D2.4 Final Business Development and Sustainability Review
Version 1.0

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Version	Author	Description of Change
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V1.0	Jon Gibson	Revised after POP internal review

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Executive Summary

This document describes the business development activity of the POP Project. We detail the marketing activities and collaborations we have undertaken and how they relate to our goals of working with SMEs and other Horizon 2020 Centres of Excellence (CoEs). We also give our recommendations for the sustainability of POP and summarise our successes in meeting the project's milestones and targets.

1. Introduction

Business Development for POP is about finding new users of its services. Our strategy is to use a variety of methods, which we discuss in this section. The partners with the most effort in this Work Package (WP2) are NAG, Teratec and IT4I, who bring their expertise and partnerships with industry and academia, as well as involvement in other CoEs and European HPC initiatives to the business development activity.

Two specific groups of users were selected for particular attention in the DoA: SMEs and our fellow Horizon 2020 CoEs. These were the subjects of our first two deliverables, D2.1[i] and D2.2[ii], in which targets and tasks were set. Most of these had been met by the time of our previous deliverable, D2.3[iii]. This report will focus on the work that has happened since its publication.

2. Marketing Activities

In this section, we describe POP's business development marketing activities.

2.1 Targeting Sectors

POP services are appropriate for any user of HPC and much of POP's business development does not target specific groups. However, it is also beneficial to focus some of our marketing effort on specific sectors. This enables us to establish ourselves in those sectors and become known within those communities, in other words to establish the POP brand.

Table 1 shows the sectors of all finished and ongoing services since the start of the current POP project.

User Sector	Number
Engineering	62
Aerospace	15
Earth and atmospheric sciences	54
Physics	38
Biology and genetics	9
Mathematics	6
Health	5
Chemistry	12
Astronomy	7
Others	16
Total	224

Table 1: POP Services by Sector

Our focus on the CAE, Materials Science, and Biology and Life Sciences sectors, as explained in D2.3, has continued. In short, this involves going to events related to those fields with appropriate marketing materials in order to better communicate with potential users. We have also investigated in greater depth the potential of High Performance Data Analytics and Machine Learning, described in the following section, for which a new sectoral flier was developed, using the same template as was used for the other sectors. The front of the flier is shown in Figure 4 (the back is the same for all sectors and was included in D2.3).

2.1.1 High Performance Data Analytics and Machine Learning

Various POP marketing and technical work was undertaken to understand if concentrating on HPDA/ML/DL/AI (high performance data analytics / machine learning / deep learning / artificial intelligence) could bring more POP customers. The work focused on the following questions:

- What software is used in HPDA/ML/DL/AI?
- Is there a need for POP like services in HPDA/ML/DL/AI?
- Can the POP tools be applied to HPDA/ML/DL/AI?
- Can the POP methodology be applied to HPDA/ML/DL/AI?

Two external contacts who work in ML and big data were interviewed to better understand the landscape. This revealed significant differences between HPDA/ML/DL/AI and traditional HPC. In traditional HPC, there tends to be a large number of parallel applications, each application with its specific functionality and domain. In contrast, HPDA/ML/DL/AI tends to be dominated by a very small number of well-regarded parallel frameworks which can be used over many domains and for many different tasks, e.g. TensorFlow and PyTorch for machine learning, and Apache Spark for big data. High quality open-source codes such as TensorFlow and PyTorch are provided by cloud computing companies as part of their business model to drive up consumption of cloud computing.

This was confirmed when the usual POP marketing processes were applied to HPDA/ML/DL/AI. A search for distributed/parallel HPDA/ML/DL/AI software identified very few codes outside the popular frameworks, and those tended to be academic codes. It was easy to identify companies offering DA/ML/DL/AI services e.g., via web searches and online lists of AI SMEs (such as "AI Startups"[iv]). Leads were identified and each was contacted twice but no one replied.

Technical work was undertaken to understand if the POP tools can be applied in this domain. Unlike traditional HPC, it is normal to scale up before scaling out, and so multi-process + multi-GPU computation was in scope. It was decided to focus on deep learning Python frameworks, as this is an important market sector. This revealed another important difference between traditional HPC and HPML/DL. Traditional HPC tends to evolve slowly and to use MPI for multi-process communication. In contrast, the popular machine learning frameworks are evolving quickly and may not use MPI. For example, Horovod, a popular framework for distributed deep learning initially used MPI, but later added Gloo as an alternative to MPI. TensorFlow implements multi-process parallelism using gRPC for communication rather than MPI, and NCCL (NVIDIA Collective Communications Library) offers another alternative method for direct communication between GPUs. The result of this is that the POP tracing tools may not detect inter-process communication, making it impossible to calculate POP efficiency metrics for the CPUs. This may not be a significant limitation however, as most tracing tools support CUDA, and it should still be possible to calculate POP efficiency metrics for the GPUs.

To test this, experiments were undertaken to see if the POP tracing tools Score-P and Extrae, along with other tracing tools (TensorFlow Profiler, Nsight Systems and Horovod Timeline), could be used with TensorFlow to generate traces and calculate GPU efficiency metrics. Score-P and Nsight Systems successfully generate traces but the trace data requires post-processing in order to calculate metrics, e.g. using Python scripts. We concluded that with a small amount work on tools and methodology, it should be possible to calculate GPU POP efficiency metrics for HPDL/ML and we will continue to investigate this during the period of the POP extension.

