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Research Infrastructures**

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PRACE-1IP

PRACE First Implementation Project

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Monitoring and Reporting Procedures**

Final

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List of Acronyms and Abbreviations

AC	Access Committee
BoD	Board of Directors
BSC	Barcelona Supercomputing Center (Spain)
CEA	Commissariat à l'Energie Atomique (represented in PRACE by GENCI, France)
CINECA	Consorzio Interuniversitario, the largest Italian computing centre (Italy)
CINES	Centre Informatique National de l'Enseignement Supérieur (represented in PRACE by GENCI, France)
CPU	Central Processing Unit
CSC	Finnish IT Centre for Science (Finland)
CSCS	The Swiss National Supercomputing Centre (represented in PRACE by ETHZ, Switzerland)
EC	European Community
EoI	Expression of Interest
ETHZ	Eidgenössische Technische Hochschule Zuerich, ETH Zurich (Switzerland)
ESFRI	European Strategy Forum on Research Infrastructures; created roadmap for pan-European Research Infrastructure.
GENCI	Grand Equipement National de Calcul Intensif (France)
HM	Hosting Member
ICHEC	Irish Centre for High-End Computing
JSC	Jülich Supercomputing Centre (FZJ, Germany)
LINPACK	Software library for Linear Algebra
NCF	National Computing Facilities (Netherlands)
NCSA	National Centre for Supercomputing Applications (Bulgaria)
NDA	Non-Disclosure Agreement. Typically signed between vendors and customers working together on products prior to their general availability or announcement
NIH	National Institutes of Health, USA
NSF	National Science Foundation, USA
PI	Principal Investigator
PRACE	Partnership for Advanced Computing in Europe; Project Acronym
PRACE-1IP	PRACE 1 st Implementation Phase project
PRACE-2IP	PRACE 2 nd Implementation Phase project
PRACE AISBL	PRACE Association International sans But Lucrative
PUE	Power Usage Effectiveness
SLA	Service Level Agreement
SME	Small and Medium Enterprise
SSC	Scientific Steering Committee
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
UC-LCA	Universidade Coimbra-Laboratório Computação Avançada (Portugal)

Executive Summary

Monitoring and reporting is an invaluable tool for good management providing a useful base for the evaluation of the health status of the organization. It enables to determine whether the resources available are sufficient and are being well used, whether the capacity is sufficient and appropriate, whether the organization is doing what it is supposed to do, and whether the environment and contextual conditions are changing.

The practice is not meant only for business or commercial oriented organizations and it has become increasingly important also for entities like PRACE that have non-profit missions and objectives, but need to implement good management practices for their sustainability.

A preliminary analysis of what is implemented in worldwide institutions that like PRACE manage the allocation of resources showed that all of them operate some monitoring and reporting process model.

While it is already a common practice of computing centres to prepare and publish an annual report on the performance of the organization mainly concerning financial and service aspect, a pan-European organization such as PRACE, given its more ambitious nature, would benefit from widen its monitoring scope to better assess the efficiency of its performance, the effectiveness of its actions, and its impact. We have found examples of organizations that are applying different monitoring methodologies showing a good level of maturity. One is the Department of Energy, Office of Science (DoE SC) whose approach is based on an operational assessment (OA) of the performance of its HPC facilities. The second one is the UK Research Council that adopted specific methodologies for measuring the impact of science using quantitative (e.g. macroeconomic, microeconomic or survey data) and qualitative approaches (e.g. interviews or expert testimonies).

The development of a monitoring and reporting process for PRACE has to take into account the structure of the organization as well as its objectives.

PRACE shows some peculiarities that should be considered carefully:

- complex processes that require intense collaboration with stakeholders and interaction with the users;
- infrastructure of geographically distributed computer centres managed on the basis of national laws and with managers with different traditions and mentalities.

Those peculiarities influence the selection of the monitoring targets to measure **efficiency**, **effectiveness** and **impact** in the different perspectives of PRACE's activities.

Based on the PRACE workflow model, the monitoring targets and the derived variables are classified accordingly to four groups:

- **Input:** what resources PRACE uses in order to create and run its services such as monetary funding and budget, personal resources and equipment.
- **Delivery:** the services provided by PRACE.
- **Output:** the concrete results obtained with allocated compute resources and with the support for application development.
- **Environment:** the market environment in which PRACE delivers its services.

The set of variables defined is fairly large and covers as much as possible the complete work flow of PRACE. Each one is described taking into consideration the following characteristics:

- Periodicity
- Priority

- the entity responsible for it
- the recipient body of PRACE
- the procedure to be followed for gathering the data.

The descriptions provide the basis for designing the process of reporting and the definition of the roles involved in the process. The latter are important for the implementation of the process tasks in PRACE AISBL organization and the mapping of roles to the actual staff profiles.

1 Introduction

Within the activities of work package WP2, task 2.4 has the objective to provide a proposal for the monitoring and reporting process and a set of procedures that PRACE AISBL can implement to evaluate the service and financial performance of the organization as well as the overall impact.

This deliverable, D2.4.1, addresses this specific objective through the analysis of the current practices and the definition of a detailed model proposal for PRACE. Current examples of monitoring and reporting in similar institutions are described in Section 2 with reference to European and US practices regarding service and financial performance, and impact assessment.

Section 3 illustrates a conceptual framework for monitoring and reporting for PRACE and a general overview of some basic steps in order to start up the process in the organization. This section indicates also what the key goals of the entire process should be and how those are essential for an organization that wants to control how well its plans are carried on and its goals are achieved.

The workflow model of PRACE is presented in Section 4. Based on that model a detailed analysis of potential monitoring targets introduces the descriptions of the set of monitoring variables.

Those are grouped accordingly to their relevance concerning:

- Resources
- Delivery of services
- Short, medium and long term results

A reporting management process for PRACE AISBL is then proposed as well as an indication of the associated roles to map to the organization for effectively completing the tasks.

Finally Section 5 consolidates the monitoring variables in one single summary table and indicates how this work will be pursued.

2 Monitoring and reporting in similar institutions

Monitoring and reporting usually concerns the way the organisation is performing its mission and also supports its impact assessment by providing initial quantitative and qualitative information on the performance of the organisation. In the case of PRACE, monitoring and reporting covers the performance of the organisation itself, the performance of the management of the services made available to users and their reliability, and the elements necessary to assess the general impact of the services provided. The impact of PRACE AISBL can be inferred from monitoring and reporting and regards mainly the scientific and socio-economic impact of the organisation at national, European and worldwide levels.

Monitoring and reporting of PRACE is also important for tracking and verifying whether the mission and associated goals are fully fulfilled. It is also a way of justifying the investments made and of creating awareness of the role of the organisation and its impact among its stakeholders, i.e. funding organisations, HPC users, other HPC organisations and Research Infrastructures, and the public in general.

2.1 Monitoring and reporting methods in practice

All institutions similar to PRACE AISBL, i.e. organisations that allocate resources through a peer review process, either in Europe or worldwide, use some type of monitoring and reporting model. Monitoring and reporting of the performance of the organisation is usually published in annual reports and other internal documents.

Surveys

For computer centres one way of measuring the effectiveness of the services of the organisations is through periodic surveys amongst the users. These surveys give in general a good measure of the performance of the organisation and are very important for correcting and refining procedures, and deciding on best practices. One example of this type of monitoring and reporting is the one followed by the Department of Energy, Office of Science (DoE SC) [1]. Each year the DOE SC (Department of Energy Office of Science) conducts an operational assessment (OA) of the performance of the Oak Ridge Leadership Computing Facility (OLCF) and the other DOE high-performance computing facilities (HPCFs). The whole process includes the implementation of a high-performance computing facility operational assessment (HPCFOA) as an SC programmatic management tool for evaluating the HPCFs' plans for providing high-performance computing and network resources as well as support to the scientific user base. The HPCFOA focuses on the measurement of results and achievements in the following areas:

- customer support;
- business and strategic results;
- financial performance;
- innovation.

For each of the areas of interest, HPCFs respond to a series of “charge questions” using methodologies developed with the concurrence of and guidance from the federal program manager. Based on previous year comments and recommendations, some new metrics and steps might be introduced and implemented. Relevant information from the HPCFOA is used to respond to the Office of Management and Budget (OMB) – Office of the Chief Information Officer annual operational analysis data call for major information technology (IT)

operations. A subset of the performance measures may also be included on the Information Technology Exhibit 300 for the facility. In addition, information is gathered to support risk management assessment analysing and rating, and retiring risk for both project- and operations-based risks as well as for the cyber security plan, i.e. development of policy, approval of policy, and assessment of how well the organization itself is managing IT resources. An interesting element in the monitoring and reporting process is the linkage between DOE's strategic plan and OLCF activities and results.

Internal audits

Another important part of monitoring and reporting is dedicated to the management of the organisation especially from the point of view of management of the finances of the organisation and this is usually covered by internal audits executed by recognised external companies. This is especially important for organisations that strongly depend on public funding. In the case of PRACE annual auditing is mandatory in the Statutes of the PRACE Association [2]. Furthermore, the annual audit has to be approved by the Council where all members of the organisation are represented.

Measuring performance and impact

Monitoring and reporting for measuring the impact of the organisation is also very important and institutions similar to PRACE AISBL, i.e. organisations that allocate HPC resources through a peer review process, either in Europe or worldwide use some type of monitoring and reporting model for measuring the performance and impact of the organisation. In most cases the impact is based on the number and type of scientific publications for which usage of the computer resources made available by the organisation was necessary. Here type of publications refers to reviewed articles in recognised scientific and technical journals taking into account their impact factor, articles in proceedings of conferences, communications to and presentations at conferences, patents, publications in non-refereed journals and magazines, citations, etc. Most organisations follow also closely the activities of HPC users, and collect and disseminate case studies and success stories. Another part more difficult to follow on corresponds to the socio-economic impact of the usage of the Research Infrastructure. This is indeed much more difficult to measure especially because this type of impact is not immediate and can take some years to be reflected in terms of economy and society in general. This is especially the case of HPC because researchers use HPC resources for top research that needs to be further developed, tested and processed before reaching some form of commercial product. There are plenty of examples in biochemistry where simulations of the behaviour of proteins and virus can give real hints for the development of new drugs that can either prevent or cure diseases. In this case the time from discovery to market, including all necessary clinical trials, can take more than 10 or 15 years. Other examples are simulations for development of nanomaterials and new types of materials, energy production, combustion, long term climate forecast, earthquake prediction, etc.

