected number of organizations that have similarities to PRACE AISBL. The analysis looks at the characteristics of the legal forms adopted by those organizations, their governance structure, their funding rules and the overall relevance to PRACE AISBL.

The strategic dimension of the funding model for PRACE is described in Section 3. This section identifies a set of principles that have to be considered as the foundations of the PRACE funding model and practice. These principles are then used to evaluate three different funding scenarios which are described in detail in Section 4.

The findings of the evaluations are then summarized in a final table in Section 5 where the main characteristics of the models are matched against the principles.

Section 6 presents the conclusions of the work.

1.1 Background

At present PRACE AISBL has 24 partners. Rights and duties of the partners are described in the statutes of the association. The Association has a funding model based on two pillars:

- An annual cash contribution from all the members that is decided by the Council (presently 60,000€);
- An in-kind contribution for the initial period whose value has been agreed at 100M€ per Hosting Member for the first five years of operation.

The annual subscription covers the cost of running the PRACE office and any activities associated solely with the infrastructure such as peer review and publicity.

During the preparatory phase project, three models were proposed for how PRACE could operate: the Cycles model, the Operator model and an intermediate option [4]. At the moment, PRACE is operating on a Cycles model, where each Hosting Partner agreed to contribute compute resources in-kind to the value of 100M€ over 5 years. It has not been decided whether after the 5 years initial period, PRACE will continue to run in this way or will move to a different model, where, for example, partners may pay a substantial subscription into a central account and procurement for a new machine is handled centrally. Whichever model is chosen it will influence the funding model used.

PRACE will run on its current model until 2015. During this time the partners plan to discuss and decide upon a longer-term funding model.

The legal form of the association is a further element to consider once the selection of the funding model has been made. Constraints could come also from some of the members‘ legal structures that either prevent or limit the amount of possible funding resources from e.g. commercial activities, paid services on a pay per use model, etc.

The presently used Belgian AISBL legal form allows only for limited, marginal commercial activities. VAT and taxation are strong constraints too. Members‘ national tax and VAT laws are further constraints for funding models that include the possibility of charging for services. Moreover the expectations of each member of a return of its investment (not necesarily in terms of pure value for money) and the role the EC is expecting to play in terms of funding (substantial funding, co-funding by project, pure political and regulatory support, proactive engagement) need to be considered.

The focus of the deliverable is on the Tier-0 infrastructure funding given the mission stated in the Statutes and the agreement among the Hosting Members for the initial period of five years of in-kind support.

The outcome of this deliverable is meant as a guideline document to be presented to the Council to support the discussions on the future funding model for PRACE.

2 Best practices for funding models

2.1 Introduction

In order to have a documented analysis of what the PRACE funding model should be, it is important to look at the models adopted by other existing research infrastructures. The five examples presented in this section, namely CERN, ESA, ESRF, EGI and INCITE, each exhibit different features suited to their missions and constraints that could help in deciding the PRACE future funding model.

2.2 Advantages and disadvantages of legal forms

One important aspect of funding models is the legal form they are based upon. The legal form has important consequences for the nature of the members (member states for some legal forms), the tax model of the organisation, and sustainability. Since there are few options for possible legal forms it makes sense to analyze each of them before describing in detail the examples.

From the legal point of view the examples fit into three categories:

- International organizations (IOs), under international law: CERN, ESA, ITER. Although ERIC is a bit different (it falls under European law), it shares most of its characteristics with IOs.
- International entity under a specific national law: PRACE AISBL, ESRF, EGI
- Non-European HPC programs: INCITE

With respect to the present situation of PRACE, those legal forms have advantages and disadvantages and these are discussed below.

International organizations and ERIC:

- Pros:
  - Long-term sustainability
  - Sustainable commitment of the members and support from their respective governments
  - Mandatory tax exemptions
  - Easier for the EC to fund (especially with ERIC but not necessarily, see ESA)
- Cons:
  - Lengthy procedure (it took ITER ten years from the beginning of the political negotiations)
  - Possible autonomy restrictions (especially for ERIC, some major changes have to be approved by the EC)
  - Less flexible
  - Relations with the industry to be investigated

Entity under a national law:

- Pros:
  - Adaptable

  - Already in place with PRACE AISBL
  - Proved to work well in some cases (ESRF, especially regarding the collaboration with industry)
- Cons:
  - Tax exemptions do not necessarily apply
  - Possible unbalance between the country whose law is used and the other ones
  - Sustainability is not guaranteed

Non-European HPC programs:

- Pros:
  - Very flexible
  - Easy to manage
- Cons:
  - National effort, no cooperation between various countries with different taxation laws
  - Sustainability dependent on strong political commitment

2.3 Examples

2.3.1 CERN (European Organization for Nuclear Research)

Legal form: International Organization

Mission:
CERN shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto.

CERN shall confine its activities to the following:

- the construction and operation of one or more international laboratories for research on high-energy particles, including work in the field of cosmic rays;
- the organization and sponsoring of international co-operation in nuclear research, including co-operation outside the Laboratories.

Members: (Budget 2009):

Member state	Contribution	Mil. CHF	Mil. EUR
Germany	19.88 %	218.6	144.0
France	15.34 %	168.7	111.2
United Kingdom	14.70 %	161.6	106.5
Italy	11.51 %	156.5	93.4
Spain	8.52 %	93.7	61.8
Netherlands	4.79 %	52.7	34.7
Switzerland	3.01 %	33.1	21.8
Poland	2.85 %	31.4	20.7
Belgium	2.77 %	30.4	20.1
Sweden	2.76 %	30.4	20.0
Norway	2.53 %	27.8	18.3
Austria	2.24 %	24.7	16.3
Greece	1.96 %	20.5	13.5
Denmark	1.76 %	19.4	12.8
Finland	1.55 %	17.0	11.2
Czech Republic	1.15 %	12.7	8.4
Portugal	1.14 %	12.5	8.2
Hungary	0.78 %	8.6	5.6
Slovakia	0.54 %	5.9	3.9
Bulgaria	0.22 %	2.4	1.6
Total	100 %	1098.6	724.0

Table 1: Percentage of contribution to CERN budget by members

HQ location: Geneva, Switzerland

Facility location: French-Swiss border

Funding model(s): Pure contribution

Funding source(s): Governments. Contributions depend on each country's GDP.

Annual budget: Around 1billion CHF (700M€)

Figure 5: 2011 Budget (Personnel, Materials and Interest & financial costs)

* Including Centralised personnel expenses, Social security, Internal mobility, Personnel on detachment (3.3%), Energy and water (8.7%), Insurances and postal charges (0.7%), Housing Fund (0.4%)

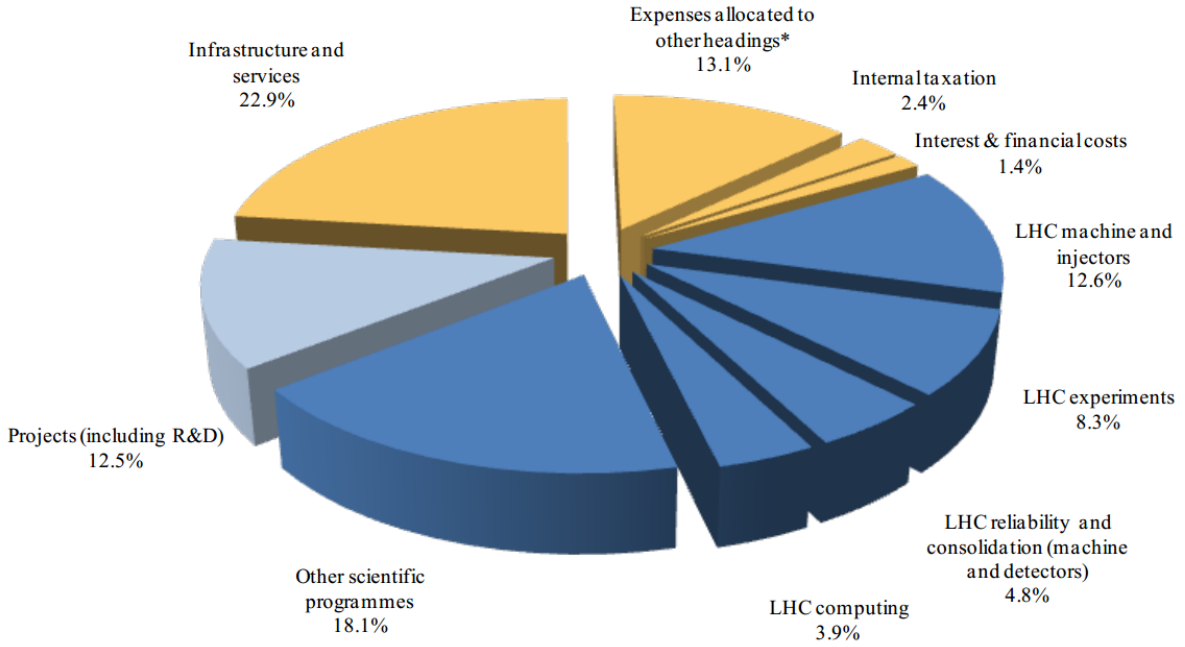

Figure 1: CERN budget in year 2011

Tax/VAT position: CERN is exempted from Value Added Tax (VAT) in its two Host States, Switzerland and France.