We found no evidence that there is a pool of potential clients with a need for POP services. This sector is dominated by a small number of well-regarded frameworks which are undergoing active development; hence it is likely any performance bottlenecks will be removed by the code developers. Having said that, we are still interested in finding out more about what performance issues are important for these codes and have recently published a blog post [v] describing what we could offer customers here.

2.2 Targeting SMEs

A significant part of our marketing has been aimed at SMEs. The KPI related to this was to have 30 SME users by the end of the project, as discussed later in Section 6.1. The plan for targeting SMEs was set out in D2.1[i] and this is

addressed specifically in Section 6.2. This section details the activities that we carried out in order to target SMEs.

2.2.1 SME-Focused POP Webinar

In D2.1, we decided to investigate opportunities for SME training at events as a way to attract new customers. This was going to be difficult to do as originally envisaged due to all events becoming virtual, so the best option seemed to be to host our own event for SMEs. In September 2021, we held the webinar, "POP: The SME Perspective", focused on attracting SMEs to POP. Three users from SMEs that had worked with POP were given a platform in which they could present something about their company, how it uses HPC and their experiences of working with POP. It was hosted by Fouzhan Hosseini of the POP service, who went on to ask the participants further questions about their use of HPC, current developments within the industry and the need for a service such as POP.

This was the 23rd webinar in the POP bi-monthly webinar series run by WP4 and was marketed in the usual way via mailing lists and social media. The webinar attracted 67 registrations, 37 of whom attended live. The recording and slides were made available via YouTube[vi] and the POP website[vii] following the webinar. The recording has had 126 views to date (25th November 2021). Any registrants from SMEs that were not already working with POP were e-mailed after the webinar to offer them POP services. Two of these signed up for an assessment shortly after, an excellent result for the event.

2.2.2 Marketing Webinars

We also organised two webinars which directly marketed the POP service to potential customers. In these, a POP analyst would describe the POP service and the free help that was available to customers.

The first of these was on the 11th of May 2021 and targeted large industry and SMEs within France. While the slides were in English, the presentation was delivered in French. Contacts were used to promote the event to competitiveness clusters[viii] dealing with IT and numerical simulation activities (Systematic[ix] and Cap Digital[x]). Details were also posted to mailing lists managed by CNRS and the Ministry of Higher Education, Research and Innovation. There were 26 registrations for the webinar, of whom 16 attended. Five of the companies participating then became POP users, an excellent return from the event.

Given the success of the first webinar, a second one was organised for the 9th of July 2021, which targeted SMEs at the European level. This was publicised via Digital Innovation Hubs, HPC National Competence centres and competitiveness clusters. This webinar had 25 registrations and 10 attendees and although it did not directly lead to any users, it gave an awareness of POP to some potentially important future clients.

2.2.3 Targeted Marketing

Most of our general marketing activities were done with a degree of emphasis on finding SME users. For example, the events we attended were chosen to be ones that SMEs might attend, rather than academic conferences. Our lead generation activities and unsolicited marketing also focused on SMEs. In Section 3.3.1, we describe our collaboration with NAFEMS, a professional body with a large number of members from SMEs.

E-mails were sent to members of organisations where many were likely to be SMEs. These include e-mails to

- 564 members of Syntec Numérique[xi] (an industry association for IT & digital activities companies)
- 20 SME members of Cap Digital[x] (a competitiveness cluster)
- Members of Aerospace Valley [xii] (a competitiveness cluster for the aeronautical industry).

Another approach that found a few SME POP users was simply to recontact the people from SMEs in POP's Customer Relation Management (CRM) system. As we have observed previously, many leads need several interactions before becoming a POP user and sometimes timing is critical. We found a couple of new users this way.

2.3 Business As Usual

Many of the standard business development activities were the same as detailed in D2.3. For example, our use of social media to generate leads and promote POP services, as described in the previous report, continued to be part of our routine work. Having said that, the use of lead generation through this and other means, as part of a programme of unsolicited marketing was used less than it had been previously, given that, as we had shown in D2.3, this is an expensive way to generate new POP users.

2.4 Events

Due to the impact of Covid, we have not been able to attend any events in person since D2.3, although we have tried to make the most of the situation by attending virtual conferences and workshops. This has meant making electronic copies of the brochure and flyers available on the booth, rather than physical ones. It is also a lot more difficult to interact with people on a virtual booth and for most events, there has been minimal traffic. However, for some events, we have managed to send post-event e-mails to the delegates and this has had a degree of success in finding users.

Giving talks at conferences is also useful as a means of directly publicising the work of POP and this has been especially useful where we have the list of attendees. For example, we gave a talk at the UK NAFEMS conference, for which attendees had to book on in advance, with the option of allowing their details to be passed on to the speaker. After the event, we had a list of those who had booked on and attended the talk and those who booked on and did

not attend. We then contacted both sets of people with a follow-up e-mail, summarising what the talk had said about POP. At the same event, 28 people visited our booth, of whom 6 sent questions. A blog post on this event[xiii], including the slides from the talk, is available on the POP website.