It is interesting to see some examples of the approach followed by other organisations to measure the impact of the organisation and its investments. Though impact of the organisation will be the main topic of the next deliverable (D2.4.2), here we give just a hint of the procedures followed by some organisations.

One of these examples is the STAR METRICS (Science and Technology for America's Reinvestment: Measuring the Effect of Research on Innovation, Competitiveness, and Science) [3] program in USA. This program aims at measuring the impact of federal investments in science, particularly with respect to job creation and economic growth. STAR

METRICS intends to use existing administrative data from federal agencies and their grantee institutions, and match them with existing research databases on economic, scientific and social outcomes. The initial goal of STAR METRICS is to provide mechanisms that will allow participating universities and federal agencies with a reliable and consistent means to account for the number of scientists and staff that are on research institution payrolls, supported by federal funds. In subsequent generations of the program, it is hoped that STAR METRICS will allow for measurement of science impact on economic outcomes (such as job creation), on knowledge generation (such as citations and patents) as well as on social and health outcomes. The STAR METRICS program is the follow up of a very successful pilot project tested in 2009 involving seven universities. STAR METRICS is a five year program for which NIH and NSF have committed to providing a total of \$1 million dollars. STAR METRICS is seen as a very ambitious program [4] that has a long way to go before giving the planned information especially regarding societal benefits of research that only begin to show up years or even decades after the research funding occurred.

Another example is the effort of the Research Councils in the UK [5] in trying to understand the economic, social research, environmental policy and practice impacts emerging from the investments in science. This initiative results from the increase of the funding for science by the British Government in the last decade and tries to put emphasis on the accountability of the Research Centres in the UK. The initiative develops in two dimensions: a) the methodological options for the measurement and/or demonstration of impact and b) the use that is made of the evidence gathered through these methods. The methodologies used for measuring the impact of science lend to quantifications (e.g. macroeconomic, microeconomic or survey data) and qualitative approaches (e.g. interviews or expert testimonies).

2.2 Recommendations towards PRACE monitoring and reporting model

The approaches followed by organisations similar to PRACE were taken into account for the proposal on how Monitoring and Reporting should be handled in the case of PRACE. In particular it is important to take into account the distributed character of the PRACE organisation in terms of organisation membership, and geographic location of computer resources and application support.

In all investigated practices there are two interconnected elements that may define the success or failure of the underlying monitoring and reporting models. These elements include collecting the operational data and correlating this information to science technological, social and economic benefits.

Based on the reviewed practices the following characteristics applying also to PRACE may be pointed out:

- Monitoring and reporting models should be established as a long term and continuous activity;
- Monitoring and reporting should lead to a mechanism for the management of the organization to know the effectiveness and efficiency of its operation;
- Monitoring and reporting should lead to strong understanding of the economic, social and environmental impact;
- Provision of a monitoring and reporting system should take into consideration the characteristics and inherent peculiarities of a distributed organisation.

All existing models have a number of limitations that also apply to PRACE. For instance, case studies may need to be complemented by qualitative data and can incur in high costs and resources for their implementation, while surveys need reasonably high response rate what is

not always the case. Additionally, the questions in the survey need to be designed accurately enough to answer the research questions and the respondents to surveys need to be identified carefully. Quantitative methods need to rely on assumptions on how the research was funded and may not provide evidence about how and why the impact occurred. Quantitative methods have the disadvantage of making the estimation of the costs necessary to measure impact difficult. These difficulties need to be taken into account when defining the monitoring and Reporting processes for PRACE.

3 Conceptual framework for Monitoring and Reporting

Businesses are normally conceived from the definition of a vision and a mission to accomplish their main purpose. The strategic plan to implement the mission (business plan) encompasses the analysis of the context (market research, and analysis of competitors and stakeholders) and also the plans of the different relevant business areas such as financial, marketing and operation plans. The business plan might be up to the level of detail of the general institutional values of the workers. This planning and detailed description of the activities sets a solid base to start operating, but independently on the type of business area or the size of the business, the activity needs to be continuously monitored and the plans adjusted accordingly with the observation on the context of the outputs and the feedbacks. Hence a monitoring and reporting activity is a key activity for a business to adjust the different plans while performing a mission following a vision.

Figure 1 gives a general overview of the influence of monitoring and reporting for PRACE. The steps of the process are analysed in the following sections.

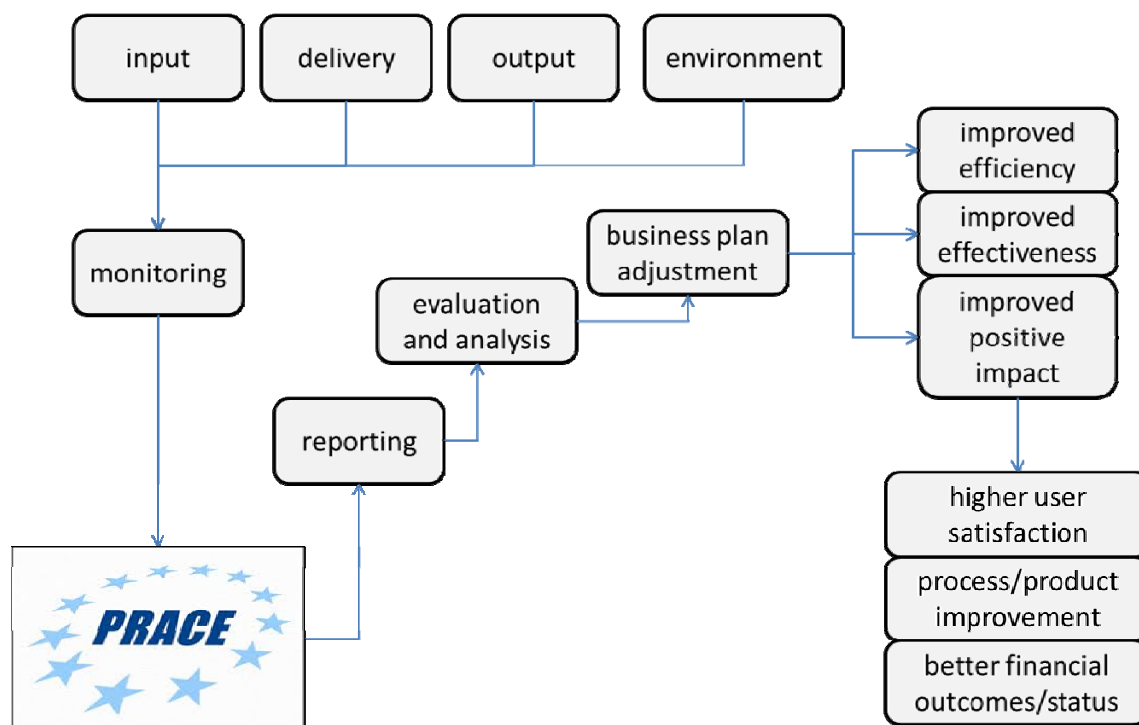


Figure 1: Monitoring and reporting in PRACE AISBL

3.1 Main goals

Monitoring and evaluation enables the assessment of the bottom line of the business activity.

Through monitoring/reporting and the evaluation of the data, it is possible to:

- Provide constant feedback on the extent to which the organisation is achieving its goals;
- Identify potential problems and their causes in planning and/or implementation;
- Suggest possible solutions to problems;
- Raise questions about assumptions and strategy;
- Monitor accessibility to the services of the organisation;
- Monitor efficiency of the organisation;
- Encourage the management to act on the information and insight;
- Incorporate views of users and stakeholders;
- Increase the likelihood that the organisation will have higher positive impact;
- Review progress;
- Make adjustments to improve the alignment with the mission and vision;
- Provide guidelines for the future.

The primary (most important) use of monitoring/reporting and evaluation should be for the organisation or project to see how it is doing against its objectives, whether it is having an impact, whether it is working efficiently, and to learn how to do it better.

Plans are essential but they should not be completely fixed. If they are not working well, or if the circumstances change, then plans need to change. Monitoring and evaluation are both tools which help a project or organisation to know when plans are not fully working, and when circumstances have changed. They give management the information it needs to make decisions about the organisation, about changes that are necessary in strategy or plans. Through this, the constants remain the pillars of the strategic framework: the problem analysis, the vision, and the values of organisation. Everything else is negotiable. While taking wrong decisions and failing may be acceptable, for an organization is key to be able to learn from mistakes, act upon them and avoid recurrences.

3.2 How to start-up monitoring and reporting

An organization usually sets long, medium and short term objectives towards the accomplishment of its mission, and for each of these objectives, the organization creates plans. Monitoring is addressed to observe the different elements that affect these plans.

Monitoring is the systematic collection of information as a project progresses. If monitoring processes are distributed among different stakeholders in the organization, reporting of the data should be articulated appropriately. This intermediate reporting step, essential in the case of a distributed organisation, should not be mistaken with the final reporting after the evaluation phase directed to the management of the organization.

Monitoring and reporting is a key step in the process of an organization aimed at improving its efficiency, effectiveness and impact. Monitoring/Reporting and the following Evaluation helps to keep the work on track, and allows management to know when and what needs corrective measures are needed. Thus Monitoring is an invaluable tool for good management, and it provides a useful base for evaluation. It enables an organization to determine whether the resources available are sufficient and are being well used, whether the capacity is

sufficient and appropriate, whether the organization is fulfilling its goals, and whether the environment and contextual conditions are changing.

Monitoring is geared towards learning from what the organization is doing and how it is doing it, by focusing on:

- **Efficiency:** tells that the input into the workflow is appropriate in terms of the output. In the case of PRACE, at present operating according with the Cycles model, the input is the type and amount of computing resources, the necessary support staff and the budget. In the near future, if PRACE evolves to a different model, the budget necessary to run the organisation will become much more relevant. These parameters are very important for the day-to-day business of PRACE and can be of utmost importance for scaling up the organization.
- **Effectiveness:** is a measure of the extent to which a development programme or project achieves the specific objectives it set. For PRACE, it will be a measure of the goals defined by the PRACE mission.
- **Impact:** Indicates whether or not what has been done made a difference to the problem situation or status quo that the organization is trying to address. In the case of PRACE it is important to track and verify the impact of the mission defined for PRACE. In other words, is the strategy defined reaching the desired goals, e.g. scientific, and socio-economic development of Europe.