Main features:

- International Organization with pure contributions from the member states.
- Each country's share depends on their GDP.
- Each member state has one vote at the council, regardless of their contribution.
- The EC is an observer member, meaning it has to contribute to the annual budget. In 2011, it contributed around 8 million euros, covering approximately 1% of the budget.
- No explicit *juste retour* policy.

Besides this main funding there are programmes for specific experiments (e.g. ATLAS Collaboration) at CERN that are co-funded by a large amount of institutions from member and non-member states. In these cases funding and usage are governed by a Memorandum of Understanding between the parties involved in the specific Collaboration.

2.3.2 ESA (European Space Agency)

Legal form: International Organization

Mission:
ESA's purpose shall be to provide for, and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems:

- by elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies

of the Member States with respect to other national and international organizations and institutions;

- by elaborating and implementing activities and programs in the space field;
- by coordinating the European space program and national programs, and by integrating the latter progressively and as completely as possible into the European space program, in particular as regards the development of applications satellites;
- by elaborating and implementing the industrial policy appropriate to its program and by recommending a coherent industrial policy to the Member States.

Members:
19 European members: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, Romania. Canada takes part in some projects under a Cooperation agreement.

In 2011, the main contributors and the respective contributions were:

- European Union: 20%
- France: 18,8 %
- Germany: 17,9 %
- Italy: 9,5 %
- United Kingdom: 6,6 %
- Spain: 5,1 %
- Belgium: 4,1 %
- Switzerland: 2,4%

HQ location: Paris

Facility location:

- ESTEC in Noordwijk, the Netherlands
- ESOC, Darmstadt, Germany
- ESRIN, Frascati, Italy
- EAC, Cologne, Germany
- ESAC, Madrid, Spain
- CSG, Kourou, French Guiana
- Redu Center, Belgium

Funding model: Pure contributions

Funding source:
Member countries, and 20% from the European Union.

The mandatory activities are funded by every member with a fraction of each country's GDP. Each member can choose whether they want to subscribe an optional program.

The *juste retour* of each member's contribution is enforced by a geographical repartition of industrial contracts.

Annual budget: Around 4 Billion € in 2011 (around 3 Billion € in 2005):

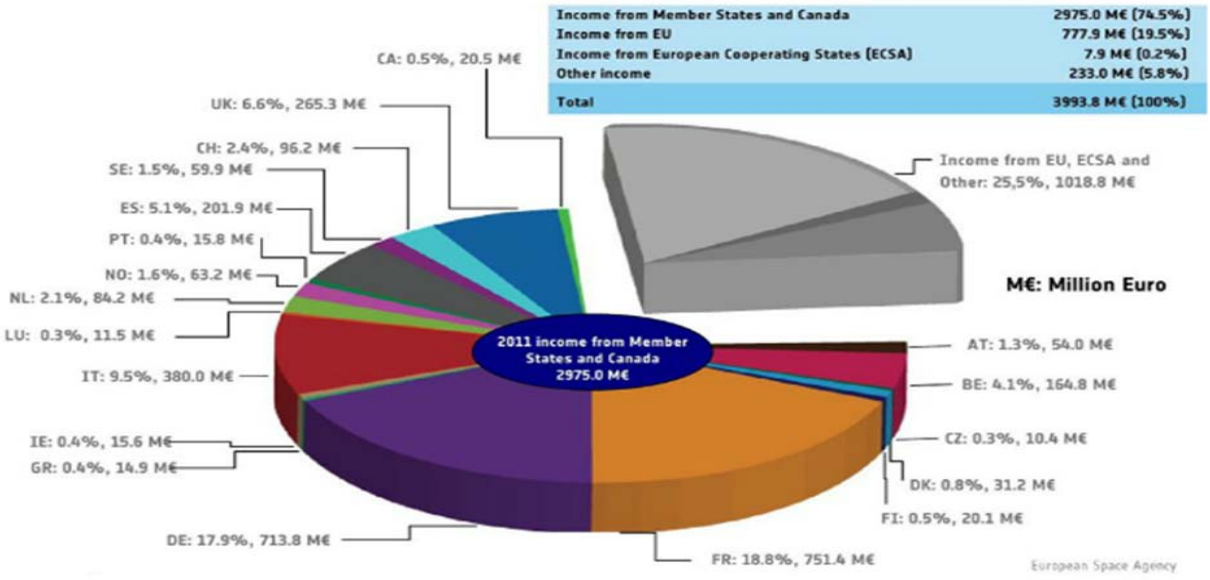

Figure 2: Percentage of year 2011 budget contribution by ESA members

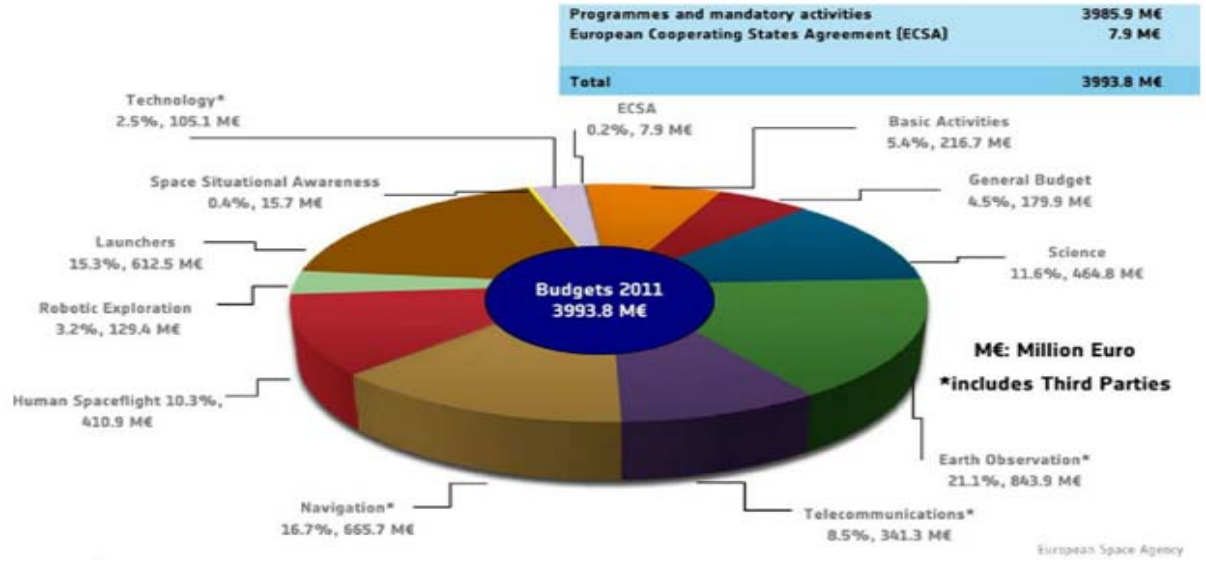

Figure 3: ESA expenses in year 2011

Tax/VAT position: Tax-free. In details, the ESA convention states that:

- Within the scope of its official activities, ESA, its property and income shall be exempt from direct taxes.
- When purchases or services of substantial value and strictly necessary for the exercise of the official activities ESA are made or used by or on behalf of ESA, and when the price of such purchases or services includes taxes or duties, appropriate measures shall, whenever possible, be taken by the Member States to grant exemption from such taxes or duties or to provide for their reimbursement.
- Goods imported or exported by ESA or on its behalf, and strictly necessary for the exercise of its official activities, shall be exempt from all import and export duties and taxes and from all import or export prohibitions and restrictions.

Main features:

- International Organization. Heavy but stable legal structure, almost unavoidable due to the highly strategic nature of ESA that also implies the need of a consistent very long-term vision.
- EC and ESA have had a direct partnership since 2004 that led to a joint European Space Policy and funding from EC.
- Shares depend on each country's GDP. Contributions also based on GDP.
- *Juste retour* implemented through geographical repartition of industrial contracts.
- The activities are separated into two categories: the mandatory ones and the optional ones. Each member can choose whether they want to fund (and therefore benefit from) optional programs.

2.3.3 ESRF (European Synchrotron Radiation Facility)

Legal form:
Société Civile: entity of international level governed under French law. The members have unlimited liability for debts in proportion to shares.

Mission:

- To design, construct, operate, and develop, for the use of the scientific communities, a synchrotron radiation source.
- To support the use of the facility.
- To draw up and execute programs of scientific research using synchrotron radiation.