Another event of note was the International CAE Conference and Exhibition 2020, which we attended virtually after being at the physical event in both 2017 (for POP1) and 2019. This time we shared a virtual booth with fellow CoEs, EXCELLERAT and MaX. As when we had attended in 2019, a successful outcome of this event was getting an article about POP published in the EnginSoft newsletter, potentially getting our message to a much wider audience. The article is available online[xiv] and is reproduced in Figure 5.

POP gave a talk at Supercomputing Frontiers Europe 2021. The slides and recording of the talk can be found in a blog article[xv] on the POP website. However, what was worthy of note here is that the event organisers sent a follow-up e-mail about POP on our behalf to all the conference attendees. Assistance of this nature at a conference is unpredictable but always very welcome.

Having said that, some events can more directly be very successful. The Teratec Forum is an annual event held in France which brings together international experts in HPC, Simulation and Big Data. In 2020, the virtual event attracted 1200 attendees. Of those, 135 were contacted and 4 became POP users, all from SMEs.

Please see Table 6 in Section 8.1 for a full list of the events attended for business development since D2.3.

2.5 POPCasts and Animations

In D2.3, we presented our use of *POPCasts* to promote the POP service by providing short video interviews to highlight various aspects of it. The first of these[xvi] delivered a high-level introduction to the service, the second[xvii] interviewed a POP user on their experiences and the third[xviii] interviewed a POP analyst to discuss their role. At around ten minutes each, they have proved very popular, having been viewed a combined total of 471 times as of the 25th of November 2021, with 15 likes.

In February 2021, we released a fourth POPCast, entitled “Why does code matter?”[xix] Taking the same format, this time an HPC Application Analyst for POP was interviewed about why code matters, its value to the customer and how we work with customers to increase that value. To date, this has been viewed 93 times, with 3 likes.

We have also started experimenting with using animation to define and promote the POP brand. This started with an animated Christmas card that was e-mailed to subscribers to the POP newsletter, as well as being made generally available via posts on Twitter and LinkedIn. The card depicted a series of scenes in which

a couple of POP analysts helped to save Christmas by optimising Santa's route-finding software. The card is unlisted on YouTube so was only viewable by being provided with the link[xx]. Nevertheless, it has had 182 views and 5 likes. Given that it cost £300 to produce, this works out at £1.65 per view. This is cheaper than sending physical cards in the post would have been and hopefully had a similar effect.

A second animation, entitled "The POP Superheroes"[xxi], was launched with POP's September newsletter, to tie in with announcing the six-month extension to the POP service. This further developed the two characters introduced with the first, but this time giving a more direct message about what the POP service does. Over the 30 seconds of the animation, the "POP Superheroes" say,

"We are the POP Centre of Excellence and we have a mission! Whether you're in industry or academia, whatever your domain or programming language, if you're in the EU or UK, we will endeavour to speed up your parallel code! And we do that for free! Let us know if you need our help at any time! We are here for you! And now will be until the end of May 2022!"

The animation features the superheroes flying over famous landmarks from the countries where the POP partners are located. As well as featuring in the POP newsletter and on Twitter, this animation is also on the front page of the POP website, given that it provides a short and eye-catching introduction to the POP service. Individual views from the website do not get included in the YouTube statistics but, as of the 25th of November 2021, the video has had 91 views. This animation cost £295.

2.6 Online Training Modules for Business Development

In D2.3, we described how we had started to create an online training "portal"[xxii], with the dual function of providing useful information to users and attracting potential new users. The portal contains a collection of self-study modules, which are being developed in cooperation with WP4. Each module includes a training video and has a page with further reading materials and links to other POP resources to give a "joined up" approach.

The portal has been developed and expanded since D2.3 and now also includes sections covering "Advanced POP Training Modules" and "POP / VI-HPS Tuning Workshop Recordings", leading to a much more complete resource. There is still scope for further modules to be added over time.

The videos in the training modules (standard and advanced, not including the workshop recordings) have a combined total of 2,008 views as of the 25th of November 2021. This illustrates that we have created a useful resource, which is increasing the profile of the POP CoE and hopefully, in turn, helping to generate new business.

2.7 External Publications

Following POP's attendance at CAE2020, we were invited to contribute an article to Enginsoft's "Newsletter Magazine", as we had been after attending the conference in 2019. The article is available online[xiv] and is reproduced in Figure 5.

As part of NAG's membership of NAFEMS, POP was given a free advertisement in their "Benchmark" magazine, shown in Figure 6.

Besides these, POP regularly publishes news and results in external publications, the details of which are provided in deliverable D4.2.

2.8 LinkedIn Advertisement

Between the 28th of June and the 28th of July 2021, POP ran a promoted advertising campaign on LinkedIn. The advert [xxiii] was posted from the "Numerical Algorithms Group (NAG)" company page. Over the one-month promotion period, it had 108,000 impressions and 452 clicks on the link to further information on the NAG website[xxiv]. This gave us a click-through rate (CTR) of 0.42%, which is around what you would expect for software-related sponsored content on LinkedIn, where the benchmark is 0.39%[xxv].

The page linked to on the NAG website contains an enquiry e-mail address and links to the main POP website. Disappointingly, no one made contact through the e-mail address. The POP website was not set up to allow traffic to be monitored so unfortunately, we cannot say how many people followed the link to the main POP website during the one-month promotion period. However, we do know that during the lifetime of the POP website, there have only been 57 accesses to it from the NAG page.