Monitoring and Reporting involves:

- Identifying specific indicators of efficiency, effectiveness and impact;
- Setting up systems to collect the information related to these indicators;
- Collecting and recording the information;
- Pre-analyse the information;
- Evaluation of the information;
- Using the information to inform day-to-day management.

3.3 Monitoring types

The Monitoring process can capture information of different degrees of specificity, in this respect monitoring could be classified as qualitative or quantitative. Qualitative measurement tells the organization how people (in and/or outside the organisation) feel about a specific procedure defined by the organisation, its implementation, accessibility and usability. Qualitative information is obtained by asking (e.g. surveys), observing (e.g. during events and/or personal contacts) or interpreting. Quantitative measurement tells the organization “how much or how many”. Quantitative measurement can be expressed in absolute numbers or as a percentage. It can also be expressed as a ratio between measurable parameters.

Although quantitative information might seem more solid, reliable and “objective” than qualitative information, which appear more unconvincing and “subjective”, that might not be always the case. Quantitative information needs usually as much interpretation in order to make it meaningful as does qualitative information. While some of the monitoring targets can result from straightforward information that will not require much interpretation, depending on the measurement objective, it will be always necessary to define and monitor indicators. Indicators are measurable or tangible indirect signs of the effect of a cause that it is being

measured, for example, an increased number of television aerials in a community has been used as an indicator that the standard of living in that community has improved.

Indicators are an essential part of a monitoring and evaluation system, and through them it is possible to ask and answer questions such as:

- Who?
- How many?
- How often?
- How much?

Indicators can have different degrees of accuracy depending on the extent to which other variables or factors may have impacted on them as well. In some cases it is possible to ensure the accuracy of the indicator by measuring the variables that might be affecting the indicator and according to their values knowing the exact extent to which they are affecting the indicator.

Sources of data

The information to be collected must be meaningful, must be collected in a homogeneous way (very important if the information is collected by various parties) and should be stored taking accessibility into account. Usually it is possible to use reports, minutes, attendance registers, financial statements, and other day to day material as a source of monitoring and evaluation information. However, sometimes other external sources are required to retrieve information. Some of the more common ones are:

- Case studies
- Recorded observation
- Diaries
- Recording and analysis of important incidents
- Structured questionnaires
- One-on-one interviews
- Focus groups
- Sample surveys
- Systematic review of relevant official statistics.

4 Monitoring and Reporting in PRACE RI

The activity of PRACE involves complex processes that require intense collaboration with stakeholders and interaction with the users of the services provided. The fact that PRACE is a distributed infrastructure makes it particular because the organisation management also needs to monitor the activities of geographically distributed computer centres managed on the basis of national laws and with managers with different traditions and mentalities. This not only increases the diversity of the solutions applied by the local management but also the perspectives regarding monitoring of this management activities. This means that all goals and the corresponding mechanisms for their achievement need to be set at an early stage, and ideally during the planning process, since it is very difficult to go back and set up monitoring and evaluation systems once procedures are not anymore in the planning phase but are actually established and running.

4.1 Monitoring Targets for PRACE

PRACE needs to set monitoring targets oriented to measure efficiency, effectiveness and impact in the different perspectives of its activities. One way of dealing with this is by analysing the workflow of PRACE and define and identify its main components based on the classical concepts of input, delivery, output and environment as depicted in Figure 2.



Figure 2: Main components of the workflow of PRACE

The next step is for each component of the PRACE workflow to identify the queries for which an answer is needed, the corresponding monitoring variables and the category they belong to, i.e. efficiency, effectiveness and impact.

Input

Input describes what resources PRACE uses in order to create and run its services such as monetary funding and budget, personal resources and equipment. According with the present organisation model (Cycles model) PRACE does not own any equipment, i.e. the Hosting Members (HM) are responsible for ownership and management of the computer systems and give compute cycles to PRACE. PRACE is then responsible for managing and allocating the compute cycles. This means that at present the compute cycles are seen as in-kind contribution from the HMs regulated by the Agreement for the Initial Period that spans till the end of 2015.

The monitoring variables associated with Input, the respective queries and the indicator type (efficiency, effectiveness and impact) are:

- Independent Financial Audit of PRACE (are finances handled legally and in a correct way?) – *effectiveness*
- Income:
 - o Monitoring of in-kind contributions (other than the compute cycle contribution from HMs) (are in-kind contributions handled correctly?) – *effectiveness*
 - o Calculated monetary value of allocated resources (what is the “real” value of the resources allocated to users and how is their geographic distribution? – *effectiveness*
 - o CPU hours contributed by the HMs (what is the actual cycle contribution of the HMs?) – *effectiveness*

Delivery

Delivery describes the services provided by PRACE. These services have a technical character and the queries to be answered regard mainly the quality of the services and the beneficiaries of the services (users).

The monitoring variables associated with Delivery, the respective queries and the indicator type (efficiency, effectiveness and impact) are:

- Peer review process:
 - o Success ratio of proposals – globally, distribution per scientific field, country, and machine (how strict is the PRACE AISBL peer review procedure?) – *effectiveness/impact*
 - o h-index [6] and g-index [7] of applicants supported by PRACE (how good is the scientific track record of the researchers supported by PRACE?) – *impact*
 - o Resource allocation (how are the resources allocated distributed (project type, scientific field, geographically?) – *effectiveness/impact*
- Compute resources:
 - o Technical specification of available resources: peak performance, number of processing elements, power consumption (what services are offered to users?) – *effectiveness/impact*
 - o Incidents and down-time (how reliable are the services offered?) – *effectiveness*
 - o Total usage relative to allocation per project (how are the resources allocated consumed?) – *efficiency/impact*
 - o Distribution of job size and job duration (how are the machines used?) – *efficiency/impact*
- User support process:
 - o Application support (how does the application support help improve scalability and performance of applications (codes)?) – *efficiency*
 - o Number of user tickets and time to response (is the Helpdesk giving good support to users?) – *efficiency*
 - o User satisfaction (how do users perceive the services?) – *efficiency*
 - o Training events (how does PRACE engage in training support?) – *effectiveness*

Output

Output is described by the concrete results obtained with allocated compute resources. Long-term, secondary effects can only be included here if they can be directly related to a awarded project and can be followed and measured during a couple of years. As referred previously, this results from the difficulties of matching the influence of computer cycle allocation to projects into commercial products that appear a long time after the projects have been supported by PRACE.

The monitoring variables associated with Output, the respective queries and the indicator type (efficiency, effectiveness and impact) are:

- Publications of any type (what is the result of the resources allocated by PRACE in terms of publications?) – *impact/effectiveness*
- Typology of projects in terms of additional funding or private/public collaborations (are the projects supported by PRACE also being funded by other institutions?) – *impact/effectiveness*

- Types of collaboration with industry (Do projects supported by PRACE collaborate with industry?) – *effectiveness*
- Industry proposals for resource request (how is PRACE fostering collaborations with industry?) – *effectiveness*

Environment

Environment describes the market environment in which PRACE delivers its services.

The market environment includes the individual members of PRACE and their respective national services, competitors of PRACE, funders of PRACE, and indirect beneficiaries of PRACE. Belonging to this component are also results that were produced using PRACE resources but could not be easily assigned to concrete results of a specific PRACE-supported project, because may result from a group of projects including some projects supported by PRACE and other not supported by PRACE.

The monitoring variables associated with Environment, the respective queries and the indicator type (efficiency, effectiveness and impact) are:

- Financial data provided in the individual Annual Reports of the PRACE members (how are the PRACE AISBL members?) – *impact*
- Technology transfer – patents and spin-offs (did the allocations to PRACE resources resulted in technology transfer?) – *impact*
- Relationships with other European Institutions (how are the relationships with other institutions?) – *effectiveness/ impact*
- HPC related job trend (is PRACE fostering the creation of new jobs?) – *impact*
- European companies in the HPC area (is PRACE influencing European HPC companies?) – *impact*
- Software development for scalability increase, industrial applications, creation of new collaborations (how is PRACE influencing HPC related industrial development?) – *impact*
- Vendor companies (how is PRACE influencing vendors?) – *impact*
- Investment of industry in HPC (what is the influence on the investments of industry in HPC?) – *impact*
- Industry participation in PRACE events (is the dissemination of PRACE reaching industry?) – *impact/effectiveness*
- PRACE awareness (is PRACE fostering awareness?) – *impact/effectiveness*
- Social and economic events (what is the socio-economic impact of PRACE?) – *impact*
- Rankings of PRACE systems: top 500, green ranking, etc. (how is the PRACE performance in international rankings?) – *effectiveness*
- Environmental impact (what is the environmental impact of PRACE?) – *impact*

The overall cycle resulting from monitoring is represented in Figure 3. This cycle begins with setting up the queries that need to be answered, definition of the corresponding monitoring variables, monitoring process, reporting, evaluation and adjustments of the way PRACE works if necessary. This cycle is important not only for the evaluation of the intern organisation of PRACE but also for asserting the impact of PRACE among users, stakeholders and society in general.

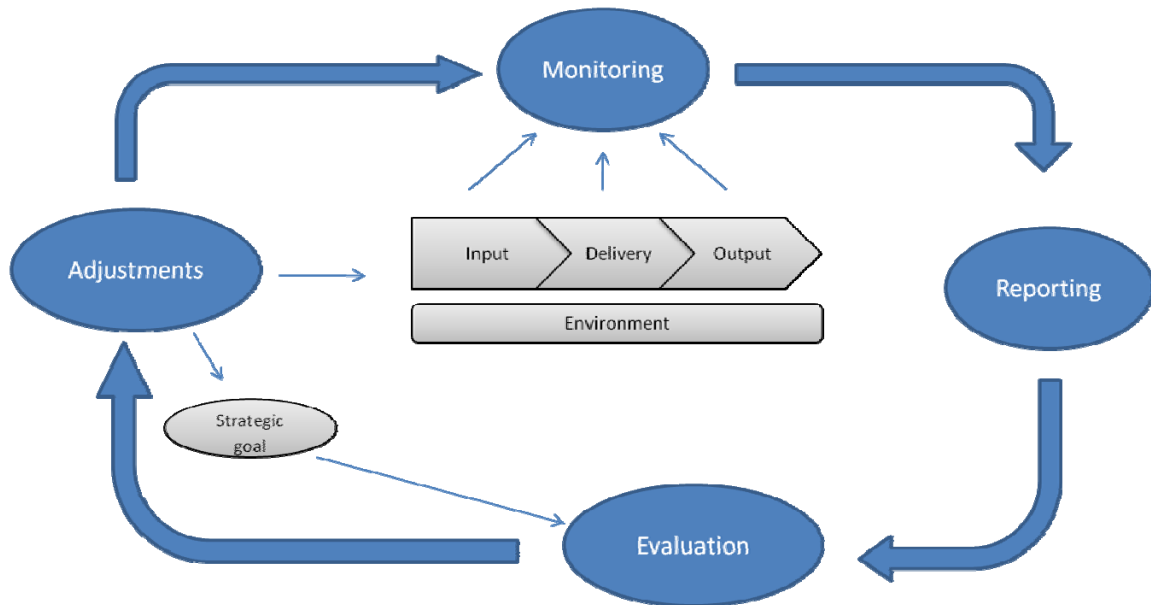


Figure 3: Monitoring cycle

4.2 Monitoring variables

Having set the general categories and objectives, this section defines the set of variables that are proposed for consideration by PRACE. Each one is described taking into consideration its periodicity, priority, the entity responsible for it, the recipient body of PRACE and the procedure to be followed for gathering the data. Regarding priority the classification is:

- Short term – in simultaneous with the starting up of operations
- Medium term – within 1 to 2 years of the starting up of operations
- Long term – after 2 years of starting up of the operations

The monitoring variables are grouped according with the 4 components defined for the workflow of PRACE, i.e. Input, Delivery, Output and Environment. Before each variable used for monitoring, the query for which PRACE AISBL will get an answer is also given.

