H2020-FETHPC-2014

Coordination of the HPC strategy

EXDCI

European eXtreme Data and Computing Initiative

Grant Agreement Number: FETHPC-671558

D5.6
Report on the HPC Training Providers Forum

Final

Version: 1.0
Author(s): Catherine Inglis and David Henty, EPCC – University of Edinburgh;
Blaž Rodič, University of Ljubljana
Date: 21.11.2017

Project and Deliverable Information Sheet

EXDCI Project	**Project Ref. №: FETHPC-671558**	
	Project Title: European eXtreme Data and Computing Initiative	
	Project Web Site: http://www.exdci.eu	
	Deliverable ID: < **D5.6**>	
	Deliverable Nature: <DOC_TYPE: Report>	
	Dissemination Level: PU	**Contractual Date of Delivery:** 30 / November / 2017
		Actual Date of Delivery: 21 / November / 2017
	EC Project Officer: Evangelia Markidou	

* - The dissemination level are indicated as follows: **PU** – Public, **CO** – Confidential, only for members of the consortium (including the Commission Services) **CL** – Classified, as referred to in Commission Decision 2991/844/EC.

Document Control Sheet

Document	**Title: Report on the HPC Training Providers Forum**	
	ID: D5.6	
	Version: <1.0>	**Status:** ***Final***
	Available at: http://www.exdci.eu	
	Software Tool: Microsoft Word 2013	
	File(s): EXDCI-D5.6-TrainingProviders.docx	
Authorship	**Written by:**	Catherine Inglis and David Henty, EPCC (University of Edinburgh)
	Contributors:	David Henty, EPCC (University of Edinburgh); Blaž Rodič, University of Ljubljana
	Reviewed by:	Thierry Bidot, Neovia Katia Soto, PRACE aisbl
	Approved by:	MB/TB

Document Status Sheet

Version	Date	Status	Comments
0.1	30/October/2017	Draft	First draft
0.2	14/November/2017	Draft	Updated draft
1.0	21/November/2017	Final version	

Document Keywords

Keywords:	Training providers, HPC training, collaboration

Table of Contents

List of Figures

References and Applicable Documents

List all external documents referenced in this document

[1] HPC Training Roadmap (EXDCI Deliverable D5.4): https://exdci.eu/jobs-and-training/training-portal/training-roadmap

[2] HPC Curriculum (produced by EuroLab-4-HPC): https://www.eurolab4hpc.eu/static/deliverables/D3-1--final-HPC-curriculum.95d306191a15.pdf

List of Acronyms and Abbreviations

Below is an extensive the List of Acronyms used in previous deliverables. Please add additional ones specific to this deliverable and delete unrelated ones.

ACM	Association for Computing Machinery
CARLA	Latin America High Performance Computing Conference
D	Deliverable
ETP4HPC	European Technology Platform for HPC
EU	European Union
EUROPT	(Annual workshop of the) Continuous optimization working group of the Association of European Operational Research Societies
GTC	GPU Technology Conference
HE	Higher Education
HPC	High Performance Computing
IEEE	Institute of Electrical and Electronics Engineers
IHPCTC	International HPC Training Consortium
ISC	International Supercomputing Conference (ISC High Performance)
ISMP	International Symposium on Mathematical Programming
IT	Information Technology
LMS	Learning Management System
MOOC	Massive Open Online Course
PATC	PRACE Advanced Training Centre
PEARC	Practice and Experience in Advanced Research Computing conference
PRACE	Partnership for Advanced Computing in Europe
PTC	PRACE Training Centre
SBAC-PAD	International Symposium on Computer Architecture and High Performance Computing
SC	Supercomputing Conference
SIAM	Society for Industrial and Applied Mathematics
SIG	Special Interest Group
WP	Work Package
XSEDE	Extreme Science and Engineering Discovery Environment

Executive Summary

The shortage of personnel with expertise in High Performance Computing (HPC) skills has been identified as a barrier to increasing the uptake of HPC in academia and industry, which in turn represents a major risk to European competitiveness. This issue is the focus of EXDCI Work Package 5 – Talent Generation and Training for the Future – the goals of which are to support talent generation, facilitate HPC staff recruitment, and identify and meet future training needs.

One of the underlying issues contributing to the lack of HPC-skilled personnel is the lack of access to appropriate HPC training, combined with a lack of awareness of the training that is available. By encouraging HPC training providers to share training material and best practices, both the quality and quantity of available training could be increased, and its visibility raised. This would make it easier for individuals to find a relevant course or training material which is both appropriate for their needs and easily accessible.

This deliverable, **D5.6 – Report on the HPC Training Providers Forum**, investigates to what extent, and in which ways, providers of HPC training currently communicate and cooperate with each other, and considers whether more could or should be done to stimulate collaboration between HPC training providers throughout Europe and even beyond.

1 Introduction

This deliverable was produced within EXDCI Work Package 5, Talent Generation and Training for the Future, and more specifically as part of **Task 5.3, *Identifying and Meeting Future Training Needs***.

One of the acknowledged barriers to increasing the uptake of HPC in academia and industry is the shortage of skilled personnel. EXDCI believes that the nurturing of young talent is a crucial element in the development of an HPC-literate workforce in Europe, and Task 5.3 focuses on identifying emerging training needs and considering how training can be made more accessible, and scaled up to meet rising demand.

Work previously undertaken within Task 5.3 has included the production of an HPC Training Roadmap (D5.4)[1], and the development of a Training Portal[2] as a central resource for finding information about courses and online materials on HPC-related topics.

EXDCI believes that collaboration between HPC training providers would lead to the sharing of materials, joint development of new materials, contribution to shared repositories, and the sharing of best practices. This would result in more material being produced and being made accessible, for less effort.

The fostering of a community of training providers is therefore considered to be a key step towards co-ordinating and directing European efforts in HPC training and education. With a view to supporting the development of such a community, we distributed a questionnaire to our network of contacts who are involved in providing HPC training around Europe and beyond. This report provides an analysis of the responses to the questionnaires.

This document is structured as follows:

Chapter 1 Introduction – a brief description of the objective of the work and its relation to the project as a whole.

Chapter 2 Existing collaborations between HPC training providers – an overview of initiatives already established in Europe and beyond.

Chapter 3 Motivation for this report – an explanation of why this specific work was undertaken.

Chapter 4 The questionnaire – statistics from the responses to the questionnaire, and some observations on these.

Chapter 5 Summary – a summary of the findings.

Chapter 6 Conclusions – concluding comments and recommendations.

Chapter 7 Annex – including the text of the questionnaire and the list of organisations to which it was sent.

[1] https://exdci.eu/jobs-and-training/training-portal/training-roadmap
[2] https://exdci.eu/jobs-and-training/training-portal

2 Existing collaborations between HPC training providers

Various projects have already been established to bring together the diverse – and dispersed – bodies of HPC training professionals, both within Europe and on a global level. These initiatives aim to promote collaborative approaches to the creation and delivery of HPC training courses, and to establish best practices for training.

2.1 European initiatives

In Europe, **PRACE**, the Partnership for Advanced Computing in Europe[3], is perhaps foremost in co-ordinating a community of HPC training providers. The dedicated training work package within the PRACE initiative brings together the key HPC training providers in Europe.

The main focus of this community is the network of 6 well-established PRACE Advanced Training Centres (PATCs)[4], which have recently been joined by 4 newly designated PRACE Training Centres (PTCs)[5]. These centres offer a co-ordinated curriculum of courses from introductory to advanced level, aiming to distribute HPC training around Europe in a way which makes it reasonably accessible to people anywhere in the continent.

PRACE also co-ordinates the Summer of HPC programme[6], which offers 2-month summer placements for students at 10 European HPC centres. Although the programme is distributed across HPC centres in different countries, with typically 2-3 students at each centre, the participants all start their placement together, attending an initial training week hosted by one of the centres, and at the end of the programme they all present their project results in a joint online session. There is also a blog to which all students contribute, in which they share their experiences, both work-related and cultural, creating a strong sense of community and the feeling of being part of a major programme, despite being geographically dispersed.

PRACE also works together with Compute/Calcul Canada[7], RIKEN[8] and XSEDE[9] to jointly organise the International HPC Summer School on HPC Challenges in Computational Sciences[10], an annual one-week summer school which takes place alternately in Europe and North America. Leading scientists from multiple domains and HPC technologies are invited to teach on the summer school, which is aimed at postgraduates and postdoctoral scholars. This is a truly global effort, bringing together HPC training specialists from Europe, the USA, Canada and Japan.

The **EuroLab-4-HPC**[11] initiative is a consortium of 13 European universities and research institutes comprising some of Europe's best research teams in HPC. The EuroLab-4-HPC members have worked together to define a "curriculum in HPC technologies and best-practice education / training methods to foster future European technology leaders"[12]. This document

[3] http://www.prace-ri.eu/
[4] The 6 PATCs are based at: Barcelona Supercomputing Center (Spain), Cineca (Italy), CSC (Finland), EPCC (UK), Gauss Centre for Supercomputing (Germany), and the Maison de la Simulation (France)
[5] The 4 PTCs are based at: GRNET – Greek Research and Technology Network (Greece), ICHEC – Irish Centre for High-End Computing (Ireland), IT4I – National Supercomputing Center (Czech Republic), and SURFsara (the Netherlands)
[6] https://summerofhpc.prace-ri.eu/
[7] https://www.computecanada.ca/
[8] http://www.riken.jp/en/
[9] https://www.xsede.org/
[10] http://www.ihpcss.org/
[11] https://www.eurolab4hpc.eu/
[12] https://www.eurolab4hpc.eu/static/deliverables/D3-1--final-HPC-curriculum.95d306191a15.pdf

contains a suggested course description, designed to be suitable for online delivery as well as face-to-face teaching, and includes a section on Best Practices for Online Education, which tends to be characterised by very low completion rates.

2.2 International initiatives

The **International HPC Training Consortium (IHPCTC)**[13] is an informal consortium of individuals from HPC centres worldwide, created in response to the high level of interest in sharing information which had been noted within the international community.

IHPCTC organises a series of workshops held each year at the SC supercomputing conference[14] – the Fourth Annual SC workshop on Best Practices for HPC Training[15] was held in November 2017. These workshops bring together individuals from HPC centres around the world to share expertise and best practices for in-person, web-based and asynchronous HPC training. The goal of the workshops is to identify and foster collaborative activities which members of the IHPCTC consortium may pursue throughout the following year. The consortium holds monthly teleconferences to discuss HPC training challenges, opportunities and lessons learned.

The **ACM SIGHPC Education chapter**[16] exists to promote interest in and knowledge of HPC and its applications. The chapter runs online seminars which are available via the SIGHPC Education YouTube channel[17], and maintains a list of education and training materials that focus on computational science skills[18].

These two organisations announced in November 2017 that they would be working more closely together to build a combined collaborative community focused on the development, dissemination and assessment of HPC training and education materials[19]. This was announced at the time that this deliverable was being prepared, and is of great interest to the authors of the report, who will watch the developments closely.

3 Motivation for this report

EXDCI believes that, in order to coordinate and direct efforts in HPC training and education, it is vital to support a community of HPC training providers from both the academic and commercial sectors, including technology providers.

However, the project partners believed that a huge amount of effort would be involved in implementing and maintaining a new online environment, and fostering its use to encourage active engagement from the community. Some comparatively low-maintenance options were suggested, such as creating a free slack channel, or even simply a mailing list. However, the previous experience of EXDCI project members, and other external experts whom we initially contacted, all pointed to the proven difficulty of establishing a successful forum environment without strong stakeholder involvement from the start. In the experience of the project members, an online forum is unlikely to get traction unless it is linked to specific stakeholder support activities and services, and this was outside the scope of this project.

