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Update on PRACE's strategic and operational developments towards EuroHPC JU

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[2] PRACE-5IP, D2.3 "Report on PRACE 2, TNA and DECI Year 2" available at https://prace-ri.eu/wp-content/uploads/5IP-D2.3.pdf
[3] PRACE-6IP, D2.1 "PRACE role in the European HPC strategy and implementation" available at https://prace-ri.eu/wp-content/uploads/PRACE6IP-D2.1.pdf
[4] PRACE-6IP, D2.4 "Report on PRACE strategic and operational developments towards EuroHPC-JU" https://prace-ri.eu/wp-content/uploads/PRACE-6IP-D2.4.pdf
[5] https://hpc-portal.eu/
[6] https://prace-ri.eu/
[7] https://training.prace-ri.eu/
[8] https://materials.prace-ri.eu/view/divisions/
[9] https://events.prace-ri.eu/
[10] https://www.eurocc-access.eu/
[11] https://prace-ri.eu/infrastructure-support/market-and-technology-watch/
[12] https://prace-ri.eu/infrastructure-support/european-workshops-on-hpc-infrastructures/
[13] https://prace-ri.eu/wp-content/uploads/Security-in-an-Evolving-European-HPC-Ecosystem.pdf
[14] https://www.cai.sk/ojs/index.php/cai/article/view/2020_4_622
[15] https://fenix-ri.eu/
[16] https://providers.eosc-portal.eu/provider/update/prace
[17] https://www.esfri.eu/
[18] ESFRI Roadmap 2021, https://roadmap2021.esfri.eu/

[19] https://www.slices-ri.eu/
[20] http://www.sobigdata.eu
[21] https://ebrains.eu
[22] https://hpc-portal.eu/contact/hpc_in_europe_request
[23] https://prace-ri.eu/hpc-access/eurohpc-access/
[24] https://prace-ri.eu/wp-content/uploads/2019/08/prace_aisbl_statutes_engl.pdf
[25] PRACE-1IP, D2.4.1 "Monitoring and Reporting Procedures" available at https://prace-ri.eu/wp-content/uploads/1IP-D2.4.1.pdf

List of Acronyms and Abbreviations

AC	PRACE Access Committee
AI	Artificial Intelligence
aisbl	Association International Sans But Lucratif (legal form of the PRACE-RI)
BDVA	European Big Data Value Forum
BoD	PRACE Board of Directors
BoF	Bird of a Feather
CASTIEL	Coordination and Support for National Competence Centres on a European Level
CERN	European Organization for Nuclear Research
CoE	Centre of Excellence
DECI	Distributed European Computing Initiative
DEISA	Distributed European Infrastructure for Supercomputing Applications EU project by leading national HPC centres
EBRAINS	European Brain ReseArch INfrastructureS
EC	European Commission
EOSC	European Open Science Cloud
EPI	European Processor Initiative
ESFRI	European Strategy Forum on Research Infrastructures
ETP4HPC	European Technology Platform for High Performance Computing
EUDAT	European Data Infrastructure
EXDCI	European eXtreme Data and Computing Initiative
FETHPC	Future and Emerging Technologies HPC
FocusCoE	Concerted action for the European HPC CoEs
FTE	Full-Time Equivalent
GB	Governing Board
GDPR	General Data Protection Regulation
GÉANT	Collaboration between National Research and Education Networks to build a multi-gigabit pan-European network. The current EC-funded project as of 2015 is GN4
GP	PRACE General Partner
H2020	Horizon 2020
HL-LHC	High-Luminosity Large Hadron Collider
HLST	High Level Support Team
HM	PRACE Hosting Members
HPC	High Performance Computing; Computing at a high performance level at any given time; often used synonym with Supercomputing
HPDA	High Performance Data Analytics
HPL	High Performance LINPACK

IAC	PRACE Industrial Advisory Committee
ICEI	Interactive Computing E-Infrastructure for the Human Brain Project
INFRAG	Infrastructure Advisory Group
JU	Joint Undertaking
KPI	Key Performance Indicator
LINPACK	Software library for Linear Algebra
MB	Management Board (highest decision making body of the project)
MFF	Multiannual Financial Framework
nCC	National Competence Centre
PA	Preparatory Access (to PRACE resources)
PI	Principal Investigator
PTC	PRACE Training Centres
POP CoE	Performance Optimisation and Productivity Centre of Excellence in HPC
PMO	Project Management Office
PRACE	Partnership for Advanced Computing in Europe; Project Acronym
PRACE 1	The initial period of the PRACE Research Infrastructure
PRACE 2	The second period of the PRACE Research Infrastructure following the initial five-year period
PRACE 3	The period of PRACE Research Infrastructure on the EuroHPC era
RI	Research Infrastructure
RIAG	Research and Innovation Advisory Group
SC	Supercomputing Conference
SHAPE	PRACE SME HPC Adoption Programme in Europe
SKA	Square Kilometre Array
SKAO	Square Kilometre Array Observatory
SLICES	Scientific Large-scale Infrastructure for Computing/Communication Experimental Studies
SME	Small and medium-sized enterprises
SoBigData	European Integrated Infrastructure for Social Mining and Big Data Analytics
SSC	PRACE Scientific Steering Committee
TB	Technical Board (group of Work Package leaders)
TCO	Total Cost of Ownership
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
Tier-1	National or topical HPC centres
WP	Work Package

List of Project Partner Acronyms

BADW-LRZ	Leibniz-Rechenzentrum der Bayerischen Akademie der Wissenschaften, Germany (3rd Party to GCS)
BILKENT	Bilkent University, Turkey (3rd Party to UHEM)
BSC	Barcelona Supercomputing Center - Centro Nacional de Supercomputacion, Spain
CaSToRC	The Computation-based Science and Technology Research Center (CaSToRC), The Cyprus Institute, Cyprus
CCSAS	Computing Centre of the Slovak Academy of Sciences, Slovakia
CEA	Commissariat à l'Energie Atomique et aux Energies Alternatives, France (3rd Party to GENCI)

CENAERO	Centre de Recherche en Aéronautique ASBL, Belgium (3rd Party to UANTWERPEN)
CESGA	Fundacion Publica Gallega Centro Tecnológico de Supercomputación de Galicia, Spain, (3rd Party to BSC)
CINECA	CINECA Consorzio Interuniversitario, Italy
CINES	Centre Informatique National de l'Enseignement Supérieur, France (3rd Party to GENCI)
CNRS	Centre National de la Recherche Scientifique, France (3rd Party to GENCI)
CSC	CSC Scientific Computing Ltd., Finland
CSIC	Spanish Council for Scientific Research (3rd Party to BSC)
CYFRONET	Academic Computing Centre CYFRONET AGH, Poland (3rd Party to PNSC)
DTU	Technical University of Denmark (3rd Party of UCPH)
EPCC	EPCC at The University of Edinburgh, UK
EUDAT CDI	EUDAT Collaborative Data Infrastructure
ETH Zurich (CSCS)	Eidgenössische Technische Hochschule Zürich – CSCS, Switzerland
GCS	Gauss Centre for Supercomputing e.V., Germany
GÉANT	GÉANT Vereniging
GENCI	Grand Equipement National de Calcul Intensiv, France
GRNET	National Infrastructures for Research and Technology, Greece
ICREA	Catalan Institution for Research and Advanced Studies (3rd Party to BSC)
INRIA	Institut National de Recherche en Informatique et Automatique, France (3rd Party to GENCI)
IST-ID	Instituto Superior Técnico for Research and Development, Portugal (3rd Party to UC-LCA)
IT4I	Vysoka Skola Banska - Technicka Univerzita Ostrava, Czech Republic
IUCC	Machba - Inter University Computation Centre, Israel
JUELICH	Forschungszentrum Juelich GmbH, Germany
KIFÜ (NIIFI)	Governmental Information Technology Development Agency, Hungary
KTH	Royal Institute of Technology, Sweden (3rd Party to SNIC-UU)
KULEUVEN	Katholieke Universiteit Leuven, Belgium (3rd Party to UANTWERPEN)
LiU	Linkoping University, Sweden (3rd Party to SNIC-UU)
MPCDF	Max Planck Gesellschaft zur Förderung der Wissenschaften e.V., Germany (3rd Party to GCS)
NCSA	National Centre for Supercomputing Applications, Bulgaria
NTNU	The Norwegian University of Science and Technology, Norway (3rd Party to SIGMA2)
NUI-Galway	National University of Ireland Galway, Ireland
PRACE	Partnership for Advanced Computing in Europe aisbl, Belgium
PSNC	Poznan Supercomputing and Networking Center, Poland
SDU	University of Southern Denmark (3rd Party to UCPH)
SIGMA2	UNINETT Sigma2 AS, Norway
SNIC-UU	Uppsala Universitet, Sweden
STFC	Science and Technology Facilities Council, UK (3rd Party to UEDIN)
SURF	SURF is the collaborative organisation for ICT in Dutch education and research
TASK	Politechnika Gdańska (3rd Party to PNSC)

TUWien	Technische Universität Wien, Austria
UANTWERPEN	Universiteit Antwerpen, Belgium
UC-LCA	Universidade de Coimbra, Labotatório de Computação Avançada, Portugal
UCPH	Københavns Universitet, Denmark
UEDIN	The University of Edinburgh
UHEM	Istanbul Technical University, Ayazaga Campus, Turkey
UIBK	Universität Innsbruck, Austria (3rd Party to TU Wien)
UiO	University of Oslo, Norway (3rd Party to SIGMA2)
UL	Univerza V Ljubljani, Slovenia
ULIEGE	Université de Liège; Belgium (3rd Party to UANTWERPEN)
U Luxembourg	University of Luxembourg
UM	Universidade do Minho, Portugal, (3rd Party to UC-LCA)
UmU	Umea University, Sweden (3rd Party to SNIC-UU)
UnivEvora	Universidade de Évora, Portugal (3rd Party to UC-LCA)
UnivPorto	Universidade do Porto, Portugal (3rd Party to UC-LCA)
UPC	Universitat Politècnica de Catalunya, Spain (3rd Party to BSC)
USTUTT-HLRS	Universitaet Stuttgart – HLRS, Germany (3rd Party to GCS)
WCSS	Politechnika Wroclawska, Poland (3rd Party to PNSC)

Executive Summary

This deliverable reports on the main activities of Work Package 2 (WP2) during the last 12 months of the PRACE-6IP project (January 2022-December 2022). These include the following:

- Support to PRACE 2 programme, including a view towards PRACE 3;
- Provision of input to PRACE's position in the EuroHPC era and the impact for the HPC community of the PRACE services, activities and their interruption once the PRACE-6IP will come to an end;
- Peer Review activity undertaken for the last PRACE 2 Calls and first EuroHPC JU Calls;
- Update of the stakeholder management;
- Legal support to the PRACE Infrastructure and other work packages of the project
- Impact assessment.

The reporting on the PRACE 2 status within the PRACE Implementation Phase projects was initiated during PRACE-4IP (D2.2 "Second Report on PRACE 2.0 Development" [1]). This report was continued during PRACE-5IP (D2.1 "Report on PRACE 2, TNA, DECI and KPIs Year 1"[1] and D2.3 "Report on PRACE 2, TNA and DECI Year 2" [2]) and PRACE-6IP (D2.1 "PRACE role in the European HPC strategy and implementation" [3], D2.4 "Report on PRACE strategic and operational developments towards EuroHPC-JU" [4]). The current deliverable provides an update on this activity during the last year of the PRACE-6IP project (Jan 2022-Dec 2022). It reports on the last calls in the Second Period of operations of the PRACE pan-European Research Infrastructure, called PRACE 2, which began in 2017 and succeeded the PRACE agreement for the Initial Period (referred to as PRACE 1). This is complemented with a number of indicators to show the impact of PRACE as a pan-European research infrastructure, including statistics on gender and country participation for the last PRACE 2 calls. As part of the PRACE 2 programme, it presents also a summary of the final reports of the High Level Support Teams.

Another important activity during the last 12 months was the Peer Review activity where the PRACE Peer Review office managed not only the last PRACE 2 calls, but also the first EuroHPC JU calls and the transfer of the Peer Review activities from PRACE to EuroHPC JU, and its implementation. The deliverable includes also a list of indicators that EuroHPC JU could monitor and use to develop a set of HPC access KPIs.

With the last allocations of PRACE 2 ending in March 2023, this deliverable underlines the added value of the PRACE services and activities, and their impact for the HPC community once the PRACE Implementation Phase projects will come to an end in December 2022. In this regard, further considerations regarding PRACE's role and the future PRACE 3 in relation to the EuroHPC JU are presented.

Additionally, this document presents an analysis of the European HPC landscape including latest coordination events organised by PRACE-6IP and feedback of the main important stakeholders with regards to the future of this ecosystem.

[1] Confidential document, only for members of the consortium (including the Commission Services)

1 Introduction

During the last year of the PRACE-6IP project (January 2022-December 2022), WP2 continued the support to PRACE aisbl, Council and Board of Directors (BoD) towards the implementation and development of the PRACE strategy. Furthermore, WP2 provided support to identify PRACE's role within the European HPC ecosystem in the EuroHPC era.

This deliverable describes the activity of WP2 during the last year of the PRACE-6IP project and is structured as follows:

- Section 2 gives an update of the end of PRACE 2, its mission and objectives towards PRACE 3, with the analysis of the final PRACE 2 Project Access calls and activity of the High Level Support Teams (HLST);
- Section 3 reports on the evolving collaboration between PRACE and EuroHPC JU and PRACE's position towards EuroHPC. Moreover, this section underlines PRACE's services and activities and the impact for the European HPC community of their interruption once the PRACE-6IP will come to an end;
- On top of the HPC services, PRACE is also engaged in enabling the European HPC stakeholders to better define their roles and identify their position within the European HPC ecosystem. Section 4 gives an update on the European HPC ecosystem and the main outcome of this coordination task - the HPC in Europe Portal [5];
- Section 5 reports on the legal support provided by WP2 regarding issues of a legal nature of PRACE aisbl. An important aspect are the Memoranda of Understanding and collaboration agreements between PRACE and other stakeholders and their impact for the HPC community;
- Section 6 reports on the impact of PRACE through different sets of indicators, namely the public KPIs, PRACE aisbl internal indicators, PRACE 2 indicators, and other Peer Review indicators, as well as on service indicators for EuroHPC JU;
- Finally, some conclusions are drawn in Section 7.

For some of the analyses presented in this deliverable, WP2 consulted the legal advisor firm Bird & Bird LLP assisting PRACE.

2 Update PRACE 2 Programme Report

This section provides an update on different aspects of the PRACE 2 Programme since the last report in PRACE-6IP D2.4 [4] in December 2021.

After seven years of operation of the "Agreement for the Initial Period" (the so-called "PRACE 1" Programme) and a significant fraction of its commitment executed by four countries (Germany France, Italy and Spain), the PRACE Council certified the continuation of the European HPC infrastructure in its 25th meeting, on 3 March 2017 with the PRACE 2 Programme. Starting with Call 14, this second programme includes the commitment of five countries (France, Germany, Italy, Spain and Switzerland) to contribute through PRACE 15M of node hours per year each, corresponding to 40% of the capacity of a standard Tier-0 HPC system of 5000 nodes and two high-end processors per node; this represented a 2.5-fold increase of the resources made available through PRACE calls. The second novelty of the PRACE 2 Programme is the High Level Support Teams (HLST) programme, funded with €3 million annually by PRACE General Partners (GPs) and created with the objective of providing European scientific communities with support in code enabling and optimisation of scientific applications, in order to fully benefit from the performance of the PRACE HPC Tier-0 systems.

The PRACE 2 Programme has allowed Europe to remain competitive in the global HPC race, with an aggregated peak performance above 220 PFlop/s (November 2022), compared to the most powerful systems in the world, Frontier with 1 685 PFlop/s. This world-class capacity of the European ecosystem, with good architectural diversity, operated by experienced centres, together with strong applications and support, is pivotal to allow European academia, government and industry to fully benefit from the strong investments that Europe will contribute through the recently created EuroHPC JU, with an initial budget of €1.4 billion for its first phase. In July 2021, the new EuroHPC JU regulation was adopted, meaning that EuroHPC's operating period has been formally extended to the year 2027. The targeted funding until 2033 is approximately €7 billion, with half of the funding mainly coming from the EU Multiannual Financial Framework (MFF), the other half by EuroHPC JU members, notably through the hosting entities.

After six years of successful operation, the PRACE 2 programme will come to an end by March 2023, when the allocations from the last PRACE 2 call (24th) will be exhausted.

In this period, spanning from March 2017 to March 2023, a total of 487 proposals were awarded nearly 24 billion core hours through PRACE Project Access call. In the same time frame, the PRACE Access Committee identified that roughly a 10% of the projects could benefit from HLST support during the evaluation process, both as a complement to the HPC allocations or standalone support.

2.1 Mission and Objectives of PRACE

The overarching goal of PRACE is to provide a federated European supercomputing infrastructure that is science driven and globally competitive. It aims to strengthen European science by facilitating the access to a research infrastructure that enables high-impact scientific discovery and engineering research and development across all disciplines to enhance European competitiveness for the benefit of society. The goal of these actions is to help create a fertile basis for research, technology development and industrial competitiveness in Europe.

This overarching goal has been driving the infrastructure since its beginning in 2010. The principles, updated in 2017 to account for the contribution of all PRACE partners, are still valid for the next phase of the infrastructure in the EuroHPC JU era –the new PRACE 3 Programme– currently in preparation with the following updated mission and objectives:

- To facilitate access to European researchers in science and industry to a world-class Research Infrastructure, offering HPC and data management, Training, Support and Knowledge services;
- To support and organise the European HPC User Forum for academic and industrial users as well as public administrations;
- To foster international collaborations on the forefront of high-end computing in simulation and data science and to bring competence to the PRACE member states;
- To help develop Europe by promoting the European idea of bringing stability and peace through open scientific discourse between all members;
- To foster healthy research competition through the unique and purely scientific review based process that promotes scientific excellence;
- To stimulate the deployment of HPC in the knowledge economy in Europe and help European industry to become more competitive.

2.2 PRACE 2 Project Access Calls

PRACE has opened eleven Project Access calls within the PRACE 2 Programme (from Call 14 to Call 24), with an average offer of resources close to 4 billion core hours per year. This has represented a substantial increase when compared to the average 1.5 billion core hours awarded until 2016. This increase is even higher if one considers the real computing capacity offered, compared across systems and calls by normalising the core hours with the results of the High-Performance Linpack (HPL) benchmark. Such a double increase (in core hours and capacity) has been possible due to the renewed commitments of all PRACE Hosting Members (France, Germany, Italy, Spain and Switzerland) and the periodic upgrades of systems made available through PRACE.