Input Variables

Financial data

A.1 Financial audit – Are the PRACE AISBL finances handled legally and correctly?

Monitoring variable: Financial data provided by the PRACE AISBL

Description: PRACE is a legal entity with its own accounting. It has therefore to release a financial statement at least once a year as prescribed in the PRACE statutes. As long as PRACE does not own any large-scale computers, i.e. as long as the Cycles Model will be used, the financial statement can be reduced to revenue and cost calculation. In the Cycles Model, Hosting Members report the allocation costs according with the policies decided upon and approved by the Council. As soon as PRACE owns large-scale computers, a balance sheet and a calculation of the assets has to be included in the financial audit. Nevertheless as the

output of the PRACE service cannot be measured financially, a cost-performance calculation cannot be carried out.

Who monitors/Reports: PRACE AISBL BoD, and HMs

Who is the Recipient: PRACE Council

When: Every quarter and yearly

Procedure: Internal accounting of the PRACE AISBL. Auditing of PRACE AISBL will be carried out by independent external auditors appointed by the PRACE Council upon proposal by the BoD. The audit is based on the financial statement of the internal accountant of PRACE AISBL.

Priority: Short term

A.2 In-kind contributions – Are in-kind contributions handled correctly?

Monitoring Variable: Monitoring of in-kind contribution (other than compute cycle contribution from Hosting Members (HM))

Description: In-kind contributions are of key importance to PRACE because the organisation works as a partnership and there is a need for each member to feel that is contributing value to PRACE and conversely to believe that is receiving value from PRACE.

In PRACE AISBL, there are two types of in-kind contributions:

- In-kind contributions in compute cycles made by each HM: the valuation and monitoring of this type of in-kind contributions is governed and regulated at present by the “Agreement for the Initial Period”. The Council approves this type of in-kind contributions on an annual basis and as such it is not covered by the same monitoring as all other in-kind contributions.
- Any other non-monetary contributions to PRACE, and accepted by PRACE, for which it is possible to assign a nominal value for e.g. voting rights or any other matters.

Who Monitors/Reports: PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council

When: Yearly

Procedure: Deliverable D2.3.1 “Report on in-kind contributions Analysis of the different options for valuating in-kind contributions” [8] has presented an introduction to in-kind contributions, their nature and the approaches taken by other organisations. Some options for measuring in-kind contributions and approaches to manage them have been outlined. Some potential issues have also been identified. The main conclusion of this deliverable is that there are a number of ways that PRACE could deal with in-kind contributions, some of which could lead to creative and innovative methods of managing the contributions of a large number of partners. Three possible models have been discussed and the advice was that the Council could use different models for different types of in-kind contributions. Once the types of in-kind contributions are defined and the Council decides on which model to be used it is rather straightforward to monitor and report on the in-kind contributions to assess the efficiency and effectiveness with which they are deployed and valued.

Priority: Medium term

A.3 Valuation of allocated resources – What is the “real” value of the resources allocated to users and how is their geographic distribution?

Monitoring Variable: Monetary value of actual allocated resources

Description: The monetary value of the resources allocated to users (i.e. compute cycles) does not only include the actual costs of the compute cycles allocated to users but also all other costs related to allocation (i.e. costs of the peer review process used for allocation of resources including costs of meetings of the SSC and AC, development and maintenance of the on-line system for application to resources, running costs of the PRACE AISBL organisation, personnel, devaluation of equipment and installations, etc.). The monetary value of the allocated resources is important to analyse the real costs of allocation and their distribution per country and scientific field as well as their evolution over time.

Who Monitors/Reports: The HMs for the costs of the compute cycles contributed and the BoD for the costs incurred by PRACE for allocation of resources and other standard expenses.

Who is the Recipient: PRACE AISBL Council

When: Monitoring twice a year. Reporting aligned with the Council meeting at the beginning of each year for approval of the financial figures of the previous year.

Procedure: Valuation of the allocated resources is divided into two parts: (i) Valuation of the cycle contribution of each HM, e.g. price per core-hour for each machine, according with the rules defined by the Council for the valuation of the cycles contributions of each HM; and (ii) price of all PRACE AISBL overheads for allocation of resources per core-hour. Both valuations will need to be reviewed on a yearly basis and will need to be approved by the Council. The BoD is responsible for coordinating the full process of valuation of the allocated resources.

Priority: Short term

A.4 Cycles contributions – What is the actual cycle contribution of the HMs?

Monitoring Variable: CPU hours contributed by the HMs

Description: Accordingly to the Agreement for the Initial Period, the cycle contribution is the annual contribution each HM has committed to provide in terms of CPU hours. The planned contribution (i.e. the planned distribution in CPU hours agreed by each HM in the Agreement for the Initial Period covering 2010 to 2015) is the baseline against which the actual contribution is compared. The assessment of the actual contribution is performed yearly by the contributor (HM) and approved by the Council. In terms of actual calculation the amount of CPU hours contributed derives from the usage accounting, i.e. the effective amount of compute time consumed by users. The AISBL BoD is interested in monitoring the contribution and usage trend and the evolution over time for management purpose. The Council is interested in the annual consolidated figure for the approval of the fulfilment of the HM commitment.

Who Monitors/Reports: The HMs monitor and collect the data and report to the PRACE AISBL BoD. The PRACE AISBL BoD reports to the Council.

Who is the Recipient: PRACE AISBL BoD and Council

When: Monitoring can be executed quarterly and reporting is yearly based.

Procedure: The hosting sites collect the data from the system accounting and usage figures and transfer those to the AISBL. Statistical post processing and reporting is done by the BoD.

Priority: Short term

Delivery Variables

Peer Review Process

B.1 Success ratio of proposals – How strict is the PRACE AISBL peer review procedure?

Monitoring variable: Success ratio of proposals

Description: The success ratio of proposals, i.e. the percentage of proposals supported by PRACE compared to the total number of proposals to the call, for each call. It is also important to compare the success ratio with the number of proposals above the quality threshold defined by the call, if PRACE does not have enough resources to support all proposals above the threshold of quality. This gives two kinds of information: how many proposals could not be supported due to lack of resources and how is the quality of the proposals.

Who Monitors/Reports: Scientific Steering Committee, PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council, PRACE members, HPC users and potential users

How often: For each call with yearly consolidated report

Procedure: The necessary data is available from the PRACE on-line system for application to resources and can be obtained in an automatized way.

Priority: Short term

B.2 H-index and g-index of applicants – How good is the scientific track record of the researchers supported by PRACE AISBL?

Monitoring Variable: h-index and g-index of applicants

Description: The h-index and the g-index are used to measure the productivity of an individual, group or institution. It is calculated by taking into account the balance between the number of publications and the number of citations per publication. The h-index is based on a list of publications ranked in descending order by the Times Cited. The value of h is equal to the number of papers (N) in the list that have N or more citations. Another possibility of inferring the productivity of a researcher is through the g-index that is calculated based on the distribution of citations received by the publications of researchers. Given a set of articles of a researcher ranked in decreasing order of the number of citations received, the g-index is the (unique) larger number such that the top g articles received (together) at least g^2 citations. One should be aware that the typical h-index and g-index of leading experts vary from area to area. Even in the same field of science, there might be some broad variations. Therefore the conclusions regarding the merit of a researcher, of a group or of an institution cannot be drawn based only upon the knowledge of the respective h-index or g-index. Nevertheless, these indexes are a useful indicator.

Who Monitors/Reports: Scientific Steering Committee and PRACE AISBL

Who is the Recipient: PRACE members, HPC users and potential users

How often: Yearly

Procedure: The information should be provided in the application form for PRACE resources. Since the h-index and g-index depend on the data base of publications used, it would be advisable to refer to the probably most used one: the ISI Web of Knowledge [9] by Thomson Reuters. Therefore, the information provided by the PI can be easily checked if necessary.

Priority: Short term

B.3 Resource allocation – How are the resources allocated distributed (project type, scientific field, geographically)?

Monitoring Variable: Resource allocation

Description: Resource allocation can be easily monitored and can give very important information about the geographic and scientific distribution of the resources allocated in each call for proposals and the amount of successful proposals compared with the total amount of proposals submitted. Several metrics can be inferred from the resource allocation: distribution of resource allocation per type of allocation (project, preparatory access, programme), per scientific field; geographic distribution of the institution of the principal investigator; geographic distribution of the institutions of all researchers who collaborate in the project proposed (i.e. principal investigator plus collaborators); types of institutions, i.e. academia or industry, etc. These metrics can be performed for a single call and also for a group of calls to infer the time evolution and eventually draw conclusions that can be used to reflect on the usage of the HPC Research Infrastructure. As for all kind of time evolutions caution should be taken regarding the analysis and the conclusions that can be drawn, especially if the time lag is rather short and includes starting up conditions, i.e. the initial calls may show an initial peak of number of applications to the PRACE resources. This effect can be due either to an over-expectation from the initial calls and may result in some proposals not fulfilling the minimum requirements for Tier-0 machines due to low scalability of the codes or not being adequate to the architecture of the machine requested. After each PRACE call, it is obviously important to analyse the number of submitted versus awarded proposals and their distribution per scientific domains, per country and per machine. These types of indicators have to be designed in collaboration with the SSC and AC.