[13] https://sites.google.com/a/lbl.gov/hpc-training-best-practices/
[14] http://www.supercomp.org/about.php
[15] https://sc17.supercomputing.org/presentation/?id=wksp120&sess=sess134
[16] https://sighpceducation.acm.org/index.html
[17] https://www.youtube.com/channel/UCHrmHj6nFfkhlxPv18LpBzw
[18] https://sighpceducation.acm.org/resources.html
[19] https://www.hpcwire.com/off-the-wire/sighpc-education-ihpctc-join-forces-promote-hpc-education-training/

Analysis of existing initiatives also showed that while these can be very successful in bringing people together for events such as workshops at major conferences, engagement with online environments is generally low. For example, the SIGHPC Education forum[20] has had a total of 6 posts, none of which received any comments or replies, and there has been no activity in the last year, while the associated blog[21] saw 6 posts in the first 14 months, then only 1 post in the following 10 months.

The overall aim of this task – to foster the creation of a vibrant community with shared resources and best practice – is a valid one, but without an active user community, a forum serves no purpose. In the previous chapter, we note that a high level of interest in sharing resources and experiences has been identified within the international HPC training community, and that some international initiatives already exist. But to what extent are individuals involved in HPC training aware of these initiatives, and how much do they engage with them? Do those who do engage with them consider themselves to be well served by them?

To answer these questions, we developed a questionnaire to try to find out how HPC training providers currently interact, whether they felt that there was a need for further support to help them do this, and if so, what mechanisms would be most useful. The questionnaire and its results are discussed in more detail in the next section.

4 The questionnaire

In order to produce some recommendations on how to improve collaboration between HPC training providers, a questionnaire was created. This aimed to establish:

- What kinds of training environment respondents are working in;
- What their current methods of collaborating with others are;
- What they would like to do, what hinders them from being able to do this and what could help them the most.

The survey was conducted in October 2017. The questionnaire was distributed to (at least) 185 email addresses of individuals from 98 organisations, including IT providers and other commercial companies, higher education (HE) institutions, research institutes, non-profit technology transfer companies, and National High-Performance Computing Centres. The questionnaire was sent to individuals in in a total of 21 countries, mainly within the EU, but including 3 in Switzerland, 2 in Norway and 5 in the USA.

In all, 65 responses from 49 organisations in 15 different countries were received. As some respondents passed the questionnaire on to their own networks of contacts, it is impossible to know exactly how many people received it, and therefore an accurate response rate is difficult to calculate. On the basis of 185 emails being received, the response rate was approximately 35%. A disproportionately large number of responses came from the USA, as the XSEDE organisation distributed the questionnaire within its own wide network.

See Figure 1 Distribution by country of email recipients and responses for a full breakdown of the countries of both people on the initial distribution list, and the responses received.

[20] http://sighpceducation.hosting.acm.org/wp/forums/forum/education-and-training-forum/
[21] http://sighpceducation.hosting.acm.org/wp/

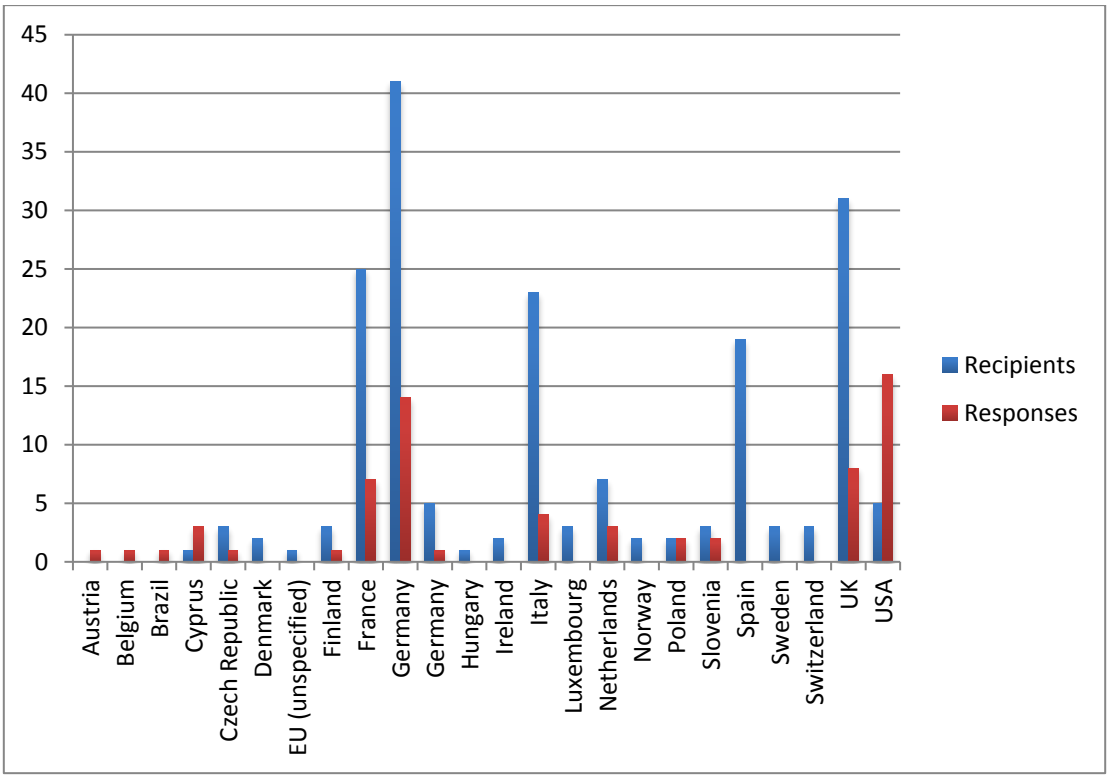

Figure 1 Distribution by country of email recipients and responses

A list of the organisations contacted can be found in the Annex, (section 7.2 List of organisations to which the questionnaire was distributed).

The survey was aimed at individuals, and sought to gather their own opinions based on their personal experience in HPC training provision. However, the first section did include some questions about their institutions, to gather some background information. We received more than one response from some of the larger organisations, such as the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities, and EPCC at The University of Edinburgh.

The survey was divided into three sections: "About you", "Interaction with other HPC trainers" and "Improving support to the community of training providers".

4.1 Questionnaire Section 1: About you

This section aimed to find out about the institutions in which respondents work and the training they provide.

Respondents by Country

Figure 2 Respondents by Country shows the number of respondents per country. As would be expected, larger countries are represented by a greater number of respondents. A total of 13 of the 28 EU member countries are represented, indicating the widespread need for HPC training.

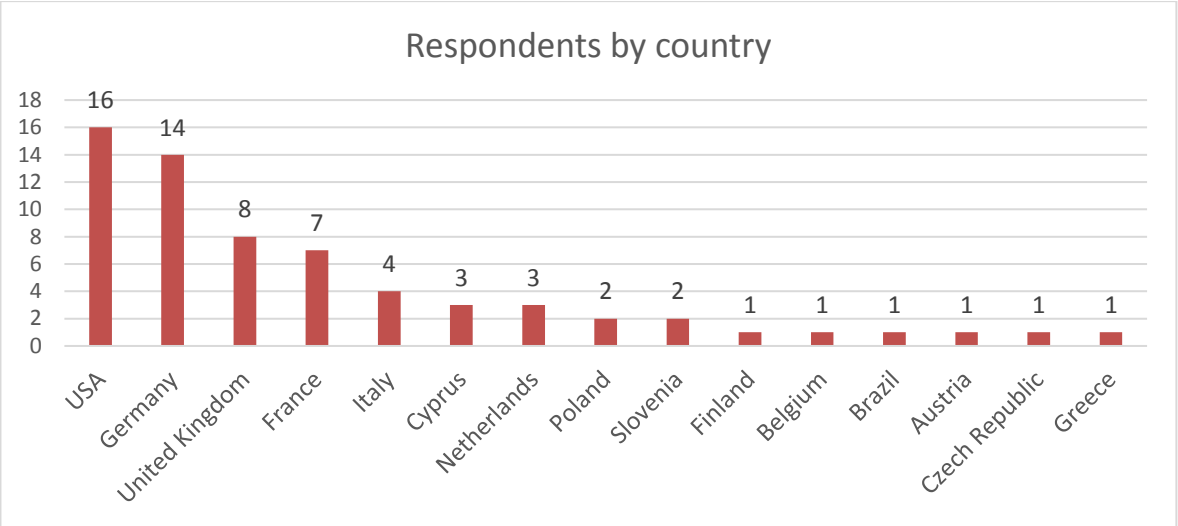

Figure 2 Respondents by Country

Institution type and association with external institutions

As indicated by Figure 3 Respondents by institution type, 26 of the 65 respondents are from a Higher Education (HE) institute, and another 20 work in research institutes, meaning that 70% of respondents were from one of these two categories, while another 10 work in HPC and computing centres. Meanwhile only 6 respondents work in commercial companies, suggesting that training is less of a core activity within the commercial sphere.

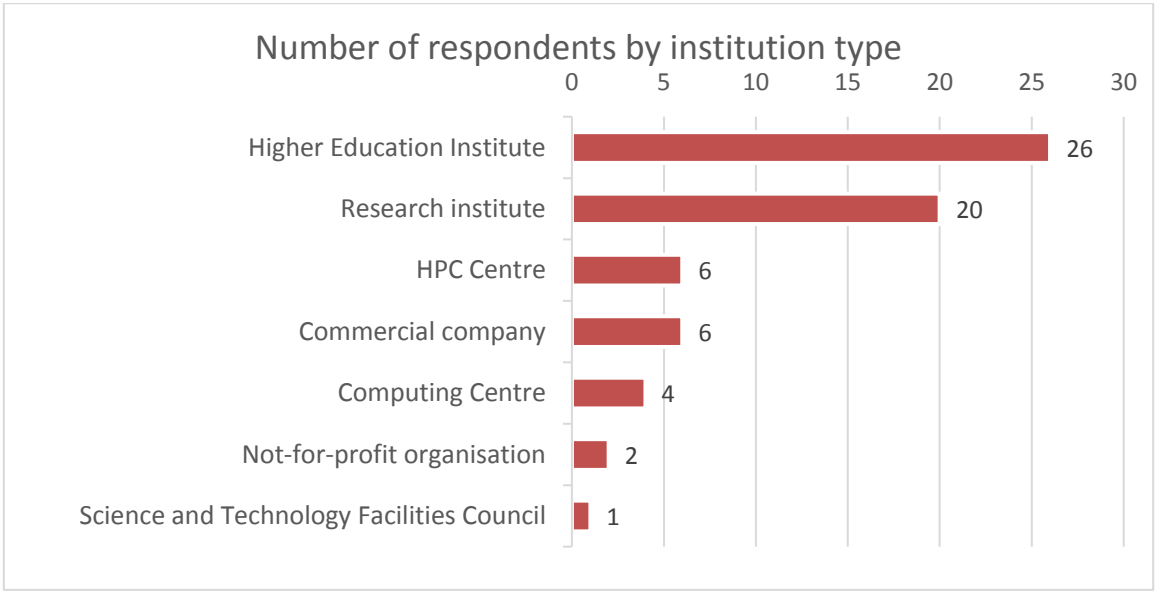

Figure 3 Respondents by institution type

A majority of respondents (38 of 65) work within organisations which are associated with other external institutions (see Figure 4 Association with other institutes). Mostly these connections were with universities or university-related organisations, although there was a wide variety of responses, which also included engineering associations and national laboratories, as well as organisations such as PRACE, XSEDE, IEEE and ACM. We can therefore conclude that there is a strong connection between HPC training activities and the Higher Education environment.