Figure 1 shows the relative evolution of resources made available through PRACE, both in absolute core hours and using HPL normalisation, as compared to the first PRACE call in 2010. A clear growing tendency can be observed, with two strong jumps in capacity in Call 14 and Call 20, corresponding to the start of the PRACE 2 Programme and the incorporation of the highly dense systems Hawk (Germany) and Marconi 100 (Italy), respectively. The late decrease corresponds to the end of the contributions to the PRACE 2 programme.

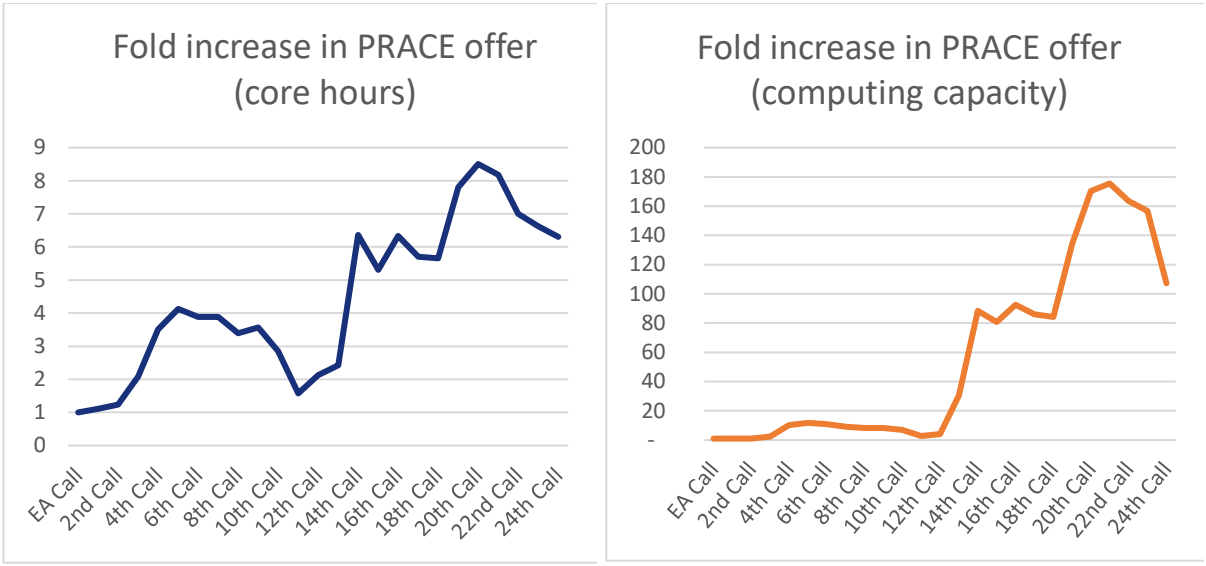


Figure 1: PRACE offer of core hours and increase of HPC computing capacity (compared to 2010)

Since the beginning of the PRACE infrastructure, the resources made available by PRACE have been distributed by the Board of Directors (BoD), strictly following the ranking elaborated by the Access Committee (AC), following the process prepared by the independent Scientific Steering Committee (SSC) and approved by the PRACE Council. This has proven a valuable mechanism with multiple control points that prevent biased decisions and guarantees a distribution of HPC resources based on the scientific and technical excellence of the proposals received. Such control points include the evaluation that the SSC carries out on the work of the AC, and the reporting on the use of resources that the BoD periodically prepares for the Council. Furthermore, these assessments serve to incorporate lessons learned into the overall process. This Peer Review and Resource Allocation cycle is shown in Figure 2.

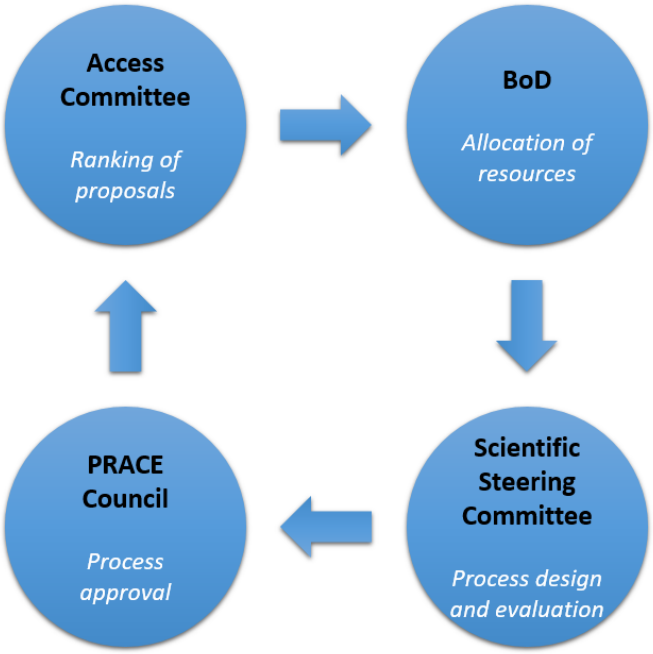


Figure 2: PRACE Peer Review and Resource Allocation cycle

The key element of the PRACE Resource Allocation is the distribution based on the scientific and technical excellence of the received proposals. This includes the important consequence that HPC resources are only awarded to projects reaching a certain technical and scientific threshold. Through this approach, PRACE has been encouraging and driving the scientific and technical improvement of European researchers throughout the years. In addition, even if resources were still available, projects below these thresholds are not eligible to receive PRACE awards. In such cases, any remaining resources are not distributed to the remaining proposals. Instead, these may be repurposed following recommendations of PRACE SSC or AC to increase support to Centres of Excellence or, as in recent calls, to support research related to COVID-19. Likewise, when high-calibre proposals cannot be fully awarded due to exhaustion of resources, PRACE may encourage the Hosting Members to top-up the pending resources above their original offer; even if this is normally a residual addition, in certain calls the increase is significant, e.g.: 8th call, 10th call and 23rd call. Figure 3 shows the number of proposals received, ranked above the quality thresholds and finally awarded. Figure 4 shows the offer of resources, resources requested and awarded.

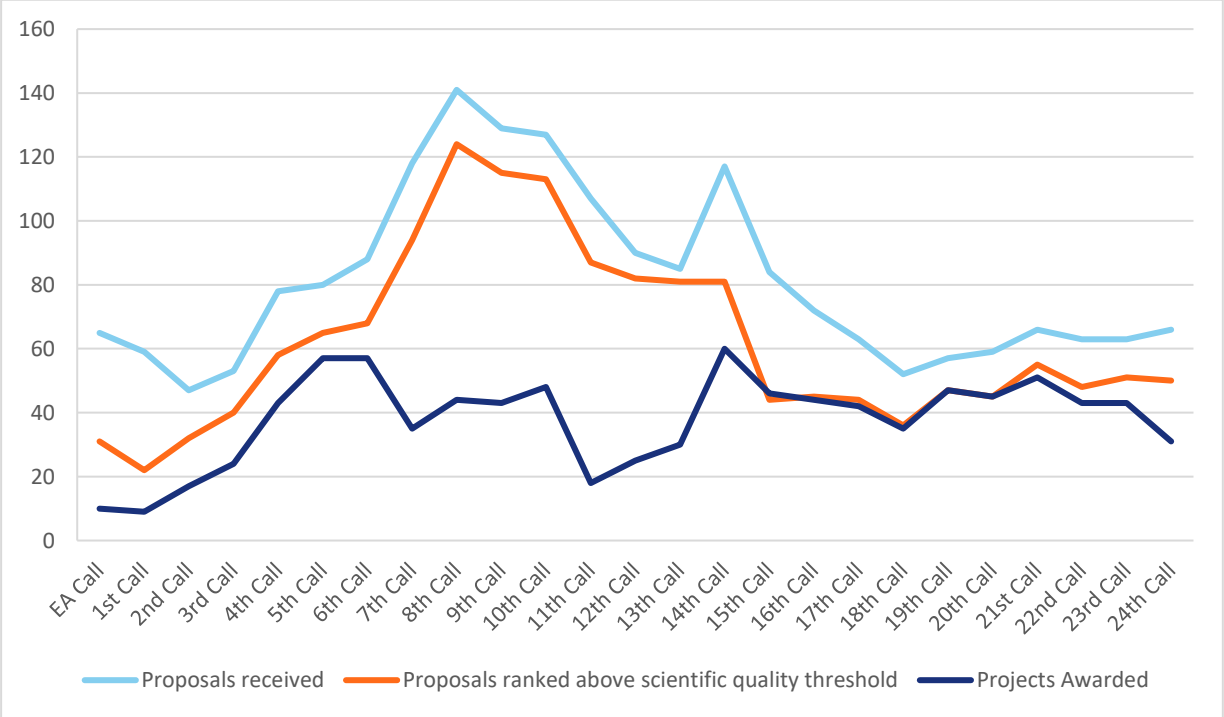


Figure 3: Total number of proposals received, ranked above quality threshold, and projects awarded

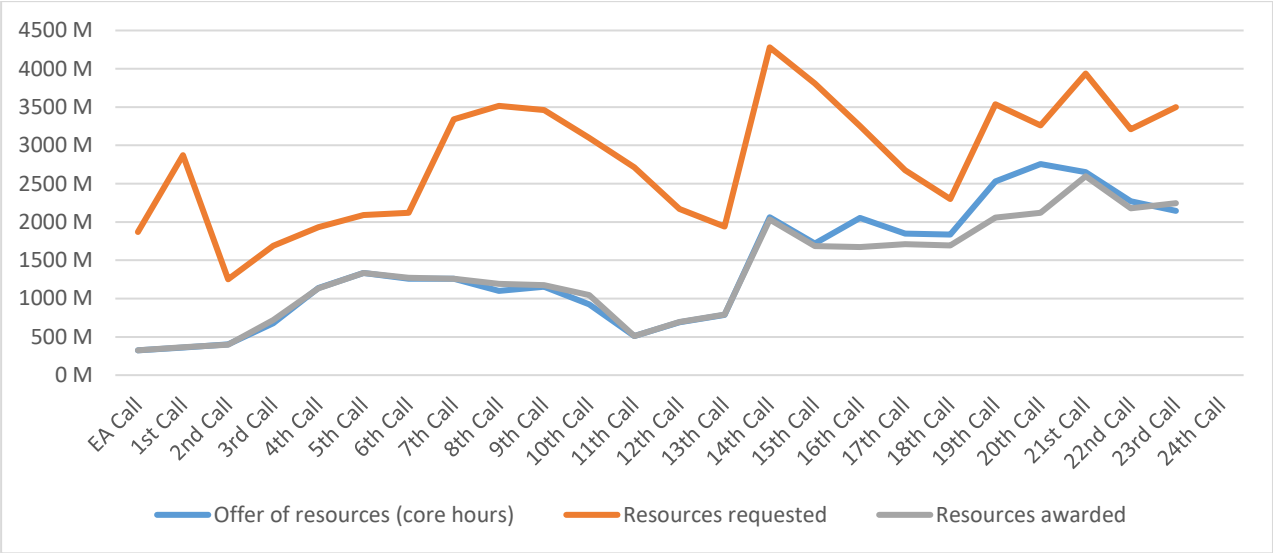


Figure 4: Evolution of resources (offered, requested and awarded) per call

The curves in Figure 3 show that not all proposals reach the quality threshold. Nevertheless, the large proportion of proposals above the set threshold is an indicator of the maturity of the community. The apparent decrease of quality observed in Call 14 and onwards is in fact a substantial rise of the quality thresholds, set by the PRACE SSC with the onset of the PRACE 2 Programme. The first impact of such increase can be observed comparing the data with Figure 4, with a certain number of calls (16th and onwards) where all the proposals above the quality thresholds are awarded and, therefore, not all the resources available were allocated due to lack of further proposals above such thresholds. A second impact is observed starting in Call 21, where the number of high-quality proposals improves again, indicating the increase of maturity of the European HPC community.

2.3 Final Reports of the High Level Support Teams

The High Level Support Teams (HLSTs) programme started in April 2017 with the implementation of 24 FTEs devoted to Level-2 and Level-3 user support in BSC, CSCS, GCS and GENCI. This was expanded with another 6 FTEs located in CINECA for a total of 30 FTEs. In this final full regime, the annual budget of the programme was 3 080 000 €, respectively 2 453 000 € in the last year of the programme, fully contributed by the PRACE General Partners through their PRACE aisbl membership fees.

This section updates on the HLSTs activity as reported in D2.1, July 2020 and gives a short overview of the final period of the HLST programme covering April 2020-November 2022.

The highlights of each HLST are as follows:

1. Team BSC: During the reported period, BSC has hosted 26 PRACE project access, allocating a total of 1026 million CPU hours, providing support to more than 241 users and solving more than 957 requests. For the long term support (3rd level support), BSC participated in the following research activities from the call "H2020-EINFRA-Centers of Excellence for computing applications": PoP2, EsiWACE-2, BioExcel2, NoMaD2, MaX 2, EoCoE, ChEESE, EXCELLERAT, which allowed the BSC HLST team to have

a direct contact with these CoEs and be able to receive the requirements and necessities from them in terms of Exascale computing, HPC software requirements and 3rd level support projects;

2. Team CSCS: The CSCS HLST was actively involved in Level-2 support to improve application scaling and workflow using well-established programming models such as MPI as well as OpenMP or OpenACC directives, and CUDA/CUDA-Fortran, and to optimise handling of huge volume of data. CSCS had a number of projects producing up to 1 PB of data that needed to be properly analysed and transferred. And starting from Call 17 the PRACE AC was also able to identify some Tier- 0 projects that needed the assistance and support of the HLST Level-2 support. A number of projects were also identified that required Level-3 support. Significant parts of the applications were on the process to be rewritten with an effort that should not exceed the 12 months. The HLST started strong collaborations with scientists who applied for resources at CSCS in order to achieve their final goal of taking full advantage of the acceleration;
3. Team CINES/GENCI and IDRIS/GENCI: In the past two years, the HLST team at CINES and IDRIS has been involved with several HPC code porting (on scalar and accelerated architectures) and optimisation projects along with significant contribution in centre's data related projects with primary focus on optimising energy consumption by the HPC jobs. The HPC codes which were optimised or ported by the HLST team include LPPic2D, VeloxChem, Voice, Smilei, SHTns and XSHELLS. Contributions were made towards the advancement of codes GCT, Gysela and YALES2 as well. Considering the amount of data generated by centre's supercomputer 'Occigen', a targeted data management project was started in the HPC Department at CINES;
4. Team GCS: The German PRACE HLST was initiated in 2018. After an initial hiring- and coordination phase it became fully operational and supported PRACE users at the German PRACE sites. It was organised as a network of three nodes. These nodes were located at the three member sites of the Gauss Centre for Supercomputing (GCS), namely at the Juelich Supercomputing Centre (JSC) of the Forschungszentrum Jülich GmbH, at the High Performance Computing Centre (HLRS) of the University of Stuttgart and at the Leibniz Supercomputing Centre (LRZ) of the Bavarian Academy of Sciences. Each node had an independent contract with the PRACE aisbl through its host institution but worked closely together with the other two under the umbrella of GCS.
   The German HLST focused on the scientific communities undertaking PRACE production projects running on the respective systems of the GCS sites. The HLST node at Juelich was in close cooperation with Lattice QCD and CFD, the one at Stuttgart concentrated on CFD as well as engineering and global system sciences, and the one at LRZ focused on Astrophysics, CFD and Quantum Chemistry. The CFD activities, which feature at all three nodes, have been closely coordinated to avoid duplicate work. During the support phase, close collaborations between advisors from the HLST nodes and user groups have been formed. The German HLST groups supported 31 Level-2 projects covering a wide range of different applications.
   It should be emphasised that the support activities of the three German HLST nodes were fully embedded in their site-local support structures, like domain-specific application labs or cross-sectional teams. Coordination between the three nodes was seamlessly maintained through the half-yearly all-hands GCS meetings. Furthermore, exchange with national, BMBF- or DFG-funded projects such as the HPC Software Initiative or the SPPEXA priority programme was guaranteed. On a European level, the

Centres of Excellence (CoEs) for computing applications were instrumental for the development and deployment of Best Practices and the exchange of experiences with respect to Level-3 and Level-4 support. Beyond level-2 support, which mainly focuses on running projects, the HLST provided Level-3 support for a number of community codes that we expect to be used in future PRACE proposals. These codes have been used in previous grants, are focus of PRACE preparatory access projects (type A or B) or stem from long-term collaboration of the centres with the code owners or scientific groups. Following application/projects were supported: Quantum Espresso (QE), EPOCH, GROMACS, Massive-Parallel Trajectory Calculations (MPTRAC), Pretty Efficient Parallel Coulomb (PEPC), OpenFOAM, Modular Supercomputing Architecture (MSA), Megatron-Deepspeed, Open3Gadget, BHAC, DPEcho, CPMD, LIBRSB, GRaSPT and BPG – modern;

5. Team CINECA: The activity at CINECA has been strongly influenced by the fact that the Tier-0 system at CINECA is based on an IBM Power 9 + Nvidia V100 architecture, which is very different from the more standard configurations based on x86. Porting community codes on this very particular architecture can require significant effort and involve many HPC experts. In particular, the Italian HLST supported the installation of major HPC community codes on the Marconi100 architecture. In addition, the CINECA HLST team gave support to the users also in preparing applications. In fact, any PRACE applicant could request support in preparing his/her technical application by sending an email to the Italian HLST team that helped applicants to solve their technical issues, preparing benchmarks and estimating the correct budget.
   Furthermore, the HLST activity also involved preparing tools to give users a better experience in using the Italian machine.
   The team has supported a large number of community codes, a selection of the most important ones are listed below:
   a. Classical Molecular Dynamics: GROMACS, NAMD, PLUMED, LAMMPS and Amber;
   b. Quantum Chemistry: Quantum ESPRESSO, Siesta, VASP, CP2K, Yambo
   c. Astrophysics: GDL;
   d. Life Science and Bioinformatics: Autodock, ctffind;
   e. Deep learning: deepmd, jupyter, detectron2.

   Many of these programs have been installed both as GPU-enabled and CPU-only.

3 PRACE Position and Services for EuroHPC

The PRACE Research Infrastructure was established in 2010 as a collaborative effort, which included most European countries. With an initial investment of €400 million in HPC resources provided by the four initial Hosting Members, this was complemented by other PRACE Members and the valuable support of the EC, for a Total Cost of Ownership (TCO) above €500 million. The infrastructure expansion continued through the PRACE 2 Programme, which included additional investments of another €300 million since 2017. Throughout these years, PRACE has developed and established itself into a successful research infrastructure. It has offered world-class HPC resources and services, through an established peer review process – solely based on scientific excellence, with a strong training and support programme which is widely respected by the European user communities, and valued by stakeholders and policy makers. So far, this great success has strongly relied on national contributions to PRACE, which have represented more than 90% of the TCO of the infrastructure, and the invaluable funding of the EC through the Implementation Phase projects. After more than 15 years of operation, and near the end of the PRACE 2 programme, there is clearly a solid basis for Europe to go beyond and break the current limits of national funding with EuroHPC JU, with a strong ecosystem ready to benefit and effectively exploit the investments ahead. PRACE is ready to play a leading role on this promising future.