Who Monitors/Reports: PRACE AISBL peer review staff

Who is the Recipient: PRACE AISBL Council, funding organisations, EC, HPC users and general public

When: After each regular call, complemented with yearly analysis

Procedure: After each call, the peer review staff will produce a short analysis of the outcomes of the call in terms of submitted versus awarded proposals per scientific field, country, institution type, allocation type and amount of resources requested and awarded. Most of this information can be collected automatically by the PRACE tool for application to the calls developed by CINES. This type of analysis is key to provide information for a medium/long term vision:

- on the attractiveness of PRACE
- on the quality cut-off of each PRACE call
- on the needs of the various scientific communities (HPC regular or emergent users)

These indicators have to be presented in simple graphical way, and can also be used for dissemination matters and for creating awareness of the PRACE RI. Furthermore, a global analysis has also to be consolidated on year basis.

Priority: Short term

Computer resources

B.4 Technical specifications of available systems – What services are offered to users?

Monitoring Variable: Technical specifications of systems available through PRACE AISBL and also of other computer systems made available by PRACE Members.

Description: Describes and quantifies the computational resources that are made available to scientific projects through PRACE and also through PRACE Members. The hardware and software environments for the production systems are described and characterized.

Possible metrics are:

- HPC systems: Name, vendor, model, installation/last upgrade, node description (CPU, GPU, memory), number of nodes, interconnect type, interconnect bandwidth, peak performance, power consumption and share made available through PRACE.
- Storage by tier: size, bandwidth
- Software environment: compilers, debuggers, libraries, software packages, etc.

Who Monitors/Reports: Every single PRACE member providing Tier-0 or Tier-1 resources.

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure: Standard table (e.g. in Excel format) to be filled out by every member. Data is then consolidated in a single report by PRACE AISBL.

Priority: Short term

B.5 Incidents and down time – How reliable are the services offered?

Monitoring Variable: Incidents and down-time

Description: The service performance is affected by different type of incidents such as hardware and/or software failures or by various types of security incidents including the non-productive time or system unavailability (down-time) due to malfunction or maintenance. Computing centres utilize well established processes to monitor their systems for incidents and down-time. All incidents and down-time are routinely reported in the “List of Incidents and Down-Time” that contains a description of the incident/down-time, its cause and possible influence on the service. The monitoring variable will gather quantitative information about the number of incidents per site and down-time on yearly basis.

Who Monitors/Reports: Computer centres

Who is the Recipient: PRACE AISBL BoD and Council, PRACE users and other HPC community groups

When: Yearly

Procedure:

- A system for monitoring (Navigator) records the overall parameters. All relevant data is logged with sufficient frequency and post-processed in order to provide the necessary information on incidents and down-time.

- The incident record is compared with the previous period and the down-time is compared with the limits defined for warranting continuity of service on month, quarter and year basis.
- The information is gathered by the computing centres according to the general standards defined.
- Every quarter the computing centres send the collected information to the BoD.
- BoD reports to the Council every 6 months and finally the information is published on a yearly basis.

Priority: Short term

B.6 System usage – How are the resources allocated consumed?

Monitoring Variable: Total usage relative to allocation per project

Description: Number of consumed computing hours versus number of allocated hours. This indicator will monitor the effective users' resource consumption of the machines, and enable possible corrective measures by PRACE in terms of allocation of resources.

Who Monitors/Reports: Computer centres

Who is the Recipient: PRACE AISBL BoD and PRACE users

When: Every quarter and yearly consolidated report

Procedure: Each quarter the computer centres provide to the PRACE AISBL the amount of consumed computing hours per project. From this information geographic usage of the machines can be also inferred. The information collected by the computer centres can be transmitted directly, e.g. through the PRACE peer-review online system and aggregated in a consolidated report, allowing a follow-up of the consumptions versus the allocations. This information needs also to be made available to the PRACE user, especially if consumption of resources allocated is not regular over the allocation period analysed. Is also important to relate actual usage to the amount of resources made available to PRACE for each machine to avoid that compute hours reserved to PRACE are left unused.

Priority: Short term

B.7 Usage per job submitted to the systems – How are the machines used?

Monitoring Variable: Distribution per job size and total duration

Description: Typology of the projects running on PRACE systems by number of cores used per run and job duration.

Who Monitors/Reports: Computer centres

Who is the Recipient: PRACE AISBL

When: Quarter and yearly consolidated report

Procedure: The pre-requisite for this indicator is that the adequate range of job size based on the amount of compute cores used has to be determined. The ranges of compute nodes depend on the system architecture and have to be decided for each system or group of systems. The duration of the jobs gives also an indication of the type of projects running in the systems. This indicator will enable to identify if the most high capability applications run on the most adequate systems. Once this indicator is automatically configured, it could be envisioned to

provide this indicator to the PRACE AISBL on a quarter basis. At a minimum, a yearly analysis has to be done, aiming at demonstrating that PRACE resources are dedicated to high capability applications.

Comment: As WP6 is creating a single management system [10] to be used by all computer centres contributing resources to PRACE, monitoring of the variables for system usage will be standardised and as such will be rather easy.

Priority: Short to medium term

User support

B.8 Application support - how does the application support help improve scalability and performance of applications (codes)?

Monitoring Variable: Type of application support and respective results

Description: The computer centres together with software experts from the PRACE Implementation phase projects are responsible for giving support to applications, e.g. porting of applications and development of applications for scalability and performance increase, upon request of the users in the form of application to the Preparatory Access call and PRACE support decision.

Who Monitors/Reports: Computer centres

Who is the Recipient: PRACE AISBL, PRACE users and other HPC community groups

When: Yearly

Procedure: Computer centres record all type of support (porting, application development for improvement of scalability and performance) given to users and the level of involvement of the software experts of each centre in terms of time spent and resources. Software experts of the PRACE projects need also to report all support to applications. These activities are usually reported in project deliverables and are performed in collaboration with experts of the computer centres. It is also important that any type of publications and success stories, e.g. major scalability or performance increase, are recorded for monitoring and reporting purposes.

Priority: Short to medium term

B.9 User tickets – Is the Helpdesk giving good support to users?

Monitoring Variable: Number of user tickets and time to response

Description: Number of user tickets handled by the Helpdesk is the amount of tickets in response to user problems or queries. Each problem or query is assigned to one user assistant or account analyst, who establishes contact with the customer (user) and tracks the query from first report to final resolution (Ticket Response Time).

Who Monitors/Reports: Computer centres

Who is the Recipient: PRACE AISBL, PRACE users and other HPC community groups

When: Yearly

Procedure:

- Day-to-day user problems and queries are recorded with the Request Tracker software and proceed to the supporting team for resolution.

- The recorded track is compared with initially defined thresholds for time response.
- The information is collected by the computing centres (it may be included in the provided in-kind contributions by them as part of system maintenance).
- Every quarter the computing centres send the collected information to BoD.
- BoD reports to the Council every 6 months and finally the information is published on yearly basis.
- This service is included in the service catalogue [10] described by WP6 that will be implemented for all computer systems available through PRACE according to common SLAs. These SLAs will outline the availability (operation hours other than 24/7) and helpdesk accessibility and service level priority. This common service will be standard to all PRACE systems with pre-defined ticket response time, and will result in clear user expectations regarding helpdesk support.

Priority: Medium term

B.10 User satisfaction – How do users perceive the services of PRACE AISBL?

Monitoring Variable: User satisfaction

Description: The objective of monitoring User Satisfaction is to collect the perception of the users regarding the PRACE services. A good knowledge of the perception of the users will be useful to identify areas of improvement and to enable PRACE AISBL to set appropriate priorities to enhance its services.

Who Monitors/Reports: PRACE AISBL BoD. An external survey expert team might be involved.

Who is the Recipient: PRACE AISBL Council. The EC commission might be interested in having a general overview on user satisfaction.

When: Yearly

Procedure: User satisfaction quantification is based on specific survey techniques that require users to actively fill a questionnaire and/or being interviewed according to a pre-defined list of queries. Another possibility of accessing user satisfaction will be by organising a session of the User Forum dedicated to user satisfaction where direct feedback from users can be collected.

User satisfaction may have two main components:

- Technical:
 - quality of service
 - queuing time
 - complaints or problems
 - technical support
 - types of other services needed
- Organisation
 - Trust in the mission and objectives of PRACE AISBL
 - Trust and understanding of the peer review procedure used for allocation of resources

Priority: Short term

B.11 Training, seminars, and related statistics – How does PRACE AISBL engage in training support?**Monitoring Variable:** Training events**Description:** Types of events organized by PRACE for support to users. These events can be directly and indirectly organized/sponsored training events EU-wide and worldwide. Support to user communities that use or intend to use the services of PRACE AISBL is not restricted to addressing potential issues for code and applications enabling but includes also activities related to hands-on training, schools, seminars and laboratories.**Who Monitors/Reports:** PRACE AISBL BoD with collaboration from PRACE members that organise PRACE events.**Who is the Recipient:** PRACE AISBL Council, EC, users and scientific communities**When:** Yearly**Procedure:** Monitoring should include:

- Number of training and laboratories events in HPC topics, number of applicants, number of attendees.
- Number of seminars in HPC topics, number of registrations, number of attendees
- Training material made available through the PRACE AISBL website

As much as possible all training activities should include a survey regarding the quality and adequacy of training as well as the quality and appropriateness of the materials distributed during the training. PRACE success depends upon the interest of the user communities and their active support to the RI in terms of effective usage of the computing resources. For that reason an effective offering of persistent training events and the feedback of attendees becomes of great importance. The organisers of the events will make the data from the event and the corresponding survey available to PRACE AISBL. It will be also important to monitor the amount of downloads of training material and ask visitors to fill in a survey. The BoD collects all info in a yearly report.