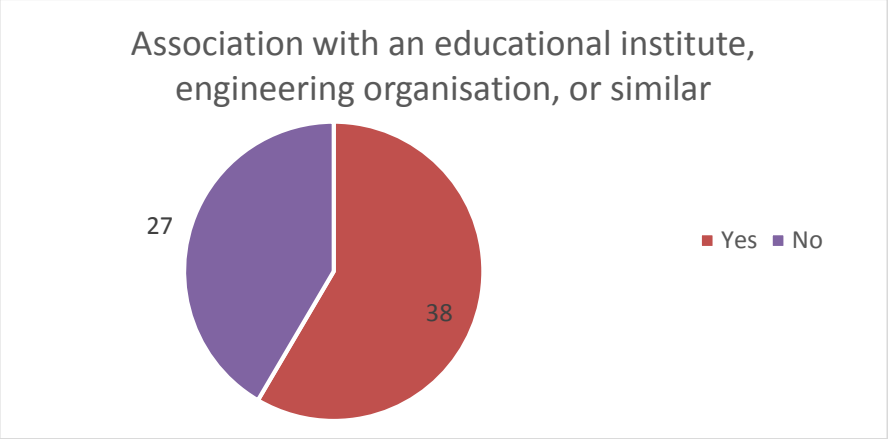

Figure 4 Association with other institutes

Targets of the training

More than one answer was possible for this question, as people often teach at different levels. Figure 5 Educational level of the HPC training shows that more than half of respondents (34 of 65) are involved in training which is not targeted at any specific education level – likely to be short courses offered to users of HPC facilities. Meanwhile, again more than half are involved in HPC training aimed at students. As 10 respondents teach at both undergraduate and postgraduate level, this gives an overall total of 39 who teach students (with 4 teaching undergraduates only and 25 teaching postgraduates only). HPC training appears to be least well established within the undergraduate sector.

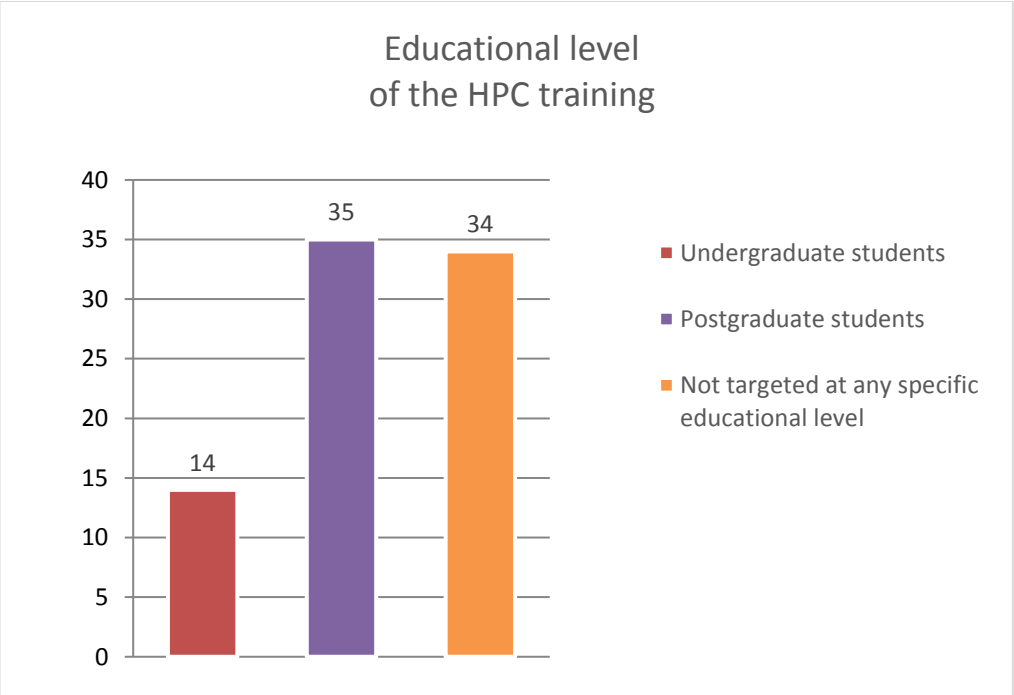

Figure 5 Educational level of the HPC training

Figure 6 Official awards offered in courses shows that 32 out of 65 respondents are involved in courses which lead to certification (14) or credits towards a university degree (18). Meanwhile, 40 respondents were involved in courses which do not lead to an official award or diploma, although in many cases a certificate of attendance is issued. We can assume that in these cases the courses are solely intended to provide applied knowledge of HPC use, rather than HPC being an academic subject in itself.

Note that the total number of responses here is more than 65, as some respondents offer both accredited and non-accredited courses.

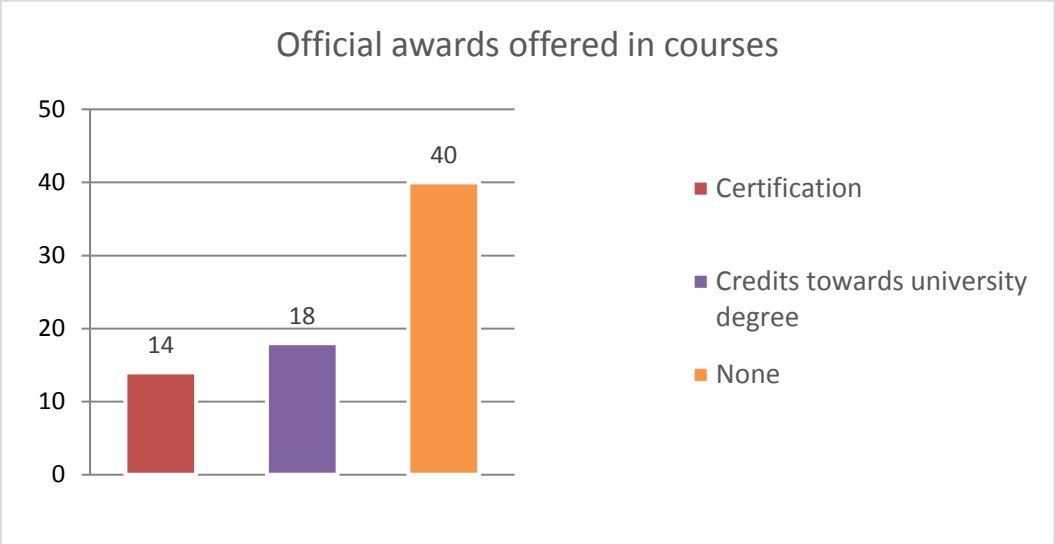

Figure 6 Official awards offered in courses

Figure 7 Availability of the training to people external to the organisation shows that even though most respondents are involved in HPC training which is aimed at graduate or postgraduate students (as shown in Figure 5), nearly all (60 out of 65) are involved in at least some courses which are open to external participants. (We assume that undergraduate and postgraduate students are counted as internal to the organisation). Very few are involved in training courses offered only to people within their own organisation.

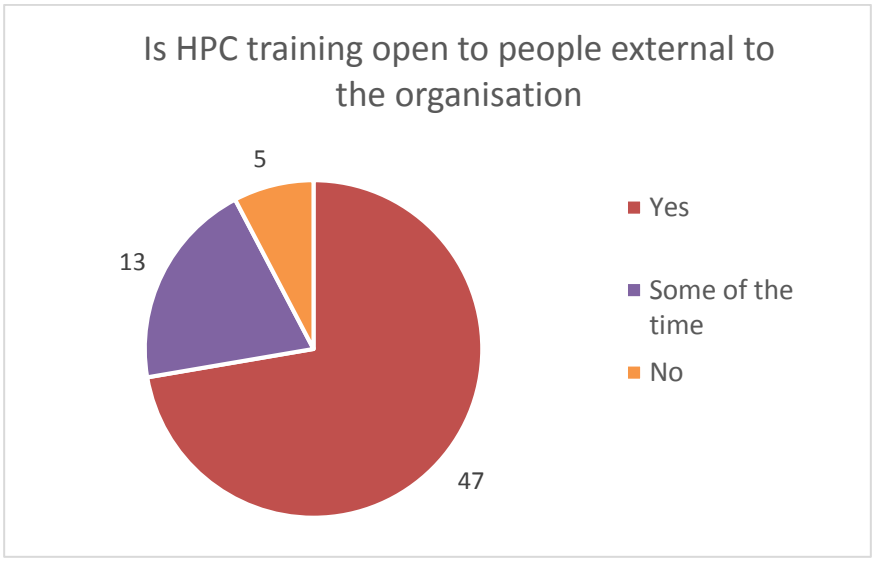

Figure 7 Availability of the training to people external to the organisation

Duration of training courses and mode of delivery

Figure 8 Duration of training courses shows that only 13 respondents are involved in full-semester HPC-related courses, and 5 in courses which last a full academic year; of these 2 are involved in both full-semester and full-year courses, so this equates to a total of 16 respondents. This is somewhat surprising, given that 26 of the 65 respondents are from HE institutes, and 39 are involved in teaching university students. Most respondents are involved in courses lasting a day or less (40) or 2-5 days (43). This suggests that HPC training is mostly limited to short courses, and is not yet a regular part of the HE curriculum. *Note that this question has multiple possible answers, as organisations may offer several lengths of courses.*

Three respondents also commented that the duration of their training varies considerably, as they provide training on demand and therefore it is adapted to the needs of the users.

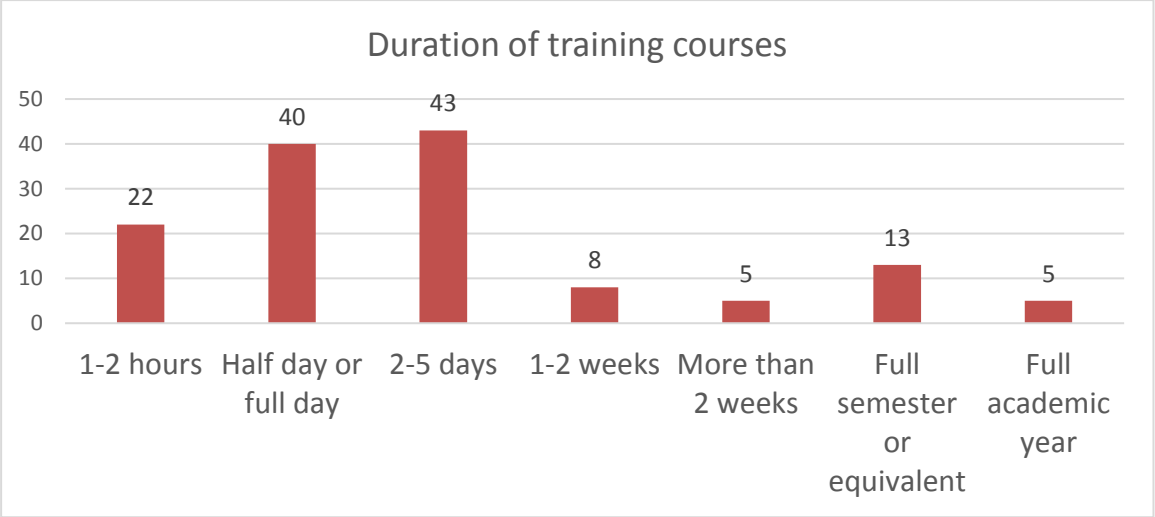

Figure 8 Duration of training courses

Nearly all (64 out of 65) of the respondents deliver "face-to-face" training (Figure 9 Mode of delivery of training). However, nearly half of these (31) also develop or deliver content in an on-line environment (webinars, tutorials, MOOCs, LMS). *Note that again multiple answers were possible.*

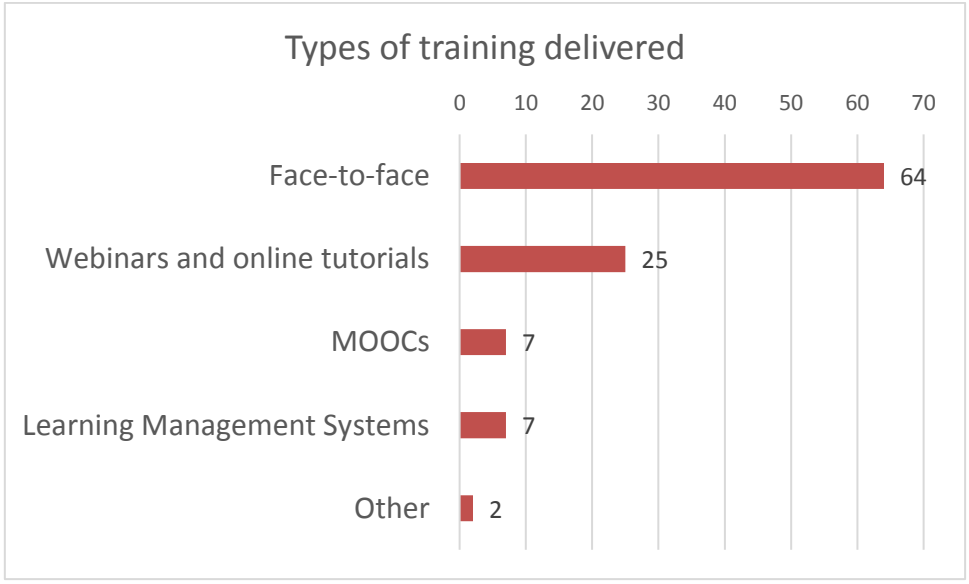

Figure 9 Mode of delivery of training

Involvement of respondents in training activities

We can see from Figure 10 Parts of training in which respondents participate that most (57 out of 65) or respondents both develop and deliver training. Of the remainder, 7 are involved only in development of courses, and only one respondent only delivers training but does not participate in course development.