This advertising campaign cost a total of $1,471. It is only possible to learn how effective such promotions are by actually running them, so the experiment was clearly useful. If its objective was to find new leads, then we might be inclined to conclude that promotions like this are not worthwhile for POP. However, the only way of someone becoming a lead was to e-mail the address given on the website. If they had studied the website and then applied directly for a service via the service request form, perhaps a day or two later, after discussing it with colleagues, then the connection to the advert would probably have been missed. At the very least, the 452 people who did click on the link, and many more of those that just saw the advert, have an increased awareness of the POP service and this may be a contributing factor to some of them becoming future POP users. We know from experience that it often takes a series of interactions to create a user. At the same time, we should be wary of reading too much into a single ad available for one month.

2.9 The POP Brand

All our activities promote the POP brand. We have worked to increase our profile on social media to help increase awareness amongst those who aren't

yet POP users. Of course, a lot of the activity of WP4 serves this purpose, which then feeds back into business development. We also actively promote the POP methodology to HPC Centres, as described in Section 3.2.

2.10 Sources of POP Users

In the second half of the project, we have generated over 1,000 new leads and found 68 new users, making a total of 157 for the project. It is important to remember that these leads were not the only source of new users, as shown in Table 2, which also breaks the users found in each category between the two halves of the project.

Source of Users	M1-M18	M19-M36	Total
Previous Contact of POP Partner	30	4	34
Local user of POP Partner	9	2	11
Business Development	20	36	56
Word of Mouth (Non-POP Marketing)	8	8	16
Source of Lead Unknown	14	7	21
Cyclic CoE Campaigns	8	11	19
Total	**89**	**68**	**157**

Table 2: Sources of POP Users

We always expected that we would need to find fewer users in the second half of the project and it is true that the total number of users found was less. However, it is interesting to note that the number of users found through business development activities actually increased from 20 to 36 in the second half. The reason that this was necessary is revealed by the Table, in that those users that were found as previous contacts of the partners were nearly all found at the start of the project, meaning more business development work was necessary to compensate for this.

If we ignore the users where the source of the lead is unknown, then in the first 18 months, 27% of new users were found through business development and in the latter 18 months, 59% of users were. Given that we found roughly 1,000 leads in both halves of the project, the increase in the number of users found through business development also means that our conversion rate almost doubled from around 2% in the first half to 3.6%. This is partly due to the lessons learned in the first half leading to more efficient and focused marketing. It is difficult to say what effect Covid has had, if any, on our ability to find users.

It is also important to remember that a given user often has multiple POP services. In this case, the 157 users have had 224 services, which can be split into 161 audits (some users had more than one code audited), 28 follow-on

audits and 35 proof-of-concepts. This gives an average of 1.43 services per user.

2.11 Sources of POP Users from SMEs

Given our particular focus on finding users from SMEs, Table 3 singles out those users. It shows an even split in the number of users found in the two halves of the project and, as in the general case, more needing to be found by business development in the second half of the project. The important difference highlighted by the table though is the greater reliance on business development for finding SME users. In the first eighteen months, excluding the user of unknown origin, 47% of the SME users were found by business development (compared to 27% for all users) and in the final eighteen months, this figure goes up to 76%, significantly higher than the 59% when all users are considered.

Source of SME Users	M1-M18	M19-M36	Total
Previous Contact of POP Partner	5	3	8
Business Development	7	13	20
Word of Mouth (Non-POP Marketing)	3	1	4
Source of Lead Unknown	1	0	1
Total	**16**	**17**	**33**

Table 3: Sources of POP Users from SMEs

In the case of SMEs, the 33 users had a total of 43 POP services. These are made up of 33 audits, 3 follow-on audits and 7 proof-of-concepts. The average number of services per user for SMEs is 1.30, slightly less than the figure of 1.43 when all users are considered.

3. Collaborations

3.1 CoE Collaborations

In D2.2, we set out our strategy for targeting other CoEs and gave ourselves six tasks which would enable us to build collaborative relationships with the other CoEs. These had all been completed by the time D2.3 was published. From this basis, our relationship with the other CoEs has continued to flourish.

Since D2.3, we have carried out three more periodic campaigns for CoEs, as set out in WP5 Task 5.3. The first of these was a second periodic campaign for the ChEESE CoE, in which the same set of codes as in the first round were reassessed, although a number of these had been ported to GPUs since the first campaign. Our new campaigns have been for the CoEC and NOMAD2 consortia, the latter of which is currently ongoing. There will be a further

campaign starting in December 2021 for the MaX CoE. We have also carried out assessments for CoEs outside of this more formal arrangement. All the studies since D2.3 are shown in Table 4.