Priority: Short to medium term**Output Variables****C.1 Publications and success stories – What is the result of the resources allocated by PRACE in terms of publications?****Monitoring Variable:** Publications of any type (peer reviewed or not), PhD theses, success stories**Description:** Number and quality (measured by impact factor of the journal) of refereed papers, conference proceedings, PhD theses, industry contracts, presentations to conferences, government/organization research contracts, other outputs of research activity, success stories associated with research activities. Publications of any type should contain a reference to PRACE RI.**Who Monitors/Reports:** PRACE AISBL BoD and all members**Who is the Recipient:** PRACE AISBL Council, PRACE members, EC, HPC users and potential users**How often:** Yearly (after the end of the second year of starting up of the PRACE services)

Procedure: The information should be provided by the principal investigator (PI) of each project in the progress (if applicable) and final reports. It would be advisable to refer to the probably most used one data resource: the ISI Web of Knowledge by Thomson Reuters. Therefore, the information provided by the PI could be easily checked if necessary. Ideally, any deliverable of a scientific or industrial project associated with resources allocated by PRACE RI, should compulsory contain an acknowledgement to PRACE AISBL. This may help to identify which publications depended on usage of PRACE resources.

Priority: Medium term

C.2 Typology of projects regarding additional funding – Are the projects supported by PRACE also being funded by other institutions?

Monitoring Variable: Typology of projects in terms of additional funding or private/public collaborations

Description: This indicator will give information on the typology of projects concerning possible additional funding or public/private collaborations. As an example, it might be interesting to know how many projects benefit from EC support or from a collaboration with industry. This indicator could also be extended to international partnerships or sources of funding.

Who Monitors/Reports: PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council

When: After each regular call, complemented with yearly analysis

Procedure: After each call, the peer review staff produces a short analysis of the outcomes of the call in terms of additional funding, trying to establish a typology of projects regarding funding by other institutions (public and/or private). The data can be easily obtained through the system for application to PRACE resources developed by CINES, because applicants are asked to indicate other types of funding received for the project in the application forms.

Priority: Medium term

C.3 Collaborations with industry – Do projects supported by PRACE collaborate with the industry?

Monitoring Variable: Types of collaboration with industry

Description: The objective of this variable is to monitor which types of projects in collaboration with the industry PRACE is involved in. The data related to this variable should be collected regularly in order to ensure access to historical data and trends. Using these findings, PRACE can adjust its model for the collaboration with industry in order to achieve the desired objective (i.e. the provision of research tools in order to strengthen the European industry). The potential indicators used to measure this variable are: i) Number of projects in various categories (R&D, prototyping, new product development, continuous improvement, etc.) and ii) Outcome (e.g. new products or technologies or revenue (if available) of projects in various categories (R&D, prototyping, new product development, continuous improvement, etc.)).

Who Monitors/Reports: PRACE AISBL and PRACE members

Who is the Recipient: PRACE AISBL BoD

When: Yearly

Procedure: 1) Annual reports using a pre-defined format filed in by PRACE Members; 2) information compiled into a separate report (using a pre-defined format) and provided to PRACE AISBL.

Priority: Medium term

C.4 Industry proposals for resource request – How attractive are the PRACE AISBL services to industry?

Monitoring Variable: Industry proposals for resource request

Description: Industry might have a varying degree of interest in using PRACE resources, whether this interest is increasing or decreasing, the RI should be aware of the trend to adapt its offer accordingly. This variable will indicate the amount and type of proposals of the industry to PRACE access.

Who Monitors/Reports: PRACE AISBL BoD

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure: The format should include: number and percentage of industrial participation in all calls, and number of collaborations with industrial partners. It will be also interesting to monitor in which country/ies the industries are operating. After some years of PRACE AISBL operation it will be interesting to analyse trends regarding industrial participation in proposals for access to PRACE resources, identification of countries with stronger/weaker industrial awareness of PRACE resources, or sectors with higher/lower trends of participation in proposals.

Priority: Short term

Environmental Variables

D.1 Financial elements in the annual reports of PRACE members – How are the PRACE AISBL members doing?

Monitoring Variable: Financial data provided in the individual Annual Reports of the PRACE Members

Description: A survey of the financial elements in the annual reports of its members gives PRACE AISBL an easy overview on how its partners are financially performing. To make sure that the figures gathered are of some importance for PRACE AISBL some basic variables should be reported on:

- Expenditures
 - Investments
 - Material/Goods/Services
 - Personnel
 - Material expenses
 - Extraordinary income/expenditures
- Income
 - Basic Budget
 - Third-Party Contributions (projects)
 - Third-Party Contributions (services)

Who Monitors/Reports: Each member of PRACE AISBL

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure: Collection of figures which are provided anyway in the Annual Report of the PRACE members.

Priority: Medium term

D.2 Technology transfer – Did the allocations to PRACE AISBL resources resulted in technology transfer?

Monitoring Variable: Patents and spin-offs

Description: One of the means by which PRACE will directly revert into economy is via the transfer of the technology directly or indirectly created with HPC resources and the exploitation of intellectual property. One of the most clear indicators for these two facts is the filling up of patents and other spin-offs. PRACE should monitor this variable in the context of the RI to assess such direct impact. However PRACE must keep exploitation rights over any developments regarding the computer systems made available by PRACE according to the funding and IPR rights referred to in the User Agreement.

Who Monitors/Reports: PRACE AISBL BoD and eventually all other PRACE AISBL members

Who is the Recipient: PRACE AISBL Council and eventually the EC and public in general

When: Yearly

Procedure: PRACE AISBL decides on the periodicity of reporting and the format and informs all members so that they can inform PRACE if they become aware of any patents filled in their countries for which PRACE resources were used. Information should be also gathered within PRACE AISBL. The format should include: number, sector of patents, and title. Once the information is gathered, statistic information could be extracted in terms of statistical trends, and also in terms of a deeper analysis of success case studies, i.e. possible relationships between case studies and patents could be established. For these cases a statistic metrics could be provided indicating the % of patent exploitation and the respective return of investment.

Priority: Medium term

D.3 Relationships with other European Institutions – How is PRACE AISBL collaborating with other institutions?

Monitoring Variable: Relationships with other European Institutions

Description: This variable refers to all relationships and/or collaborations with other European Institutions. Between all European Institutions the most relevant ones for PRACE AISBL include the EC, ESFRI projects and other projects and initiatives that require HPC resources, and European organisations that represent scientific fields that are dependent of HPC usage for research development. Here we can also note that relationships with non-European institutions may also be important. One such example is TeraGrid or the new project eXtreme Digital that has shown interest in exchanging resources with PRACE. In general what will be described below for relationships with European Institutions can be easily extrapolated to non-European Institutions. Task 4.4 of the PRACE-IIP project is

currently analysing possibilities of PRACE collaborations with non-European institutions [11]. These possibilities need to be analysed by the BoD and approved by the Council.

Who Monitors/Reports: PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council and eventually the EC

When: Yearly or in some cases every two years

Procedure: Though most partnerships usually start up in an ad-hoc way and in some cases through personal contacts, it is important that partnerships reach maturity and become established at the level of institutions with clear and defined processes and objectives commonly accepted. Procedures for the establishment of collaborations can be found in deliverable D4.4 [11] of the PRACE-IIP project. If the processes and the objectives are clearly defined and accepted by the partners it is easy to infer on which parameters need to be monitored and reported upon to evaluate the success of the partnership. It is advisable that the BoD will analyse all partnerships to be established by PRACE. One of the interesting points to monitor regarding other institutions and especially the EC is the sources of funding for projects supported by PRACE. This will give a global perception of the funding involved in these projects. It will be also important to engage with institutions representing scientific communities and/or other European projects to map their HPC needs to proposals submitted to PRACE in the same scientific fields. This mapping may allow PRACE to draw conclusions regarding the fulfilment of the needs of these scientific communities.

Priority: Medium to long term

D.4 HPC related jobs – Is PRACE AISBL fostering the creation of new jobs?

Monitoring Variable: HPC related job trend

Description: The evolution of the job market and the related statistics concerning employment of highly skilled professionals in the area of scientific research, industrial research and development, and high-end IT industry (both software and hardware) can provide a useful indication of the impact produced by PRACE, although indirectly. Figures can be also provided by more direct sources such as the PRACE AISBL members and their affiliated institutions and ministries.

Who Monitors/Reports: PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council, EC and the general public

When: Monitoring can be performed yearly, reporting every 2 years

Procedure: The measurement is based on direct input from PRACE members and statistics from public specialized sources:

1. EC Employment, Social Affairs & Inclusion Statistics and analysis reports
2. European Centre for the Development of Vocational Training (CEDEFOP)
3. Sector studies

Priority: Medium term

D.5 European companies in the HPC area – Is PRACE AISBL influencing European HPC companies?

Monitoring Variable: European companies in the HPC area

Description: This variable demonstrates the capabilities of the European HPC supply chain and is equivalent to a HPC Industry Matrix – a comprehensive report showing Europe’s competencies in the HPC supply chain (reflecting the various components of a typical HPC system and related applications). The indicators that can be measured in this variable are: i) Number of indigenous European SMEs providing HPC solutions; ii) Revenue of indigenous European SMEs providing HPC solutions; and iii) Number/List of indigenous European SMEs potentially capable of providing HPC solutions.

Who Monitors/Reports: PRACE AISBL BoD and PRACE AISBL Members

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure: Monitoring of this variable requires a substantial amount of survey and research work. Some information could be collected in a somehow random manner from PRACE Members and from projects that run on the PRACE infrastructure. The majority of the data required is not available in a structured way. Some of it would emerge from surveys, and some other data are available in individual sources such as press releases, project information, articles, company reports, etc. Monitoring of this variable will require the creation of a new capacity within PRACE. This role should focus on researching developments in European HPC and translating that information into understandable trends. A key objective would be to identify information related to PRACE and HPC resources available in the European Economic Area and then interpret these data in terms of PRACE and HPC impact on society, science and industry.

Priority: Medium to long term

D.6 Software development and industrial applications – How is PRACE AISBL influencing HPC ?

Monitoring Variable: Software development for scalability increase, industrial applications, creation of new collaborations

Description: This variable will demonstrate the tangible impact of PRACE on European industrial achievements. The indicators that could be measured within this variables are: i) Current benchmark of software capabilities – as achieved by European software providers; ii) Evidence in the form of breakthrough inventions and milestone achievements; iii) New or emerging industrial collaborations.

Who Monitors/Reports: PRACE AISBL and members of PRACE AISBL

Who is the Recipient: PRACE AISBL BoD

When: Yearly

Procedure: Information regarding software development could be collected from projects (mainly preparatory access projects) allocated by PRACE. This information can be obtained from the reports filled by applicants after completion of those projects. Information on industrial applications can be obtained in a random manner from PRACE members and from projects run on the PRACE infrastructure by conducting market research or by receiving information from applicants to projects in some cases long after the end of the projects. It will be necessary to design a procedure for identifying project with potential industrial applications and follow up on their development long after the allocation of resources to the project. This methodology needs to be analysed in more detail.