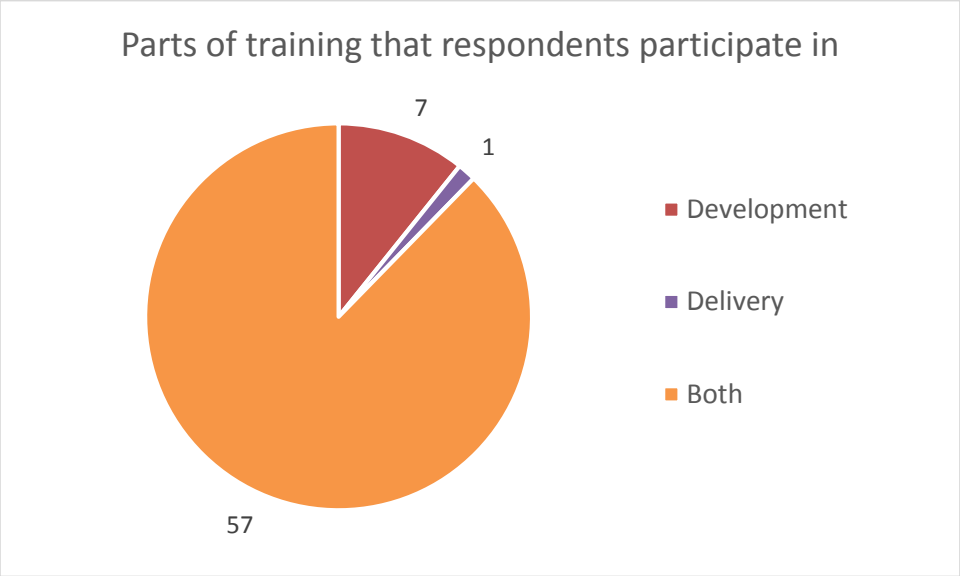

Figure 10 Parts of training in which respondents participate

Figure 11 Percentage of work time spent on training indicates that most respondents do not exclusively focus on HPC training. We can assume that the respondents are largely engaged in regular HPC-based research and/or development activities, and provide HPC training as a part of their function.

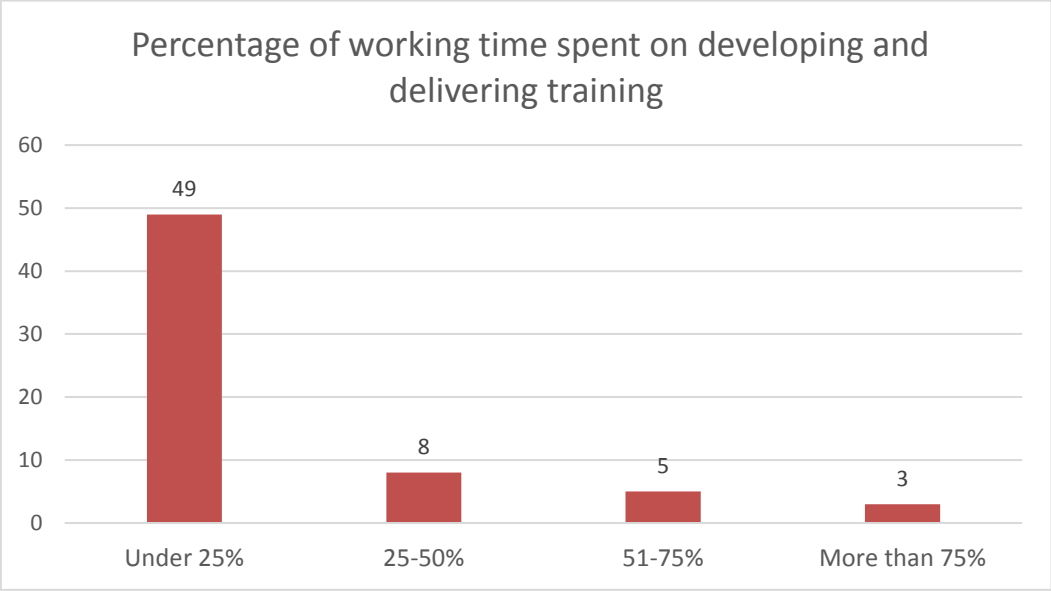

Figure 11 Percentage of work time spent on training

4.2 Questionnaire Section 2: Interaction with other HPC trainers

This section of the questionnaire aimed to find out more about how the respondents currently develop and deliver their training, and how they interact with other HPC training providers in different parts of the world.

Size of training team and methods of course development

Figure 12 Size of training team shows that the largest number of respondents (21) work in small teams (up to 3 members); however larger teams are also common. Very few (only 3) work alone.

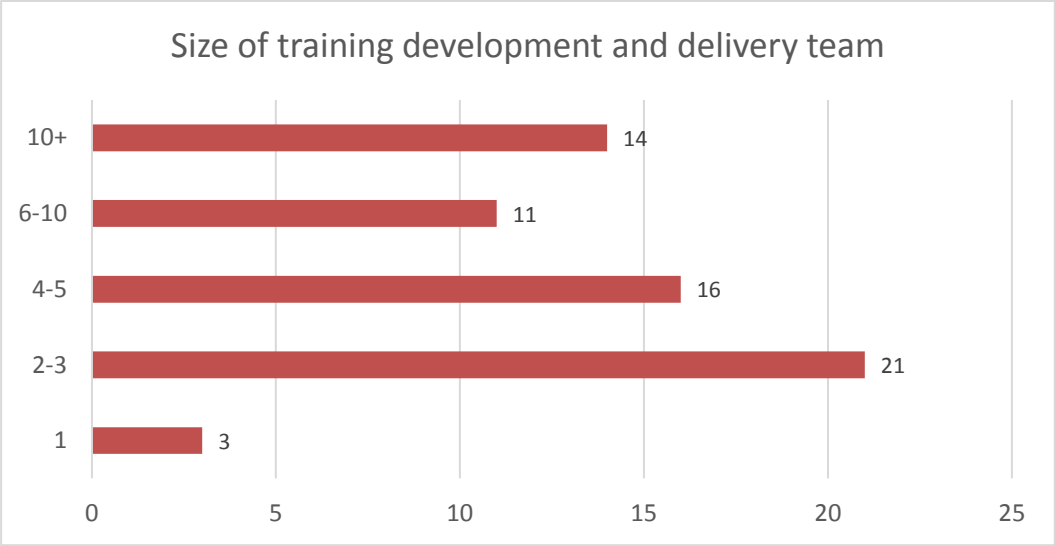

Figure 12 Size of training team

The most frequent method of curriculum and course development is collaboration with colleagues from the same organisation (50), while 37 say they collaborate with people outside their organisation (Figure 13 Source of training content). All options are however well represented, including the use of open-source content (23 out of 65). *Note that this question has multiple possible answers, as respondents may combine various methods.*

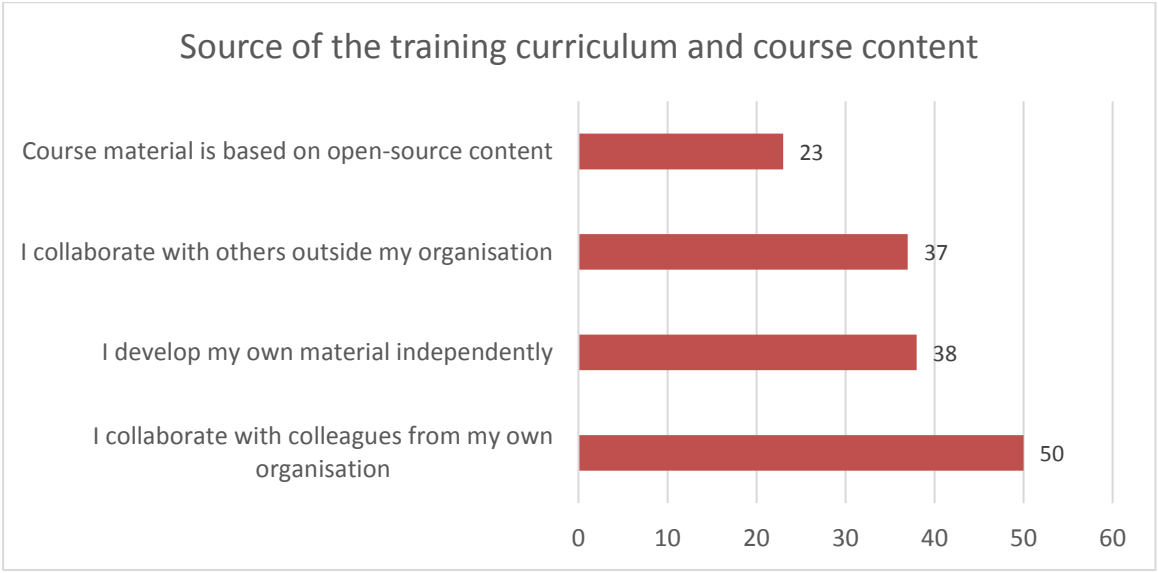

Figure 13 Source of training content

Interaction with other HPC training professionals

Figures 13-15 – Interaction with other HPC training professionals within the same country / continent / worldwide – indicate that interaction among HPC training professionals is common, but the method of interaction is influenced by distance. While all but 5 respondents currently interact with training providers at other institutions within their own country, 17 respondents do not interact with those in other countries within the same continent, and 25 do not interact with others outside their continent. Perhaps not surprisingly, personal contact decreases with distance, and interaction through formal training projects drops considerably outside the same continent, although on a continental level there is little difference compared to the national level, possibly due to European respondents involved in PATCs and similar initiatives. The degree of cooperation through mailing lists and online forums varies little with distance, which again is not surprising, as distance and time zone have less impact in this environment.