Code Name	EU CoE	POP Partner in charge of the work	Number of Assessments/PoCs
SPECFEM3D (CPU)	ChEESE	HLRS	1
SPECFEM3D (GPU)	ChEESE	JSC	1
Salvus	ChEESE	JSC	1
SeisSol	ChEESE	JSC	1
FALL3D	ChEESE	BSC	1
PARODY_PDAF	ChEESE	NAG	1
HySEA	ChEESE	BSC	1
ASHEE	ChEESE	HLRS	2
ExaHYPE	ChEESE	AACHEN	1
XSHELLS	ChEESE	NAG	2
PhysiCell	PerMedCoE	BSC	2
Nek5000	CoEC	JSC	2
Alya	CoEC	BSC	1
Disco	CoEC	AACHEN	2
YALES2	CoEC	UVSQ	1
OpenFOAM	CoEC	BSC	1
CIAO	CoEC	AACHEN	1
CLIO	CoEC	HLRS	1
AVBP	CoEC	BSC	1
exciting	NOMAD2	BSC	1
GPAW	NOMAD2	NAG	1
ABINIT	NOMAD2	JSC	1
FHI-aims	NOMAD2	HLRS	1
IFS-ST and IFS-FVM	ESiWACE	BSC	1
NEMO	ESiWACE	BSC	1
HemeLB_GPU	CompBioMed	JSC	1

Table 4: Performance Assessments and PoCs for CoEs since D2.3

3.2 HPC Centres

A number of POP partners are also HPC Centres and this has been a valuable source of users, i.e. the "local users" shown in Table 2. Beyond this, the partners often have close working relationships with HPC Centres within their own countries. These relationships help us to widen the understanding and use of the POP methodology amongst both their employees and their user communities. This in turn increases awareness of the POP brand and attracts users to our services. It also, of course, leads to the performance of more codes getting improved than would otherwise be possible by POP analysts alone.

During POP2, we have continued to develop collaborations with local and national HPC Centres around Europe. From a business development standpoint, this means focusing on those countries without a POP partner, where such relationships do not already exist, such as the Netherlands, Sweden and Poland. We have also started to explore the possibilities offered by the EuroHPC National Competence Centres and would like to develop closer ties with these during any future POP service.

3.2.1 SURF

In the mid-term deliverable, we described how SURF (then SURFsara), the Dutch National High Performance Computing centre, had offered to advertise POP within their user community and identify user codes running on their machines which could benefit from POP services. One POP assessment had already started. That service has since been successfully completed.

SURF would like their analysts to be actively involved in the performance assessment services with the goal of eventually being able to do the assessments themselves. With this in mind, on 17th May 2021, POP delivered a one-day online training for SURF. This was focused on applying the POP methodology using the POP tools so that attendees could then do the same on their own codes. The training day received very positive feedback from the sixteen attendees, with more than 80% of them feeling that they had benefitted from the course and more than 70% considering the quality of the material, presentations and hands-on session to be very good or excellent. Carlos Teijeiro Barjas (Supercomputing Advisor at SURF), who both participated in and helped organise the training day, said,

"I really appreciate the dedication and effort that NAG spent to prepare and deliver this well-organized online training and the set-up. I appreciated a lot that the online training has been tailored to our own system."

A report on the training is available on the POP website[xxvi]. SURF have expressed an interest in further training, and this is currently being discussed.

3.2.2 Nordita

Nordita[xxvii] is the Nordic Institute for Theoretical Physics, a Stockholm-based research institute. We have already performed an assessment on one of their

codes. We have agreed to deliver a one-day hands-on online training course to their users on the use of the POP methodology to optimise parallel code performance. This will be similar to the one given to SURF in May.

3.2.3 Nicolaus Copernicus University

Nicolaus Copernicus University is located in Toruń, Poland. We have performed two assessments, on different codes, for a user here. A blog post on one of these assessments is available on the POP website[xxviii]. We have agreed to do a one-day hands-on online training here, again similar to that given to SURF on the POP tools and methodology. This will be primarily aimed at the University's Institute of Astronomy but will be opened up to attendees from Poznan Supercomputing and Networking Center (PSNC) and possibly other institutions in Poland. This should be a great opportunity to market POP services to new customers, as well as spread the POP philosophy.

3.2.4 Durham University

POP has carried out one assessment for a user at Durham University in the UK during POP2. It also collaborated with them on the training for the ExCALIBUR programme. As a follow-up to this, we will deliver a half-day online training on the POP methodology, which is being organised by Durham for December 15th, 2021[xxix]. We hope to use this to help build more of a relationship with the university.

3.3 Professional Bodies

3.3.1 NAFEMS

NAFEMS[xxx] is the International Association for the Engineering Modelling, Analysis and Simulation Community. With more than 16,000 individuals at 1,400 organisations worldwide being a part of NAFEMS, many of whom are within Europe, it is potentially a good way to find new POP users. NAG became a member of NAFEMS in September 2021 and were consequently given a free advertisement in their "Benchmark" magazine, shown in Figure 6. They intend to publish an article about the POP service in a future issue of the magazine and to present a webinar to their members.

POP had a booth and gave talks at three NAFEMS events, the UK NAFEMS (see Section 2.4) and NAFEMS France conferences, both in November 2020, and the NAFEMS World Congress in October 2021.

3.4 Cloud Provider

In D2.1[i], we set ourselves the target of forming one formal partnership with a cloud provider by the end of the project. In 2021, POP collaborated with cloud provider, Alces Flight[xxxi] with the goal of developing such a mutually beneficial partnership. This was to begin with the "POP x Flight Program", where we offered a free six-month integrated performance optimisation and cloud migration program. The opportunity was open to any EU/UK based organization with a strong interest in moving their parallel software or workflow to the cloud,

The call for applications was advertised via a web page[xxxii], the POP newsletter, mailing lists, Twitter and LinkedIn.