Priority: Long term

D.7 Vendor companies – How is PRACE AISBL influencing vendor companies?

Monitoring Variable: Vendor companies

Description: As an indicative value of the evolution of the HPC ecosystem, PRACE will be interested to know the names, sectors, locations and amount of software and hardware companies with some application or relationship with HPC active in Europe, and if available, it might be also interesting also to know this at worldwide level as a benchmark.

Who Monitors/Reports: Members of PRACE AISBL and PRACE AISBL

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure:

- PRACE AISBL informs on the periodicity of reporting and the format to its members.
- The format should include basic standard information for each company censused: name, sector, relationship with HPC (continuous, occasional, punctual)
- Other fields might not be mandatory, although interesting to know: yearly revenue, and relationship with PRACE
- Once the information is gathered, statistic information could be extracted like identification of areas with increasing or decreasing HPC related industrial activities. This information can be afterwards analysed to assess the potential impact of PRACE or other factors in these trends.

Priority: Medium term

D.8 Investment of industry in HPC – How is PRACE AISBL influencing investment on HPC

Monitoring Variable: Investment of industry in HPC

Description: Although the main focus of PRACE is the creation of a research environment providing state-of-the-art HPC services to users, it is also important to measure the impact of PRACE on European industry, namely on HPC investments of industry. The trend of HPC investments of industry could be followed by surveying the following indicators: i) Value of HPC purchases; ii) Value of HPC purchases as percentage of total investment, iii) Value of HPC purchases as percentage of investment in R&D. It will be interesting to also to follow the previous parameters for the top 10 European R&D spenders.

Who Monitors/Reports: PRACE AISBL and members of PRACE AISBL.

Who is the Recipient: PRACE AISBL BoD and Council, and EC

When: Yearly

Procedure: Purchases are defined as acquisition of ownership rights to software, hardware or services. For example, the cost of buying an HPC system or the cost of running simulation software falls into this category. Monitoring HPC acquisitions of European companies may require extra resources and quite a lot of effort. It is advisable that this variable will be initially handled in a passive way, i.e. no direct surveys should be used but some follow up of important acquisitions (usually reported in the media or in newsletters) of the largest European industries could be an initial step.

Priority: Medium to long term

D.9 Industry participation in PRACE events – Is the dissemination of PRACE AISBL reaching industry?

Monitoring Variable: Industry participation in PRACE events

Description: The objective of this variable is to monitor the awareness of the industry regarding the PRACE services. One possibility of getting this information is by monitoring the participation of industry in PRACE events. This is important for PRACE since one of its objectives is to provide research tools to strengthen the European industry.

Who Monitors/Reports: PRACE AISBL dissemination team

Who is the Recipient: PRACE AISBL BoD and Council

When: Yearly

Procedure: The information should be mainly collected during PRACE events by monitoring the following indicators: i) Number of industry participants in PRACE-related seminars and events and ii) Types of industry participants in PRACE-related seminars and events (SMEs versus large enterprises, industrial sector, types of collaborations with PRACE). This information should be compiled into a report using a pre-defined format.

Priority: Short to medium term

D.10 PRACE awareness – Is PRACE AISBL creating awareness of its mission and services?

Monitoring Variable: PRACE raising awareness events and media coverage

Description: PRACE raising awareness events and media coverage is a synthetic variable that combines in itself 3 major groups of quantitative variables:

- Organization of special PRACE events: industrial events; scientific seminars/symposia; PRACE training events; collaboration activities with non-PRACE members and other RIs;
 - Variables: number of HPC events; number of attendees to the events; annual budget for PRACE events;
- Participation in international exhibitions and other events (for instance: ISC, SC, European ICT events);
 - Variables: annual budget of PRACE for participation in international exhibitions and other events; number of PRACE presentations for an international audience; number of visitors to PRACE booths (approximation);
- Public audience reached by the following channels: audio and video broadcasting; web streaming; printed materials (news in the press and other news channels, press releases) and give-aways;
 - Variables: annual budget for PRACE audio, video and paper materials as well as give-aways; number of printed paper materials – articles and magazines, posters, brochures, flyers; number of broadcasted PRACE video images on TV and radio interviews; number of web streaming events open to the general public; number of press cuttings uploaded on PRACE media channels.

The visibility of PRACE to the general public is a step in the right direction leading to the creation and increase of the overall understanding of the impact of HPC on the society and

economy. In this sense, PRACE AISBL efforts and perspectives should not be restricted to address the code enabling and applications, but also include actions towards further dissemination explanation of important achievements obtained with PRACE resources in a way understandable to the general public. PRACE success depends also on attracting the attention and interest of the public authorities and of different scientific and industrial communities that actively use and support the PRACE development.

Who Monitors/Reports: Local event organisers on behalf of PRACE AISBL, PRACE AISBL Members and PRACE AISBL BoD

Who is the Recipient: PRACE AISBL Council, EC, scientific and industrial communities

When: Yearly

Procedure:

- Defining a list of events to be included in the PRACE AISBL Dissemination Plan, in collaboration with the PRACE AISBL Members;
- Requesting local organizer(s) to collect information based on concrete pre-defined quantitative variables and send it to BoD (in some cases information can be collected directly by the PRACE dissemination team);
- Requesting information from every PRACE Member (every 3 months) regarding PRACE media coverage. This should be done by the BoD;
- Preparing reports by the BoD to the Council (every 6 months) and final information published on yearly basis.

Priority: Short term

D.11 Social and Economic events – Is PRACE AISBL having socio-economic impact?

Monitoring Variable: Social and Economic events

Description: Identification of key social and economic events (inventions, economic turns, technology trends, etc.) and analysis of their relationships with the HPC industry in general and with PRACE in particular. This assessment should be made on a case by case basis study through a panel of analysts who should try to find clear objective relationships between the facts and the PRACE services. The monitoring task, however, is just about the identification of these events.

Who Monitors/Reports: PRACE AISBL BoD and PRACE AISBL Members

Who is the Recipient: PRACE AISBL BoD and Council

When: Information to be collected continuously, and to be processed as soon as there is enough evidence of significant impact. Review of the information gathered should be performed yearly.

Procedure:

- PRACE AISBL informs its members of the passive monitoring task.
- Those members who report events should also gather the reasons why the event should be considered for evaluation.
- PRACE AISBL makes a pre-assessment once a year to decide on the need of triggering an in-depth case base analysis.
- If a case base analysis is triggered, PRACE AISBL creates an assessment committee with clear and objective rules to analyse the relevance of PRACE for the event.

- The result of the analysis will be a qualitative (and quantitative if possible) assessment of the impact of the event and the role of PRACE.

Priority: Long term.

Comment: The common cycle of return of investment of a Research Infrastructure in terms of benefits for society, industry or economy usually takes several years. Since PRACE is a young Research Infrastructure, this mechanism is likely to provide very little insight at present. Nevertheless, PRACE should passively keep track of events to be analysed and members of PRACE should also contribute to that in case they are aware of an event worth to be analysed.

D.12 Ranking of PRACE systems – What is the ranking of PRACE systems?

Monitoring Variable: Positioning in rankings of PRACE systems (TOP500, green ranking)

Description: TOP500 and GREEN500 rankings provide quantitative information on computational systems for high end applications. The ranked lists cover different dimensions such as performance (TOP500) and energy usage efficiency (GREEN500).

Who Monitors/Reports: PRACE AISBL BoD and PRACE AISBL Members

Who is the Recipient: PRACE AISBL, members of PRACE AISBL, HPC users and potential users, national decision makers and funding agencies, EC

When: Twice a year (actually this is the frequency of the publication of the lists)

Procedure: The information on the TOP500 and GREEN500 rankings is publically available in the internet. The global rankings contain lists of supercomputers and their main characteristics grouped according to pre-defined criteria and are pertinent to investigate whether an increase in European presence in TOP500 leads to higher impact on society, science and economy and vice-versa. The TOP500 ranking is based on the LINPACK benchmark (see www.top500.org) and the GREEN500 ranking is based on energy efficiency (see www.green500.org). The position of PRACE systems or systems operated by PRACE members in these lists increases the visibility of PRACE AISBL.

Priority: Short term

D.13 Environmental Impact – What is the impact of PRACE AISBL in the environment?

Monitoring variable: Environmental impact

Description: This variable refers to the environmental impact of the PRACE research infrastructure in terms of energy resources coupled with changes in terms of equipment efficiency, utilisation levels and hosting practices. Details should also be gathered regarding facilitated environmental research. This will likely be in two forms: RI users undertaking research projects or projects involving the respective centres that focus on environmental matters particularly energy usage.

Who Monitors/Reports: PRACE AISBL BoD and members of PRACE AISBL

Who is the Recipient: PRACE AISBL Council, members of PRACE AISBL Members, the public

When: Yearly

Procedure: Computer centres will be asked to provide the core data on a per machine basis showing:

- System power consumption.
- Cooling and plant power consumption.
- A sustained Linpack performance figure from which flops/kW, etc. can be derived.
- Exception reports that capture novel developments relating to energy source, cooling technology enhanced PUE, etc. Such reports should cover both positive and negative developments.

PRACE AISBL will also examine the list of projects granted access to check for projects which may be relevant to environmental impact reporting. Summarisation and analysis of this data will be provided by PRACE AISBL. Care should be taken to note changes from previous reports and highlight significant changes and any exception reports submitted.

While the data as outlined above will be of interest to HPC professionals, alternative presentation of the data could also be produced to help convey the numbers in terms of more day to day activities or means of energy consumption. The data should be collected over time for inferring possible trends.

Priority: Short term

4.3 Reporting

The set of variables described in the preceding section is the basis for the reporting process that PRACE may want to implement.