Members:

Contracting party country	Member institution	Contribution to annual budget
France	Centre National de la Recherche Scientifique (CNRS)	13.75 %
	Commissariat à l'Energie Atomique (CEA)	13.75 %
Germany	Deutsches Elektronen-Synchrotron (DESY)	25.5 %
Italy	Consiglio Nazionale delle Ricerche (CNR)	15 %
	Istituto Nazionale di Fisica Nucleare (INFN)	
	Istituto Nazionale per la Fisica della Materia (INFM)	
United Kingdom	Science and Technology Facilities Council (STFC)	14 %
Belgium Netherlands	BENESYNC consortium formed by: Le Service Public Fédéral de Programmation Politique Scientifique (previously: Services Fédéraux des Affaires Scientifiques Techniques et Culturelles) (BELSPO) Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)	6 %

Spain	Ministerio de Ciencia e Innovación (MICINN)	4 %
Switzerland	The Swiss Confederation represented by the State Secretariat for Education and Research (SER)	4 %
Denmark Finland Norway Sweden	NORDSYNC consortium formed by: Forskningsrådet for Naturog Univers (FNU) Suomen Akatemia (AKA) Norges Forskningsråd (Forskningsradet) Vetenskapsrådet (VR)	4 %

Table 2: Percentage of contribution to ESRF budget by members

Scientific associates:

- Government of the Republic of Portugal (contribution 1%)
- the Israel Academy of Sciences and Humanities (contribution 1%)
- the Austrian Academy of Sciences (contribution 1%)
- the Institute of Physics of the Polish Academy of Sciences (contribution 1%)
- the CENTRALSYNC consortium (contribution 1.05%); CENTRALSYNC is formed by the countries Czech Republic, Hungary, Slovakia and represented by their respective academies: the Institute of Physics, Academy of Sciences of the Czech Republic, the Hungarian Academy of Sciences, and the Slovak University of Technology in Bratislava.

HQ location: Grenoble, France

Facility location: Grenoble, France

Funding model:
Funded by contributions from the members but also includes commercial activities by charging fees to industry for core services: companies can acquire ESRF technologies and equipment (beamlight instrumentation, data and control analysis, etc.. ESRF has also developed a spin-off called Small Infinity for commercialization of first-class atomic force microscopes.

ESRF policy for industry transfer is based on the following:

- promote the use of ESRF technologies to benefit society through licensing to companies who turn them into successful commercial products;
- support the innovative goal of the ESRF by generating licensing income which is recycled to user and development programs, and contribute to the recognition of the inventors;
- develop partnerships with local and international industrial networks.

Funding source:

Members (through governments) and EC for the Upgrade program (new facilities, beamlights, etc.)

Annual budget:

98 million euros in 2010, including 5 million euros from the EC for the Upgrade Program. Industrial income (1,7%) from sale of beam time and license agreements.

- **Tax/VAT position:** The Company is subject to French value added tax. Contributions from Members established outside France shall not be subject to value added tax in France. This provision does not limit the right of the Company to deduct VAT.
- Goods imported by the Company from other countries shall benefit from exemption from customs duties in accordance with the regulations of the European Community.

Main features:

- Same type of legal structure as PRACE AISBL. Representation of many European countries on the Council.
- It has demonstrated its stability over a long period of time (launched in 1988 and an upgrade program is on the way) and its constant ability to produce top-class results. It is a good example of fruitful European collaboration in the science area.
- Located at a single site and with mainly one unique initial funding (construction costs)
- Juste retour concept is achieved through proportional usage : some access time is devoted to compensate imbalance between cash contributions and scientific usage. Scientific usage is monitored through the use of a Juste retour coefficient (JRC). JRC is the ratio between the percentage of scientific usage and the ideal share of a contracting party. Ideal share is the percentage of a parties' financial contribution to the ESRF budget. JRC is based on a three year rolling average of those coefficients.
- Good integration of industry. ESRF can provide usage of the facility, equipment and technologies to companies on a pay per use basis.

2.3.4 EGI (European Grid Infrastructure)

Legal form:

The foundation is a not-for-profit organization under Dutch law.

Mission:

- Operate a secure integrated production grid infrastructure that seamlessly federates resources from providers around Europe
- Coordinate the support of the research communities using the European infrastructure coordinated by EGI.eu
- Work with software providers within Europe and worldwide to provide high-quality innovative software solutions that deliver the capability required by the user communities
- Ensure the development of EGI.eu through the coordination and participation in collaborative research projects that bring innovation to European Distributed Computing Infrastructures (DCIs)

Members:

Participant	Country	Participant	Country
BELNET	Belgium	VU	Lithuania
IPP-BAS	Bulgaria	RESTENA	Luxembourg
SWITCH	Switzerland	LUMII	Latvia
CESNET	Czech Republic	UoM	Montenegro
CyGrid	Cyprus	MARGI	Macedonia
Gauß-Allianz	Germany	NCF	the Netherlands
DCSC	Denmark	UNINETT Sigma AS	Norway
EENet	Estonia	CYFRONET AGH	Poland
CSIC	Spain	UMIC	Portugal
CSC	Finland	ICI	Romania
CNRS	France	IPB	Serbia
GRNET	Greece	ARNES	Slovenia
SRCE	Croatia	SlovakGrid	Slovakia
NIIF	Hungary	SNIC	Sweden
Grid-Ireland	Ireland	ULAKBIM	Turkey
IUCC	Israel	JISC	United Kingdom
INFN	Italy	CERN	EIRO

Table 3: Members of EGI

HQ location: Science Park Amsterdam, The Netherlands

Facility location:

None, except for the HQ. It is an e-infrastructure coordinating national grids. Those national grid infrastructures are not owned in any way by EGI.

Funding model(s): Pure contribution

Funding source(s):

Membership fees, EC (through EGI-Inspire funded by the 7th Framework Program), national co-funding

Annual budget: Budget 2010

Table showing EGI.eu participation fees for 2010:

PARTICIPANTS	INCOME €	PARTICIPANTS	INCOME €	PARTICIPANTS	INCOME €
NGI-DE	79,880	NGI-NO	39,940	NGI-SI	9,985
NGI-UK	79,880	NGI-GR	29,955	CERN	4,993
NGI-FR	79,880	NGI-DK	29,955	EMBL	4,993
NGI-IT	79,880	NGI-FI	29,955	NGI-CY	4,993
NGI-ES	59,910	NGI-IE	29,955	NGI-EE	4,993
NGI-AT	39,940	NGI-PT	29,955	NGI-BG	3,994
NGI-NL	39,940	NGI-IL	19,970	NGI-RS	3,994
NGI-TR	39,940	NGI-CZ	19,970	NGI-LT	3,994
NGI-CH	39,940	NGI-RO	19,970	NGI-LV	3,994
NGI-BE	39,940	NGI-HU	19,970	NGI-MK	1,997
NGI-SE	39,940	NGI-SK	9,985	NGI-ME	1,997
NGI-PL	39,940	NGI-HR	9,985	NGI-AL	1,498
TOTAL					1,000,000

Country-based participants pay a participation fee and receive votes based upon their national Gross Domestic Product. Associated participants select their own fee and voting level, subject to the approval of the EGI Council.

Figure 4: Participation fees to EGI budget by members

INCOME

INCOME 2010	€
Start of year balance	468,150
INCOME	
EGI InSPIRE[5]	354,060
eScienceTalk	30,964
EGI.eu participants	1,000,000
Interest	7,603
Total income	1,392,626
TOTAL	1,860,777

EXPENDITURE

EXPENDITURE 2010	€
Staff salaries[6]	690,087
Subsidy for EGI Global Tasks	398,436
Office costs[7]	150,620
Direct project costs[8]	59,668
TOTAL	1,298,810

Figure 5: EGI income and expenditure in year 2010

EGI-Inspire is a four-year project which total cost is 72M€, supported by 25M€ from the EC

Tax/VAT position:

Some tax exemptions and benefits but since EGI does not own the physical infrastructure, the procurements are subject to the corresponding national policies. 65% of the NGIs are not eligible to tax exemptions.

Main features:

- Similar to PRACE in many ways: it has a large number of European members, roughly the same budget, and moreover it is supported by a project funded by the 7th Framework Program.
- Voting rights at the council are related to the financial contributions.
- Its mission is to federate national grids infrastructures. Hence, ownership and daily operation of the physical systems is not part of the mission of the organisation.
- According to their report on their MS212 milestone, dated 24/01/2011, they are seriously considering moving to the newly created ERIC organisational model. It is foreseen that it would improve their sustainability and their tax position but the alignment with ERIC also has major drawbacks (lengthy procedures, need for every partner to be reappointed as their official government representatives, etc.)

2.3.5 INCITE (Innovative and Novel Computational Impact on Theory and Experiment)

Legal form: Program of the US Department of Energy. Now in its ninth year, the INCITE program grants scientists and engineers at universities, national laboratories, industry and other research organizations across the world access to Tier-0 high-performance computing systems.

Mission: INCITE is under the umbrella of the Advanced Scientific Computing Research (ASCR) program whose mission is to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena important to the Department of Energy (DOE). A particular challenge of this program is fulfilling the science potential of emerging computing systems and other novel computing architectures, which will require numerous significant modifications to today's tools and techniques to deliver on the promise of exascale science.