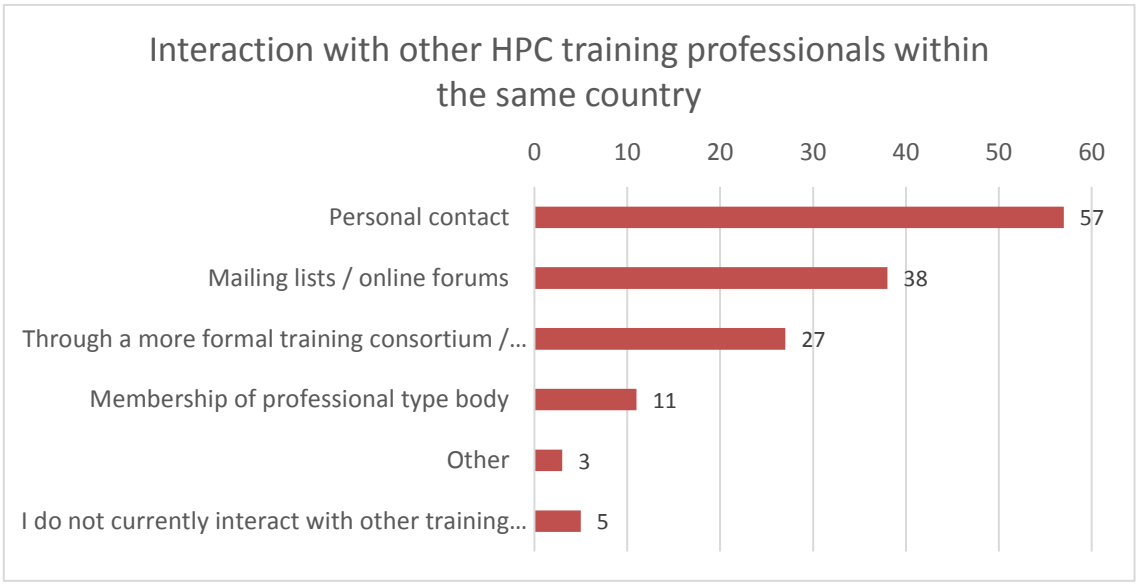

Figure 14 Interaction with HPC training professionals in same country

"Other" includes: Joint website http://formation-calcul.fr; XSEDE training workshops; GitHub.

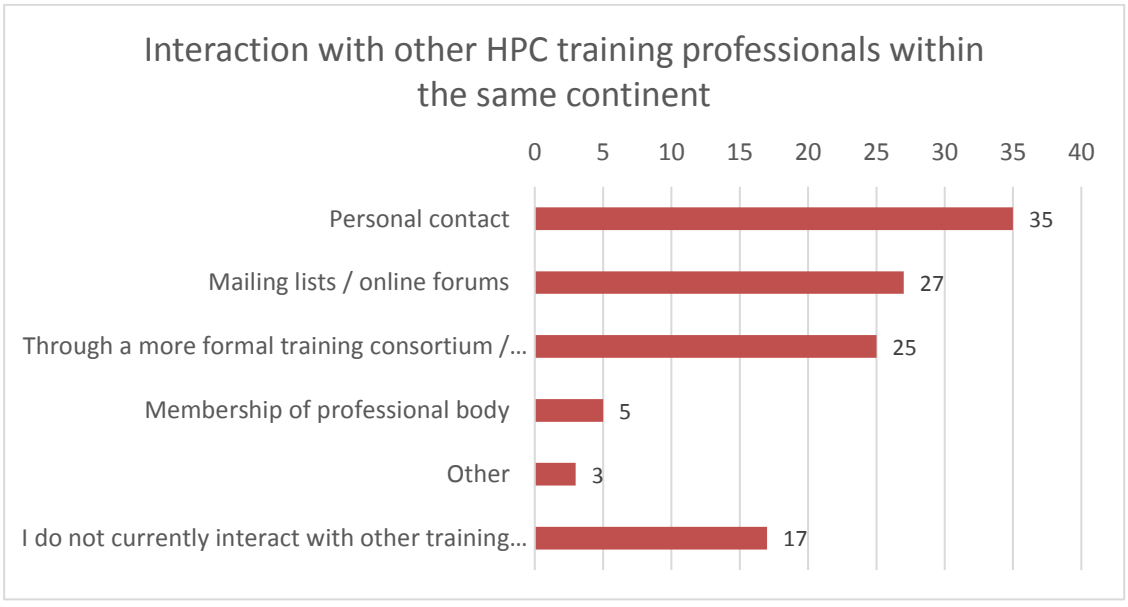

Figure 15 Interaction with HPC training professionals in same continent

"Other" responses include: conferences; GitHub.

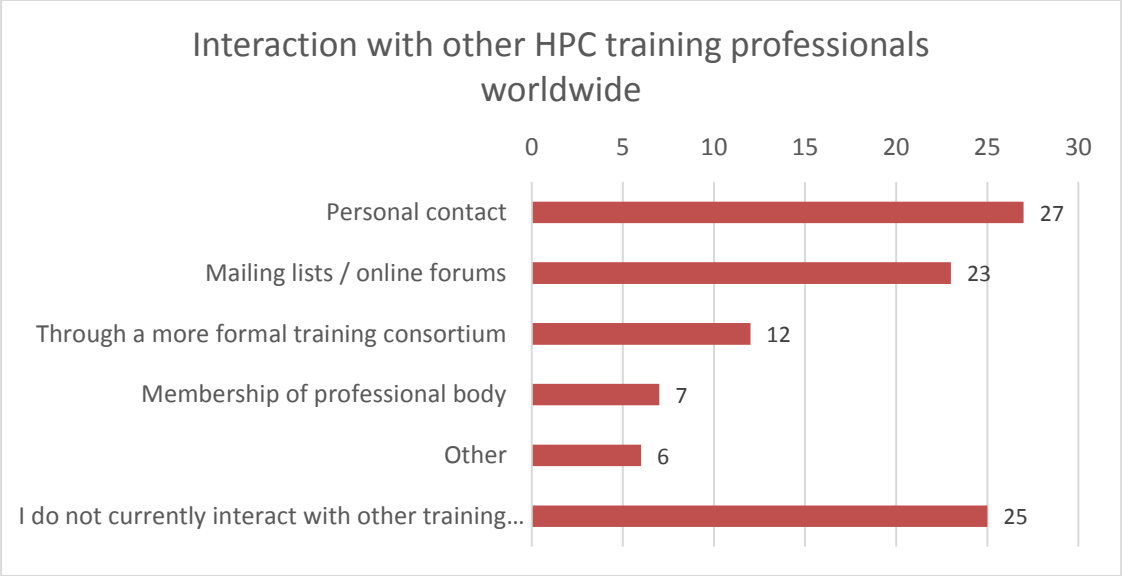

Figure 16 Interaction with HPC training professionals worldwide

"Other" responses include: We organise training with our HPC suppliers and vendors; STEM-Trek meet-ups at SC; VI-HPS; conferences; GitHub.

Attendance at HPC / Data Science conferences

Respondents were asked to state which HPC or Data Science conferences they attend, to see where there might be likely opportunities to set up collaborative ventures. Two-thirds of respondents attend SC, and while it should be remembered that the greatest number of respondents were in the USA, many HPC experts based in Europe also attend this event. Nearly half of respondents attend the ISC High Performance event[22] in Europe, and a number of other conferences were also mentioned, although mostly by only 1 respondent each. Perhaps surprisingly, 17 out of the 65 respondents do not regularly attend any HPC or Data Science themed conferences.

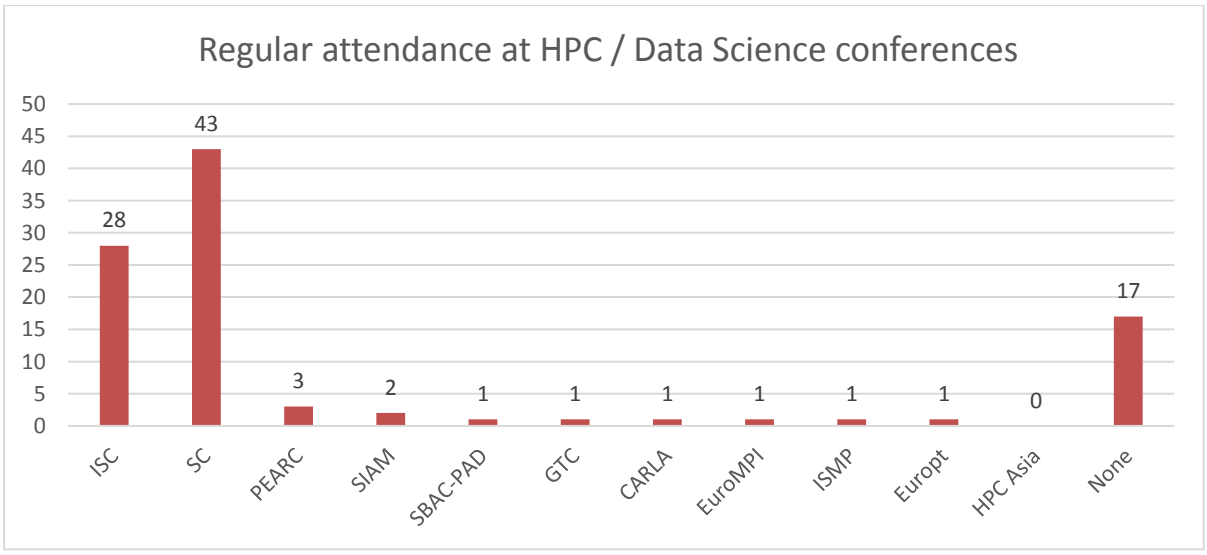

Figure 17 Attendance at HPC / Data Science conferences

[22] http://isc-hpc.com/

4.3 Questionnaire Section 3: Improving support to the community of training providers

This section aimed to find out to what extent the community felt that opportunities to collaborate with other HPC training providers already exist, what barriers there are, and what the training community felt was important in terms of support for establishing and sustaining training collaboration.

Assessment of existing opportunities for collaboration with other HPC training providers in different geographic regions, and the relative perceived importance of increasing collaboration with each group.

As seen in Figures 13-15 (Interaction with other HPC training professionals within the same country / continent / worldwide), the amount of collaboration among training providers decreases with distance. It is therefore not surprising to see (in Figure 18 Perceived opportunity to collaborate with other HPC training providers) that more than half of respondents felt that they have insufficient opportunities to collaborate with others worldwide, while only 15 of the 65 respondents felt that there is already ample opportunity for this. When considering the availability of opportunities to collaborate within the same country or continent, there was a spread of opinions, although these tended towards the positive, with more respondents agreeing than disagreeing that ample opportunities already exist.

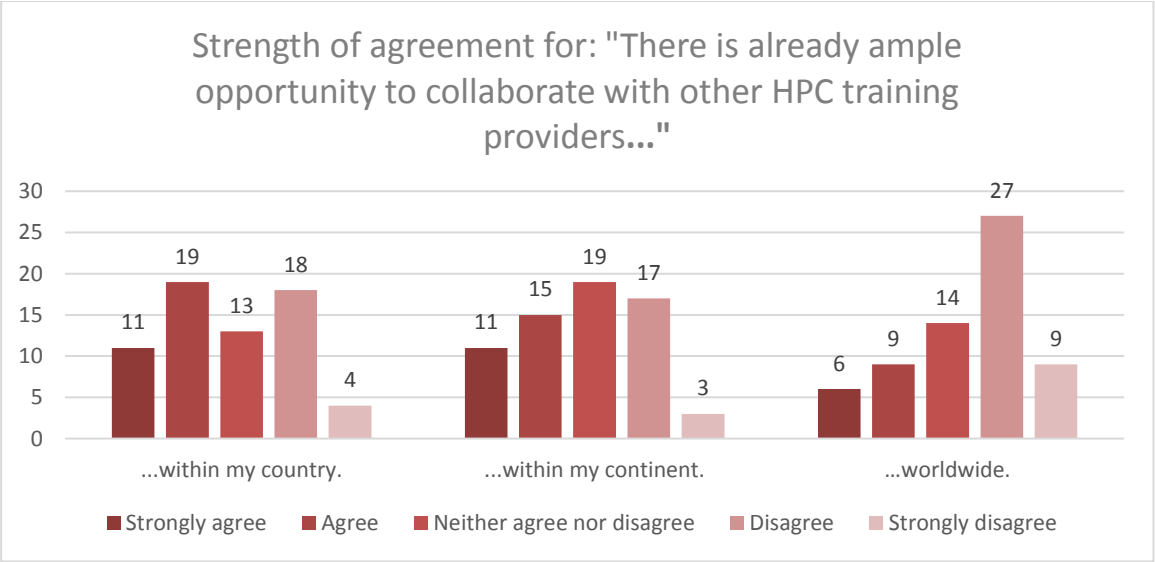

Figure 18 Perceived opportunity to collaborate with other HPC training providers

Respondents were asked to rank in order of importance the groups with which they would like to have increased opportunities to collaborate: with others in their own country, the same continent, or around the world. Despite what we saw previously, where respondents felt that there were fewer available opportunities available to collaborate with those outside their own continent, Figure 19 Perceived importance of increased collaboration opportunities shows that most respondents would still consider support for improved collaboration within their own country as most important, while they considered increased opportunities to collaborate with others worldwide as less important.