In this section, we describe the PRACE position and services towards the forthcoming EuroHPC Joint Undertaking era, where we expect to reach a new order of magnitude in the global HPC race.

3.1 PRACE-EuroHPC Relation

Over the last 15 years, PRACE has gained tremendous experience and the strong trust of all involved stakeholders in the European High-Performance Computing (HPC) Ecosystem. This has been achieved through its scientific and industrial bodies, and end-user engagement and activities. This experience and track record are extremely valuable in ensuring the evolution, development and success of the ecosystem now undertaken by the EuroHPC JU initiative.

A well-defined relation between PRACE and EuroHPC JU will be instrumental in ensuring continuity, inclusivity and equal opportunities for the HPC users across Europe and the adoption of a uniform standard in HPC for European excellence in research and innovation across all sectors.

In order to achieve this, PRACE has been in discussion with EuroHPC and has worked towards proposing a clearly defined formal relation of PRACE to the EuroHPC JU that recognises the mission and role of PRACE in a complementary and collaborative environment between the two entities. In this way, a formal relation will fully utilise the experience of PRACE and ensure that Europe's investment in PRACE and its established experience is integrated within the new ecosystem.

Through these discussions, PRACE proposes to become a Private Member of EuroHPC JU (and if not possible, to formalise the relationship in any other appropriate way) so it can directly be connected to EuroHPC JU and formally have a voice as an organisation within the EuroHPC governing board. This will enable PRACE to best fulfil its future role in the European HPC ecosystem, avoid conflicts of interests and work in unison with EuroHPC JU.

Through this relationship, PRACE will be able to support users and user communities, both in academia and industry, through complementary training, porting, scaling and optimisation of their applications – reaching out to scientists beyond what is covered by other EuroHPC programmes. Future activities of PRACE will aim to fully exploit the capabilities of supercomputers and the convergence of HPC, HPDA & Artificial Intelligence (AI) that will include hybrid computing technologies connected (but not limited to) to quantum accelerators. In addition, PRACE through its members proposes to continue to offer resources, expanding the EuroHPC JU ecosystem of computers in a complimentary manner. It will function in full alignment, harmony and complementarity within the framework of the European initiative EuroHPC JU.

3.2 PRACE Services in the EuroHPC Era

With this relationship, PRACE will be able to complement the EuroHPC ecosystem with the following activities and services:

- PRACE as the voice of the user communities

  PRACE can represent the interests of HPC users (academic and industrial) and service providers and establish a clear relation to the User Forum of EuroHPC JU. PRACE can also, given its expertise and user involvement, maintain the design, monitoring and evolution of the Peer Review process - ensuring that scientific excellence remains the priority. In addition, PRACE represented in EuroHPC JU can manage the steering of the scientific panels for the EuroHPC access calls;

- Training

  The PRACE training network can continue to provide high quality training to the European HPC community, specifically targeting training to enable efficient usage of EuroHPC JU machines, new architectures and forward looking topics including development of artificial intelligence and quantum computing;

- Efficient use of technologies

  Following the recommendations from the PRACE Scientific Steering Committee (SSC), Industrial Advisory Committee (IAC) and the success of "PRACE-6IP WP8: Forward-looking Software Solutions", PRACE can continue supporting co-development activities led by the European HPC community towards the efficient use of EuroHPC JU systems, as well as promoting the adoption and enhancement of this work by the community;

- PRACE as a provider of complementary resources

  Defining PRACE as a Transnational Access Node within EuroHPC JU will enrich the European landscape, providing a more diverse ecosystem of machines and more resources – allowing for seamless coordination within EuroHPC JU. Such resources can include prototype systems or new architectures and other complementary resources. Users will have the ability to access such systems so communities can prepare for future machines, thus allowing for European researchers and innovators to be more readily competitive. Furthermore, experts from computational centres, members of PRACE with expertise on these systems, can provide support.

Through this, users from academia and industry will have access to a greater variety of supercomputing, prototype systems and architectures and targeted support. Such transnational access will ensure scientific excellence on equal participation across Europe and allow PRACE to retain its research infrastructure status;

- Technology assessment

  PRACE can assist EuroHPC JU in the collection of information and analysis of technology trends, and in the monitoring of scientific needs of researchers and communities including industry. PRACE can contribute to the scientific and technical watch in the HPC, AI and quantum computing world as a body independent from vendors.

This kind of relationship between PRACE and EuroHPC will be beneficial to both parties. The benefits for EuroHPC include:

- Linking the European Scientific and Industrial User communities and ensure that EuroHPC has access to these user communities;
- Preparing regularly the Scientific and Industrial User Case for HPC research and innovation in Europe by working together with the European scientific and industrial user communities;
- Providing to the EuroHPC Peer Review operations as in kind contribution access to the peer review tool developed by PRACE;
- Being in a good position to organise the HPC User forum on behalf of EuroHPC, taking advantage of the direct link to the user communities PRACE has established over the last decade;
- Continuing, on behalf of EuroHPC, to oversee the scientific and innovation aspects of the peer review and develop it further considering the specific needs of EuroHPC and relying on the input from the scientific and industrial communities;
- Contributing to an independent technology and usage assessment and the preparation of a yearly market watch report working together with EuroHPC advisory bodies, such as the RIAG and the INFRAG;
- Making codes ready for EuroHPC machines through co-development activities with the involvement of highly trained personnel from its members and user communities, and in collaboration with CoEs and other relevant stakeholders;
- Enabling efficient usage of EuroHPC machines through a targeted training program on a European scale open to all scientists and innovators across Europe taking advantage of PRACE's longstanding experience;
- Strengthening communication and dissemination activities on the European level, such as PRACEdays, PRACE prizes, etc;
- Enriching the EuroHPC ecosystem with more diverse computer architectures as a node within EuroHPC that can provide access to resources to European users through its members and linked parties including industry by e.g., the transnational access, complementing the resources of EuroHPC machines. Such access will provide early access to prototype and innovative systems preparing users and developing codes for future machines, serve community-specific access and access for co-development with researchers and industrial partners;

- Ensuring the continuity of the actions taking place over the last 15 years through the Memoranda of Understandings contracted with many of HPC stakeholders, in Europe and worldwide.

In turn, the benefits for PRACE in this relationship include:

- PRACE will attain a clear endorsement of its role in the new European ecosystem;
- A clear structure and relation to EuroHPC would help PRACE maintain its activities and provide good incentives for governments to continue their support;
- PRACE would best represent the interests of EU users (academic and industrial) if its role within EuroHPC is clearly defined and this mission is acknowledged and accepted by the EuroHPC JU. In particular, having PRACE giving access to novel technologies and possibly additional resources to all EU researchers would be an activity that can be under the umbrella of EuroHPC JU (and not competitive or separately);
- Regarding PRACE as part of the EuroHPC ecosystem would allow PRACE to work in cooperation with EuroHPC to best exploit its experience over the last 15 years, providing added value for the European ecosystem;
- PRACE can better utilize its experience, and scientific and industrial bodies to connect with the Centres of Excellence and industry initiatives to offer targeted assistance in the exploitation of HPC resources;
- Becoming a Private Member of EuroHPC will symbolise the official recognition of PRACE's past role in the European HPC ecosystem built up by PRACE over the last 15 years and further support its future role for the European HPC community.

For this relationship and activities to continue, a finance model between PRACE and EuroHPC will be required. Ideas for this include:

- Peer Review tool will be accounted as an in-kind contribution and hence as part of PRACE's contribution as a Private Member;
- PRACE operational costs will be covered by the PRACE membership fees;
- PRACE activities, beyond the operational costs, can be funded by projects, including upcoming EuroHPC calls that can be coordinated by its Project Management Office.

3.2.1 Peer Review for Calls for Computational Access

Towards the start of 2022, EuroHPC opened a tender for the peer review process. PRACE considered the tender and was prepared to submit a bit.

Before doing so, an analysis of its tax status and any changes that could be required because of this was carried out. The analysis showed that engaging in commercial services, would mean that the VAT status of PRACE would have to change as thus far it was considered a non-profit organisation and thus was VAT exempt.

After considering the pros and cons of such a change, the PRACE Council decided against changing the VAT status of PRACE, meaning that PRACE could not answer the EuroHPC tender. As mitigation measure, the PRACE-6IP project could cover the Peer Review funding for the year 2022 with a project extension which was granted. Since the PRACE-6IP project will end by 31 December 2022, after that there will be no funding available for the Peer Review service. Moreover, PRACE does not have a formal collaborative and cooperation agreement with EuroHPC, and whatsmore, beyond the end of 2022 there is no available funding for

PRACE to provide any kind of services to EuroHPC. As the end of the year approaches, it is not clear how EuroHPC management will be able to have a functional peer review office by 1 January 2023, as agreed by the EuroHPC Governing Board.

As a result of a PRACE Council action item, PRACE considered and applied to become a private member of EuroHPC JU at the end of September 2022. At the time of writing this report, EuroHPC suggested that PRACE cannot become a Private member but they indicated that an alternative official relationship between PRACE and EuroHPC is being investigated.

3.3 Continuity of Training and User Support Activities

Besides the provision of HPC cycles for the European research community, one of the key successes of PRACE has been the development and offering of complete and multidisciplinary training and user support programmes. These two programmes are under the risk to be discontinued with the end of the PRACE-6IP project, and considering them as strongly important for the continued development of the European HPC user community, PRACE organised two workshops during the PRACE-6IP All-hands meeting in Wien, Austria, 5-6 May 2022.

3.3.1 Workshop for User Support

The workshop for User Support, jointly prepared by PRACE-6IP WP2 and WP7, included a general overview of the PRACE process for providing support to HPC users, starting from the open calls for support, how the proposals are evaluated and distributed among the available experts, and finally how the support is executed. Following this, three centres (BSC, CINECA and JSC) presented their structure for User Support, and finally two beneficiaries from the support programme presented their experience and results. Representatives from EuroHPC JU, as well as from the EuroHPC JU petascale hosting entities were invited and attended the workshop.

During the workshop, it was demonstrated that Europe has benefited from a coordinated HPC users support all over the past 10 years, which has matched users from any European country with the most appropriate experts from the PRACE network. The conclusion of the workshop is that the HPC user support programme has been a successful initiative that has contributed to attract further users to large HPC systems, and also to the efficient use of these expensive research infrastructures. This programme should be continued and expanded by EuroHPC JU for Europe to fully benefit from the new capacities and investments.

3.3.2 Workshop for European Training

The workshop for European Training highlighted the effort conducted by PRACE to develop an integrated and coherent HPC training programme since 2012 through the PRACE Training Centres, including the important international component of this programme. After the success of the six initial PRACE Advanced Training Centres located in France, Germany, Italy, The Netherlands, Spain and UK, the network was expanded to 14 countries allowing an excellent competence and geographical coverage across Europe. Overall, more than 17 000 students were trained through PRACE training offer.

With the end of the PRACE-6IP project there is a risk that the set of courses is discontinued. In some countries the local universities may continue some of the courses, and in some countries it is the recently created National Competence Centres in HPC that are providing resources for them. Nevertheless, there is no initiative prepared to continue the integration of academic curricula and international vision that PRACE has been conducting for the past ten years.

The conclusion of the workshop is that the European Training programme conducted by PRACE has been a successful initiative that has contributed to train and incorporate further users to large HPC systems, by enabling them to develop their competences (from beginner to intermediate to advanced) and approach larger scientific challenges. There is a need to provide centralised funding beyond national scope to continue this coordination of the European training offer.

3.4 Decommissioning Plan of PRACE Services and Activities

During the PRACE-IP projects, various IT services and activities were developed and optimised, responding to the needs of the European HPC community by implementing a coherent set of services that together built a Research Infrastructure and activities best served the European HPC community. With the end of the PRACE-6IP project, all services are currently scheduled to be decommissioned and all activities are due to end. All services and activities have the potential to be re-opened if future projects or funding allows. In this section, we highlight some of these services and activities, their importance, and the impact for the user community if there is a discontinuity of these services and activities.

3.4.1 Unavailability of PRACE Services: Risk Evaluation

3.4.1.1 PRACE Infrastructure Operational Services and Network Monitoring

Importance: The PRACE HPC infrastructure connected HPC systems from most PRACE members, which included both Tier-0 and Tier-1 systems. This unified all the systems into a single "virtual" network, where users could easily and seamlessly move from one system to another in an interoperable manner. This allowed users to have the same operational environment and allowed for fast transfer of their data from one system to another. This is the cumulative result of all the previous PRACE IP projects, where the collective effort of PRACE partners allowed developing and maintaining a catalogue of services (mandatory and optional services) which could be deployed. These were chosen, to take into account a coherent way across all centres with regards to security and performance. To develop this catalogue of services required a significant amount of effort. Members of the computational centres operations teams had to evaluate the constant evolution of the implementation of these services, and the security policies which should always have been kept up to date. The exchange of best practices on energy efficiency, federated systems, and similar architectures is one of the most important added value of having a common Research Infrastructure across Europe. This is especially important for less mature HPC Centre to scale up their skill, to mitigate disparity and to allow better inclusivity of all European users.

Why this should continue: It is important that these services continue, as these have been selected through many years of experience and refinement. Loosing these will result in loss of operational infrastructure knowledge, and will likely result in duplication of work when the interconnecting of HPC systems is again required in the future. Beyond these services, it is

important to keep the collaboration spirit and trust developed across Europe between the teams in charge of the operation of the European HPC centres.

Impact of interruption: Very high. Without a common umbrella to coordinate, discuss, decide and put in place the services there is strong risk of divergence of these services, loss of interoperability and security issues. Without an adequate governance of this activity, there is a high risk of divergence, with each centre making their own choices, following divergent standards and making it a lot more difficult to coordinate afterwards.

3.4.1.2 PRACE GitHub

Importance: The PRACE GitHub serves as a repository for code, which whether for development, operational or training cases can be useful for people at any one time.

Why this should continue: Keeping this code available online is essential, as it can help in the debugging, support and training of users. Users may chance upon relevant code through a simple google search, or they may specifically seek out some code to learn or explore something. Of course, there are other similar repositories online, but for users to be able to access specific examples from PRACE and its relative training, it is important that PRACE GitHub remains live, and the code remain available online.

Impact of interruption: Medium. Without this repository and the maintenance of it, HPC users could seek similar repositories from the US, providing less visibility on the work of the European HPC ecosystem.

3.4.1.3 PRACE Website

Importance: The PRACE website [6] is a very important service to the European HPC ecosystem, as it holds the history of PRACE, how it supported users, the outcomes of the PRACE Implementation Phase projects – including deliverables, white papers, best practise guides, market and technology watch and outcomes of people accessing PRACE resources through scientific/innovation success stories.

Why this should continue: The PRACE website will remain online for a few years after the end of the PRACE-6IP project. However, it is important that it continues to be populated with content, as due to the established PRACE brand, it could be used to communicate and disseminate information about HPC activities on a European level. At the moment, there is no project or initiative which communicates and represents the activities of HPC on a European level. This is something that can be carried out on the PRACE website through the effective communication office of PRACE aisbl.

Further to the above, the PRACE-6IP WP3 also had a task of disseminating information related to EuroHPC. As such, a section of the PRACE website is devoted to the various EuroHPC calls and provides details of these and how users can apply.

This is carried out, because EuroHPC's website follows a strict EC template and such details cannot be displayed in a clear and coherent manner. A good example of this is the allocation of resources to projects. PRACE has a clear presentation of all projects which were awarded resources in previous PRACE calls, whereas on the EuroHPC website, these details can only be viewed by downloading an excel file which can be found under the documents section of the EuroHPC website. However, once the PRACE-6IP project will come to an end (31 December 2022) there will be no formal relation or agreement between EuroHPC and PRACE anymore.

Therefore, PRACE has no mandate and resources to continue maintaining and presenting content for or on behalf of EuroHPC on its website.

Impact of interruption: Very high. The PRACE brand is very well known and valued in Europe and abroad, and the PRACE website is a major source of information, for PRACE-IP projects but also for the whole European ecosystem. Without this website and its maintenance, HPC users would have to seek information on other non-European sources. The impact will be very severe for future new European users, especially from SMEs and Industry which seek an entry gate to the HPC ecosystem.

3.4.1.4 PRACE Training Portal

Importance: The PRACE Training Portal [7] is important, as it retains information of PRACE Training Events which have taken place throughout the PRACE-IP projects. Through the Training Portal people can see the content of the previous training events and access material too.

Why this should continue: Keeping the PRACE Training Portal online is important, as it acts as a HPC training resource. People can view previous events and search for material on specific HPC subjects across events. Due to the number of events and material available, it is thus vital this be funded and remain live and online.

Impact of interruption: High. Especially for entry-level HPC users, SMEs and Industry who require such material to get started in their HPC journey.

3.4.1.5 PRACE Material Portal

Importance: The PRACE Material Portal [8] is closely tied to the PRACE Training Portal – hosting the material which can be found and accessed via the Training Portal.

Why this should continue: For similar reasons to the Training Portal, keeping the PRACE Material Portal running is important to maintain the free access of a training repository which people can use to learn important skills to enhance their knowledge and expertise.

Impact of Interruption: High. Especially for entry-level HPC users, SMEs and Industry who require such material to get started in their HPC journey,

3.4.1.6 PRACE Events Portal

Importance: The PRACE Events Portal [9] is based on the Indico software and it is used by PRACE – and other parties, to manage training events, allowing for description of training events and registration by participants.

Why this should continue: The PRACE Events Portal has been configured based on the needs of PRACE members for the training events they host. PRACE members and other related partners in the CASTIEL and FocusCoE projects have requested for this service to remain, so they can manage their own training events on this platform – even though their events may be regional/national events and not necessarily PRACE events.

Impact of interruption: Medium. Although the advertising and registration of events can be carried out with other tools – such as webpages and use of google forms, the PRACE Events Portal is a complete package service for events.

3.4.1.7 CRM (Mailerlite)

Importance: The PRACE Customer Relationship Management software allows for a database of contacts and an email system to inform them of specific information which may be of interest to them. It has been used in the past to inform contacts of PRACE events, news, calls and other related information.

Why this should continue: Given the PRACE brand and size of the contact database (over 2 000 entries), the PRACE CRM can be used to disseminate to the European and International HPC Community important information concerning HPC activities in Europe – such as opening of calls, advertising of key European HPC events, and success stories from European scientists.