Members: Co-managed by Argonne and Oak Ridge

Facility location:

Lawrence Berkeley National Laboratory, Oak Ridge National Laboratory, Argonne National Laboratory

Funding model: Pure contribution

Funding source: US Government, through the Department of Energy

Annual budget: Around 465M$ requested for FY2012 about Advanced Computing Research: Mathematical, Computational, and Computer Sciences Research for 175M$ and High Performance Computing and Network Facilities for 292M$.

Tax/VAT position: National program, thus national taxation applies.

Main features:

- The evolution of the ASCR program will enable the U.S. to take advantage of the changes in computer hardware technology and deliver computers and networks that are a thousand-fold more energy efficient than today, drive unprecedented improvements in the scientific understanding of areas critical to the future of USA, and secure a competitive advantage in high-tech and information technology industries.

- PRACE is similar in terms of European mission and uses a very similar peer review process to allocate resources (core hours) to applicants
- Nationally funded with taxpayers dollars. It escapes most of the difficulties arising from building an infrastructure with members from several countries, having its own interest, vision and governmental institutions.
- *Juste retour* is not very relevant for INCITE since there is a sole funding source. However, some of the computing cycles are reserved to projects of special interest to the Department of Energy. Moreover, European researchers can apply to INCITE resources.
- Industrial projects are eligible to apply to the calls.

2.4 Conclusion

The examples studied each have their own characteristics but they differ on two main points: the structure of the financial contributions and the enforcement of *juste retour*.

On the one hand, CERN and ESA have chosen a financial contribution depending on countries' GDP. In the case of CERN, the convention states that the council may determine a maximum percentage that any Member State may be required to contribute. Both CERN and ESA are International Organizations and this legal form may make this policy of GDP dependent contributions easier to implement since states, not specific organizations representing them, are members. On the other hand, EGI and ESRF agreed on fixed shares of the budget for each member.

Concerning the notion of *juste retour*, there is no single solution broadly adopted, each organization has a different way to enforce it based on its own operational model. There are no explicit *juste retour* policies for CERN and EGI, but in EGI voting rights are related to the financial contributions whereas in CERN every member has equal rights at the council. Amongst those who do have an explicit *juste retour* policy, ESA can give access to industry through the settlement of specific industrial contracts while ESRF allocates usage of the synchrotron mainly according to shares with only very limited commercial activities. In certain cases those shares are periodically reviewed depending on the usage.

It is important to recall that PRACE has a peculiar model when compared with the examples studied in this section for two key reasons: firstly, unlike CERN and ERSF where the main funding consists in building the facility and upgrading it every 10 years or so, Tier-0 machines need to be replaced every 3 years in order to keep up with the pace of leadership computing, which means that it needs continuous funding from the members. Secondly, the user community of HPC is not as strongly structured as the ones usually backing other ambitious projects partly because PRACE users may come from a large number of scientific fields and also because PRACE is still in a ramping up phase and requires time to reach a critical mass.

Those elements have to be kept in mind to provide a route towards long-term financial stability and sustainability for the PRACE funding model and keeping in mind that there are legal and financial issues that need to be sorted out by any members hosting computer facilities, with respect to national legislation and policy.

3 Principles for a PRACE funding model

Before the analysis of potential funding models could be undertaken, it was essential to establish some principles that should be present in funding models that could apply to PRACE. Nine principles have been identified, two of which are in fact fundamental parts of any model to be applied to PRACE. These are **legality** and **acceptability to the AISBL** and, although they are classed under the list of principles, in fact they will form the platform of any successful funding model.

This section gives a brief description of each principle and why it is important to PRACE. The current funding model is analysed against these principles, which highlights that it is not a suitable long-term model for PRACE. These principles are also used in section four where three funding models are proposed and analysed.

3.1 Definition of the principles for a PRACE funding model

Acceptability to the AISBL

Any funding model must be acceptable to the AISBL and be clearly understood by all partners.

Legality

Any model must fit within a legal framework and be enforceable. The model should also try as much as possible to foresee the implications resulting from the different tax models used in the partners' countries. Depending on the funding model, it is also necessary that remote centres and stakeholders are included under the legal umbrella.

Sustainability

Any funding model must be sustainable to allow, for example, political and economical changes of the partners' countries or the results of scientific and technologic evolution.

Meeting the mission of PRACE

A critical aspect of any funding model is that it must be able to ensure that PRACE meets its mission as stated in the following excerpt from the Statutes of the Association PRACE AISBL:

"**....**

- ***a) to develop and provide an Infrastructure at European level which allows the scientific communities, inclusing those within industry, to access European High-end Computing systems;***
- ***b) the management of the coordination between the Infrastructure and existing national computing centres (Tier-1) and also, if agreed, regional computation centres (Tier-2), to allow for the establishment of relationships with the HeC user communities; and***
- ***c) the provision and rationalization of access to the Infrastructure by qualified European and international scientific communities, either academic or industrial, whose projects may be evaluated for such purpose.***

…"

Without this fundamental principle, the funding model cannot be accepted.

Fairness to partners within PRACE

The model should be fair to all members. This implies that a fair return of investment is granted by the funding model in parallel to the common interests defined in the PRACE mission.

Transparency

There are two aspects to this principle. A funding model must be transparent to and between the partners themselves through the establishment of trustable and clear mechanisms of communication between all partners. The second aspect is ensuring that the users of the infrastructure understand the main goals of the association and all resource allocation procedures defined (e.g. peer review process, representation in committees, etc.).

Meeting user needs

Users are integral to the success of PRACE so any funding model should be developed to ensure that users are provided with an excellent service to enable them to carry out world-leading research.

Flexibility

The rapidly changing nature of HPC technology, coupled with the changing needs of the research community and changes politically and economically within Europe mean that any funding model needs to have the flexibility to meet changes as they arise. This flexibility should also address changes in the composition of the association.

Ability to bring to a close

The funding model needs to take into account procedures for the possible closure of the organisation. This possibility needs to be taken into account for the acquisition of assets and the contracts of staff of the organisation.

3.2 Analysis of present funding model against key elements

The current funding model for PRACE is based on in-kind contributions of 100M€ over 5 years from four Hosting Partners plus a cash contribution of currently 60,000€ per annum from each partner. This is seen as a fixed term model and is covered by the Agreement for the Initial Period which runs until May 2015.

Peer review is managed centrally but each of the Hosting Member sites is managed by the partner organisations, or their representatives. There is an overall Managing Director, who manages the day-to-day activity of PRACE, in place and the Scientific Steering Committee have been set up to advise PRACE on its scientific direction.

The authors analysed the current funding model against the principles developed for a funding model to see if there is merit in continuing the current arrangement. As can be seen from the table presented below, there are significant flaws in the current model, which leads to the recommendation from this group that this model should not form the basis for future funding of PRACE.

Principle	Is it met?	Explanation
Acceptability to the AISBL	Yes	The model was developed and ratified by the AISBL.
Legality	Yes	There is an accepted legal entity through the AISBL and associated statutes which all partners must adhere to. The Hosting Partners have also signed a legal document guaranteeing their contribution of computing resource to the value of 100M€.
Sustainability	No	The funding model has been planned with five years duration, and legally established in an internal agreement of the legal form. Sustainability of the infrastructure is thus ensured for an initial period of five years, but not beyond that horizon.
Meeting the mission of PRACE	Yes	The model allows access to Tier-0 systems for users across Europe and therefore is meeting the mission of PRACE. Mechanisms to open PRACE to industry are being established.
Fairness to partners within PRACE	No	A *Juste retour* mechanism has not been implemented yet.
Transparency	Yes	<u>Among partners</u> Channels of communication between partners and between partners and the management of the organisation are defined in the statutes of the association. The Council is the main decision body of the association. All partners have voting rights in the Council and voting majorities are defined in the statutes. The Board of Directors of the organisation executes the decisions of the Council and reports on its activities to the Council. <u>To users</u> The peer review process is well established and is publicised through the PRACE website. Users are able discuss matters of their interest and issue recommendations to the Council via the User Forum.
Meeting user needs	Yes	This is met by providing cycles to the user community. Contact and exchange with the scientific community is taking place. Getting input from the scientific community is essential and the Scientific Steering Committee has been established to facilitate this.
Flexibility	Yes	The lightweight infrastructure in place and the clear management rules defined in the statutes grant the current implementation of the funding model with a high flexibility degree.
Ability to bring to a close	Yes	There are clear mechanisms defined in the legal documents to wind up the association. The fact that the association does not own any asset that could be disputed representing an obstacle for the wind up process adds a high degree of flexibility in this respect.

Table 4: Analysis of PRACE funding model against key elements

4 Evolution of the PRACE funding model: three scenarios

Various options for PRACE funding were discussed and put forward. In this section three possible models are discussed and are analysed within the context of the principles. These models are analysed according the following points:

- Definition of key terms;
- Structure of the organisation;
- Financing of the model;
- Key people in the organisation;
- Advantages and disadvantages for PRACE;
- Risks;
- Matching to the principles of funding for PRACE.