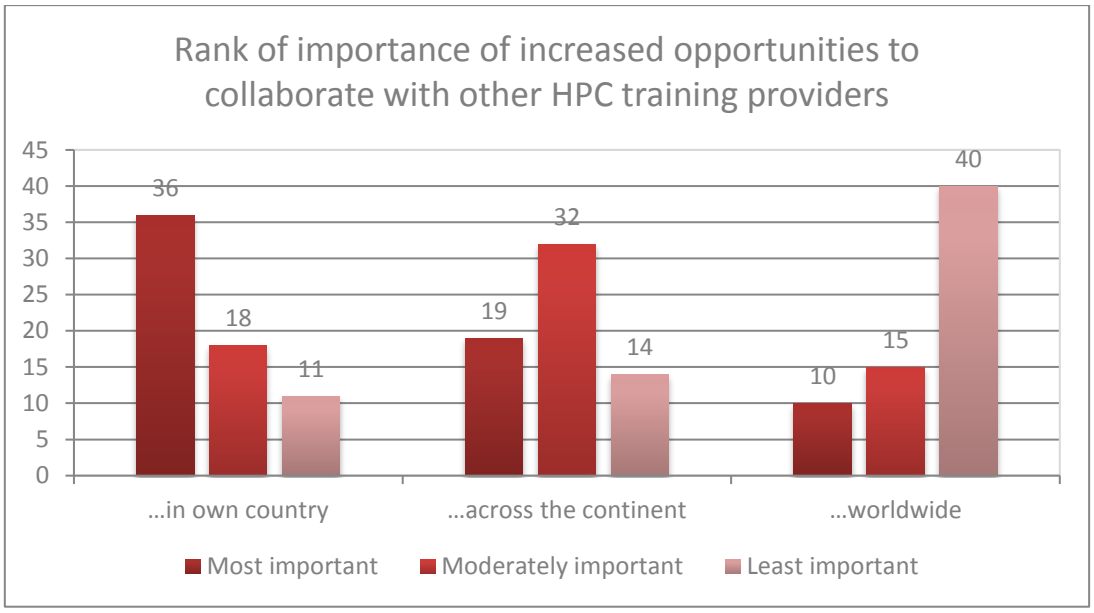

Figure 19 Perceived importance of increased collaboration opportunities

Perceived barriers to collaboration

In Figure 20 Perceived barriers to collaborationwe can see that the major perceived obstacle is the lack of travel funds (32 respondents), which may also be related to the next most-selected answer "Too few opportunities to make initial contact…" (28 respondents) and "Too few opportunities to discuss collaboration possibilities…" (23 respondents). "Lack of access to other people's training material" is also significant (25 respondents). Very few (7 respondents) felt that there were no major barriers. Eight individuals also cited "Other" (lack of time) as an obstacle. *Note that multiple answers were possible for this question.*

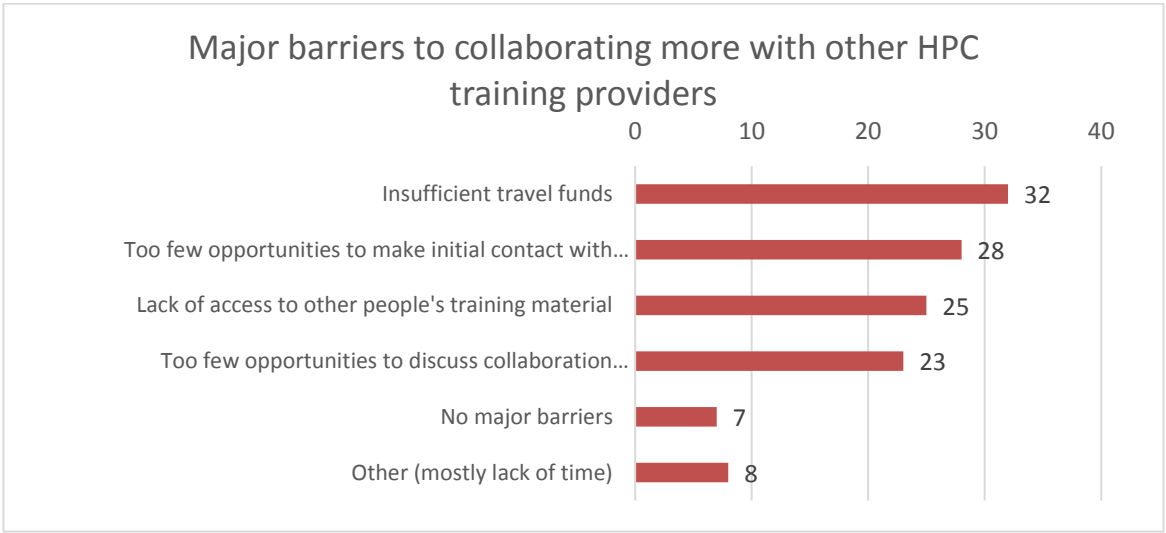

Figure 20 Perceived barriers to collaboration

Preferred methods of supporting development of training material and fostering collaboration among HPC training providers

In Figure 21 Preferred methods to support development of training material we find that most (37 respondents) consider the most important option to be the creation of better opportunities to meet other HPC training providers to discuss collaboration opportunities and best practice. This is in line with conclusions from Figure 20 Perceived barriers to collaboration. "Access to other people's training material" and "Access to examples which could be used in training

material" are also considered reasonably important, while "Access to HPC resources at other organisations" and "Training in presenting online courses (how to present webinars, MOOCs, etc)" are not seen to be of key importance by many respondents.

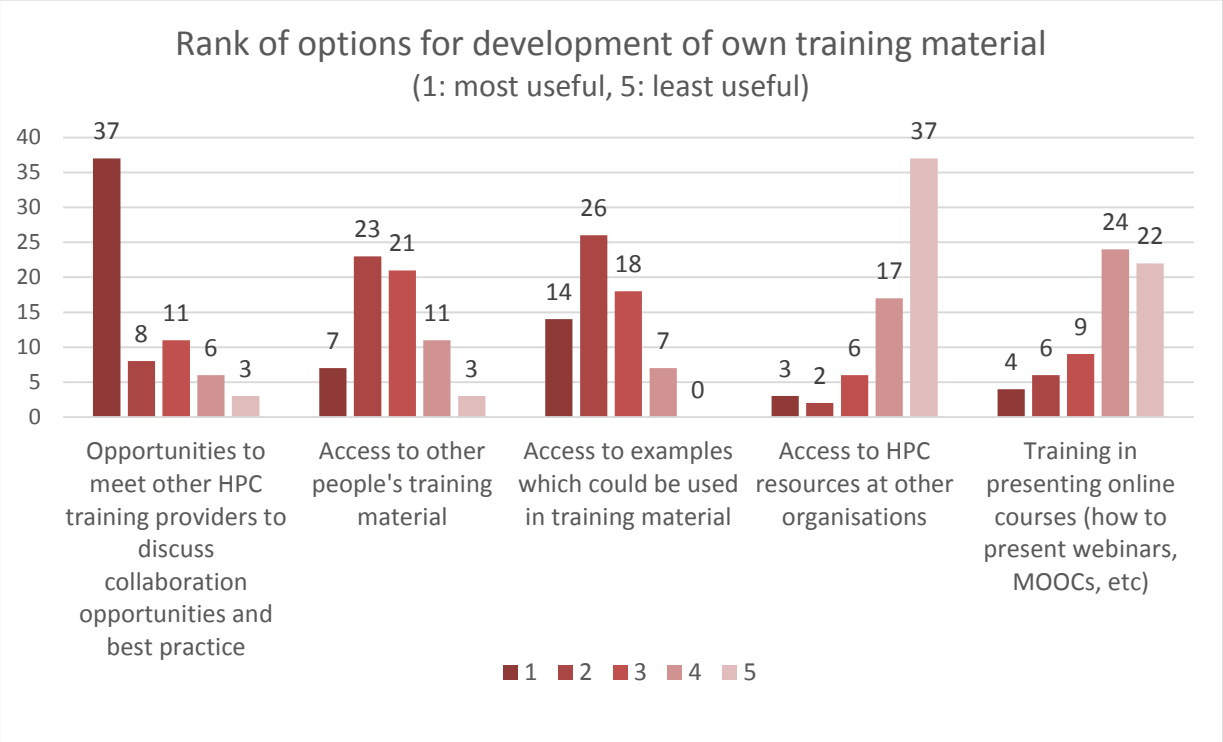

Figure 21 Preferred methods to support development of training material

In Figure 22 Preferred modes of fostering collaboration among HPC training providers, we can see that the creation of a new repository of shared training material was the most popular option, rated "most important" by 33 of the 65 respondents, while the remaining respondents were split almost equally between preferring a new online forum for collaboration, and new regular webinars. These results should be used by EXDCI and other related initiatives in further development of HPC training support. A repository of shared training material is clearly favoured and should be included in future HPC ecosystem development projects.

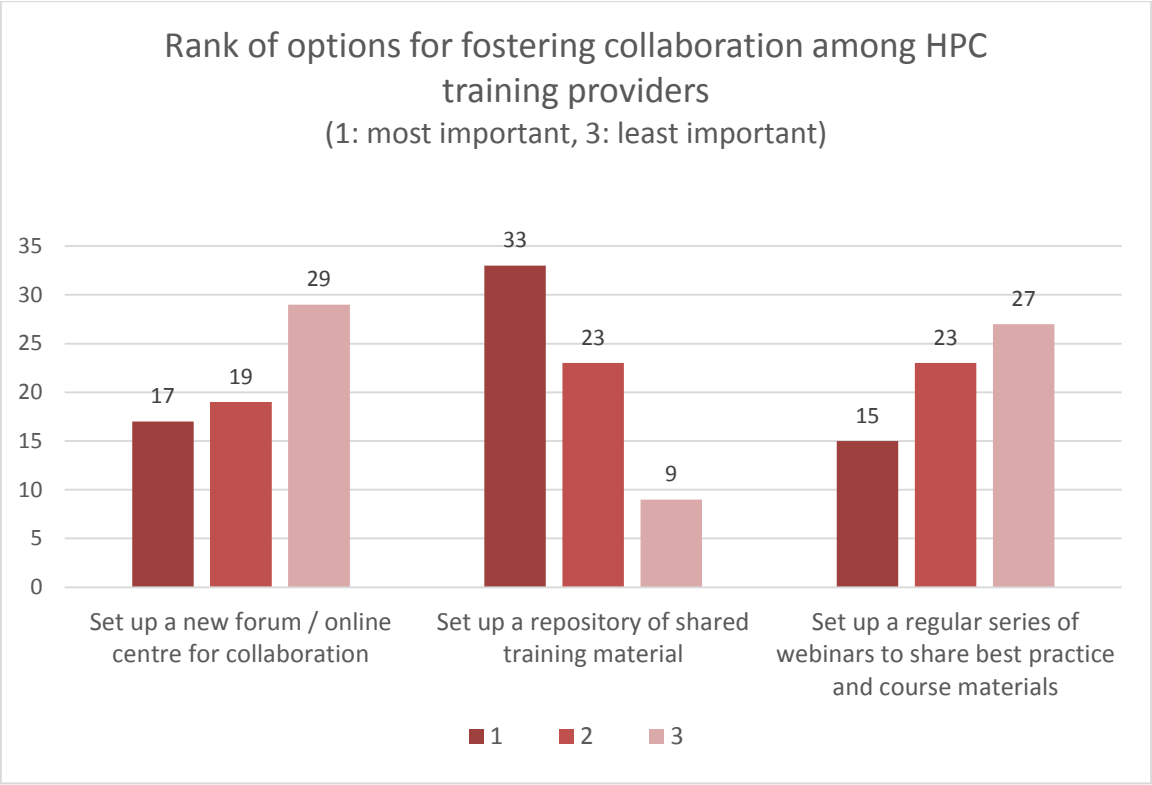

Figure 22 Preferred modes of fostering collaboration among HPC training providers

Respondents also submitted their suggestions for fostering collaboration in the HPC training community. Here we list some of them:

- "Given the level of collaboration and meetings that already exist, it seems we still lack the effort (time) needed to create and curate accessible materials that could be adopted by trainers."
- "XSEDE Campus Champions are an extensive collaborative training resource in the US which should be interacting with the corresponding PRACE organisation."
- "Instead of a repository of shared material, just a place where information regarding other training and material is listed. Additionally, it would be beneficial if trainers publish their material for example use GitHub to store material that anyone can access. I've had folks who landed on my GitHub repository while searching for training material."
- "The notion of European HPC community could be improved by having a kind of Stack overflow like forum. Trainers and trainees could meet there with offer and needs appearing."
- "An international annual venue in Europe and a better-connected community based on open source content."
- "The case is, the lack of permanent long-lasting financial programme. We are the member of PRACE and other projects. What will happen with the training activity when project ends?"
- "Although I've had a lot of collaboration with other training providers, I have also had a lot of resistance from other providers. A lot of people viewed collaboration as a threat, so they chose not to. It's a shame because I strongly felt I was complimenting what they were already offering."
- "There are also the competitive aspects, which block collaboration."