Impact of interruption: High. Loss of these set of contracts, due to GDPR purposes, will make it very difficult to compile such a list of contacts again, which includes a high number of people from the European and international HPC Community in industry and academia.

3.4.2 Unavailability of PRACE Activities: Risk Evaluation

In this sub-section, further to the decommissioning of PRACE services described above, we now present a risk evaluation analysis for the unavailability of PRACE activities which it has been offering to the European HPC Community over the past decade, and we describe the consequences of these no longer being available after the end of the PRACE-6IP project. With the apparent delay of EuroHPC JU with regards to them opening calls, this will result in a time gap of non-activity for users and we describe the consequences of these.

Throughout the various PRACE Implementation Phase Projects, various work packages and their related tasks have been implemented. For the purpose of this section, we will focus on PRACE-6IP Work Packages and tasks which are relevant for the European HPC Community. Because of this, we do not consider WP1 (Management of the Contract) and most of WP2 (Sustainability and Development of the RI) tasks. We thus focus on the following PRACE activities. As these activities are well known – from their respective PRACE-IP projects deliverables, we identify their impact of their disruption.

3.4.2.1 Task 2.3: Support for Stakeholder Management

Impact of interruption: High. EuroHPC JU seems to have a one to one relationship with various stakeholders in the European HPC ecosystem. On the contrary, PRACE seems to have a better relationship and is engaging with other actors in one to many and more collaborative relationships. A good example of this is the design and development of the HPC in Europe portal [5], where various actors were contacted and involved in discussions towards its development. By engaging with a greater diversity of users and stakeholders, PRACE has been inclusive and open to ideas from others; respectively PRACE has been working and engaging together with related actors in the ecosystem towards the collaborative advancement of the ecosystem for the benefit of the users. On the contrary, with EuroHPC not being as inclusive, it can result in a closed set of solutions that is not available to everyone. An example of this is CASTIEL which publishes outcomes of the National Competence Centres of EuroCC (such as best practises) on the eurocc-access.eu website [10], but these are only visible to users of the EuroCC network who have an account and can view this restricted content.

3.4.2.2 WP3: Communication, Dissemination, Outreach and Events

Impact of interruption: High. PRACE seems to be the only body in the European HPC ecosystem which presents the outcomes of HPC in Europe – through its representation in events such as ISC, SC and various science festivals and other stakeholder events as well as the publications of articles and success stories. Such activities carried out by PRACE so far, which raised public awareness of the benefits of HPC to Europe will be of tremendous importance also in the future when informing the general public about the large investments in the European HPC infrastructure. An additional PRACE activity which seems will no longer be available to the European HPC community is diversity and inclusivity. PRACE has led the way with promoting diversity and inclusivity in HPC. This included being part of the founding committee of Women in HPC and the initiation of the annual PRACE Ada Lovelace award. Without PRACE and such initiatives – which EuroHPC is not able to promote at the moment, the European HPC community will go backwards leading to more disparity between various groups of researchers and innovators in Europe.

3.4.2.3 WP4: Training

Impact of interruption: High. PRACE for the past years has provided an extensive and coordinated annual training programme across Europe, which was delivered by its PRACE Training Centre network. These training events provided advanced training on various HPC related topics, and was open to everyone, for free. Although the National Competence Centers of EuroCC provide national training, their number of training events per year is far lower (about 2-5) than what each PTC provided. Furthermore, the nCC training events are tailored based on the maturity and competences of each country's national community. Without PRACE and its training programme, the disparity between HPC mature and less mature countries in Europe will increase and no coordination of such training events at European level will take place. This because the nCCs of less mature countries will not be able to provide specialised training for experienced users – something that throughout the years they were able to follow through PRACE. This will result in greater inequalities in the competences and competitiveness of European researchers from less HPC mature countries. The general outcome of this is that European competitiveness as a whole will fall. In addition, without any future iterations of the Summer of HPC programme, it will be more difficult for students from various fields of study, to be introduced to HPC and to continue their studies in a related field of HPC.

3.4.2.4 WP5: Europe-Centred View of the Worldwide HPC Technology and Market Landscape and HPC Infrastructure workshops

Impact of interruption: Medium. PRACE-6IP WP5 over the past years produced independent Market and Technology Watch reports which are available online [11], and were authored after a rigorous assessment of the HPC technology and market landscape. Such reports were useful in identifying the new technologies available for institutions to invest. Without such annual reports being available in the European community, the centres/institutes will have to make their own assessment of what will need to be purchased – without an expert opinion which was provided by the reports. Because of this, wrong or inefficient investments could be made, and such issues will most likely occur in less mature countries – exacerbating the divide between them.

In addition to the above reports, WP5 also held annual HPC Infrastructure workshops [12] where HPC specialists from around the world met to discuss the latest trends in HPC infrastructure and supporting technologies for supercomputing centres. Without these workshops and reports of these, the operation of computational centres in Europe could lead to being carried out in an inefficient manner with regards to effort, manpower and energy, when the latest standards and best practises – as these were highlighted in the workshops, are not followed. Finally, the European leadership in establishing such conferences as THE conferences in HPC Infrastructure will be lost.

3.4.2.5 WP6: Operational Services for the HPC Ecosystem

Impact of interruption: High. Throughout the past decade, PRACE has been operating the European HPC infrastructure, where various HPC centres were seamlessly connected "as one". In order to achieve this, a great amount of communication and cooperation between the centres was required. If these operational services were to end, this would have a detrimental effect on the HPC operations throughout Europe. By working together, the operations staff of the PRACE HPC infrastructure were able to share information between them – such as best practices on deployment, best practices on energy efficiency and on security aspects. Security is an important aspect of HPC centres. PRACE had a dedicated PRACE Security Forum focusing on this and produced the "Security-in-an-Evolving-European-HPC-Ecosystem" technical report [13] highlights this. Throughout the years, operations staff from the PRACE network shared details of security vulnerabilities discovered on their systems and provided advice on how these could be handled. In this way, the security of all HPC centres in Europe was maintained. We fear that with the end of PRACE-6IP WP6 activities, security vulnerabilities of European HPC centres, who will now be working in isolation, will greatly increase.

3.4.2.6 WP7: Applications Enabling and Support

Impact of interruption: High. PRACE has been carrying out various tasks in this Work Package. This included the SHAPE programme where support staff could collaborate with European SMEs in the co-development of their projects and code to be HPC enabled. Although EuroCC encourages the nCCs to support SMEs, hands on support and co-development activities do not fall under the funding mechanism of EuroCC. As such, SMEs receive a far lower level of support than what was possible with SHAPE. Furthermore, some of the nCCs cannot provide computational access to companies due to legal issues. Thus discontinuing SHAPE activities will have a detrimental effect on supporting SMEs.

Benchmarking was also an important activity during the PRACE Implementation Phase Projects. With this activity no longer being available to the European community, it will only bring a disadvantage to the European HPC Community and its users, as they will no longer have publicly available information on the most optimal way in which their codes could be run.

3.4.2.7 WP8: Forward-looking Software Solutions

Impact of interruption: High. One of the major successes of the PRACE-6IP project was WP8, where research groups from various PRACE partners worked together towards developing community codes.

Without this activity continuing, it is likely that research groups will no longer cooperate to the extent that this Work Package allowed. This will result in duplication of work, inefficient solutions and a decrease in the competitiveness of Europe's research community.

4 Update on the European HPC Ecosystem

On top of the HPC services offered to European researchers from academia and industry, PRACE is also engaged in enabling the European HPC stakeholders to better define their roles and identify their position in the European HPC ecosystem. The coordination activities organised by PRACE started already in 2018 and include the following events:

- 2018: PRACE-CoEs-FETHPC-EXDCI Workshop (Brühl, Germany, 30-31 October 2018) attended by 80 persons and with speakers representing EuroHPC, PRACE, EXDCI-2, CoEs, FETHPC;
- 2019: HPC Ecosystem Summit (Poznan, Poland, 14 May 2019) attended by 45 persons representing EC, PRACE, GÉANT, CoE – FocusCoE, FETHPC – ETP4HPC, EOSC, BDVA;
- 2019: a Bird of a Feather (BoF) on the European HPC Ecosystem during SC19 with 40 persons attending;
- 2020: European HPC Ecosystem (online, 24 March 2020 replacing the session during the EHPCSW 2020 that had to be cancelled due to the pandemic) attended by 40 persons representing PRACE, GÉANT, EUDAT, EOSC, FETHPC projects;
- 2020: online BoF on the European HPC Ecosystem during SC20 attended by 560 people, the most attended BoF during this SC edition;
- 2021: online European HPC Ecosystem Summit during the virtual EHPCSW 2021, on 26 March 2021;
- 2022: European HPC Ecosystem Workshop during the EHPCSW 2022 including PRACEdays22 (Paris, France, 22 March 2022) attended by 80 persons and with speakers representing EuroHPC, PRACE, SKAO, FocusCoE, CASTIEL/EuroCC, TERATEC, ETP4HPC, EPI, Fenix, GÉANT, ESFRI, EOSC;
- 2022: User Support and Training workshops together with WP7 and WP4 during the PRACE-6IP All-Hands meeting (Vienna, Austria, 5-6 May 2022) with representatives of EuroHPC and the EuroHPC Petascale Hosting sites;
- 2022: BoF on the European HPC Ecosystem Summit during SC22 (Dallas, US, 15 Nov 2022) organised together with CASTIEL and with 45 persons attending.

This has been complemented with two editions of a survey to European HPC stakeholders and regular communication with them. All these efforts have led to the architecture design of the HPC in Europe portal, which fulfils the two-fold objective of providing a one-stop-shop for all European HPC services, as well as to establish a well-defined structure for stakeholders to position themselves. This also led to one scientific paper and an update of this paper published in Peer Reviewed journals [14].

The actions related to ecosystem coordination are detailed in this section. This section is an update of the analysis of the stakeholders' ecosystem presented in D2.3 [2] and previous documents referenced therein.

4.1 European HPC Ecosystem Workshop, Paris, March 2022

The "Workshop on the European HPC ecosystem" organised by PRACE-6IP WP2 took place Tuesday 22 March during the EuroHPC Summit Week 2022, organised by PRACE and GENCI in Paris, France.

The objective of the workshop was to present and discuss the current European HPC landscape and the efforts undertaken to further deploy and consolidate the position of Europe in the global HPC environment.

The workshop was attended by 80 people and was divided in two parts. In the first part, the diversity of the European HPC ecosystem was presented around the Infrastructure, Applications and Technology pillars, with participation of the key institutions GÉANT, SKAO, ETP4HPC cPPP, Fenix infrastructure [15], CASTIEL / EuroCC and FocusCoE coordination projects, the European Processor Initiative (EPI) technology project and TERATEC Campus which showcased their role, complementarities, interactions and coordination process. Each of these parties was asked the following question:

- **What are the synergies and main common challenge of the European HPC stakeholders?**
  In general, all parties answered that all of them have in common users and serving the needs of their users. They recognised that coordination and alignment of activities between big projects and initiatives is needed, to encourage collaboration and co-design and prevent duplication of work and effort and to enable solutions for users to carry out science beneficial for society. Furthermore, users will need to be guided towards future technologies which will be available to them.

In the second part, the present and future deployment of HPC Infrastructure in Europe and its coordination of competence development was analysed. EuroHPC investments in Infrastructure and Research, within the framework of ESFRI roadmap was mainly considered, and the role of PRACE RI in this framework, complemented by the relation with EOSC initiative was discussed. Each of these parties was asked the following question:

- **To be able to project yourselves in the roadmap, in the future, what will stay what will evolve?**
  In general, the parties answered that continuity and clarity of the future direction of the European HPC ecosystem is needed – so each of them is able to best serve users and communities into the future and upon new technologies.

Each of the initiatives was also asked about their established services they could continue to provide. The discussion identified the initiatives as part of the supply chain for science and innovation – providing the tools and services for European researchers and industry to compete. It was also stressed that scientific research and expertise should work together with industry to enable development of products upon a unified research and innovation set of infrastructure and services. It was recognised that some initiatives and companies (SMEs) may not be as mature as others, and it was highlighted that supporting them to mature and grow in their potential was important.

Some pictures from the workshop follow:

Figure 5: Attendees European HPC Ecosystem Workshop, Paris, March 2022

Figure 6: Speakers European HPC ecosystem workshop, Paris, 2022 from left to right: S. Bogaerts (PRACE aisbl), C. Ferrari (SKAO), A. Grant (GÉANT), S. Garavelli (EOSC), J. Kolar (ESFRI), G. Lonsdale (FocusCoE), E. Walter (EPI), K. Azoum (TERATEC), H. Zeisel (EuroHPC JU), S. Alam (Fenix), M.F. Gerard (TERATEC), and P. Segers, (GENCI) as moderator. Gender Balance of the panel: 50%-50%.

Figure 7: Organisers and speakers of the European HPC ecosystem workshop, Paris, 2022 from left to right: V. Teodor (JUELICH), S. Garavelli (EOSC), O. Pineda (BSC), S. Erotokritou (CaSToRC), P. Segers, (GENCI), A. Grant (GÉANT), F. Berberich (PRACE aisbl), S. Bogaerts (PRACE aisbl), C. Ferrari (SKAO), E. Walter (EPI), G. Lonsdale (FocusCoE), S. Alam (Fenix), H. Zeisel (EuroHPC JU)

The workshop concluded with round table discussions to assess the integration of actors, investments and competences towards a well-integrated, strong, world-class HPC ecosystem. The required projects to deploy this vision and what structure to guarantee the delivery of a persistent set of services to the benefit of academic and industrial users of HPC was discussed.

The projects/initiatives agreed that they all needed to fulfil their own mission in serving their communities, while considering others too, and to help users with optimisations, hardware and software for their scientific output. In addition, SMEs were identified as important actors which should be enabled toward HPC through support, consultancy/guidance, training to enhance their skills and access to resources.

At the end of the workshop, each initiative concluded with a summary for the workshop. These were as follows:

- PRACE: We should answer call for proposals to best serve communities in the future;
- SKAO: Require community access and it is important to have the expertise to translate and solve problems in astrophysics;
- GÉANT: Initiatives need to coordinate, collaborate and cooperate;
- EOSC: Servicing the needs of users requires collaboration and cooperation of expertise;
- ESFRI: Agree that the complex nature of servicing users requires greater cooperation;
- EPI: We need to plan ahead for the future and the needs of the users;

- EuroCC France: We need to be more inclusive in training and train everyone, not just experts;
- EuroCC: We need to plan ahead for the future, taking into account the different levels of maturity throughout Europe;
- FENIX: We need to articulate clearly how we enable science and innovation so it will be recognised.

As conclusions to the workshop, it was agreed by all parties, that taking the best interests of users into account, it is important that everyone works together, and define a clearer roadmap for the future. Future needs of users should be identified and how these can be serviced through infrastructure, support, training and collaboration between initiatives was a requirement. Discussions with the commission and other funding bodies would also need to take place, so they can work in line for future calls towards the benefit of users for research and innovation.

Since March 2022, we can only report on PRACE's behalf. Unfortunately, there has not been much activity with regards to the cooperation and collaboration between the different initiatives. This was not because there was no will to do this, but because no one from the funding agencies took the initiative to lead and coordinate this. As such, the situation towards the end of 2022 remains as unclear as it was in March 2022. There is the strong need for coordination. PRACE could lead and coordinate the interaction between the European HPC stakeholders if the mandate, opportunity and resources are available.

With the end of the PRACE-6IP project approaching, members of the PRACE Council Board have been in discussion with EuroHPC with regards to the future. It is quite clear for everyone to see that EuroHPC is overwhelmed with work and is currently unable to open up project calls in time, properly plan for the future, and for essential services to users (such as training, support and enablement work) to continue to be available to researchers and SMEs in a European coordinated and experienced. The EuroCC National Competence Centers, although being mandated to focus on industry, are more nationally focused, and as such the sharing of European expertise to solve problems throughout Europe – something that PRACE has been doing the past decade, is missing. With all this in mind, members of the PRACE Council Board have been discussing with EuroHPC, so PRACE and EuroHPC can work together, in a collaborative and complementary manner, towards the benefit of users, and ensuring continuity of training and support services towards their development, and the enablement of science and innovation. These talks, even so close to the end of 2022 are still ongoing, and still unclear – mainly due to a lack of feedback and discussion from EuroHPC.

Below, we have compiled a word cloud from the workshop which clearly identifies the keywords and key issues discussed for the future of the European HPC ecosystem landscape.

Figure 8: Word cloud European HPC workshop, Paris, 2022

4.2 BoF "European HPC Ecosystem Summit" at SC22

PRACE has been engaged since 2018 in the coordination of European HPC activities, including access to HPC systems, user support, training, policy, technology, operations and dissemination. This has included the organisation of dissemination events during the different editions of the EuroHPC Summit Week and notably as Birds-of-a-feather sessions in SC19, SC20 (online) and SC22.

The agenda of the edition of this year (SC22) included an update of the European HPC ecosystem, the status of the HPC in Europe portal and a highlight of the collaboration with CASTIEL/EuroCC. The BoF continued with an open discussion with contributions from Scapos, ETP4HPC and EuroHPC JU, where the important role of coordination of activities and identification of gaps after the end of PRACE-6IP was highlighted. The BoF counted with 45 participants, a great success considering that it coincided with the schedule of the TOP500 BoF.