4.1 Scenario one: Central Organisation - One system

This scenario describes the organisation and funding of a number of existing research infrastructures. According to examples of well-known RI like the ESRF European Synchrotron Radiation Facility or CERN the basic principles are analysed in order to investigate the relevance for PRACE RI. The common feature of these examples is one centralised research infrastructure, often an expensive installation on one site funded by various European governments either directly or via a research organisation which represents the country.

Definition of key terms

The basic attribute of this scenario is on central organization. Normally it is one expensive large scale facility with attached administration. A good example is the European Synchrotron Radiation Facility (ESRF) with 600 employees and 7000 researches visiting the installation. Normally such a RI has a long life time. ESRF started its operation in 1992 and initiated the first update programme in 2010.

PRACE RI differs in terms of periodic investments. The Tier-0 systems need to be replaced every 3 years in order to stay at the top of the HPC pyramid. With an average investment of 40 – 60M€per system and operation costs of the same order, a real PRACE Tier-0 system needs an investment of around 100M€ every 3 years. This compares to a similar investment every 12 years for other big single-site research infrastructures.

If PRACE were to evolve to a one site system scenario in the future the funding could be realised by cash contributions either from the participating countries or from national HPC organisations representing the different participating countries. Since cash contributions would be the main contribution for the RI a model based on shares would be possible. This would facilitate the fair return principle with the possibility to check and to adapt the shares after a defined period.

Another possibility which is used for some European or International RIs is the contribution based on the GDP. This reflects the industrial development of the individual counties but respects only partly the scientific needs of the individual partners. Since the GDP is a fixed value, the funding with shares based on the GDP seems to be more reliable instead of having the freedom to define the contribution according the actual need. Nevertheless both ways are possible and existing examples prove that both solutions are working.

The following table shows how the initial 5 years investment of 400M€ for PRACE would have been distributed in terms of contribution based on GDP of the members:

Country	GDP Billion € (est. 2011)	%	PRACE investment for the initial 5 years period (M€)
Austria	322,66	2,29	9,17
Bulgaria	41,21	0,29	1,17
Cyprus	19,51	0,14	0,55
Czech Republic	167,21	1,19	4,75
Finland	205,39	1,46	5,84
France	2131,31	15,15	60,60
Germany	2754,46	19,58	78,32
Greece	236,81	1,68	6,73
Hungary	112,26	0,80	3,19
Ireland	168,73	1,20	4,80
Italy	1704,74	12,12	48,47
The Netherlands	651,46	4,63	18,52
Norway	363,80	2,59	10,34
Poland	403,64	2,87	11,48
Portugal	183,61	1,31	5,22
Serbia	33,32	0,24	0,95
Spain	1166,60	8,29	33,17
Sweden	433,85	3,08	12,34
Switzerland	505,43	3,59	14,37
Turkey	579,20	4,12	16,47
UK	1883,11	13,39	53,54
Sum	14068,31	100,00	400,00

Table 5: PRACE contribution by member GDP

The model would be especially interesting, if PRACE were to decide to fund in the future only one site with a single European Tier-0 system. This may become more likely in future when Exascale systems are deployed but turn out to be too expensive for one single country. The drawback of this scenario is the concentration on one system which will not suit all requests from different scientific communities. Also the influence of the national HPC organisations will be limited. A more or less independent new HPC centre with all needed infrastructure, administration and operation will take the role of European Tier-0 provider. The centralized organization will be responsible for the operations and provision of Tier-0 resources.

The centralised RI will attract more attention as a distributed RI and will be seen as a strong and important RI within the ERA. This concept will underline the European character of PRACE.

Structure of the organization

Depending on the Legal form chosen, the exact organisation (required bodies) of the centralized organization will be defined. The organisation will nevertheless include governance which will be very similar to the governance of PRACE AISBL today. The main decision body will be the Council; the executive will be the Directors: either a Board of

Directors or simply scientific and managing Directors. The scientific advice will come from the Scientific Steering Committee and the distribution of the available cycles will be proposed by the access committee.

Unlike today, the central organisation needs its own functional operation, particularly for the technical operation, which will be responsible for all services required, as well as for the administration. In the current Cycles model the PRACE RI relies on the technical operation of the Hosting Members. For the centralised RI that operates one European HPC system, many more staff will be needed. A rough estimate leads to 40 people for management of finance, procurement and operation. Offices for procurement, administration and technical operation have to be set up, like other large scale facilities.

Tasks	Persons
Management	
o Directors	2
o Finance / Legal	1
o Procurement	2
o Personal	1
o Assistant o Secretary	3
Operation	
o Tier-0	5
o Network	2
o Data	2
o Security	2
o User Support / Helpdesk	3
o Applications	5
Peer-Review	
o Coordinator	1
o Scientific Officer	2
o Secretary	2
Outreach and Dissemination	
o Communication	1
o Training	1
o Secretary	1
Project Office	
o Project Manager	1

Financing model

As already mentioned this funding scenario requires cash contributions from the members. The advantage of the cash contribution is flexibility in the shares. The shares can be either based on the GDP or on the effective usage of the PRACE RI. For both possibilities there are good examples (CERN – GDP, ESRF – usage). The shares will be defined in the consortium contract. It will be very important to have the possibility to adapt shares on a regular basis.

At the beginning huge investment costs for the facility and system have to be funded. These could partly be covered by in-kind contributions from the host country. However the investment costs for the Tier-0 system need to be cash contributions. An additional difficulty with the sustainable funding of the RI will be the need to renew the Tier-0 system periodically (every 3 years) which leads to discontinuous finance requirement (which could be smoothend e.g. through loans of the European Investment Bank or leasing of machines). On top of the running costs e.g. operation, electricity and administration, every three years additional investments are required to update the Tier-0 systems. Except for the building there are only few possibilities for in-kind contribution, like secondments or training activities. The European Commission can support the centralized RI via projects e.g. in application enabling. The VAT status of the centralized RI depends on the legal form (ERIC, intergovernmental convention).

Key people in organization

Key people in the RI will be the director or directors executing the council decisions. In addition all personnel being responsible for the administrative and technical operation will be essential for a successful RI.

Advantages / Disadvantages for PRACE

In order to allow a detailed discussion, some advantages and disadvantages are listed:

- Advantages:
  - Depending on the legal form (ERIC, inter gov. treaty) funding is secured;
  - Clear structure;
  - Easy decision process: straight forward and fast.
- Disadvantages:
  - Only one single architecture available on Tier-0;
  - Only one new system every 3 years (compared to one each year in the current model) can lead to reduced competitiveness at the end of a 3 year period;
  - Lack of flexibility for more specific investments;
  - Punctual investments might be difficult;
  - Implementation from scratch will require long preparation (5 years);

In addition to the listed advantages and disadvantages, the selection of the seat will also be crucial. The seat selection process might prove to be difficult and time-consuming. A well-defined and approved process will facilitate the selection process.

Risks

Before taking a decision on a future operation or funding model, the implied risks have to be analyzed. With the one central organisation scenario one risk is evident: Since in HPC often specific problems require specific systems / architectures, it is clear that having only one architecture may not cover all scientific needs. The creation of a centralised RI will be strongly influenced by political decisions. The creation may therefore fail or be delayed due to

political decisions. In addition it might be a challenge to get the necessary funding for such a central organisation.

Matching to the principles of funding for PRACE

Principle	Is it met?	Explanation
Acceptability to PRACE AISBL	No	A new structure is needed
Legality	Yes	
Sustainability	Yes	In general for ensuring the necessary cash contributions in every participating country, even if the contribution is variable according to usage, it would be necessary to have a very solid support of the scientific communities, if scientific communities are not strong enough, the sustained financial support could be endangered.
Meeting the mission of PRACE	Yes	The funding provided by means of cash contributions from the members allows the organization to procure, install and operate a top rank Tier-0 system
Fairness to partners within PRACE	Yes	Implementing a *juste retour* mechanism is necessary, but possible
Transparency	Yes	The transparency is guaranteed by the definition of shares depending on the contribution level
Meeting user needs	Partly	Only one architecture at a time will be available and therefore it might be difficult to accommodate different users' needs
Flexibility	Yes	The financing model grants the possibility to change shares of the members. It might require negotiation.
Ability to bring to a close	Partly	The underlying legal form will determine the difficulty of dissolving the structure.Furthermore, the Tier-0 system and centre constitute a significant assets that needs to be handled.

Table 6: Analysis of scenario one

4.2 Scenario two: Central Organisation – Several Systems

Definition of key terms

The infrastructure is distributed across various sites but has a central HQ with dedicated personnel.