The program was to start with a POP assessment on the user's own hardware or a PRACE machine, before moving to the cloud, where Alces Flight would work with the customer through managing and testing environments to find the optimum cloud architecture for their runs. During the cloud environment testing, they would have a free three-month subscription to Alces Flight Center, to provide any help required for creating, maintaining, and growing their cluster environment. Continuing with this service at the end of the free access period would have been entirely the customer's choice. The only commitment being asked of the users was one or two hours per week over the six-month period, probably not too dissimilar to that required by many POP assessments. The POP assessment element of the program could, like any other, have led to a Proof-of-Concept study, but no advance commitment could be made to this within the POP x Flight Program.

The program was open to applications for a period of one month, after which the plan was to assess the various applications and to choose the most promising one or two to enter the program. The application form[xxxiii] was a little longer than that for a POP assessment because it needed to include the information useful for setting up a suitable cloud environment, as well as that required for the POP assessment. The ideal candidate would perhaps have been from an SME, with an MPI (or hybrid MPI with OpenMP or CUDA) code ripe for improvement, and with plenty of enthusiasm. These attributes should help maximise the effectiveness of the publicity that would follow the program, hopefully attracting many more customers to this kind of service. Of course, any unsuccessful applications would still have been entitled to a free POP assessment.

Despite considerable effort being put into developing and then publicising this program, no applications were received and it had to be abandoned, clearly a disappointing result. Perhaps the perceived competition element put some people off applying and maybe it sounded like too much of a commitment for some users. It may also be that we needed to catch the right person, someone receptive to a new collaboration, at exactly the right time, when they were looking to move over to a cloud environment. Nevertheless, this idea is one that we are likely to explore again in the future, given that use of cloud services for HPC is only likely to increase.

4. Business Development Strategy for the Period of the Project Extension

Most of POP's business development activities can be scaled right back for the period of the project extension. Given the number of projects that will still be in progress and the periodic campaign for the MaX CoE due to start in December, along with the limited remaining funding, it is not envisaged that many new

customers will be required. We will, however, periodically assess the situation and adjust the level of our business development work accordingly.

5. Sustainability

In D2.3, we set out a number of proposed options for a sustainable POP service. It is now clear that the only viable option for a future service is one that is fully-funded under the EU research and innovation programme, or similar public funding. In fact, we believe that this option will increasingly provide a valuable resource to industrial and academic HPC users throughout Europe.

The first POP service started in October 2015 and from then until the end of May next year, our work has led to improvements in the performance of hundreds of parallel codes, not only through our performance assessment and proof-of-concept services, but also through users who have attended trainings or used our online learning resources and are now applying the methodology and using the tools themselves. Among these resources, the co-design repository developed under WP7 is now becoming a valuable asset for code developers, but further work is needed if it is to truly reach its potential. We have also built a community, not just made up of users of our services, but also those who attend our webinars, read our newsletter and follow us on Twitter and LinkedIn. In other words, we have built up a community of people for whom parallel code performance is important. Of course, integral to this success is the expertise and experience of the partners and the people who work for the POP service, who will undoubtedly continue to use the POP tools and methodology whether the service continues or not.

Customer feedback obtained by WP3 has shown that very few people are willing to pay for POP-like services and those that say they are, imagine paying a fee that would only cover a fraction of the costs incurred. Even if such a model were attempted, the service would have to be cut back to the essentials and it would be difficult to justify spending time and money on things like the co-design repository, given that there's no direct return on the investment.

While we are fully aware that services such as POP need to evolve with the changing HPC infrastructure in the EU, we also feel that a degree of continuity is valuable. The work we have provided the other CoEs has made an important contribution to their success, and expertise such as ours is going to be essential in the pursuit of exascale. At the same time, SMEs tend to work at the other end of the scale and so it is important that they do not get left behind. POP has been a good fit for both of these types of customer, as well as all those that lie in between. We therefore recommend the continuation of POP as a fully-funded service.

6. Results and Impacts

In this section we consider our project KPIs, along with the targets and tasks from earlier deliverables. Note that all the targets from D2.2 had already been met by the time of the previous deliverable, D2.3.

6.1 POP KPIs for the Third Customer Milestone

The POP KPIs associated with the third customer milestone needed to be met for this deliverable. Table 5 shows that they have been. Note that the numbers in the table refer to unique users and not services. The numbers of services carried out is greater because often more than one is carried out for a given customer. More details on this are given in Sections 2.10 and 2.11.

POP KPI	Month to Achieve by	Result
110 POP Users	36	157 POP Users; KPI met
30 POP SME Users	36	33 POP SME Users; KPI met

Table 5: POP KPIs related to Business Development

6.2 D2.1 Plan for Targeting SMEs

This deliverable outlined how POP planned to identify and attract SMEs as customers of its services. We identified the methods we would use to research the market and locate possible SME users, and then described the material we would produce to target them.

6.2.1 Tasks

The deliverable set a number of tasks, most of which had been met by the time D2.3 was published. However, two were still outstanding at this stage.

- Investigate the potential of strategic partnerships with at least one each of HPC vendors, integrators and cloud providers.
- Investigate opportunities for SME training at events.