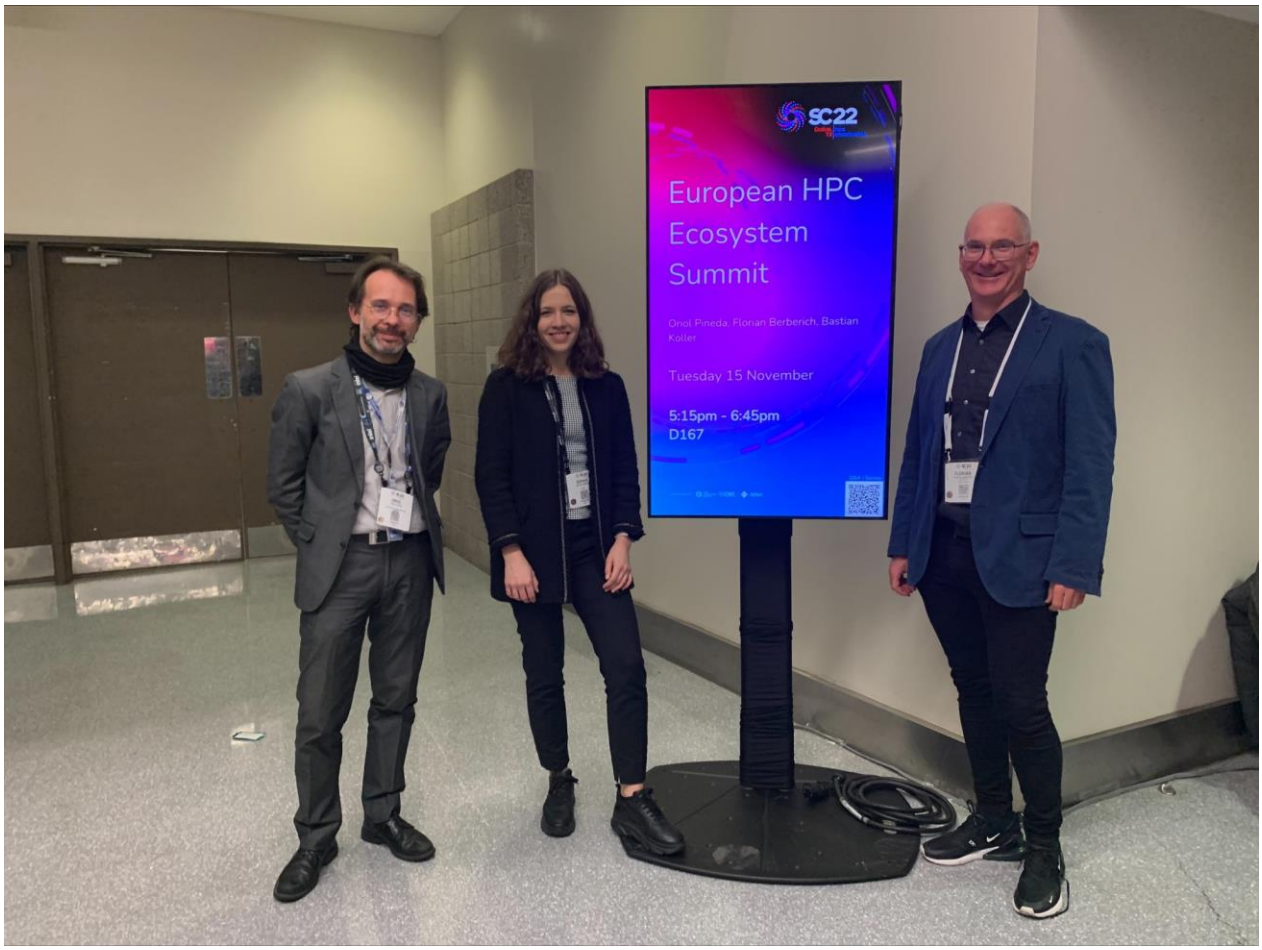


Figure 9: Organisers BoF "European HPC Ecosystem Summit" at SC22 from right to left: O. Pineda (BSC, PRACE BoD), S. Honisch (HLRS, CASTIEL/EuroCC), F. Berberich (PRACE aisbl, Operations Director)

4.3 PRACE-EOSC Relation

PRACE has been a long-time partner of the different EOSC initiatives, since participating to the EOSC pilot project with a direct involvement in its Stakeholder Management and Governance WP, leading task on "Governance framework piloting process". It considered some of the main governance challenges of establishing an EOSC, how to construct a framework allowing strong but disparate stakeholders to work together. Stakeholders include: research communities, research institutions, research infrastructures including e-infrastructures, and research funding bodies. This framework also needs to address cultural challenges, encouraging the adoption of new ways of working and scientific practices. Overall, it has shaped and overseen future development of the European Open Science Cloud. PRACE has contributed to EOSCpilot-D2.7: Stakeholder Scoping and produced EOSCpilot-D2.8: Report on governance piloting process 1st Report on Governance Development Forum involvement and activity.

Since this early stage PRACE has always been participating to many meetings organised by EOSC, and has also invited EOSC to participate to PRACE meetings, such as the European HPC Ecosystem Workshop, held in Paris, March 2022 during the EuroHPC Summit Week 2022 (see 4.1).

PRACE aisbl also decided to take an active contribution to EOSC, by joining the EOSC Association aisbl created in 2021. Finally, PRACE has published its services on the EOSC portal, allowing EOSC users to easily find and get access to them [16]:

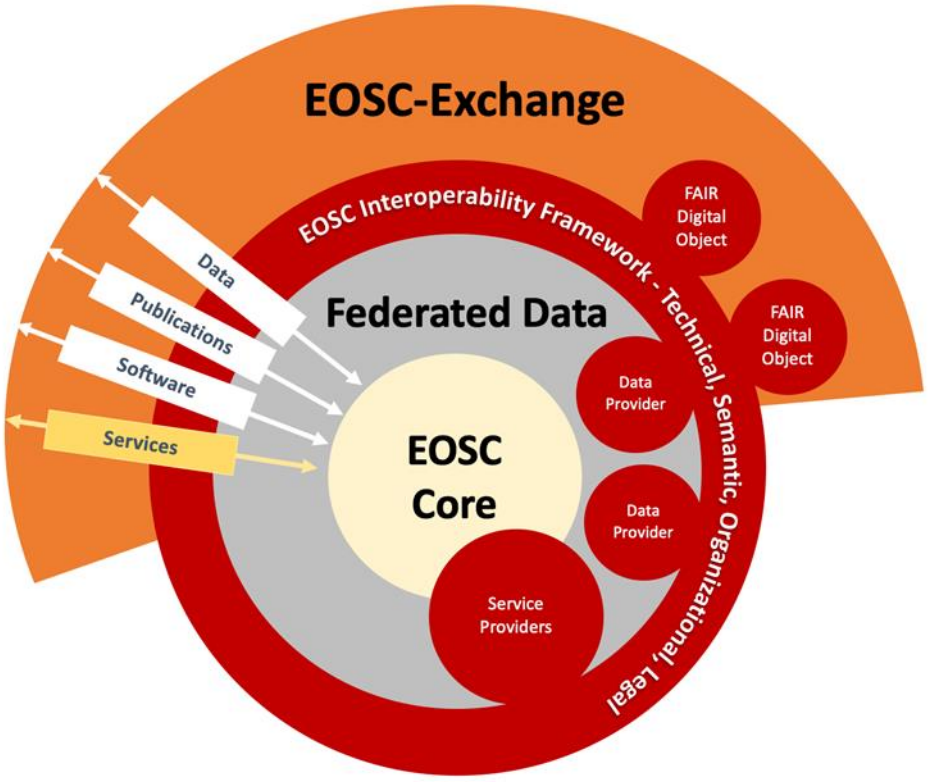


Figure 10: Schematic of the Minimum Viable EOSC including: a web of FAIR data and services; federation of e-Infrastructures and other Research Infrastructures (RIs); environment in which data can be brought together with services to perform analyses and address societal challenges

PRACE services could be a very important contribution to the Federation of e-Infrastructure and other Research Infrastructures (RIs) envisioned by EOSC on its so-called "Minimum Viable EOSC". This would allow researchers, scientists and citizens using the EOSC portal chose the right level of computational resources needed for their specific needs, from small cloud-based computation to the different level of High-Performance Computing proposed by EuroHPC, and also include the many other knowledge services offered by PRACE, depending on their future availability (see discussion on the chapter above).

4.4 The European Strategy Forum on Research Infrastructures (ESFRI)

4.4.1 Presentation of ESFRI

The European Strategy Forum on Research Infrastructures (ESFRI) supports a coherent and strategy-led approach to policy-making on research infrastructures in Europe, and facilitates multilateral initiatives leading to the better use and development of research infrastructures, at EU and international level. ESFRI was established in 2002 with the purpose of developing a European approach to Research Infrastructure policy as a key element of the emerging

European Research Area. Following a vision for sustainable policies and funding, ESFRI updates the European Roadmap for Research Infrastructures systematically.

The following definition for RI from Art. 2 of the Regulation n° 1291/2013 of 11 December 2013 "Establishing Horizon 2020 - the Framework Programme for Research and Innovation (2014- 2020)" applies: "RIs are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. They include: major scientific equipment (or sets of instruments), knowledge-based resources such as collections, archives and scientific data, e-Infrastructures, such as data and computing systems and communication networks and any other tools that are essential to achieve excellence in research and innovation." Accordingly, RIs are implemented along different organisational models, including central sources and laboratories for experiments and measurement sessions, coordination and management of geographically distributed observatories or laboratories, remotely accessible resources for computing, data banks, physical sample repositories, surveys and longitudinal studies.

The ESFRI has a key role in policy-making on Research Infrastructures in Europe. In particular, the ESFRI contributes to the development of a strategic roadmap that identifies vital new European RIs for the next 10-20 years. In 2006, ESFRI published its first roadmap for the construction and development of the next generation of pan-European Research Infrastructures. The roadmap was updated in 2008, 2010, 2016, 2018 and 2021 [17], to include projects and landmarks that intend to foster European leadership across a broad range of scientific fields.

4.4.2 ESFRI Landmark and Roadmap

The ESFRI Landmarks are the RIs that were implemented or started implementation under the ESFRI Roadmap and are now established as major elements of competitiveness of the European Research Area. The ESFRI Landmarks need continuous support for successful completion, operation and upgrade in line with the optimal management and maximum return on investment.

The ESFRI roadmap 2006 first stressed the need for a European strategic approach to High-Performance Computing, concentrating the resources in a limited number of world top-tier centres in an overall infrastructure connected with associated national, regional and local centres, forming a scientific computing network to utilise the top-level machines. This overall architecture was meant to respond both to Capability (high-performance) and to Capacity Computing (high-throughput) needs with different machine architectures fulfilling the requirements of different scientific domains and applications. This was represented as a pyramid, where local centres constituted the base of the pyramid, national and regional centres would constituted the middle layer and the high-end HPC centres the top. This was the blueprint of PRACE RI, called at this time "EU-HPC".

PRACE was then present in the 2008 roadmap, as the first e-Infrastructure, with the status of advanced preparation for construction. At that time, most of the PRACE centres were already operating as a network of supercomputers, through the project DEISA, but without the Tier pyramidal architecture. PRACE was put in place in this framework, as a European strategic approach to High-Performance Computing. PRACE concentrated the available resources in a limited number of world-class top-tier centres in a single infrastructure connected to national, regional and local centres, forming a scientific computing network to utilise the top-level

machines. The effective Peer-Review mechanisms for the allocation of computing time helped avoiding a fragmented use of the top-level computers and sped up adaptation/ development of codes and algorithms for the new computers - an essential step for their effective use.

In the 2010 roadmap, PRACE was presented as a success story of ESFRI, being part of the 10 projects of the 44 roadmap projects already in the implementation phase.

The 2016 roadmap puts emphasis on the impact of PRACE within its connection to many ESFRI and international RIs, such as XSEDE – the Extreme Science and Engineering Discovery Environment (USA), RIKEN (Japan), Compute Canada, GÉANT – the pan-European data network for the research and education community, EGI – the European Grid Infrastructure, EUDAT– the European data infrastructure and the Human Brain Project (HBP).

The 2021 roadmap [18] celebrated the consolidation of the European RI landscape, including collaboration between CERN, SKAO, GÉANT and PRACE aiming at realising the full potential of the coming new generation of High-Performance Computing (HPC) technology, and preparing them to be efficiently linked with giant RIs, within the new landscape that included EuroHPC JU. It also included three new digital RIs – the Scientific Large-scale Infrastructure for Computing/Communication Experimental Studies (SLICES) [19], the European Integrated Infrastructure for Social Mining and Big Data Analytics (SoBigData) [20] and the European Brain ReseArch INfrastructureS (EBRAINS) [21].

The ESFRI Project SLICES is a distributed e-Infrastructure that focuses mainly on cloud and edge computing, Internet of Things (IoT) and networking/future internet. Traditionally, the e-Infrastructures focussed on centralised High-Performance Computing, distributed High-Throughput Computing, storage or network but it is true that dedicated e-Infrastructure on cloud and edge computing, IoT and networking has been missing in the European Roadmap of RI. As the clear separation between computing, network and storage is vanishing, the infrastructure SLICES in the Roadmap 2021 covers the gap.

The ESFRI Project SoBigData (SBD) aims to establish a European infrastructure of big data and social data mining, using new methods and implementing it in different fields of data analysis. This is in line with current scientific trends in machine learning and data science to promote ethically sound and open research in large datasets that democratises the value of data science. SBD is expecting to become the leading RI for realising large-scale social mining experiments.

The ESFRI Project EBRAINS is defined as the one-stop-shop that is offering scientists and developers the most advanced tools and services for brain research. The Human Brain Project (HBP), which is one of the FET flagship projects, is the developer and the provider of EBRAINS. As HBP has the internal means to create a self-contained structure, it is a challenge to create an outward looking environment and to serve groups that are not part of the original HBP project.

PRACE partners already implement tools provided by FENIX, a spin-off of EBRAINS/HBP, providing infrastructure tools for Federation of identity and Data exchanges, that is also foreseen to be the backbone of the future European Quantum Computing RI that will be coupled to the European HPC RI.

The overall Digit Landscape of the 2021 ESFRI Roadmap is represented in the figure below.

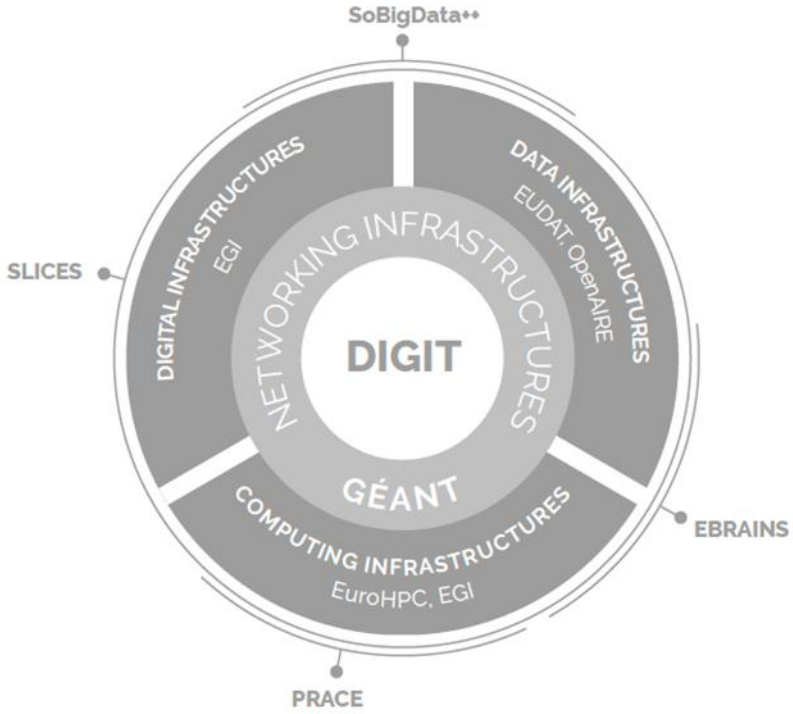


Figure 11: ESFRI Landscape of the Data, Computing & Digital Research Infrastructures domain

4.4.3 Monitoring of ESFRI Landmarks

ESFRI has also put in place a Stakeholders Forum, initiated in March 2022, in which PRACE plays an active role. The ESFRI Stakeholders Forum is a newly established platform, developed by ESFRI with the ambition to instigate an open dialogue among the different European Research Infrastructures in order to reinforce their position as an essential pillar of the European Research Area (ERA). The Stakeholders Forum initiative reflects ESFRI's intention to look beyond the traditional RI communities. The platform aims to attract stakeholders, raise their awareness across the whole research and innovation ecosystem, and facilitate their cooperation and mutual learning. Expected results are new and improved services by RIs, with their enhanced use across various communities. These stakeholders include, amongst others, decision and policymakers, municipalities, citizens, socio-economic actors, research organisations and higher education institutions with scientific communities participating in ERA activities, which may contribute to or run the RIs, or are their potential users of RIs.

Guaranteeing the excellence of the Landmark label, ESFRI has responsibility for monitoring the quality of the RIs listed in the ESFRI roadmap as Landmarks. In the follow-up to the Competitiveness Council Conclusions of May 2018, and the pilot review of four Landmarks assessing the scientific status and their implementation, ESFRI has set up an ad hoc Working Group on "Monitoring of Research Infrastructures Performance". It prepared a final report containing general criteria for Landmark and RI assessment and considerations for implementing an appropriate methodology in the future. Monitoring will cover Landmarks which have already started their operational phase and actively provide services. All eligible Landmarks will be monitored before the end of 2024, in three batches. Monitoring of the first

batch, that includes PRACE started in September 2022, after preparatory work starting from June 2022.

4.5 The HPC in Europe Portal

The coordination efforts undertaken by PRACE over the past years have been used to structure the European HPC services and develop them into the HPC in Europe portal. This has been a highly successful pilot carried out on a best effort basis, with resources redirected from other project activities. During the pilot, an important collaboration with CASTIEL/EuroCC and FocusCoE was achieved, ultimately proving the value of this activity.

The objective of PRACE in this activity was to develop and make available a well-structured framework where all European service providers can contribute and be present. In other words, the role of PRACE was not to populate and maintain the information and services on the portal but rather to facilitate that providers can do that for their respective services. To that effect, PRACE has dedicated good efforts to promote the usage and adoption of the portal. The following statistics show the relevance and impact of the HPC in Europe portal:

- More than 80 provider accounts from 31 different countries, including academic and research centres, public administration, and industrial partners;
- Tailored (national) extracts for 34 countries;
- Estimated 20 000 visits from June 2021 to May 2022, roughly half of them accessing directly the portal, and the other half accessed through the EuroCC-Access portal or the tailored national extracts.

After this successful pilot, the next step is to transform the portal into a fully working platform, starting by a professional redevelopment and refinement of categories, including the necessary resources to attract new user communities and better support to service providers, and specially marketing and promotion activities to boost the usage of this platform.

4.5.1 General Information Services

The design of the HPC in Europe Portal has been user-orientated based on inclusive feedback from various HPC Ecosystem Initiatives. The portal is structured around six main categories (HPC Access, Training and Events, Support, Applications, Technology, and Documentation) and five target audiences (Researchers, Industry, HPC beginners, HPC community, and General Public, stakeholders and policy makers). A neutral branding, inspired by EuroHPC was applied to depict the neutrality and vast scope of the services broadcasted in the platform for the EuroHPC Ecosystem.

This structure invites to use the portal as a platform for a General Information Service. This has been also included as a pilot activity by the end of this year. A contact form has been included, and a workflow to provide an answer has been established. As a first structure, the requests are received by PRACE and distributed to the relevant WP leaders based on the topic of the request, as follows:

- HPC Access, WP2 and PRACE aisbl;
- Training, WP4;
- Support, WP7;

- Technology, WP5 and WP6;
- Applications, WP7 and WP8;
- Others, WP3.

While this activity is ramping up, it is important to re-establish the workflow and identify the right contacts that can take over each HPC service domain after the end of the PRACE-6IP project.