Depending on the level of competencies of the infrastructure in this scenario, we can describe two general models: an In-Kind Financing Model where the HQ would coordinate peer review/access, and a Cash Financing Model where the HQ would coordinate the procurement and/or the operation. If the HQ takes full responsibility for procurement and operations, the model would correspond to the Operator Model (previously defined in D2.3.2 of PRACE-PP

[4]). However, intermediate options where the operation is under the responsibility of the hosting partners would also be possible, and are covered in the analysis of the scenario.

The distribution of Tier-0 systems in different Hosting Member countries can create an unbalanced financing situation. Hence it is important to have a closer analysis of the *juste retour* concept. The most relevant elements that can create unbalance are:

- In the Cash Financing Model Hosting Members would have to provide a hosting environment that includes operation and support staff, maintenance services, and hosting infrastructures (this may be paid for by the member hosting the system).
- In the In-Kind Financing Model Hosting Members in addition would have to procure and pay for the systems
- Between different Hosting Members operating costs may be different

It is clear that depending on the investment in the infrastructure, Hosting Members would have to have different benefits in order to level the Return of Investment (ROI) amongst the members to ensure the sustainability of the funding model.

In the previous section “4.1Scenario one: Central Organisation - One system" a potential distribution of financial contributions using GDP to calculate the ratios was discussed.

In the current scenario the level of contribution depends on which members are providing or hosting the systems, hence a *juste retour* concept that ensures a return of investment based on some type of control could be considered.

An example of *juste retour* implemention is the usage quota mechanism that is being successfully applied in other Research infrastructures such as ESRF.

If we were to use a quota mechanism in the Cash Financing Model the distributed payment of the procurement and/or operating cost from each member would be proportional to the usage of the system and the investment made.

For the In-Kind Financing Model since the most significant contributions are made in-kind, these should be evaluated and mapped to an economic cost. This way partners with higher levels of investment (directly into the infrastructure or indirectly in the provision of Tier-0 systems) would benefit from higher quotas of usage.

Such a mechanism would allow to have a proportional contribution and usage.

4.2.1 In-Kind Financing Model

Structure of the organisation

Given that in this modality the most significant contributions are provided in-kind by Hosting Members, the organisation under this model would require a relatively lightweight structure with a headquarters staffed with the necessary personnel to run the peer review, monitoring, dissemination and the representation tasks The structure of the organisation would be equivalent to the one that PRACE has currently operating the cycles model (D2.3.2 PRACE-PP[4]).

Financing model

The model presented here can be considered a long term continuation of the current cycles model agreed for the initial period and evaluated in section “3.2Analysis of present funding model against key elements”. However, the evaluation of the principles is not strictly the same, since the in kind-model presented here is evaluated on a long term basis, taking into

account the implementation of elements like a *juste retour* mechanism that was not considered for PRACE during the initial period.
Partners contribute cycles and services which are quantified and controlled by the central office. A small amount of cash is paid by the partners in order to fund the central office.

This model is characterized by having a PRACE central entity managing mainly the peer review and other support services, while the operation and procurement relays financially and operationally on the hosting partners.

This model is currently in use and is governed under the agreement for the initial period, by which Hosting Members commit to make available a Tier-0 service to PRACE with a TCO of 100M€/system in a 5 year timeframe, and all members commit to contribute with a membership fee to the association to run the peer review and general representation tasks of the HQ personnel. The agreement has been made for a limited time and if PRACE were to be run with a similar in-kind financing model, a new agreement would be necessary. This would require new commitments from Hosting Members for an extended period of time.

While the implementation of the In-Kind Financing Model is successful in the usage of the Cycles Model for the time being, the extension of the same model with the same or new Hosting Members is not straightforward. The In-Kind Financing Model has proved useful for building up the infrastructure and creating a solid operational structure, however, the model can only be sustained with the extended commitment of very high investments from a reduced set of partners, which in the mid-term may be difficult to justify to national governments if there is not a *juste retour* policy that ensures a fair usage and return on investment.

Key People in the organisation

This model requires the structure previously defined during the Preparatory Phase project and further specified in D2.2.2 of the current PRACE-1IP project [5].

Advantages / Disadvantages for PRACE

Similarly to other funding scenarios, this model has some advantages and disadvantages.
Regarding advantages the following points should be mentioned:

- Easier to attract and include partners in an initial stage
- Quicker, possible to be more agile
- Proved

As far as disadvantages are concerned the following aspects should be taken into consideration:

- Difficult to measure contributions
- Possible tax issues depending on the legal personality of future Hosting Members
- Sustainability depends heavily on the contributions of Hosting Members and on the economic situation of the respective countries

Risks

Within the scenario of the central organisation (In-Kind Financing Model), the following risks may appear:

- Difficulties in obtaining funding from the EC
- Difficulties in finding continued support of Hosting Members committing resources to PRACE if no *juste retour* policy is implemented ensuring the return of investment at a minimum level for the hosting country

Matching to the principles of funding for PRACE

Principle	Is it met?	Explanation
Acceptability to AISBL	Yes	The In-Kind Financing Model is currently accepted in PRACE and has been the model in use for the initial period. Hence the acceptability of this model is validated by the running experience.
Legality	Yes	The general taxation for PRACE in this model does not impose any extra load on the organisation finances. PRACE qualifies as a non-taxable entity, and in many cases, contributions of members are not charged national tax, however, depending on the legal nature of the national entity who procures the Tier-0 systems, it might be unavoidable to have the systems procured charged by non-refundable VAT. Moreover, the specific legal character of a hosting member could prevent the provision of cycles in-kind to a foreign association without affecting its legal status. This limitation could prevent some interested PRACE Members to become a Hosting Partner. The current non-taxable status of PRACE under Belgian law is subject to various conditions including the type of contribution to the association. By providing a contribution that is dependent on the service obtained, the regime to apply in terms of taxes will change. The contributions to PRACE under a taxable regime would also be subject to taxes for the majority of contributing Members, so even if PRACE adopts the ERIC legal form with certain VAT advantages, the contributions of members would be subject to the rules of the contributing country, and if the payment is a contribution in exchange for a service, this payment will be taxable.
Sustainability	Partly	Sustainability is hard to achieve without the implementation of a mechanism that ensures *juste retour*. The In-Kind Model has an additional disadvantage in this respect: given the current financial downturn, and the foreseen economic panorama for the next decade in Europe, sustaining continuous financial support to Tier-0 systems with the contribution of a reduced set of Hosting Members could be really challenging. As a result, the number of Tier-0 systems or their global performance could decrease.

Principle	Is it met?	Explanation
Meeting the mission of PRACE	Yes	The provision of Tier-0 services in-kind for the organisation having a centralised management and coordination will ensure the fulfilment of the PRACE mission as stated in the current statutes, however the mission achievement might be endangered in the long run by the following factors: the In-Kind Financing model is subject to the mandate of the national governments of the Hosting Members and continued funding might be affected by problems that escape the control of PRACE like duplicity of architectures, limitations on the allocation of resources or even the entire survival of the PRACE infrastructure if no Member can commit resources at a Hosting Member level.
Fairness to partners within PRACE	Yes	Hosting Members have to pay for the Tier-0 systems as well as providing a hosting environment that includes operation and support staff, maintenance services, and hosting infrastructures. Moreover, between different Hosting Members, the operating costs can be different. However, if a *juste retour* mechanism is agreed and applied, these elements can be addressed.
Transparency	Yes	The degree of autonomy and control possibilies for the organisation might be smaller in this model since resources are not directly controlled nor owned by the association, however, the experience with the present model indicates that Transparency can be achieved in an in-kind model by regulating appropriately the rules of the organisation between members and towards the user community.
Meeting user needs	Yes	As long as deployment of systems is ensured and done in a coordinated manner, and sufficient resources are provided.
Flexibility	Yes	The In-Kind Financing Model does not require a heavy dedicated organisation, and the small staff required to operate the management office and the peer review can easily adapt to changing circumstances despite of the size of the organisation.
Ability to bring to a close	Yes	The underlying legal form will determine the difficulty of dissolving the structure, but in principle, since the computing services are provided in-kind, the infrastructure would not won assets that would difficult the winding up of the organisation

Table 7: Analysis of scenario two (in-kind financing model)

4.2.2 Cash Financing Model

Structure of the organisation

In this modality, the organisation will have to manage a significant amount of cash in order to procure the systems. Hence the organisation will be significantly more complex that in the in-kind variant. The usage model corresponding to this organisation will be the Operator model (D2.3.2 PRACE-PP [4]), and it would require a bigger organisation in order to manage finances, procurement, and control. If the organisation would also have to manage the operation of the systems, the necessary technical staff will also need to be provided or controlled by the organisation.

Financing model

The model would require management of collective funding for procuring the Tier-0 systems. It would also potentially need to manage the operation and will require collective funding for operating and maintaining the systems. The model would also require collective funding for having the central entity maintaining its staff in charge of management, peer review, dissemination, etc. As in the current Cycles model, the costs for that part can be covered with a relatively small fixed membership fee.

