# 1   The PRACE Training Strategy

Since the beginning of PRACE, there has been a growing emphasis on training the community of researchers and developers to maximize efficiency and productivity on large HPC systems. This has resulted in a diverse range of activities in PRACE that have grown organically (from Seasonal Schools, to PRACE Training Centres, On-demand events, MOOCs). While these activities are sometimes differentiated internally due to operational differences – Seasonal Schools are organised in different ways to On-demand events but ultimately they both provide a face-to-face training service to the community – the collective set of activities contribute to an overarching list of objectives, which are as follows:

1. Develop an advanced base of researchers and developers for exploiting exascale and EuroHPC systems (PTCs),
2. Support a community of intermediate to advanced HPC users and developers, enabling availability of a diverse range of HPC courses across Europe, the stepping stones to more advanced courses (PTCs, Seasonal Schools),
3. Bring new user groups and scientific disciplines, such as SMEs, bio- and life sciences, digital humanities, into HPC (PTCs, Seasonal Schools, On-demand events),
4. Actively pursue training collaborations with other organisations and projects and contribute to invited training events (PTCs, Seasonal Schools, On-demand events, International HPC Summer School),
5. Build a pan-European web portal that is a "one stop shop" for users to find HPC & computational science courses all around Europe, as well as access to material, self-learning resources (e.g. Training Portal, CodeVault),
6. Take advantage of new online platforms to grow the range of PRACE remote learning services to reach larger audiences (e.g. MOOCs),
7. Promote HPC training to undergraduates and universities (e.g. SoHPC, PRACE for Universities in WP3).

This section aims to set out the PRACE training strategy that will provide improved clarity to the approach taken in the planning, implementation and impact assessment of the various activities.

## 1.1   The European HPC User Base and Target Audience

Somewhat similar to the European HPC infrastructure landscape that can be divided into Tier-0, Tier-1 and Tier-2 systems in a pyramid representation, the HPC user base in Europe consists of a large group of users with a basic knowledge of HPC, followed by a smaller group of "intermediate level" users, and finally an even smaller group of advanced users, as shown in Figure 1.

**40-50% of investment**
**Target: 400 participants**
20-25 advanced PTC courses
Int. HPC Summer School
New Extreme Workshop
On demand events

**50-60% of investment**
**Target: 1400 participants**
70+ intermediate PTC courses
3 Seasonal Schools
On demand events

Advanced HPC users

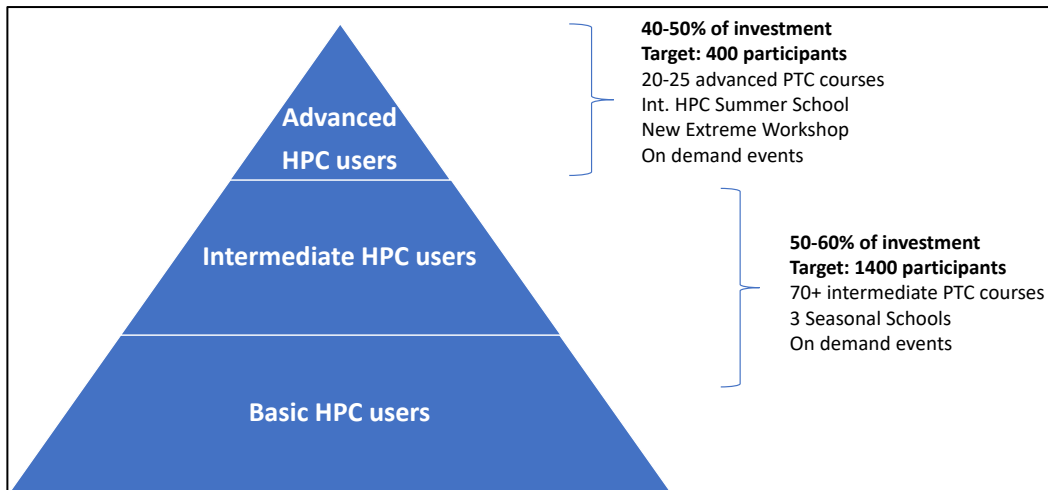Intermediate HPC users

Basic HPC users

**Figure 1: The HPC user pyramid, in context of HPC training**

While recognising that PRACE cannot be responsible for providing the necessary training for the entire European HPC user base, the strategy of PRACE is to:

- Recognise that most basic to intermediate level HPC training remain the responsibility of national HPC training programmes.
- Focus a significant proportion of its resources on face-to-face training services that grow the community of advanced users who would gain the prerequisite experience and know-how to exploit pre-exascale and EuroHPC infrastructure. This investment is targeted towards a relatively small audience of 400 participants per year (Figure 1). It will also organise advanced training that no individual HPC centre can provide by pooling European HPC expertise.
- Dedicate its remaining resources to enable a diverse range of intermediate level HPC courses across Europe, the stepping stones to more advanced courses. Some effort is put also into training that brings new user groups (SMEs, new scientific disciplines) into HPC. This investment is more diffused relative to that for advanced users because the target audience is 1,400 participants per year (Figure 1). But it is a necessary and cost-effective investment by PRACE (in terms of cost per participant) to ensure continued accessibility and dissemination of such courses to all European researchers.

It is important to note that without the investment of resources and coordination by PRACE for both advanced level and some intermediate level courses, HPC training provision in Europe would be disjointed and fragmented; only a handful of large countries may have the training resources to cater for its HPC user base across all levels.

## 1.2 Regular programme – PTCs, Seasonal Schools

Target audience: intermediate to advanced HPC users.

- PRACE "Extreme Scalability & Performance Workshop" (to be piloted in the PRACE-6IP project): the PTCs will pool their resources (trainers) to invite some of the most talented software developers to attend a week-long event that focuses on cutting edge HPC technologies.
  - Advanced MPI
  - Advanced threading

- – Accelerators
- – I/O performance at scale
- – Programming for exascale, tools and new paradigms

The special format and features of the school will include the following:

- – Set aside time for ad hoc sessions between participants and trainers to focus on particular codes/solvers/paradigms.
- – Most trainers will spend the whole week at the event to facilitate communication and interaction.
- – Limited to 40 participants.
- – Prerequisite: code developers with 1-2 years with MPI/OpenMP, preferably those already actively developing parallel code on Tier-1 or Tier-0 systems.

- PTCs: collectively offers 20-25 advanced courses per year on cutting edge HPC topics, exploiting maximum performance and scalability using available and new HPC hardware, software and programming paradigms.
  - – The objective is to train researchers and developers to exploit pre-exascale systems.
  - – Prerequisites: code developers with extensive experience in developing parallel codes (MPI, OpenMP, accelerators) with some know-how in performance analysis and optimisation.
- PTCs: in addition to advanced courses, another 70+ PTC courses per year receives support from PRACE that offers a diverse range of courses aimed at intermediate HPC users that:
  - – Adheres to consistent standards of quality.
  - – Are readily made available to all European researchers through PRACE dissemination channels and common registration platform.
  - – Prerequisites: mainly HPC users and developers with some basic knowledge of HPC code development and/or deployment.
  - – Small portion of courses (< 10) maybe targeted for new user groups with only a little previous HPC experience.
- Seasonal Schools: offer HPC and computational science courses in non-PTC hosting sites targeted at all levels of users that:
  - – Caters for any regional interests
  - – Allow each hosting site to organise courses that cannot be delivered by itself, via support for external trainers to these schools
  - – Prerequisites: None required.
- International HPC Summer School: attracts top students from Europe, US, Canada and Japan to participate in a prestigious school that:
  - – Is taught by international HPC experts.
  - – Provides an overview of HPC challenges in different scientific domains.
  - – Prerequisites: Experience with parallel programming, top students with strong motivation and research plans that will benefit from the school.