5 Summary

We have seen that some collaborative initiatives already exist among HPC training providers, both Europe-wide and worldwide, and that these have been established to address an identified need among some training providers for more opportunities to work together to share experiences, material and best practices.

In order to better understand the training community's specific needs in terms of support to increase collaboration, a questionnaire was distributed, and this received 65 responses from 13 EU countries, the USA and Brazil. The questionnaire referred to "your continent" rather than "Europe" in order to make it relevant to participants anywhere. A total of 15 responses – the largest from any single country – came from the USA, demonstrating that there is considerable interest in this matter there.

We saw that most respondents were from Higher Education or research institutes, although a few commercial organisations (6) were represented. Of the 38 respondents who were affiliated with an external organisation, most were associated with universities.

Despite this strong association with HE institutes and universities, most training courses last a week or less, and only 14 of 65 respondents were involved in teaching undergraduates, demonstrating that HPC training is not yet part of the regular HE curriculum, although 13 respondents did state that they were involved in courses that lasted a full semester or equivalent, and 5 were involved in teaching courses lasting a full academic year.

Almost all respondents were involved in both developing and delivering training, and worked in teams of varying sizes, from just 1 person working alone to teams of more than 10. Most (49) spent less than 25% of their work time on these activities, meaning training was only a part of what they do. There was considerable variation in how respondents developed training, with 50 developing material in collaboration with others in their institute, 37 (still more than half of the respondents) working with others outside their organisation, and 38 developing material independently. Additionally, 23 of the respondents use open-source material to develop their own training materials.

Almost all respondents stated that they currently interact with others within their own country to develop training material, most commonly via personal contacts, but also through online forums or mailing lists, involvement in training consortia / projects, and membership of professional bodies. Significantly fewer collaborate on a continental or worldwide basis, and collaboration through online forums or mailing lists was the only method which saw little variation in use depending on location. While the significance of personal contact decreased considerably with distance, this nevertheless remained the most frequent route to training collaboration across every region.

When respondents were asked to comment on the existing opportunities for collaboration, 30 thought there were sufficient opportunities within their own country while 22 thought there were not; 26 thought there were sufficient opportunities within their own continent while 20 did not, and 15 thought enough opportunities existed to collaborate with others worldwide while 36 did not. (The remaining numbers in each case gave a neutral response). While we can see that more people thought there were enough opportunities nationwide and continent-wide than thought there were not, nevertheless fewer than half of respondents thought there were sufficient opportunities to collaborate with others in any location, which demonstrates a need to create more opportunities.

It may be surprising, then, that despite a perception that there were fewest opportunities to collaborate with people in other continents, when asked to rank the importance of each region, most respondents (36) felt that having increased opportunities to collaborate with others in their

own country was most important, while only 10 felt that increased support for collaborating with others worldwide would be most important. Indeed, 40 of the respondents ranked support for worldwide collaboration as least important. This may be due to language or cultural factors, or perhaps due to the ease of travel to work with people located closer to the home institute.

The respondents' preferred option for increasing collaboration was to have the opportunity to meet other HPC training providers to discuss collaboration opportunities and best practice. However, gaining access to other people's training materials and examples also rated highly.

Respondents felt that a number of barriers existed to collaborating with other HPC training providers: primarily a lack of travel funds, but also too few opportunities to make initial contact with others, and, almost as importantly, a lack of opportunities to discuss the potential for collaboration even where contact has already been established. A lack of access to other people's training material was also cited as a barrier to collaboration, and indeed this came up in some of the additional comments, where respondents referred to resistance from potential collaborators who saw this as competition or a threat, despite the complementarity that may exist.

One concrete example of this was where an institute in the USA was unwilling to participate in a joint MOOC with a European institute. The European institute felt that this was a missed opportunity, given that the target audiences of each institute were unlikely to overlap, and that by pooling their effort they could potentially have reached twice the audience with half the effort, compared to if each of them had run their own MOOC. Additionally, the European institute felt that there was also a missed opportunity to benefit from the raised profile and prestige that can be gained from being associated with another organisation.

One respondent felt that in fact sufficient collaboration opportunities and meetings were already in place, but the lack of progress despite this suggests that training providers lack the time to create and curate accessible materials that could be adopted by trainers. This statement clearly gives strong evidence of the need for initiatives to support this sort of activity, but any such initiative would probably have to include funding for staff time in order to make it successful. Funding from bodies such as national research councils and the EU could be possible sources of such funding. However, one respondent felt concerned by the lack of a permanent financial programme to support this sort of initiative, commenting that, while PRACE has, over a period of years, significantly contributed to the cohesion of the European HPC training community, like any other project its funding may end, and with it all of the good work that has been done.

Other recommendations which came from the respondents included for PRACE to establish much stronger collaboration with XSEDE Campus Champions, and for an international annual event to be held in Europe, supplemented by a better-connected community based on open course content. Some reasonably straight-forward suggestions were made, such as creating a Stack Overflow type forum where trainers and trainees could meet, with offers and needs being advertised, and for trainers to publish their material on, for example, a GitHub repository which anyone can access.

One respondent commented that instead of necessarily creating a repository of shared material, all that is needed is a place where information about other training and material is listed. This suggests that the visibility of the PRACE Training Portal and EXDCI Training Portal should be improved, as it appears that even some people who are involved in HPC training are not aware of these resources.

6 Conclusions

This report has shown that there is evidence of both a need and a desire for increased support for HPC training providers to collaborate with each other. However, in order for this to be

successful, funding for staff effort is necessary. Other initiatives, such as organising events, providing funds for travel, and making available tools for collaboration, are all cited as potentially useful support mechanisms, but are deemed to be insufficient alone without funding for staff time. This can be seen from the fact that while various initiatives do already exist, training providers report that a lack of time prevents them from participating – and time in this context equals money to fund staff effort.

While future funding mechanisms to support a community of training providers should be investigated, any initiative must be developed with the direct involvement of the HPC training community as key stakeholders, in order to ensure their active engagement and make sure that it responds to their needs. Further, it must be designed to be sustainable, to minimise the risk of losing the results of the work if funding is stopped.

The two key themes seen throughout the responses to the questionnaire were a lack of funds (for travel and staff effort), and a lack of access to shared resources, whether training materials, examples, or best practices. These should be the starting point for proposing new collaborative initiatives.

Although respondents felt that opportunities to collaborate on a worldwide basis were the most lacking, their priorities were focused more locally, with most placing the greatest value on support for more opportunities to collaborate with others within their own country. Key issues identified were the lack of opportunities to discuss potential collaborations – even where contact already exists (most likely to be within the same country) – and the lack of travel and effort budgets. The preferred means to address these issues was to provide support to meet other HPC training providers. It is clear from the survey that respondents consider meeting face-to-face – and having time to do so – to be the best way forward, and for practical reasons, working with people from the same country has many advantages.

A relatively high number of questionnaire responses were received from the USA, a country in which there are some significant initiatives in stimulating collaboration between HPC providers, and therefore it is recommended that key organisations from Europe, such as PRACE, work more closely in future with those in the USA, such as XSEDE Campus Champions and the International HPC Training Consortium, as well as with Compute/Calcul Canada, and RIKEN (Japan), who are also involved in the organisation of the annual International Summer School on Challenges in Computational Sciences. Similar organisations from other countries and continents should be identified and invited to join.

One of the most significant barriers encountered was the view of some HPC training providers that collaboration means competition and that this would represent a threat rather than an opportunity. A necessary first step, before embarking on any concrete plans, would be to draw up some convincing counter-arguments for those that hold this view.

Finally, the visibility of training portals such as those developed by PRACE and EXDCI should be increased, as while these were designed thinking of the needs of the targets for the training, they contain material – or links to material – which could be of much benefit to anyone developing courses, and may help to bring trainers into contact with others who have developed complementary material, potentially stimulating new collaborations at no cost.

We therefore conclude this report by highlighting the key challenges and making the following recommendations to address these:

Challenge: Lack of funding, especially for staff effort

Challenge: Establish new initiatives, including key organisations from EU and USA

To address the two challenges above, we recommend the establishment of an annual workshop to bring together HPC training providers to focus on collaboration. One idea could be to refocus the PRACE training workshop[23], which has been held for the last 3 years at the European ISC conference. This could be extended to a full-day event and used to bring people together to explore the issue of training collaboration, and to discuss how to break down the barriers to this, and dispel the perception that sharing resources means competition. If funding can be secured (perhaps via PRACE), a number of places could be made available with travel costs and conference workshop registration fees paid.

A similar event could be held at the SC conference, to increase collaboration with US-based organisations, and the authors note that at the time of writing this report, an announcement was made regarding SIGHPC Education and IHPCTC joining forces to promote HPC education and training. This shows that the findings of this report are timely, and this initiative will be watched closely. It is highly recommended that PRACE tries to identify ways to become involved with this collaboration.

Further, we recommend that the findings of this report are disseminated to national funding agencies as well as to the European Commission, to encourage them to consider funding such initiatives.

Challenge: Lack of access to shared resources

This is a difficult obstacle to remove due to the fact that there is a general reluctance to share proprietary information / IP. It is probably easier to convince people to contribute towards a shared effort in creating new material than to share material which they have previously created. We recommend looking to the HPC Carpentry course[24], which is currently being developed following the Software Carpentry[25] and Data Carpentry[26] models. We will follow closely the development of this, in order to see if the same methodology processes, with courses being developed collaboratively from the outset, could be applied more generally to a wider range of more technical courses.

A simple GitHub repository could be a quick solution to share material from those who are happy to make this available. However, a strategy to publicise the existence of the repository would need to be drawn up in order to create maximum impact. On the other hand, for those who are reluctant to share their material widely, a members-only shared repository could be set up, with strict policies on the use of shared materials, and a required share ratio, whereby the more someone shares, the more access is given to them.

Challenge: Increased visibility of EXDCI / PRACE training portals

EXDCI and PRACE could embark on a specific campaign to raise awareness of the portals, e.g. through social media. A link exchange, possibly formalised using a Memorandum of Understanding, could be established with relevant HPC websites. Options for paid advertising could also be considered where funding is available, e.g. through Google AdWords or advertisements in relevant professional journals and websites.