The necessary funds for Tier-0 systems could be collected yearly from members together with a contribution from the EC. The European avocacy for this model and high commitment of nations giving away ownership and money to be managed by a European entity would make this model of financing more eligible for significant European Community financial support.

The cost to share under this model is significantly high. If the infrastructure has from three to five different Tier-0 systems operating with an estimated TCO of 20M€/year each during five years, that makes a total of 60 to 100M€/year to be funded. Assuming co-funding from the EC of 25 to 50%, the cost to share from partners under this model would be from 30 to 75M€/year. If under this model PRACE had from 10 to 20 members, the average cost to share per member would be between 1.5 to 6M€/year.

Given that PRACE has partners who would expect very different levels of use of PRACE resources a rule of proportional payment according to usage could be designed.

Partners who host systems under this model would benefit indirectly from having the systems in their countries for various reasons: hiring personnel, reputation, direct dissemination impact in their scientific communities and society in general, consumption of services and related payment of national taxes (electricity, facilities, personnel, etc). It seems fair that in order to compensate for these benefits, the partners who host systems under this model, would also have to make a higher contribution to the budget.

There are possibilities for additional income from the sale of services to industry and from projects, however this revenue is expected to be marginal because of the current reduced demand of commercial Tier-0 services and also because provision of such services could be in breach of European competition rules.

Key People in the organisation

On top of the requirements for the In-Kind model, this model would require a finance department to manage in the best possible manner the significant contributions made in cash, the payment to the providers and the investments, general balances, and provisions for the association. A legal and procurement team will also be necessary as well as the foreseen technical committee (defined in D2.2.2 of PRACE-1IP project [5]) in order to take decisions on architectures and providers.

Advantages / Disadvantages for PRACE

Similarly to other funding scenarios, this model has some advantages and disadvantages.

Regarding advantages the following points should be mentioned:

- Better value for money as the higher volume of procurements will result in lower prices
- Easier to convince the EC to fund systems

As far as disadvantages are concerned the following aspects should be taken into consideration:

- More difficult to convince national funding bodies to come up with cash for a machine owned by PRACE
- Procurement requires a much larger central organisation
- Takes longer to establish
- The contributions would likely be subject to taxes
- The members might have conflicts of interests between the association and their national strategies
- If the organisation procures the systems, it might be difficult to achieve consensus

Risks

Within the scenario of the central organisation (Cash Financing Model), the following risks may appear:

- The EC influence on the association and the potential conflict of interest between the members and the association might endanger the sustained participation of the different members.
- Risk of an irreversible disagreement between partners
- Under the circumstance of having resigning members, or a significant amount of members reducing their contribution, the infrastructure could be under budgeted

Matching to the principles of funding for PRACE

Principle	Is it met?	Explanation
Acceptability to AISBL	Partly	The Cash Model represents a big challenge to the AISBL and its individual members. For PRACE it would be very desirable to manage decisions on procurement, architectures and location of systems however there could be many conflicts amongst partners because of different interests in the ownership or location of the systems, as well as disagreement in the economic terms for hosting or paying for the hosted systems.
Legality	Yes	The Cash Financing Model could face some significant legal challenges. The most important would involve the analysis of the centralised procurement process. The procurement of assets that would be hosted in different countries is an uncommon practice, and its feasibility and tax implications would need to be deeply analyzed. The current non-taxable status of PRACE under Belgium law is subject to various conditions including the type of contribution to the association. By providing a contribution that is dependent on the service obtained, the regime to apply in terms of taxes will change. The contributions to PRACE under a taxable regime would also be subject to taxes for the majority of contributing Members, so even if PRACE adopts the ERIC legal form with certain VAT advantages, the contributions of members would be subject to the rules of the contributing country, and if the payment is a contribution in exchange for a service, this payment will be taxable.
Sustainability	Yes	In general for ensuring the necessary cash contributions in every participating country, even if the contribution is variable according to usage, it would be necessary to have a very solid support of the scientific communities, if scientific communities are not strong enough, the sustained financial support could be endangered.
Meeting the mission of PRACE	Yes	The Cash Financing Model centralises the financial management of the Tier-0 European budget ensuring that PRACE would meet its mission with little national interference. The procurement decisions and the control of scientific strategies by the central organisation would permit PRACE to deploy its strategy in a seamless manner.
Fairness to partners within PRACE	Yes	The distributed payment of the procurement and/or operating cost from each member shall be proportional to the usage of the system and the investment made (see *juste retour* analysis in precedent section). The investments will also be reflected in the voting power of the member in the association.

Principle	Is it met?	Explanation
Transparency	Yes	Having the infrastructure managing the resources, and all decisions made following the decision rules of the association, transparency is ensured as long as the management implements the necessary control and reporting procedures.
Meeting user needs	Yes	As long as the infrastructure has the necessary budget to deploy the systems required by the scientific communities.
Flexibility	Yes	The Cash Financial Model requires a robust organisation with a significant human infrastructure in place. Such an organisation imposes restrictions in its management and once it is in place, it would be difficult to adapt to changing circumstances like the increase or decrease in the size of the organisation, or changes in the funding if a *juste retour* mechanism is implemented. Having robust Statutes in place should make sure that, in this eventuality good process can be followed.
Ability to bring to a close	Partly	The underlying legal form will determine the difficulty of dissolving the structure, and in the particular case of the Cash Model we find the additional difficulty of the ownership of the systems. If PRACE owns the systems procured, the ending of the structure would imply also that the responsibility for the decommissioning of these systems would rely on PRACE. Having robust Statutes in place should make sure that, in this eventuality good process can be followed.

Table 8: Analysis of scenario two (cash financing model)

4.3 Scenario three: Loosely-coupled, distributed organisation

This model is based on contributions of the computer cycles of national systems of members of PRACE AISBL. Entrance and exit into the partnership needs to be flexible as it can be foreseen that partners decide to join or may be forced (e.g. due to economical down turn or national political decisions) to exit. Two cases can be considered:

1) Loosely-coupled, distributed organisation **without central system** – only contributions of computer cycles from national computer systems.
2) Loosely-coupled, distributed organisation **with central system** – besides contributions of computer cycles from national computer systems, the organisation shall procure, acquire and manage a leading class computer system to be installed in one hosting country.

4.3.1 Without central system

Definition of key terms

When considering the Loosely-coupled, distributed organisation without central system every member of this organisation would contribute with its national computational resources and open them to all other members of the organisation. Timelines for joining, exiting or continuing partnership need to be regulated. Contributions need also to be reviewed on a regular basis to fulfil the concept of *juste retour*. One possibility will be to allow partners to align their contributions for the next period based on the usage during the previous period.

The terms under which the ensemble of those resources are available (peer review and resource allocation process) would be defined by the organisation, and would be executed either centrally by the organisation or de-centrally by the members for their own systems.

In such a model there is no exchange of cash and the members must provide user support locally for their individual machines.

Structure of the organisation

In this funding scenario, the organisation itself defines the procedures and the requirements for minimum contributions (mainly in terms of type of resources contributed). Moreover the organisation takes full responsibility for overall monitoring and reporting, and ensures the link to the EC and other entities and organisations. Apart from those aspects, the loosely-coupled, distributed organisation without central system coordinates additional programmes and may execute peer review (either for all or for only those members who do not want to do it themselves).

Financing model

As already mentioned above, when implementing such a model there will be no exchange of cash. Members contribute with their resources in terms of computer cycles and some other necessary activities (e.g. training) and provide user support, as well as management and operation of the machines. Furthermore, all members provide reporting regarding usage of computer cycles in their national computer systems and other usage parameters deemed necessary and they may execute peer review of the projects running in their national machines (according to the general peer review procedure defined by the organisation) if they want. Additionally members can participate at EC projects and optional programmes coordinated by the organisation.

This model would require that all the members pay only a flat fee for the functioning of the organisation.

However, this funding scenario requires EC contribution in terms of funding of major challenge projects, and coordination of outreach actions, training and networking that need to be coordinated by the organisation and not by each national member. Of course the EC receives allocation and monitoring reports as well.

Key people in the organization

Regarding the key people in the organisation the loosely-coupled, distributed organisation without central system requires a position of coordinator, scientific advisory board, user representation and staff that would be responsible for preparing and submitting reporting.

Staff for peer review will depend on the agreements between the contributors and the organisation regarding the ownership of the peer review process.

Advantages and disadvantages for PRACE

Similarly to other funding scenarios, this model has some advantages and disadvantages.

Regarding advantages the following points should be mentioned:

- It is a light-weight organisation.
- This model can be built on the existing PRACE organisation.
- No sophisticated legal structure is required.
- No national money has to be provided out of the country.
- There will be no tax issues.
- *Juste retour* is inherent to the organisation system and can be based on a system where usage is related to the contribution of each country. The relationship between contribution and usage needs to be reviewed regularly, e.g. every three or five years.
- It provides a variety of architectures.
- It is a very transparent system.
- It is easy to enter and to leave, as well as easy to dissolve and easy to grow and shrink.
- It assures equality of all members (weighted by the size of the contribution).
- There is a need to determine only the location of the headquarters, no search for installation of machines is required.
- This scenario provides a variety of architectures.