Our collaboration with Alces Flight is detailed in Section 3.4. This was successful in that we found a cloud provider who was interested in pursuing a strategic partnership with POP and then set up an experiment to test this by making a joint offer of our services to potential users. Although we received no applications, it was still a valuable learning exercise and the idea would be worth revisiting in the future.

In terms of the SME training, the approach we decided to take was the SME-focused webinar, described in Section 2.2. The presentations and discussions here were interesting to attendees from SMEs and directly brought in two new SME users.

6.2.2 Targets

D2.1 also set a number of targets. D2.3 explained how some of these could not be measured because of the difficulty in associating users with a specific business development activity. However, the following two targets were measurable.

- Increase POP Twitter followers from 500 to 1000.
- Form one formal partnership with an HPC cloud provider by the end of the project.

As of 25th November 2021, we have 1,111 Twitter followers[xxxiv] so the first target has been achieved comfortably. On the other hand, despite high expectations, the experiment we conducted with Alces Flight meant that a formal partnership was not worth pursuing.

6.3 The Impact of POP

In Figure 1, we can see the distribution of POP2 users by country. One positive thing to note here is that we had users from twenty different countries, an impressive reach. It is also clear that those countries with larger economies also provide more POP users.

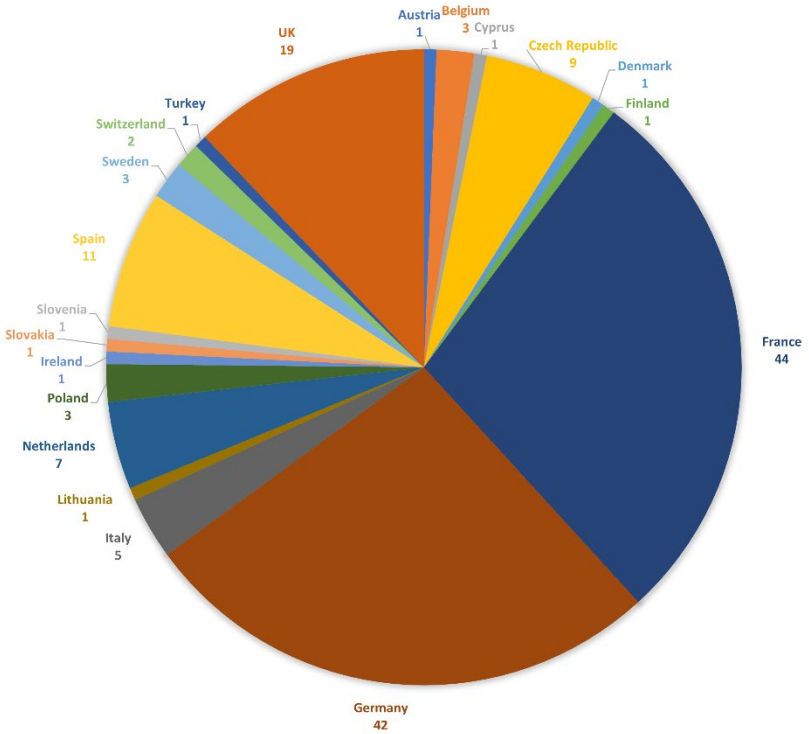


Figure 1: The Distribution of POP2 Users by Country

Figure 2 just looks at those users from SMEs and their distribution by country. An impressive ten countries are represented here between the 33 users. Again, those countries with larger economies tend to provide more users.

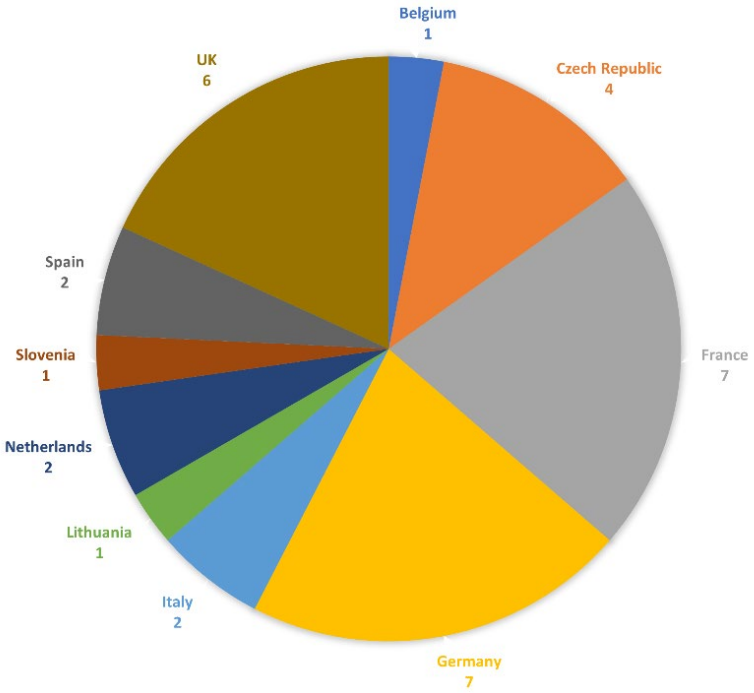


Figure 2: The Distribution of POP2 SME Users by Country

In Figure 3, we can see the classifications of the types of organisations that the different POP users came from. While it is often easier to get academic users, this type does not dominate and we can see a significant proportion from each of research/government, large industrial and SMEs.