This service is available on the portal through a "Contact" button which appears at the end of each page of the portal. This directs the users to the "HPC in Europe Request" page [22] where they can fill in and submit the available online form with their request. This can later be directed to the appropriate person who would be able to answer the query.

4.5.2 Collaboration with CASTIEL

As a result of networking events, the portal was adopted as the management framework for training events by both CASTIEL/EuroCC and FocusCoE projects. This was considered a first and major achievement in the establishment of the portal as the central platform for European HPC services.

To acknowledge the importance of the portal to CASTIEL and FocusCoE, and to tailor the portal to their needs, a collaboration agreement was prepared and signed between PRACE, CASTIEL and FocusCoE. This facilitated developments to the portal for content specific to the requirements of these projects. Once these were designed and implemented, population of the portal was carried out by the partners of these two projects.

4.5.3 Continuity Plan

The HPC in Europe portal's development was mainly led by PRACE through BSC, which currently hosts the portal, too. Despite PRACE-6IP soon ending, BSC can continue hosting the portal free of charge; however, there will not be the possibility for PRACE to provide maintenance or engage in further development of the portal. The ownership of the portal will remain within PRACE aisbl after the end of PRACE-6IP, which enables also the continuity.

Nevertheless, in order to fully exploit the proven benefits of the portal, it is important to arrange dedicated funding for marketing effort and professional development. This is currently under discussion with EuroHPC JU, aiming at a solution by the beginning of 2023.

4.5.4 Ecosystem Overview and Integration

As a result of the networking and coordination activities, PRACE has identified the various European HPC actors and their activities, including boundaries and potential overlaps. This has also facilitated an adequate level of cooperation. A brief summary is provided here:

- HPC Access: in this topic, the role of PRACE is clear. That is to manage the access to the top level of the HPC systems pyramid (Tier-0) and to facilitate the interaction with the next levels (Tier-1) through programmes like DECI and Preparatory Access Type D. The fact that Tier-0 centres are also involved in the national Tier-1 programmes is a further guarantee of this integration;

- HPC Support: in this category, PRACE identified a number of centres providing user support and applications development, including potential duplication of scopes. This has been addressed by defining a series of support levels and assigning each actor to their most appropriate ones:
    - Level 1, helpdesk for system/user support, mandatory service provided directly by HPC centres;
    - Level 2, short-term user support for code enabling and scaling, provided by user support programmes;
    - Level 3, medium-term support for R&D on code refactoring, provided by application support programmes;
    - Level 4, long-term projects of applications development, carried out by research communities, notably Centres of Excellence in HPC.

  Given their nature, Levels 1 to 3 are directly associated with HPC centres. While level 1 is clearly mandatory, the extent and resources devoted to levels 2 and 3 depends on the strategy of each centre. In the case of PRACE centres, the resources devoted to level 2 and level 3 have been coordinated and funded centrally, in order to guarantee a high level of user support.

  Related to this item is the audit service provided by the POP Centre of Excellence, specialised in the analysis of application performance and consultancy on optimization and productivity. This is understood as a horizontal service with a potential to provide valuable inputs to support levels 2 and 3. Most PRACE centres are part of POP or well connected to it, therefore its audit services are commonly used, fully or partially, as part of their standard user support. Nevertheless, the scope of POP goes beyond PRACE centres, since it can analyse and serve virtually any existing HPC system;
- HPC Training: in this category, the standard providers are universities and research centres. Most of them are already part of the PRACE training programme, and coordinate their annual academic curricula to offer a wide training offer; based on their nature, all this training is considered as domain-generic, based on programming languages, models, and algorithms. Additional to this offer, and out of the scope of PRACE, is the training programme of Centres of Excellence, specific for their scientific domains and complementary to the PRACE training programme;
- HPC Research and Development, including technology: this is not on the scope of PRACE, and is currently undertaken by the European Processor Initiative, the Centres of Excellence, and other EC-funded collaborative projects.

4.6 User Association

In the forthcoming European HPC landscape, HPC users are mainly represented in the infrastructure and application pillar through diverse projects and initiatives with no strong and unique user organisation. ETP4HPC, and in particular the EPI project, work on technology, CoEs focus on selected applications, GÉANT on interconnectivity, and new structures represented by the nCCs provide local support and attainment of HPC competences to industrial and academic users. EuroHPC itself provides compute cycles, but has not yet established a user representation. So far, in EuroHPC JU only the technology providers are represented by the European Technology Platform for High Performance Computing (ETP4HPC), the Big Data

Value Association (BDVA) and the European Quantum Industry Consortium (QuIC) as private members. The User perspective is crucial for the success of EuroHPC.

PRACE can build on and extend on existing links to both the academic and industrial user communities with the involvement and support of the PRACE bodies, SSC and IAC. Over the last 12 years, PRACE created a trust relationship to the European HPC users. In PRACE 3 it is proposed to adapt the governance in order to give the users and institutional members equal votes. The different user communities will be organised in topical chapters. One chapter will be reserved for industrial users and private members.

The new PRACE structure and governance would allow PRACE to become the voice of the scientific and industrial users - an element that is missing in the new European HPC landscape.

The PRACE User Association could support and organise the EuroHPC User Forum for academic and industrial users as well as public administrations. Main elements of the User Association are:

- Establishing agile communication channels (e.g.: mailing lists) with European HPC users;
- Organising an annual European Scientific HPC event;
- Collaborate with highly recognised scientific journals for special issues dedicated to European HPC simulation achievements;
- Highly recognised Awards: PRACE Ada Lovelace and a PRACE prize recognising ground breaking research relying on HPC;
- Training and user support;
- Organise PRACE seminars towards novel use of HPC including HPC/AI convergence, link with large scale scientific instruments, urgent computing, new domains like social sciences, smart cities, agriculture, etc.;
- Organise regular road mapping exercises for gathering scientific and industrial user communities' needs requiring HPC, HPDA, AI or in the future quantum computing facilities. PRACE has a long-standing experience in running such exercises like the PRACE Scientific Case or EXDCI projects;
- Foster international collaborations;
- Promote, help to industrialise and provide a first level of support to European open source software (from low level system software to end users applications) installed on PRACE members HPC systems;
- Perform independent technological watch on novel architectures (integrating HPC, AI, quantum…) and services by involving HPC agencies/centres and end user communities.

5 Legal Support to PRACE Infrastructure and other WPs

In addition to the support mentioned in previous sections of this deliverable, the PRACE-6IP WP2 working group has provided direct legal support to PRACE aisbl on several topics of current relevance and to issues of a legal nature that arose in the different work packages of the PRACE-6IP project.

5.1 PRACE Collaborations

PRACE has three different levels of collaborations. At the 6th Council, Copenhagen, 24 January 2012, the following classification and decision was approved.

Council-2012-06-05: *The Council agrees on the rationale for collaborations presented above and approves the methodology presented. BoD shall apply this process to the pending requests from SPECS, IGE and HP-SEE.*

And the referenced methodology is:

1. *If the collaborators are PRACE users, seek advice of the Scientific Steering Committee on the pertinence and suitability of pursuing this collaboration or of expressing PRACE support to the project proposal. If the answer is affirmative, BoD makes a proposal to Council voting via e-mail and acts based on the Council decision.*
2. *If the collaboration is technology oriented, set-up an evaluation committee composed of the PRACE Association and the PRACE project to assess the interest of PRACE to engage in such collaboration and identify who would be the PRACE contact person. The contact person is the person in charge of proposing collaboration work plan and presented to the BoD for approval. After approving it, the BoD makes a proposal to Council voting via e-mail and acts based on the Council decision.*
3. *If the collaboration is related to strategic issues (e.g. international collaborations with peer actors, investments on HPC at national or international level, access programme design), then the Board of Directors makes a proposal in the subsequent Council (including contact person, work plan and draft MoU, if applicable) and a voting decision will take place at that time.*

During PRACE-6P, the following Memoranda of Understanding (MoU) and collaboration agreement were prepared:

5.1.1 Collaboration Agreement between PRACE-GÉANT-CERN-SKA

The Collaboration Agreement (CA) between PRACE-GÉANT-CERN-SKA was signed in July 2020 and addressed the transition to exascale computing. In anticipation of the delivery of the exascale systems late 2020, the global HPC community broadened its horizons, as well as providing a step change in capability for its traditional user base (computational fluid dynamics, quantum chemistry etc.). The exascale systems needed to provide the e-Infrastructure required by large experimental facilities that were due to generate unprecedented volumes of data as new capabilities come on line in the next decade. In addition, exascale platforms were required to run artificial intelligence/machine learning (AI/ML)-related workloads as the fields of HPC and machine/deep learning continued to converge. ML/DL techniques were planned to be widely adopted to enhance both scientific analysis and improve the performance, usability and

reliability of the underlying platforms. Ensuring effective collaboration between HPC experts, scientists and engineers working on world leading 'big science' experiments, and the national and international bodies that facilitate the underlying e-Infrastructure to move data across the world was therefore critical for the successful delivery of projects such as the SKA and HL-LHC (High Luminosity LHC). The challenges and opportunities of the exascale computing era and its convergence with AI/ML were the motivation for this CA between CERN, SKA, PRACE and GÉANT.

In the Collaboration Agreement, a work plan was included in Annex I, which describes in more detail the collaboration activities. This includes, but is not limited to training support, work on a common set of demonstrators (Benchmarking proof-of-concept, Data Access, Authenticated Workflow) and the capability by providing training & centre of expertise.

This Collaboration Agreement ended in December 2021, but all organisations involved showed big interest in further working together to help realise the full potential of the coming new generation of HPC technology.

5.1.2 MoU between PRACE, FocusCoE and CASTIEL

Following the launch of the HPC in Europe portal, a number of promotional events were organised, including participation in workshops of other projects. The benefits of the portal as a central and versatile platform were appreciated by the two major initiatives; FocusCoE, coordinator of the activities of Centres of Excellence HPC, and CASTIEL, support action for the activities of the EuroCC network of national Competence Centres in HPC. The initial collaboration, involving usage support and minor developments provided by PRACE, quickly evolved to a joint effort where the three initiatives contributed significant effort on designing improvements of the portal and their implementation. To facilitate this great achievement, the hosting by BSC was adapted to allow for external teams from FocusCoE and CASTIEL to participate in the portal developments.

During this fruitful journey, the three initiatives (PRACE, CASTIEL and FocusCoE) decided to formalise the ongoing collaboration in the form of a Memorandum of Understanding. This MoU recognises the intention of PRACE, FocusCoE and CASTIEL to establish a close collaboration in order to address a common current need – the joint development and maintenance of the HPC in Europe portal, and to work together for their mutual benefit. This portal, started by PRACE, is currently an important tool used by both CASTIEL/EuroCC and FocusCoE. Furthermore, this MoU will avoid the formal dependency of CASTIEL and FocusCoE on the effort and resources provided by PRACE. It will also facilitate expanding the collaboration to further initiatives in the future. Included in this MoU will be the transfer of ownership of the portal to PRACE aisbl, to facilitate continuity beyond the end of the signing projects.

The outcome of this MoU has been to enable the use of resources of both PRACE-6IP and CASTIEL/EuroCC for the joint development of the HPC in Europe portal (described in section 4.5) as well as to ensure its continuity after the end of each single project.

5.2 Support to Other WPs and PRACE aisbl

5.2.1 PRACE's Support for EuroHPC Peer Review Process

In order to allow for a smooth and timely start of the EuroHPC JU calls, PRACE agreed to provide access to its established peer review platform. During this transition period, the processes rely on PRACE tools and their existing branding, but with the highlighted different access modes available to the end users and their respective providing organisation. PRACE and EuroHPC were closely collaborating to implement an adapted appropriate branding of the tools supporting the peer review process by the end of this phase 1, 31 December 2021.

Beginning of 2021 when the discussions on this topic started, PRACE and EuroHPC agreed to implement the access to the peer review platform through a letter of support limited only to this service and until the end of December 2021. PRACE consulted the legal advisor Bird & Bird for the elaboration of this document. In the end after several meetings, PRACE and EuroHPC decided to further collaborate in implementing this project without signing any document for the period until the end of December 2021.

As mentioned in section 3.2.1, starting from January 2022 the PRACE-6IP project is covering the Peer Review funding for the year 2022 with a project extension which was granted. During the extension of PRACE-6IP, the Peer Review support was one of the main activities with the PRACE aisbl Peer Review office managing not only the last calls of PRACE 2, but also the implementation of the peer review process for the new HPC access mechanisms (Benchmark and Development Access Mode, Regular Access Mode and Extreme Scale Access Mode - [23]), in order to prepare the European HPC users for the EuroHPC systems that started operation end 2021/ beginning 2022.

The three new calls already established last year - Benchmark and Development Access Modes and Regular Access Mode, are continuously open for application. The first two have a monthly cut-off, while the last one has three cut-offs a year - March, July and November. Benchmark and Development Access are meant for users to extract benchmark data on the target machines and further develop their codes before applying to the Regular Access or Extreme Scale calls. The evaluation of Regular Access call is done by in-house panels, composed by experts in the domains of research and a final meeting called Super Panel meeting is organised to consolidate all the results. The allocation of resources takes place during the Resource Allocation panel.

Since the PRACE-6IP project will end by 31 December 2022, after that there will be no funding available for the Peer Review service and at the time of writing of this document, no official agreement between PRACE aisbl and EuroHPC JU is in place.

5.2.1.1 Regular Access call March 2022 cut-off

In the Regular Access call March 2022 cut-off only one proposal was submitted to the Industry track, all the remaining ones were belong to the Scientific track. From a total of 16 submitted proposals, 14 were awarded a total of 196 million core hours.

Domain	#Proposals received from Male / Female / Unspecified	#Proposals awarded
Chemical Sciences and Materials, Solid State Physics	5 5 / 0/ 0	5

Domain	#Proposals received from Male / Female / Unspecified	#Proposals awarded
Biochemistry, Bioinformatics, Life Sciences, Physiology and Medicine	2 1 / 1 / 0	2
Engineering, Mathematics and Computer Sciences	7 6 /1 / 0	6
Computational Physics: Universe Sciences, Fundamental Constituents of Matter	2 2 / 0 / 0	1
Earth System Sciences and Environmental Studies	0 N/A	N/A
Socio-Economic Sciences and Humanities	0 N/A	N/A
Total	16	14

Table 1: Number of proposals received and awarded on the Regular Access call March 2022 cut-off

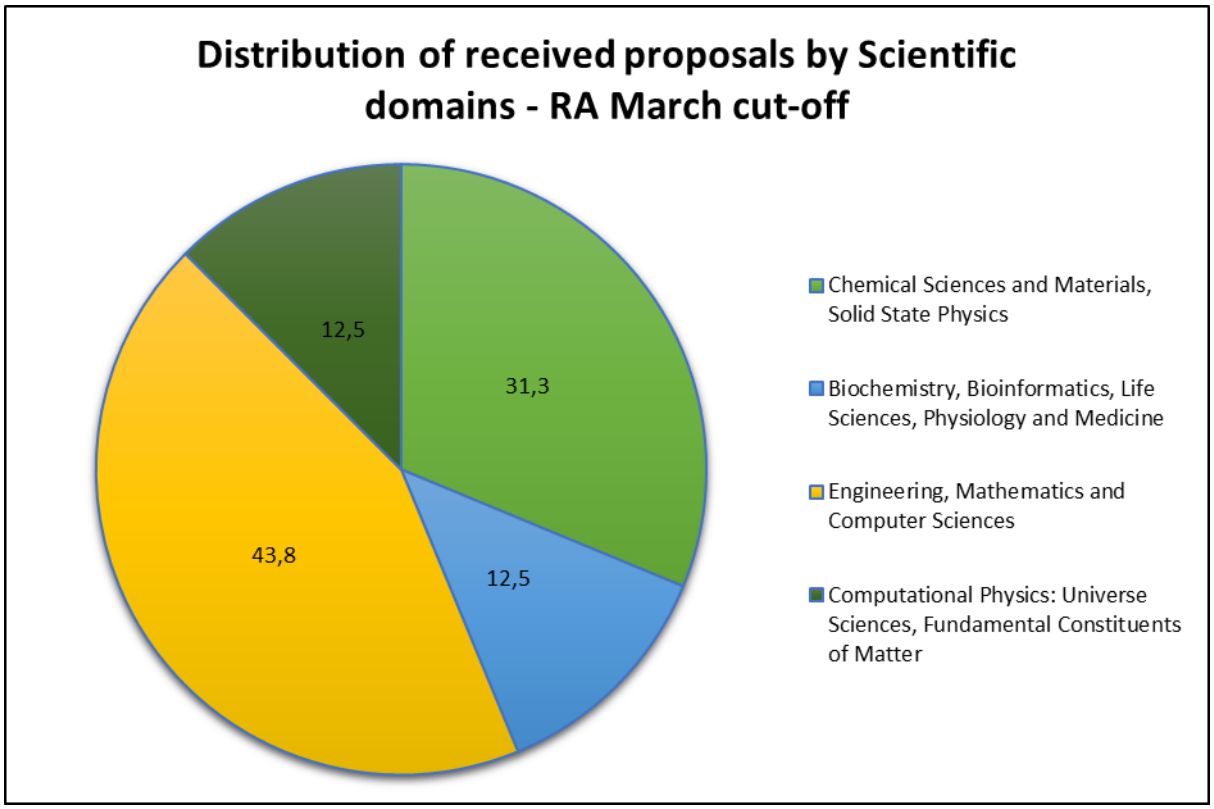


Figure 12: Distribution of proposals received in the Regular Access (RA) March 2022 cut-off proposals by scientific domain

System	Offered	Requested	Minimum request	Awarded
Vega CPU	150.000.000	140.854.173	15.000.000	112.916.445
Vega GPU	4.100.000	1.000.000	1.000.000	1.000.000
MeluXina CPU	65.500.000	95.000.000	10.000.000	0
MeluXina GPU	11.100.000	9.430.000	2.000.000	9.430.000

System	Offered	Requested	Minimum request	Awarded
Karolina CPU	60.000.000	19.400.000	10.000.000	19.400.000
Karolina GPU	6.000.000	0	1.000.000	0
Discoverer CPU	104.000.000	17.310.720	10.000.000	17.310.720
LUMI-C	262.800.000	35.986.176	20.000.000	35.986.176
Total	663.500.000	318.981.069	N/A	196.043.341

Table 2: Amount of resources, in core hours, offered by the centres, requested by applicants, awarded and minimum request per system for the Regular Access call March 2022 cut-off