As far as disadvantages are concerned the following aspects should be taken into consideration:

- This model does not make a system bigger than the biggest national system available to users.
- In this scenario there is very little additional funding generated on the top of national funding and therefore it does not give incentives to countries to grow beyond what they already have.
- Usage is only open to members, who may decide to make agreements with international organisations (e.g, XSEDE, INCITE, etc.) or even other European organisations.

Risks

Within the scenario of the loosely-coupled, distributed organisation without central system the following risks may appear:

- Peer review standards may be compromised.
- Difficult to compare the contributions of cycles from various types of machines.
- May deviate from the mission by becoming similar to grid computing.
- Impact depends on the strength of the coordinator.

- Quality control of the contributed resources needs to be monitored.
- Definition and implementation of minimum rules for defining the type of computer resources to be contributed.

Matching to the principles of funding for PRACE

Principle	Is it met?	Explanation
Acceptability to PRACE AISBL	Yes	It is easy to migrate to this model and should be acceptable for a majority of present members
Legality	Yes	It is easy and lightweight
Sustainability	Yes	It is easy to assure, depends largely on national funding, levels contribution fluctuations out.
Meeting the mission of PRACE	No	It does not meet the mission of PRACE because it may not ensure leadership class computer systems
Fairness to partners within PRACE	Yes	It is inherent to the model and can easily handle *juste retour*
Transparency	Yes	It is easy to ensure
Meeting user needs	Partly	It makes various computer architectures available but may not fulfil the needs of grand challenges
Flexibility	Yes	It is very flexible for the organisation and the members
Ability to bring to a close	Yes	It is easy especially because there are no assets involved

Table 9: Analysis of scenario three (no central system)

4.3.2 With central system

Definitions of key terms

All the definitions of key terms are the same as for the loosely-coupled, distributed organisation without central system described in chapter “4.3.1Without central system” with one difference – besides the cycle contribution of all members from their national computer systems it requires a leadership class system located at a single site financed by the EC as a percentage of the total funding of the in-kind contributions (expressed as cycles) of the members. This will of course motivate members to join the organisation and to contribute cycles to match the EC contribution.

Structure of the organisation

The structure of the loosely-coupled, distributed organisation with central system is very similar to the one described in chapter “4.3.1Without central system“ but it will require a fully staffed computer centre. This model also requires a hosting country, i.e. a country in which the computer centre for the central leadership-class machine is located. The hosting country must provide the building for the organisation as an additional in-kind contribution.

The central system is procured by the organisation and peer review for the central computer is managed by the organisation.

Financing model

Regarding members it is similar to what was described in chapter "4.3.1Without central system" but the members have additionally to add a monetary contribution for the operational cost of the central machine. Furthermore, as mentioned above, the hosting country will be responsible for providing the building to the organisation as an additional in-kind contribution.

For the loosely-coupled, distributed organisation with central system the EC funds the acquisition of the leadership-class central computer system.

Key people in the organization

In this scenario, in addition to what was referred to in"4.3.1Without central system", operational staff for the central computer site would be required. Operational staff will be responsible for the procurement, operation and management of the machine, user support and specific training.

Advantages /Disadvantages for PRACE

Advantages of the loosely-coupled, distributed organisation with central system:

- It provides a leadership computer system suitable for grand challenges.
- It focuses investments in leadership-class computing systems to be installed in a single site (in contrast to the current PRACE model).
- It can be built on the existing PRACE organisation with adaptation concerning the central computer site (e.g. by creating a spin-off subsidiary of the main organisation).
- Peer review for the central computer is managed by the organisation, i.e. single peer review process for grand challenges.
- A quality standard for peer review can be enforced on all PRACE systems, not only on the central leadership-class site.
- No sophisticated legal structure required for the organisation but possibly not the same for the central computer site.
- It includes a system larger than the largest national system available to users.
- It does guarantee substantial additional funding on the top of national funding and therefore does give incentives to countries to grow beyond what they already have.
- Tax issues are easier because there is only one central site.
- *Juste retour* is inherent to the model.
- It is very transparent and it allows easy comparison of investments.
- Entering and leaving is relatively easy, and it is easy to grow and shrink.
- Equality of all members (weighted by the size of the contribution).
- It provides a variety of architectures.
- Consistent procurement rules apply to the central system, which could be done by the EC or by the organisation itself, and each member keeps control over its own investments.

Disadvantages of the loosely-coupled, distributed organisation with central system:

- It requires staff for the operation of the central computer site (spin-off possibility).
- National money needs to be transferred out of the country (for operational costs).
- It is more difficult to dissolve because of existing assets.
- Location search for the central computer site is needed (may be easily managed by the requirement that the hosting country has to provide the building).

Risks

The following risks should be taken into account:

- Peer review standards for non-grand challenge projects may be compromised.
- Difficult to compare the contributions of cycles from various types of machines, so performance and usefulness for science might be difficult to compare.
- Quality control of the resources contributed by members needs to be monitored.
- Definition and implementation of minimum rules for defining the type of computer resources to be contributed by the national contributions.
- Funding from the EC for acquisition of a central computer system may be difficult.
- Funding for operation of the central computer depends on the funding policies of the countries of the members.

Matching to the principles of funding for PRACE

Principle	Is it met?	Explanation
Acceptability to PRACE AISBL	Partly	Can be more problematic from the point of view of the hosting members because there will be only one site. However, it has the advantage of possible rotation of the central site between members when the hosting building is not functional (this in most cases coincides with decommissioning and acquisition of a new computer system)
Legality	Yes	One single computer site managed by the organisation
Sustainability	Partly	No major funding from countries necessary, needs strong negotiations with EC for funding the acquisition of a leadership computer system through a long term specific funded programme
Meeting the mission of PRACE	Yes	Fully meets the mission of PRACE
Fairness to partners within PRACE	Yes	It is easy to manage
Transparency	Yes	It is easy to ensure
Meeting user needs	Yes	To higher degree than the model without central system, because it also provides the leadership-class system
Flexibility	Yes	It is very flexible
Ability to bring to a close	Yes	Although there are assets, they are centralised in one single site. It will make sense to coincide winding up with decommissioning (without replacement) of the computer system.

Table 10: Analysis of scenario three (central system)

5 Summary table of scenarios against principles

To evaluate better how the different funding models presented by the three scenarios can prove to be real options for PRACE a summary table has been compiled. The table consolidates the result of the matching to the principles for PRACE funding derived by the analysis of the scenarios.

Principle	Present funding model	Central Organisation - One system	Central Organisation – Several Systems		Loosely-coupled, distributed organisation	
			In-Kind Financing Model	Cash Financing Model	Without central system	With central system
Acceptability to the AISBL	**Yes**	**No**	**Yes**	**Partly**	**Yes**	**Partly**
Legality	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Sustainability	**No**	**Yes**	**Partly**	**Yes**	**Yes**	**Partly**
Meeting the mission of PRACE	**Yes**	**Yes**	**Yes**	**Yes**	**No**	**Yes**
Fairness to partners within PRACE	**No**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Transparency	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Meeting user needs	**Yes**	**Partly**	**Yes**	**Yes**	**Partly**	**Yes**
Flexibility	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Ability to bring to a close	**Yes**	**Partly**	**Yes**	**Partly**	**Yes**	**Yes**

Table 11: Summary analysis of scenarios

6 Conclusion

This document analysed a number of financing models for the evolution of PRACE AISBL funding scheme and provided three possible scenarios as options for the consideration of the governing bodies of the association.

The analysis of the funding models and practices implemented by other RIs show that some measures to ensure *Juste Retour* are present in almost all cases. Also for PRACE, we consider *Juste Retour* as mandatory to maintain fairness to the partners, which is a pre-requisite for sustainability.

The funding model must be sustainable in order to give persistence to the infrastructure and provide each contributor with a flexible, although consistent, means to plan the contribution for as long as needed. There is no preferred approach but it might be worth noting that the structure of the financial contribution varies from a division of the budget based on GDP or based on some shares that depend on the usage, whether planned in advance or resulting from some balance at the end of a fixed period of time.

Both the approaches have the advantage of creating a stable, secured funding scheme that makes planning ahead easier and effective and is particularly suited to large investments.

The legal form adopted influences the funding options and a strong governmental involvement (intergovernmental organization) at convention level allows for a stronger structure where long term persistence is a requirement.

The drawback is that it usually takes a long time to build such organizations given the long negotiation phase among the participating governments.

The notion of *juste retour* is implemented in almost all the examples analysed. Clearly the given solutions are different although all of them tend to answer the basic demand of what kind of return of investment each member expects to receive.

A final consideration about the different models analysed concerns the role that the EC is expected to play.

In terms of co-funding the EC is an important element that needs to be considered for the PRACE future funding model (substantial long term funding, co-funding by project, pure political and regulatory support, proactive engagement).