From the detailed descriptions of the proposed variables a common process can be identified based on the following general elements:

1. Source of monitored variables – origin of the data necessary to monitor the variables defined:
 - PRACE AISBL member's organizations
 - Hosting Member sites
 - Specialized repositories
 - Survey activities necessary for monitoring the variable
2. Reporting data collector – entity responsible for collecting the data:
 - PRACE AISBL Hosting Members and in particular staff of the hosting sites of HMs.
 - PRACE AISBL Members
 - PRACE AISBL BoD. BoD in the previous section is meant as the entity responsible for monitoring, but of course the BoD will need to delegate the responsibilities of monitoring most of the variables to personnel of PRACE AISBL, e.g. peer review, financial, dissemination, technology and other necessary staff
3. Reporting builder – entity responsible for preparing the report:
 - PRACE AISBL HMs
 - PRACE AISBL staff, on behalf of the PRACE AISBL BoD
4. Reporting receiver – entity receiving the report:

- PRACE AISBL BoD
- PRACE AISBL Council
- EC
- Scientific communities
- HPC users
- General public

A further element is the appropriate identification of the job profiles involved in the actual tasks of data processing and report building. The definition and association of the appropriate job profiles will start from the classification of the monitoring indicators presented in section 4.1 and the results are presented in Table 1.

	Skill/expertise	Job profile	Reporting process Task
Input indicators	Financial expertise	Financial officer	Report requirement engineering, data post-processing, report generation, report validation
Delivery Indicators	Service management expertise, operation expertise	Administrative officer, Technology officer, Service manager	Report requirement engineering, data collection, data post-processing, report generation
Output Indicators	Service management expertise, dissemination expertise	Service manager, Dissemination officer	Report requirement engineering, data collection, data post-processing, report generation
Environment Indicators	Business expertise, technology expertise	Business manager, Service manager, Technology Officer	Report requirement engineering, data collection, data post-processing, report generation

Table 1: Definition and association of the appropriate job profiles

The management of the reporting process will require the following roles to be defined and clearly assigned:

Reporting process manager responsible for effectiveness and efficiency of the reporting process.

Reporting Agent currently responsible for either an activity or task within the overall activity of reporting.

Reporting Builder responsible for generating the report.

Reporting Validator responsible for validating the report (if necessary) before it is sent to the receivers.

Reporting Data Collector collects and transforms the data from its source in the form necessary for the report.

Reporting Receiver is the person or group who receives the Final Report.

The above role structure associated with the profiles defined in Table 1 will have to be mapped to the actual PRACE AISBL organization taking into account that reporting will be one of the basic processes that need to be implemented.

5 Conclusions and future work

In this document, we have presented a proposal with variables that PRACE may decide to use to measure its performance. For each of them, we have proposed, among other parameters, its purpose, description and a draft process for its implementation. The variables are classified according to categories that measure Efficiency, Effectiveness or Impact and also according to the components of the PRACE operational model, i.e. Input, Delivery, Output and Environment (see Table 2).

The set of monitoring variables presented is not exhaustive, but it is a result of a prioritisation process made by the consortium according to the utility and feasibility of measurements. We believe that these variables can depict the operational status of PRACE in an optimal way. PRACE AISBL, as a service organisation, should have a balanced operational scorecard in place and the suggestions put forward in this document can be used to build it. Such type of tools are used by large business organisations on a daily basis and PRACE should take advantage of these solutions. The monitoring variables identified here, upon the necessary processing and assessment, will provide enough information for further impact analysis that will help the management of PRACE AISBL to fulfil its mission.

The majority of the indicators described operate in either Effectiveness or Impact domain. The low number of Efficiency-related variables is due to two main facts: first of all due to the nature of PRACE as a distributed service organisation delegating lower level, strictly operational tasks to its members, and secondly because efficiency measurements are mainly addressed to organizations with a clear business orientation to maximise their return of investment by optimising their business operations. Though this point is also important for PRACE, it is necessary to make sure the quality of the services is not compromised by strong business orientation.

Furthermore, it is noticeable that the indicators related to Impact are the most laborious in terms of preparation and they might require additional resources. These, however, are the indicators that could deliver the most information about “the return on investment” of PRACE as a concept. In general, some variables can be collated using existing data and without excessive investment. Impact assessment variables will be further analysed in the next deliverable and some will be demonstrated with the data gathered so far.

We have not laid out a step-by-step process for collecting the data required to carry out these measurements, nor have we recommended a detailed process for putting a set of metrics in place. This should be done as a follow-up to our project after having decided which variables can be implemented at present.

Process Component	Monitoring Variable	Who Monitors	Recipient	Periodicity	Priority	Indicator type
Input	Financial data provided by the PRACE AISBL	PRACE AISBL BoD and HMs	PRACE AISBL Council	Every quarter and yearly	Short term	Effectiveness
Input	Monitoring of in-kind contribution	PRACE AISBL BoD	PRACE AISBL Council	Yearly	Medium term	Effectiveness
Input	Monetary value of actual allocated resources	The HMs for the costs of the compute cycles contributed and the BoD for the costs incurred by PRACE for allocation of resources and other standard expenses	PRACE AISBL Council	Twice a year	Short term	Effectiveness
Input	CPU hours contributed by HMs	HMs	PRACE AISBL BoD and Council	Every quarter and yearly	Short term	Effectiveness
Delivery	Success ratio of proposals	Scientific Steering Committee, PRACE AISBL BoD	PRACE AISBL Council, PRACE members, HPC users and potential users	Each call with yearly consolidated report	Short term	Effectiveness/impact
Delivery	H-index and g-index of applicants	Scientific Steering Committee, PRACE AISBL BoD	PRACE AISBL Council, PRACE members, HPC users and potential users	Yearly	Short term	Impact
Delivery	Resource allocation	PRACE AISBL peer review staff	PRACE AISBL Council, funding organizations, EC, HPC users and general public	After each call, complemented with yearly analysis	Short term	Effectiveness/impact

D2.4.1

Monitoring and Reporting Procedures

Process Component	Monitoring Variable	Who Monitors	Recipient	Periodicity	Priority	Indicator type
Delivery	Technical specifications of available systems	Every single PRACE member providing Tier-0 or Tier-1 resources	PRACE AISBL BoD and Council	Yearly	Short term	Effectiveness/impact
Delivery	Incidents and downtimes	Computer centres	PRACE AISBL BoD and Council, PRACE users and other HPC community groups	Yearly	Short term	Effectiveness
Delivery	Total usage relative to allocation per period	Computer centres	PRACE AISBL BoD and PRACE users	Every quarter and annual consolidated report	Short term	Efficiency
Delivery	Distribution per job size and total duration	Computer centres	PRACE AISBL	Every quarter and annual consolidated report	Short to medium term	Efficiency/impact
Delivery	Type of application support and respective results	Computer centres	PRACE AISBL, PRACE users and other HPC communities	Yearly	Short to medium term	Efficiency
Delivery	Number of user tickets and time to response	Computer centres	PRACE AISBL, PRACE users and other HPC community groups	Yearly	Medium term	Efficiency
Delivery	User satisfaction	PRACE AISBL BoD. An external survey expert team may be involved	PRACE AISBL Council, EC	Yearly	Short term	Efficiency

D2.4.1

Monitoring and Reporting Procedures

Process Component	Monitoring Variable	Who Monitors	Recipient	Periodicity	Priority	Indicator type
Delivery	Training events	PRACE AISBL BoD with collaboration of PRACE members who organize PRACE events	PRACE AISBL Council, EC, Users and Scientific communities	Yearly	Short/medium term	Effectiveness
Output	Publications, theses, success stories	PRACE AISBL BoD and all PRACE members	PRACE AISBL Council, PRACE members, EC, HPC users and potential users	Yearly	Medium term	Effectiveness/impact
Output	Typology of projects in terms of additional funding of private/public collaborations	PRACE AISBL BoD	PRACE AISBL Council	After each call, complemented with annual analysis	Medium term	Effectiveness/impact
Output	Types of collaboration with industry	PRACE AISBL and PRACE members	PRACE AISBL BoD	Yearly	Medium term	Effectiveness
Output	Industry proposals for resource request	PRACE AISBL BoD	PRACE AISBL BoD and Council	Yearly	Short term	Effectiveness
Environment	Financial data provided in the individual Annual Reports of the PRACE members	Each member of PRACE AISBL	PRACE AISBL BoD and Council	Yearly	Medium term	Impact
Environment	Patents and spin-offs	PRACE AISBL BoD, all members of PRACE	PRACE AISBL Council, EC, general	Yearly	Medium term	Impact

Process Component	Monitoring Variable	Who Monitors	Recipient	Periodicity	Priority	Indicator type
		AISBL	public			
Environment	Relationships with other European Institutions	PRACE AISBL BoD	PRACE AISBL Council and EC	Yearly or every two years	Medium/long term	Effectiveness/impact
Environment	HPC related job trend	PRACE AISBL BoD	PRACE AISBL Council, EC, general public	Monitoring yearly, reporting every two years	Medium term	Impact
Environment	European companies in the HPC area	PRACE AISBL BoD and members of PRACE AISBL	PRACE AISBL BoD and Council	Yearly	Medium/long term	Impact
Environment	Software development for scalability increase, industrial applications, creation of new collaborations	PRACE AISBL and members of PRACE AISBL	PRACE AISBL BoD	Yearly	Long term	Impact
Environment	Vendor companies	Members of PRACE AISBL, PRACE AISBL	PRACE AISBL BoD and Council	Yearly	Medium term	Impact
Environment	Investment of industry in HPC	Members of PRACE AISBL, PRACE AISBL	PRACE AISBL BoD and Council, EC	Yearly	Medium/long term	Impact
Environment	Industry participation in PRACE events	PRACE AISBL dissemination team	PRACE AISBL BoD and Council	Yearly	Short/medium term	Impact/effectiveness
Environment	PRACE raising awareness events and	Local event organisers on behalf of PRACE AISBL,	PRACE AISBL Council, EC, scientific	Yearly	Short term	Impact/Effectiveness

Process Component	Monitoring Variable	Who Monitors	Recipient	Periodicity	Priority	Indicator type
	media coverage	members of PRACE AISBL and PRACE AISBL BoD	and industrial communities			
Environment	Social and Economic events	Members of PRACE AISBL and PRACE AISBL BoD	PRACE AISBL BoD and Council	Continuous collection of information, yearly review	Long term	Impact
Environment	Positioning in rankings of PRACE systems (TOP500, green ranking)	Members of PRACE AISBL, PRACE AISBL BoD	PRACE AISBL, members of PRACE AISBL, HPC users and potential users, national decision makers and funding agencies, EC	Twice a year	Short term	Effectiveness
Environment	Environmental impact	Members of PRACE AISBL and PRACE AISBL BoD	Members of PRACE AISBL, PRACE AISBL Council, general public	Yearly	Short term	Impact

Table 2: Monitoring variables and their main characteristics