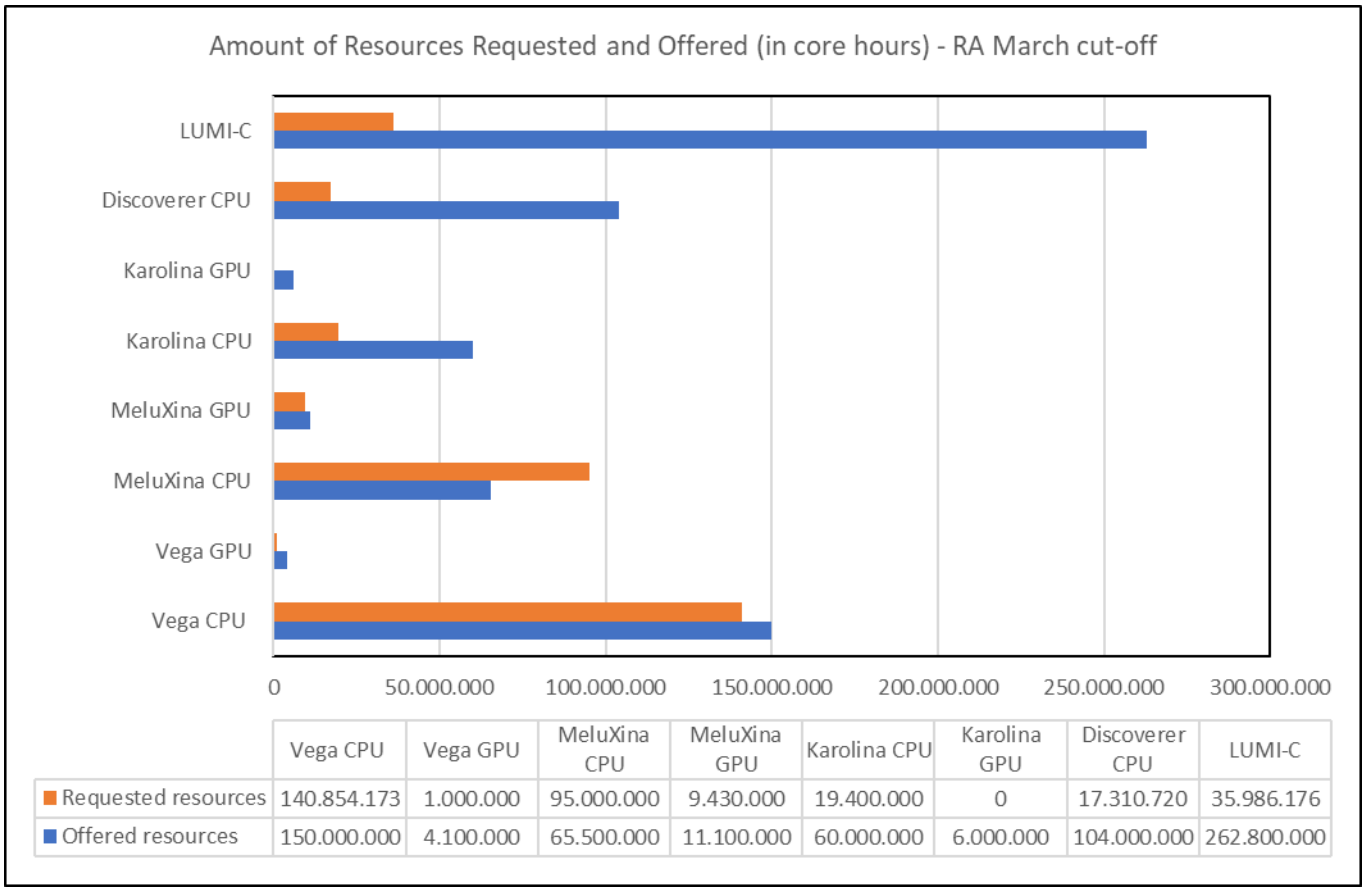


Figure 13: Amount of Resources Requested and Offered (in core hours) in the Regular Access call March 2022 cut-off

System	Number of proposals awarded
Vega CPU	5
Vega GPU	1
MeluXina CPU	0
MeluXina GPU	3
Karolina CPU	2
Karolina GPU	0
Discoverer CPU	1
LUMI-C	2

System	Number of proposals awarded
Total	14

Table 3: Number of proposals awarded per system in the Regular Access call March 2022 cut-off

5.2.1.2 Regular Access call July 2022 cut-off

In the July 2022 cut-off there was only one proposal submitted to the Industry track and one in the Public Administration track, the remaining 28 were submitted in the Scientific track.

Domain	#Proposals received from Male / Female / Unspecified	#Proposals awarded
Chemical Sciences and Materials, Solid State Physics	7 6 / 1 / 0	6
Biochemistry, Bioinformatics, Life Sciences, Physiology and Medicine	7 6 / 1 / 0	4
Engineering, Mathematics and Computer Sciences	8 5 / 3 / 0	4
Computational Physics: Universe Sciences, Fundamental Constituents of Matter	8 5 / 2 / 1	7
Earth System Sciences and Environmental Studies	0 N/A	N/A
Socio-Economic Sciences and Humanities	0 N/A	N/A
Total	30	21

Table 4: Number of proposals received and awarded in the Regular Access call July 2022 cut-off

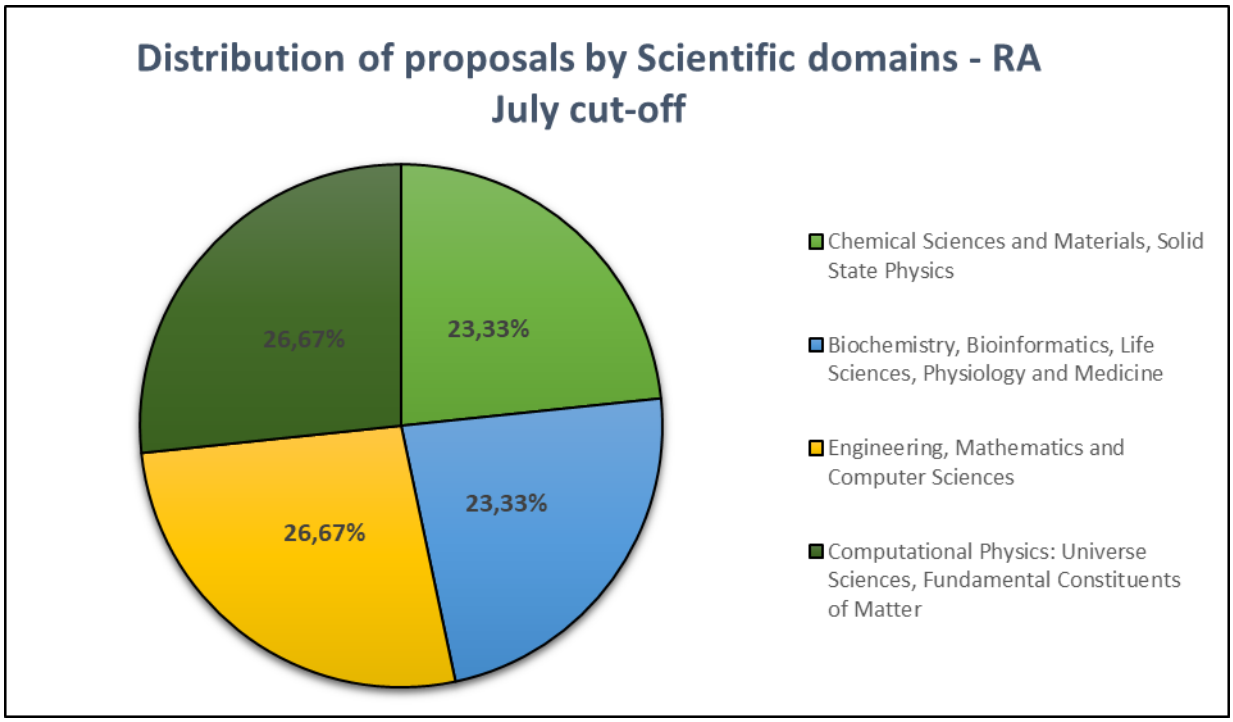


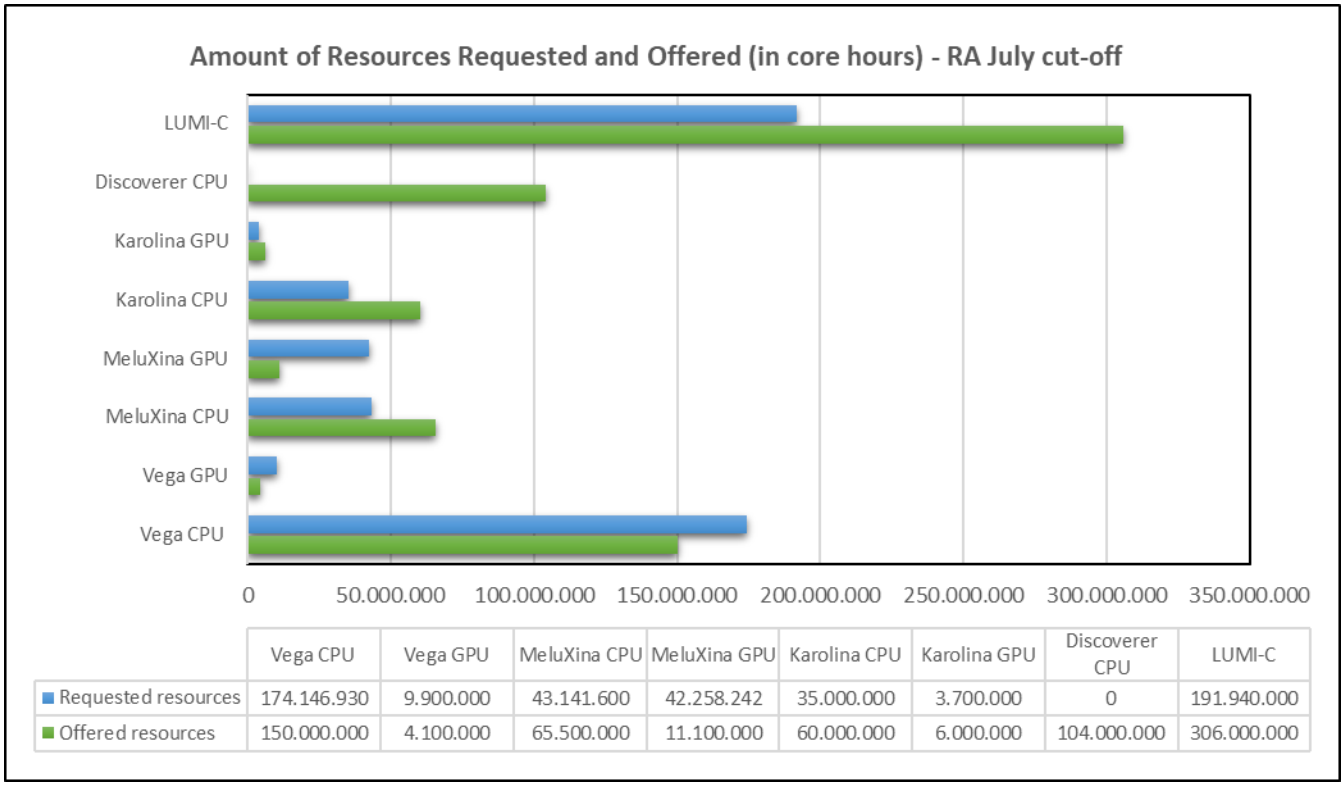
Figure 14: Distribution of proposals received in the Regular Access (RA) July 2022 cut-off by scientific domain

System	Offered	Requested	Minimum request	Awarded
Discoverer CPU	104.000.000	0	10.000.000	45.000.000
Karolina CPU	60.000.000	35.000.000	10.000.000	35.000.000
Karolina GPU	6.000.000	3.700.000	1.000.000	7.200.000
LUMI-C	306.000.000	191.940.000	20.000.000	171.940.000
MeluXina CPU	65.500.000	43.141.600	10.000.000	15.641.600
MeluXina GPU	11.100.000	42.258.242	2.000.000	14.566.400
Vega CPU	150.000.000	174.146.930	10.000.000	150.046.936
Vega GPU	4.100.000	9.900.000	1.000.000	4.500.000
Total	706.700.000	500.086.772	N/A	443.894.936

Table 5: Amount of resources, in core hours, offered, requested, awarded and minimum request per system for the Regular Access call July 2022 cut-off

System	Number of proposals awarded
Discoverer CPU	1[2]
Karolina CPU	3
Karolina GPU	2
LUMI-C	4
MeluXina CPU	1
MeluXina GPU	3
Vega CPU	8
Vega GPU	2
Total	24

Table 6: Number of proposals awarded per system in the Regular Access July 2022 cut-off



	Vega CPU	Vega GPU	MeluXina CPU	MeluXina GPU	Karolina CPU	Karolina GPU	Discoverer CPU	LUMI-C
Requested resources	174.146.930	9.900.000	43.141.600	42.258.242	35.000.000	3.700.000	0	191.940.000
Offered resources	150.000.000	4.100.000	65.500.000	11.100.000	60.000.000	6.000.000	104.000.000	306.000.000

Figure 15: Amount of Resources Requested and Offered in the Regular Access call July 2022 cut-off (in core hours)

5.2.1.3 Extreme Scale call November 2022 cut-off

Information regarding the Regular Access call November 2022 cut-off cannot be given at this stage as it is still under evaluation, and can only be made public in the end of the peer-review evaluation process. Three machines are offering resources to this call, Leonardo Booster (CINECA, IT) and, LUMI-C and LUMI-G (CSC, FI). The amount of resources offered to the call are shown in the table below.

[2] In this call, EuroHPC kindly helped PRACE to award a Multi-Year proposal from Project Access call 21; after evaluation the proposal was awarded 45 million core hours on Discoverer CPU.

System	Architecture	Total offer in core hours (node hours)	Minimum request (in core hours)
Leonardo BOOSTER	BullSequana XH2000	189.000.000 (5.900.000)	20.000.000
LUMI-C	HPE Cray EX	826.700.000 (6.500.000)	80.000.000
LUMI-G	HPE Cray EX	689.000.000 (10.800.000)	55.000.000

Table 7: Amount of resources offered to the 1st Extreme Scale call (November 2022 cut-off)

5.2.2 PRACE Legal Form and its Statutes

The evolving European HPC landscape will also inevitably affect PRACE's legal form and Statutes [24]. In order to prepare the transition period, PRACE consulted the legal advisor to help clarifying the initial steps needed, such as the following:

- Impact of delivering access services to EuroHPC Joint Undertaking. The outcome of the first analysis was that in light of the more extensive purpose of PRACE, it is considered that the provision of peer review services to EuroHPC in the framework of a possible public procurement contract would be compatible with the statutory purpose of PRACE as set out in Article 3 of the PRACE Statutes. Additionally, the non-for-profit nature of PRACE as an association would not be jeopardised by this public procurement contract. The possibility for non-profit associations to engage in commercial and economic activities has been extended under the recent reform of Belgian corporate legislation. Moreover, it became clear that the VAT status of PRACE may have to be reassessed in light of such a service contract and a more thorough analysis will be conducted. Further internal audit with the assistance of Bird &Bird confirmed the outcome of the previous analysis, meaning that engaging in commercial services would imply for PRACE aisbl a change of its VAT status handled so far as a non-taxable person. For the time being, the PRACE Council took the decision to keep the current VAT status and not reply to the open tender for provision of peer services to EuroHPC JU;
- Impact of the phasing out of PRACE 1 and PRACE 2 on the PRACE governance. In the event that after PRACE 2 no Hosting Members will continue to provide compute resources to the research communities, the current governing rules will no longer be adequate and an amendment will be required. Currently, with the assistance of Bird &Bird PRACE is working on the PRACE Statues to be simplified and be more flexible while of course being within Belgian Law and in line with the objective and future relationship with EuroHPC (see the User Association, section 4.6: voting power, nomination of PRACE members, etc);
- PRACE aisbl as Private Member of EuroHPC JU. As mentioned in section 3.1 PRACE-EuroHPC Relation, PRACE proposes to become a Private Member of EuroHPC JU (and if not possible, to formalise the relationship in any other appropriate way) so it can directly be connected to EuroHPC JU and formally have a voice as an organisation within the EuroHPC governing board. Legal analysis conducted by Bird & Bird

indicates that the current PRACE Statues would not prevent PRACE from becoming a Private Member of EuroHPC. The legal representative of EuroHPC JU instead indicated that from the point of view of the EuroHPC JU Regulation (Regulation 2021/1173), PRACE is not eligible to act as a Private Member of EuroHPC JU and alternative possibilities are being investigated at the moment.

6 PRACE Impact Assessment

A performance indicator or Key Performance Indicator (KPI) is a type of performance measurement. KPIs evaluate the success of an organisation or of a particular activity in which it engages. The work on Key Performance Indicators in the context of PRACE-RI started as early as the first Implementation Phase (PRACE-1IP) project and continued to evolve in the succeeding series of PRACE-IP projects until today. Deliverable D2.4.1 in PRACE-1IP [25] described in detail all aspects regarding monitoring and reporting in the PRACE-RI. After a period of refinement and elaboration by PRACE aisbl, a total of 15 variables were finally selected as official PRACE-RI KPIs and became publicly available on the official PRACE website. These KPIs rely on actual data collected on a yearly basis.

The work on PRACE-RI KPIs has continued since then, with the corresponding tasks in WP2 focusing on the development and analysis of internal indicators that should help to understand the usage and trends of HPC users in PRACE, and the impact of the PRACE 2 programme in European research. Among them, the most relevant are presented and discussed in this section.

6.1 PRACE aisbl Impact

The following indicators show the impact of PRACE as an international research infrastructure, capable of constantly attracting new users and foster international cooperation.

Evolution of new users

This indicator refers to the fraction of new applicants that apply to PRACE, and those that are finally awarded resources made available through PRACE, for each call. The target of this metric is that new applicants and new awardees represent an important percentage, as an indicator for the capacity of PRACE to attract and serve new users and their projects. Figure 16 shows the trend for this metric.