## 1.3    Impact Review of PTC Courses

A number of key statistics (e.g. number of participants, training days, overall course ratings) are currently used as indicators of impact of PRACE face-to-face training activities. But there are additional mechanisms that can be implemented in future PTC programmes to gauge other aspects of impact (e.g. whether PRACE courses are catering for some of the most advanced European users/developers). These include:

- Advanced content assessment:
  - Examine the implementation of advanced courses.
  - Ensure that these attract top researchers and developers (prerequisites, profiles of participants).
  - PRACE Scientific Steering Committee (SSC) and Board of Directors (BoD) to provide recommendations on topics.
  - Potentially, follow up surveys/analysis of impact on participants.
- Intermediate content assessment:
  - Ensure a good balance of topics.
  - SSC and BoD to provide recommendations on topics.
  - Prerequisites examined.

## 1.4    On-demand Opportunities

PRACE will continue to work with relevant organisations and projects (e.g. CoEs, EUDAT **Error! Reference source not found.** ), contributing to external events and/or organise joint events. This requires budget and planning flexibility in order to address more *ad hoc* On-demand opportunities.

## 1.5    Training Portal

PRACE Training portal acts as the main access point for PRACE training activities. All the PRACE training events are announced on the portal, and the registrations are carried out within it. The portal provides also access to the training material, and provides view to other PRACE online resources, such as MOOCs and CodeVault.

## 1.6    Remote Learning

While the face-to-face trainings remain the core of the PRACE training, remote learning complements the face-to-face activities by providing more scalable training which is not tied into a place or into a time. The PRACE remote learning activities target mainly the same user groups as face-to-face trainings.

- Massive Open Online Courses (MOOCs) are developed both for intermediate and advanced users. Small part of the effort is put on introducing HPC to new user groups,
- Short video tutorials are available for all interested users,
- CodeVault provides a repository of code samples that can be used in self-learning,

- The lecture and exercise material of past PRACE face-to-face events is provided in the training portal,
- Some face-to-face events provide also remote participation possibility.

## 1.7 Outreach to Universities

The main target audience of PRACE Training is researchers (including early stage researchers i.e. Ph.D. students). However, PRACE Training has also outreach and dissemination role in introducing HPC to undergraduates and promoting PRACE training to universities. The main activity is the PRACE Summer of HPC which provides early-stage postgraduate and late-stage undergraduate students a two month placement at top HPC centres around Europe with the opportunity to learn and share more about PRACE and HPC. Summer of HPC includes also a training week.

## 1.8 Summary of PRACE Training strategy

With the increasing importance of HPC in various fields of science and industry, PRACE has central role in proving state-of-the art training for European HPC ecosystem. PRACE has special focus on advanced training which targets to exploiting the pre-exascale and future exascale systems, however, developing a solid base of advanced users requires significant amount of training also in the lower parts of the user pyramid.

PRACE will place special emphasis (~40-50% of its investments in face-to-face training for ~400 participants per year) on offering courses that cater for advanced user communities in Europe. These will be offered on a regular, sustained basis by the PTCs, the International HPC Summer School, and a special "Extreme Scalability and Performance Workshop" (to be piloted in the PRACE-6IP project) that will pool together European HPC training expertise.

While recognising advanced training that caters for European Tier-0 users is well aligned with the PRACE position, and acknowledging that more basic HPC training should mostly be supported on a national level, it is important that PRACE maintains some level of support (albeit more "diluted" level of support) for intermediate courses and a small proportion of basic courses to attract new/emerging user communities. Therefore some 50-60% of investment in face-to-face training, mainly offered by PTCs and Seasonal Schools, will be on intermediate courses that will attract 1,400 participants per year. PRACE support ensures these courses are offered and advertised on a pan-European basis, free-of-charge and organised in a coordinated manner; without PRACE support, many of these courses will be much more restricted in terms of reach, organised in a fragmented manner.

Apart from face-to-face training events, PRACE will maintain and develop online resources that will provide pan-European information on face-to-face courses, training material, sample codes, online tutorials, etc. The cornerstone will be the PRACE Training Portal to facilitate users. There is also tremendous potential for PRACE partners to pool their training expertise to develop MOOCs to attract a global audience for its training offerings. Finally, PRACE will continue its outreach programme to universities to stimulate interest in HPC training among undergraduate students.