[23] https://events.prace-ri.eu/event/498/material/slides/0.pdf
[24] https://github.com/hpc-uk/sc17-hpccarpentry-bof
[25] https://software-carpentry.org/
[26] http://www.datacarpentry.org/

7 Annex

Two annexes are included in this document: 7.1 The questionnaire, and 7.2 List of organisations to which the questionnaire was distributed.

7.1 The questionnaire

A copy of the questionnaire can be found below.

EXDCI Training Community questionnaire - 2nd EXDCI HPC Training in Europe Survey

This survey is being conducted for EXDCI, the European eXtreme Data and Computing Initiative (http://www.exdci.eu/), as part of Work Package 5: Talent Generation and Training for the Future. The survey data will be used to prepare a report on how best to foster a community of HPC training providers within Europe and beyond.

We are looking for your personal experience with HPC training, not your official company position on the issue - we therefore welcome multiple responses from the same institution.

Following the privacy declaration, this survey has 3 sections: the first is about you and the HPC training you provide; the second looks at how you currently interact with other HPC training providers elsewhere; and the final section looks for ideas to enhance this communication and foster a collaborative network of HPC training providers.

NOTE: This is the 2nd EXDCI HPC Training in Europe Survey: the participants of the 1st survey from February 2017 will find page 2 familiar - please fill in this part of survey nevertheless, as the surveys are (optionally) anonymous, to facilitate data analysis.

* Required

Data protection and privacy policy: The responses to this questionnaire will be published in aggregate form only, and respondents will not be identified. Responses will initially be stored on Google servers, which may be located outside the EU. They will be deleted from Google by 31st January 2018. To proceed with this questionnaire, you must agree to your data being treated as described. Do you wish to continue? *
Mark only one oval.

- Yes
- No After the last question in this section, stop filling out this form.

Your email address (optional)

About you

In this section, we want to find out more about you, and the HPC training in which you are involved.

Please enter the full name of your organisation *

In which country is your organisation? *

What type of organisation is it? *
Mark only one oval.

- Higher Education Institute
- Research institute
- Commercial company
- Other:

What is the duration of the training courses you provide? Select all which apply.*
Check all that apply.

- 1-2 hours
- Half day or full day
- 2-5 days
- 1-2 weeks
- More than 2 weeks
- Full semester or equivalent
- Full academic year
- Other:

Is the HPC training you provide targeted at any specific educational level? Select all which apply. *
Check all that apply.

- Undergraduate students
- Postgraduate students
- Not targeted at any specific educational level

Is the training open to people external to your organisation? *
Mark only one oval.

- Yes
- No
- Some of the time

What parts of training development and delivery do you participate in? *
Mark only one oval.

- Development
- Delivery
- Both

Approximately what percentage of your working time is spent on developing and delivering training? *
Mark only one oval.

- Under 25%
- 25-50%
- 51-75%
- More than 75%

Which methods do you use to deliver training? Select all which apply. *
Check all that apply.

- Face-to-face
- Webinars and online tutorials
- MOOCs
- Learning Management Systems
- Other:

Do your courses lead to any official awards? Select all which apply. *
Check all that apply.

- Certification
- Credits towards university degree
- None
- Other:

Please specify type of certification or credits awarded, if applicable
Are you associated with any educational institute, engineering organisation, etc?*
Mark only one oval.

- Yes
- No

If yes, please provide details

Interaction with other HPC trainers

In this section, we want to learn about how you currently interact - both formally and informally - with other HPC trainers working elsewhere.

How many colleagues work with you to develop and deliver training?
Mark only one oval.

- None
- Between 1 and 2
- Between 3 and 5
- Between 6 and 10
- More than 10

How do you develop your training curriculum and course content? Select all which apply. *
Check all that apply.

- o I develop my own material independently
- o I collaborate with colleagues from my own organisation
- o I collaborate with others outside my organisation
- o Course material is based on open-source content
- o Other:

How do you currently interact with people providing HPC training within the same country as you? Select all which apply. *
Check all that apply.

- o Personal contact
- o Mailing lists / online forums
- o Through a more formal training consortium / training-focused project (e.g. PRACE Training Centres)
- o Membership of professional type body
- o I do not currently interact with other training providers at other institutions in this country
- o Other:

How do you currently interact with people providing HPC training in other countries within the same continent as you? Select all which apply. *
Check all that apply.

- o Personal contact
- o Mailing lists / online forums
- o Through a more formal training consortium / training-focused project (e.g. PATC)
- o Membership of professional body
- o I do not currently interact with other training providers in other countries in this continent
- o Other:

How do you currently interact with people providing HPC training elsewhere around the world? Select all which apply. *
Check all that apply.

- o Personal contact
- o Mailing lists / online forums
- o Through a more formal training consortium / training-focused project (e.g. PATC)
- o Membership of professional body
- o I do not currently interact with other training providers beyond this continent
- o Other:

Please list any professional bodies referenced in your answers above

Which HPC / Data Science conferences do you regularly attend? Select all which apply. *
Check all that apply.

- ISC
- SC
- HPC Asia
- None of the above
- Other:

Any other comments: if not covered above, please provide any further relevant information about how you currently interact with other HPC training providers.

Improving support to the community of training providers

In this section, we seek your opinions on how interaction between training providers could be improved in order to share resources and best practice.

To what extent do you agree with the statement, "There is already ample opportunity to collaborate with other HPC training providers within my country"? *
Mark only one oval.

1 2 3 4 5

Completely disagree Completely agree

To what extent do you agree with the statement, "There is already ample opportunity to collaborate with other HPC training providers within my continent"? *
Mark only one oval.

1 2 3 4 5

Completely disagree Completely agree

To what extent do you agree with the statement, "There is already ample opportunity to collaborate with other HPC training providers across the world"?*
Mark only one oval.

1 2 3 4 5

Completely disagree Completely agree

Please rank the importance to you of having increased opportunities to collaborate with other HPC training providers. Note that, since we would like you to rank these in order, each response must be in a different column. *
Mark only one oval per row.

	Most important	Moderately important	Least important
...in your own country			
...across your continent			
...worldwide			

Which (if any) of the following do you consider to be major barriers to collaborating more with other HPC training providers? *
Check all that apply.

- Too few opportunities to make initial contact with other HPC training providers
- Too few opportunities to discuss collaboration possibilities even where contact is already established
- Lack of access to other people's training material
- Insufficient travel funds
- No major barriers
- Other:

What would be most useful to help you develop your training material? Please rank. Since we would like you to rank these in order, each response must be in a different column. *
Mark only one oval per row.

	1 (most useful)	2	3	4	5 (least useful)
Opportunities to meet other HPC training providers to discuss collaboration opportunities and best practice					
Access to other people's training material					
Access to examples which could be used in training material					
Access to HPC resources at other organisations					
Training in presenting online courses (how to present webinars, MOOCs, etc)					

Please rank the following proposals for fostering collaboration among HPC training providers. Since we would like you to rank these in order, each response must be in a different column. *
Mark only one oval per row.

	1 (most useful)	2	3
Set up a new forum / online centre for collaboration			
Set up a repository of shared training material			
Set up a regular series of webinars to share best practice and course materials			

If you have any other suggestions for fostering collaboration please describe them below and indicate their importance.

Any other comments: if not covered above, please provide any further relevant information about how you currently interact with other HPC training providers.

7.2 List of organisations to which the questionnaire was distributed

The questionnaire was circulated to a wide network of people involved in HPC-related training, including the training activity mailing lists for both PRACE and XSEDE. As recipients were asked to forward the questionnaire to their own contacts, it is not possible to give an exhaustive list of everyone who was contacted.

The following list of organisations includes those of the contacts on the initial distribution list, as well as those of survey respondents who chose to provide their details in the questionnaire.

Allinea Software Ltd., UK

APPENTRA Solutions, Spain

ARCHER, UK National Supercomputing Service, UK

ARCOS – Computer Architecture and Technology Area - UC3M, Spain

Arctur d.o.o., Slovenia

Arm Holdings, UK

Asetek A/S, Denmark
Atos, Frante

Barcelona Supercomputing Center, Spain

Bright Computing, Inc., Netherlands

Carlos III University of Madrid (UC3M), Spain

Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas, Spain

Centro de Transferencia de Tecnología (CTT), University of Valencia, Spain

CERN, Switzerland

Cineca, non-profit consortium / HPC centre, Italy

ClusterVision BV, Netherlands

Cray U.K. Limited, UK

CSC - IT center for science LTD., Finland

CybeleTech SAS, France

DataDirect Networks,USA

Distene, France

Dpto. de Informática de Sistemas y Computadores, University of Valencia, Spain

E4 computer engineering,Italy

EDF, France

ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development
EPCC at The University of Edinburgh

Euro-Mediterranean Center on Climate Change, Italy

European Centre for Medium-Range Weather Forecasts (ECMWF)

Eurotech Italy, Italy

eXact lab, Italy

Faculty of Mechanical Engineering, Uni of Ljubljana, Slovenia

Forschungszentrum Jülich, Germany

Fraunhofer Institute for Industrial Mathematics ITWM, Germany

Fraunhofer Institute, Zentrale München, Germany
Free University of Berlin, Germany

French Alternative Energies and Atomic Energy Commission (CEA) , France

Fujitsu EMEIA, Technical Support, Germany

Fujitsu Systems Europe, France

Grand équipement national de calcul intensif (GENCI), France

GRNET S.A. (academic internet provider), Greece

Hewlett Packard Enterprise, USA, branch in Germany

High Performance Computing Center Stuttgart (HLRS) of the University of Stuttgart, Germany

High Performance Computing Wales (HPC Wales), UK

Huawei Technologies Co, China, Germany office

IBM - Deutschland, Germany

IBM, Zurich Office, Switzerland

Inria - Inventeurs du monde numérique, France

Institute for Combustion Technology, RWTH Aachen University, Germany

Institute of Computer Science (ICS) of the Foundation for Research and Technology, Greece

Intel Corporation EMEA, Paris office, France

International Centre for Numerical Methods in Engineering (CIMNE), Spain

INTERTWinE project (H2020 project)

Irish Centre for High-End Computing (ICHEC), Ireland

IT4Innovations, Czech Republic

KTH Royal Institute of Technology, Sweden

Lenovo corporation (China), French office, France

Linnaeus University, Sweden

LRZ: Leibniz Supercomputing Centre, Germany

Luxembourg Institute of Science and Technology (LIST), Luxembourg

Maison de la Simulation, France

Maxeler Technologies, USA, UK Office

Megware Computer Vertrieb Und Service Gmbh, Germany

Micron Semiconductor (Deutschland) GmbH, Germany

National Centre for Nuclear Research (NCBJ), Poland

Nice Software SpA, Italy

Numascale AS, USA

NVIDIA Bristol, UK

Onera, French Aerospace Lab

ParTec Cluster Competence Center GmbH, Germany

PDC Center for High Performance Computing, Sweden
PRiSM Laboratory, France

Quantum ESPRESSO Foundation (QEF), UK

Queens University Belfast, UK

Reims University, France

RWTH Aachen University, Germany

scapos AG, Germany

Science and Technology Facilities Council, UK

Scilab Enterprises S.A.S., France

Seagate PLC, UK branch, UK
SICOS BW GmbH, Germany

Simula Research Laboratory, Norway

Stream HPC, Netherlands

SURF, collaborative ICT organisation for Dutch education and research, Netherlands

Synelixis Solutions Ltd, Greece

Teratec : High performance simulation, France

Termofluids, Spain

The Cyprus Institute, Cyprus

The Institute for Biocomputation and Physics of Complex Systems (BIFI), Spain
The Istituto Nazionale di Fisica Nucleare, Italy

The Numerical Algorithms Group (NAG), UK

TU Delft, Netherlands

University College London, UK

University of Bologna, Italy

University of Luxembourg, Luxembourg

University of Mainz, Germany

University of Salento, Italy

VŠB - Technical University of Ostrava, Czech Republic

Wigner Research Centre for Physics, Hungary