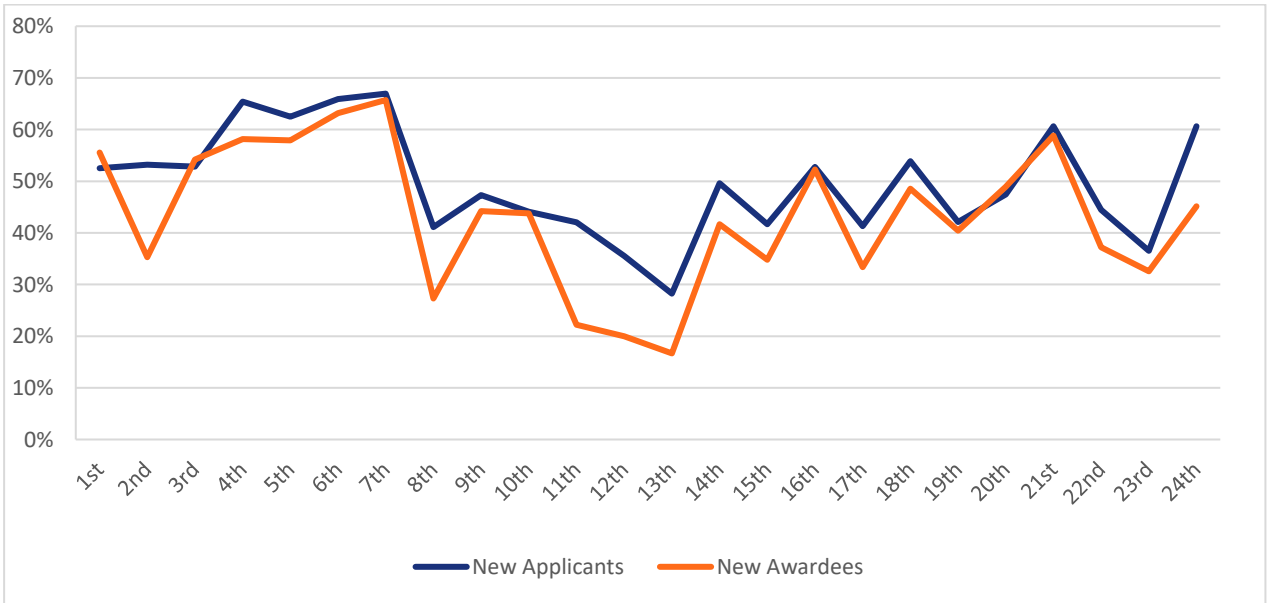


Figure 16: Ratio of new applicants and new awardees in each PRACE call

The ratio of first-time applicants and awardees is relatively high. On average, more than 50% of applications to PRACE resources are submitted by new applicants. Their success rate is also important, representing 46% of the projects awarded. The message of this metric is two-fold: on the one hand, after more than 10 years of operation, PRACE is still capable of attracting new users call after call; on the other hand, new users have equal opportunities to get their applications awarded. Combined, this indicates that the infrastructure remains well open to the evolving community of European HPC users. This capacity is specifically visible for the period of the PRACE 2 programme, starting in Call 14.

Transnational cooperation

This indicator collects the number of "foreign projects" and the resources awarded to them. Foreign projects are defined as projects with Principal Investigators (PIs) from a different country (recorded as the country of the PI's primary institution) than the system on which the research is executed. This is an important indicator to monitor the European and international dimension of PRACE. The target for this indicator is to maintain the trends above 50%. Figure 17 shows the evolution of this metric.

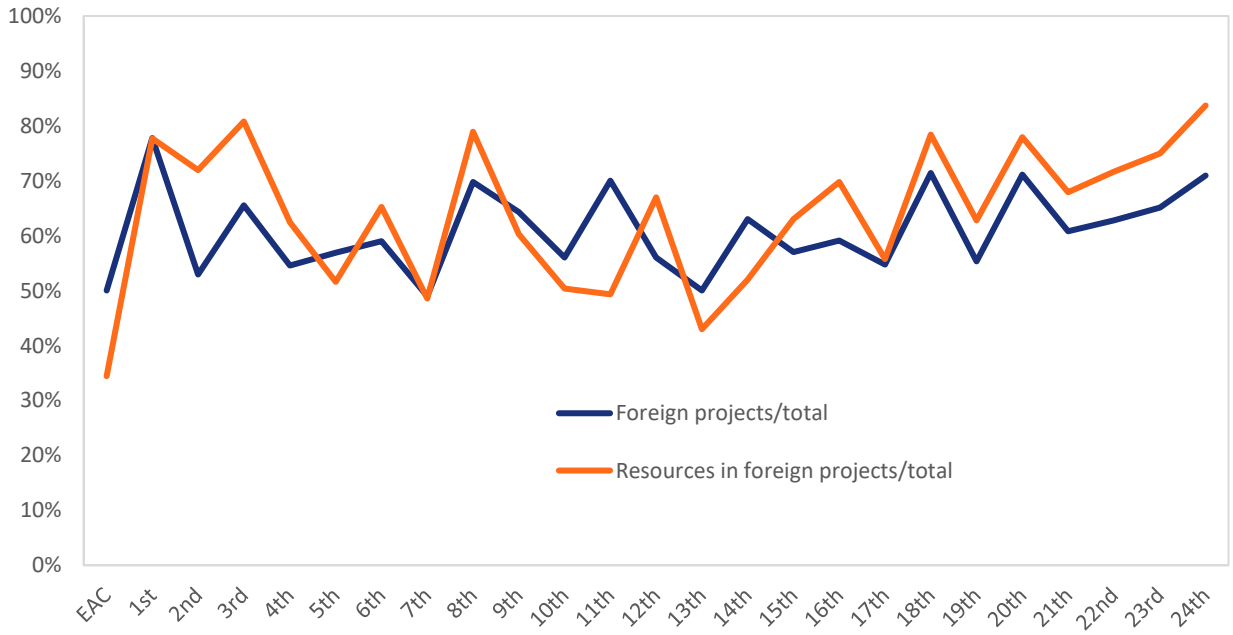


Figure 17: Ratios of awarded 'foreign' projects and resources for awarded 'foreign' projects

On average, more than 60% of the resources are awarded to foreign projects, with an evolution that remains rather stable over time. Taking into account that PRACE is currently offering resources in five different countries, the relative ratio of country matching is rather low, indicating that the nationality of the PI's institution does not influence the chances of a project being awarded, and also that PRACE systems are not exclusive assets of the local community. Overall, this demonstrates PRACE's impact in the enhancement of European and International collaboration.

Collaboration and interoperability

The scope of this indicator is to monitor the number of proposals involving more than one country and proposals requesting more than one PRACE system. The target is to identify the collaboration and interoperability features of PRACE projects.

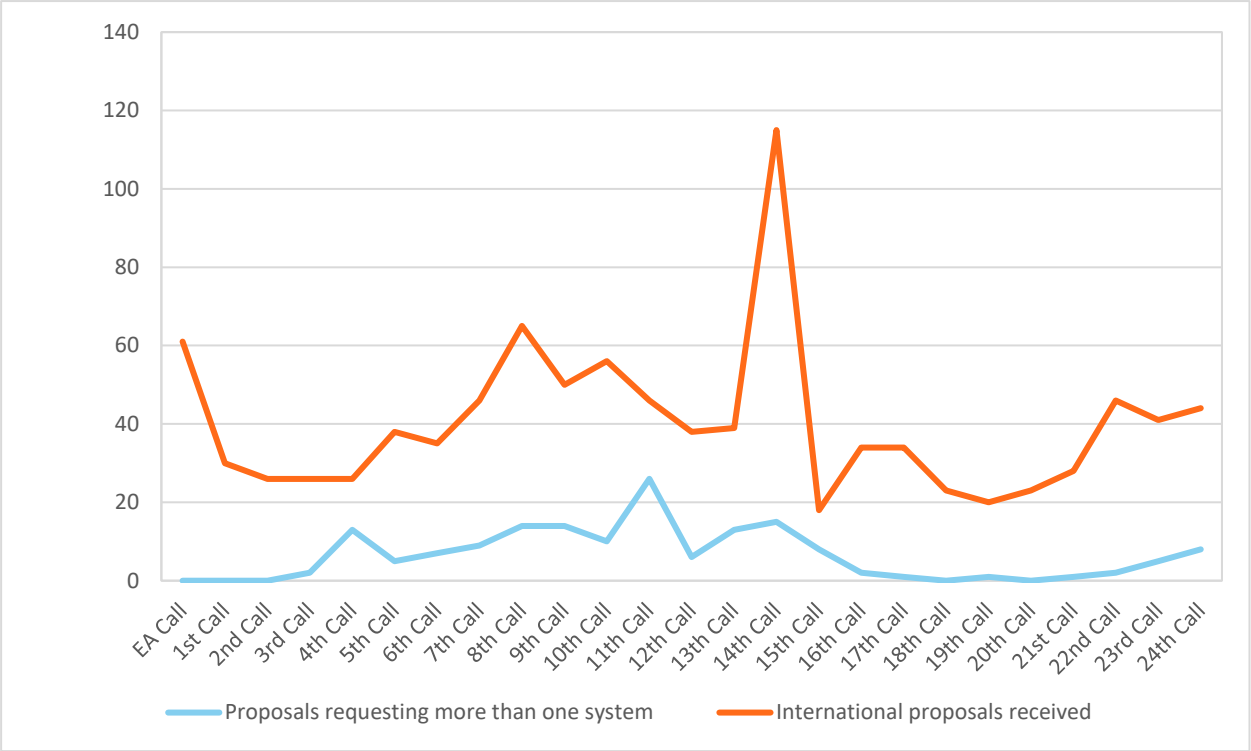


Figure 18: Proposals requesting more than one system

As seen in Figure 18, a large amount of the received proposals are international. Comparing with the total number of proposals per call (in Figure 3), this represents that nearly half of the proposals received involve research groups from different countries. Even if there is no numeric target for this indicator, the current average value is considered a good sign of the capacity of PRACE to foster wide collaborations across European countries.

In relation to interoperability, the average of proposals ready to use more than one system is below 10%. The value of this indicator is not consistent over time, it showed a maximum value of 24% in Call 11, and since then has been decreasing to nearly none, even if on the last call we received 5 such proposals. On a first analysis, we have observed that most proposals requesting more than one system are large-scale initiatives divided into independent work packages, each of them led by a different research group and run in a different system. While this is further analysed, apparently users do not perceive a benefit, or even they perceive a disadvantage on the simultaneous usage of multiple HPC systems. At this stage, this is neither considered positive nor negative, though it serves to balance the resources devoted to interoperability.

6.2 PRACE 2 Indicators

The PRACE 2 programme began in 2017 with Call 14 where a set of constraints in the access to PRACE 2 systems were introduced, namely a target in the allocation of resources based on

the nationality of the principal investigator of the Tier-0 projects. Whenever the targets are exceeded, i.e.: when allocating a proposal would deviate from the quotas set by the PRACE 2 programme, the corresponding Hosting Member is asked if it can accept the deviation. When this is not possible, movement of the corresponding proposal to another suitable system is attempted. When this is not possible, the AC Chair is requested to confirm if the proposal is still viable with the highest available resources. When that is not possible, the proposal is rejected due to PRACE 2 constraints.

For reference, the coexistence of the PRACE 1 and PRACE 2 programmes was due to the gradual start of countries to execute their PRACE 1 contributions. These started with Germany in 2010 and France in 2011, and once their €100 milion PRACE 1 commitment was fully executed, the PRACE 2 programme started, including as well contributions from Switzerland. Later on Spain (Call 18) and Italy (Call 20) joined the PRACE 2 programme, once their PRACE 1 commitment was also fully executed. This is summarised in the following scheme:

Country	Call 14	Call 15	Call 16	Call 17	Call 18	Call 19	Call 20	Call 21	Call 22	Call 23	Call 24
France	PRACE 2 programme										
Germany	PRACE 2 programme										
Italy	PRACE 1 programme						PRACE 2 programme				
Spain	PRACE 1 programme				PRACE 2 programme						
Switzerland	PRACE 2 programme										

Table 8: Overview PRACE 1 and PRACE 2 programmes

The Board of Directors has defined a set of allocation indicators to understand the impact of these constraints in Project Access allocations. These are internal indicators used to report to PRACE Council about the usage and distribution of PRACE 2 resources and are presented in Table 9.

Name	Description	Call 14	Call 15	Call 16	Call 17	Call 18	Call 19	Call 20	Call 21	Call 22	Call 23	Call 24
Ref.1	Number of proposals received	117	84	72	63	52	57	59	66	63	62	66
Ref.2	Number of proposals ranked above scientific excellence threshold	81	44	45	44	36	47	45	55	48	51	50
RAS.1	Proposals moved from a PRACE 2 system to a PRACE 1 system due to a potential deviation in the distribution of resources	3	0	0	1	0	0	N/A	N/A	N/A	N/A	N/A
RAS.2	Proposals moved from a PRACE 1 system to a PRACE 2 system	6	2	4	0	0	1	N/A	N/A	N/A	N/A	N/A
RAS.3	Total proposals moved	20	3	8	9	13	12	13	11	7	8	9
RAS.4	Proposals where the HM accepted a deviation on the distribution of Resources	6	4	3	7	5	5	12	7	13	9	12
RAS.5	Proposals not allocated due to PRACE 2 constrainss	0	0	0	0	0	0	0	0	0	0	0

Table 9: PRACE 2 internal indicators

Movement indicators

Indicator RAS.1 shows how the PRACE 2 quotas were never strongly enforced. Only in a limited number of cases the quotas were applied, moving proposals from one system to another, in order to avoid major deviations on PRACE 2 constraints.

Indicators RAS.2 and RAS.3 are used to provide a context to indicator RAS.1. While moving proposals across systems is a normal operation in PRACE allocation of resources, the target is that RAS.1 values across calls remain lower than RAS.2 values and only a fraction of RAS.3 values. During the relevance period of these three indicators, the movement of projects due to PRACE 2 constraints (RAS.1) has remained under 7% of the total proposals moved.

It is worth noting that PRACE has entered in full PRACE 2 regime as of Call 20. Therefore, indicators RAS.1 and RAS.2 are not applicable anymore and indicator RAS.3 is not necessary for the comparison purposes it was set. Nevertheless, the fact that the value of this indicator for Call 20 is in line with the previous ones re-confirms that movement of proposals across systems is a standard PRACE procedure and not a by-product of the PRACE 2 programme. Analysis of the RAS.3 metrics, both backwards and forward, will be continued.

For reference, the total number of proposals received and the total number of proposals ranked above the scientific excellence threshold are included in the same table, in order to provide a relative meaning to these movement indicators. On average, 23% of the proposals received are moved to alternative systems, with the majority of these movements motivated by technical reasons or exhaustion of the requested resources.

Deviation indicators

Indicator RAS.4 collects those cases when a deviation of PRACE 2 allocation target is accepted. There is no objective set for this indicator, though comparing it with RAS.1 shows the real flexibility in the application of PRACE 2 constraints.

Unallocation indicator

Indicator RAS.5 is the most important one of this group. It collects the amount of proposals rejected due to the application of PRACE 2 target allocation of resources. Based on the PRACE 2 principles the target for this indicator is zero. This target has been achieved call by call so far, showing the lack of effective impact of PRACE 2 constraints in the allocation of resources, and that the main principle of "allocation of resources based on scientific excellence" of PRACE is still valid and followed with PRACE 2.

6.3 Service Indicators for EuroHPC JU

One of the activities planned for this period was to propose KPIs for the HPC access provided through EuroHPC JU. At this stage, this is considered premature, given that the new EuroHPC JU systems have been in production for less than one year, which is not sufficient to analyse the trends and set objectives to them. Nevertheless, the following is a list of indicators that EuroHPC JU could monitor and use to develop a set of HPC access KPIs:

- *Availability and allocation of resources*: Indicator collecting the resources made available by EuroHPC JU on a yearly basis, compared with the total of resources requested and awarded. This can be further refined with the resources requested by eligible proposals and the resources requested by proposals above a certain technical and scientific threshold. Further stratification could be added by splitting the indicator according to the different HPC architectures;
- *User trends*: The objective of this indicator is to inform about the recurrence of EuroHPC JU access users across calls or on a yearly basis. It is considered important to monitor the fraction of new applicants, and the fraction of new awardees, to follow-up on the capacity of the ecosystem to evolve and incorporate new users and group communities;
- *Transnational and international scope*: By definition, all the access to EuroHPC JU systems is transnational. Nevertheless, it is important to monitor the geographical distribution of the users and compare that to the location of the hosting entities. The objective of this indicator is to demonstrate that the country in which a PI is located does not significantly affect the chances for accessing a system;
- *Research cooperation*: An important aspect of the HPC access awards is that these do not include the necessary human resources to carry out the simulations planned - such human resources must be secured by the teams themselves when applying for the HPC access. The objective of this indicator is to monitor the sources of such human resources (regional, national, European or international), which may help creating synergies or joint research programmes in the future;
- *Industrial access*: The access of industry to HPC is always an element to monitor. Even if industry has different interests and objectives than academic partners, it is expected that they can benefit from the competitive calls of EuroHPC JU. The objective of this

indicator is to monitor the applications received and the projects awarded, stratified between SMEs and large private companies as well.

6.4 PRACE-ICEI Calls

Another important Peer Review activity was the organisation and managing of the PRACE-ICEI collective call, with four calls being opened in 2022:

- January 2022: PRACE-ICEI Calls for Proposals - Call #8;
- April 2022: PRACE-ICEI Calls for Proposals - Call #9;
- June 2022: PRACE-ICEI Calls for Proposals - Call #10;
- October 2022: PRACE-ICEI Calls for Proposals - Call #11.

The PRACE-ICEI call offers users the possibility to apply for scalable computing resources, interactive computing services, virtual machine services and data storage to carry on their research. These resources come from the Fenix Research Infrastructure that is funded by the European ICEI project [15].

Call	# Proposals received	# Proposals awarded
PRACE-ICEI Call #8	3	3
PRACE-ICEI Call #9	12	8
PRACE-ICEI Call #10	7	7

Table 10: Number of proposals received and awarded in the collaborative PRACE-ICEI Calls #8, #9 and #10. The Call #11 is currently under evaluation

7 Summary

In this deliverable, we have reported on the strategic and operational developments of PRACE towards EuroHPC JU. Starting from the capacity of PRACE to deliver world-class computing resources, distributed to the European community based on scientific and technical excellence, this document presents the complete set of current PRACE services, their value for the European HPC ecosystem and an analysis of their future after the end of the project.

The main business of PRACE, i.e.: the management of HPC access mechanisms, has been complemented with strong training, support and knowledge programmes, where PRACE has so far been leading the activities and coordinating with relevant actors where necessary. A strong example of this capacity to fit within the ecosystem is the collaboration with the European Centres of Excellence (FocusCoE) and Competence Centres (CASTIEL) on HPC for the joint development of the HPC in Europe portal. Finally, we also presented the future plans of PRACE to further involve European HPC users in the infrastructure.

It is PRACE's hope that a formal collaborative working relationship between PRACE and EuroHPC JU can be established soon, by the end of 2022, and for it to be in effect for a number of years.

The major delays in originally foreseen timelines of the EuroHPC calls will currently create a gap between the end of the PRACE-6IP project and the start of the respective EuroHPC-funded activities.

PRACE would like for part of its activities to continue, but PRACE recognises – as should other actors in the EuroHPC ecosystem, that throughout the years it has gained the expertise and knowledge to best implement certain activities for the benefit of the European HPC community as a whole.

PRACE believes that it is capable of contributing to a positive effect towards the activities and Work Programme of EuroHPC JU, and ideally, a collaborative partnership between the two parties can soon be forged, for the benefit of the European HPC community.