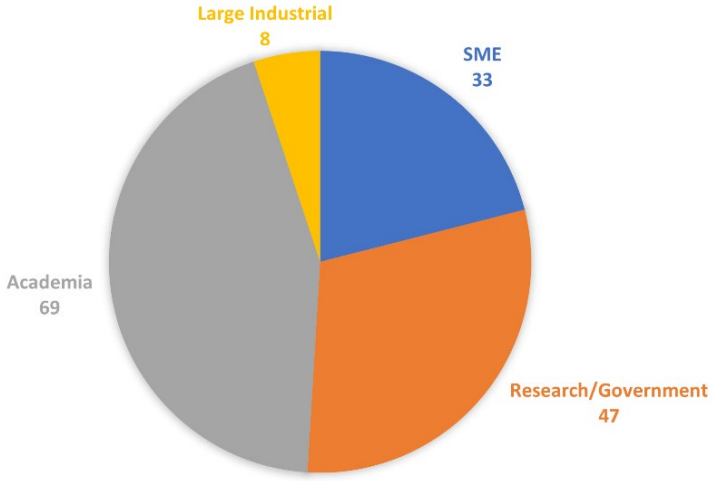


Figure 3: The Classification of POP2 User Organisations

7. Conclusion

We have successfully met the KPIs for this, the second POP service. Specifically, we found 157 POP users, significantly beating the target of 110,

and 33 POP users from SMEs, where the target was 30. The users come from 20 different countries and the SME users from 10.

Towards the start of the project, D2.1 and D2.2 set out our plans for targeting SMEs and CoEs, respectively. These included tasks and targets for our work package. All tasks were carried out and, where they could be measured, all targets met, with the exception of developing a formal partnership with a cloud provider by the end of the project. This was an ambitious goal and failed due to a lack of interest from the user community for the joint service we offered in partnership with a cloud provider. It was still a valuable experience that we can learn from and hopefully revisit in the future.

During this period, we have continued to experiment and develop new and innovative approaches to business development, both in a bid to streamline the effort required to find new business, as well as by necessity, with the impact of the Covid pandemic preventing any in person events from taking place. The evidence for our improved efficiency can be seen in the increase in the conversion rate of leads to users from around 2% in the first 18 months to around 3.6% in the second 18 months. More users needed to be found from business development in the second half of the project because of the tendency for users that are previous contacts of POP partners to be found at the start of the project.

Along with all the other work packages, we are continually improving the visibility of the POP brand and building new collaborations, putting us in a strong position to continue to offer our technical expertise to HPC users throughout the European Union. We presented the options for a sustainable POP service in D2.3 but now, with the feedback gathered by WP3, we recommend a fully-funded service as the best way to achieve continuity in the POP service.

8. Appendices

8.1 Events Attended for Business Development

Location is not shown in the table because all events were virtual.

Event Name	POP Partner(s) Attending	Activity	Audience
ELIXIR Bioinformatics Industry Forum[xxxv]	BSC	Talk	Industry
2nd Workshop on HPC Education and Training for Emerging Technologies (HETET20)@ISC20[xxxvi]	NAG	Talk	Academia
N8 Centre of Excellence in Computationally Intensive Research (N8 CIR) Training Event	NAG	Talk	Academia
Third Workshop on Strategies for Enhancing HPC Education and Training (SEHET20)@PEARC20[xxxvii]	NAG	Talk	Academia
International Series of Online Research Software Events[xxxviii]	NAG	Talk	RSE Community
NAFEMS UK Virtual Conference 2020[xxxix]	NAG	Talk and POP booth	Industry
CAE2020	NAG	POP booth, shared with EXCELLERAT and MaX	CAE Community
Teratec Forum 2020	Teratec	POP booth	Industry, Academia
Digital infrastructure and IOT for industry 4.0	Teratec	Attending	Academia, Industry
"Sparse days" CERFACS	Teratec	Attending	Academia, Industry
45th ORAP Forum	Teratec	Attending	Academia, Industry
NAFEMS 20 France	Teratec, UVSQ	Talk	Industry, Academia
Software Engineering and Reuse in Modeling, Simulation, and Data Analytics for Science and Engineering (SC2020 BOF)[xl]	NAG	Lightning Talk and Panel	Industry, Academia
SC 2020 Exhibitor presentation	IT4I	Booth presentation	Industry, Academia

4th Users' conference of IT4Innovations	IT4I	Talk	Academia
3rd EMMC International Workshop 2021[xli]	NAG	POP Booth	Industry, Academia
Teratec Forum 2021	Teratec, JSC	Teratec booth and Talk at PRACE booth (JSC)	Industry, Academia
46th Forum ORAP	Teratec	Attended	Academia, Industry
ISC 2021	IT4I	POP talk at IT4I booth	Industry, Academia
Supercomputing Frontiers Europe 2021	NAG	Talk	Industry, Academia
NAFEMS World Congress	NAG	Talk and POP booth, shared with EXCELLERAT	Industry, Academia

Table 6: Events attended by POP for Business Development since D2.3

8.2 Marketing Materials

In this section, we include examples of some of the marketing materials produced for POP in the second half of the project.

8.2.1 HPDA Sectoral Flier

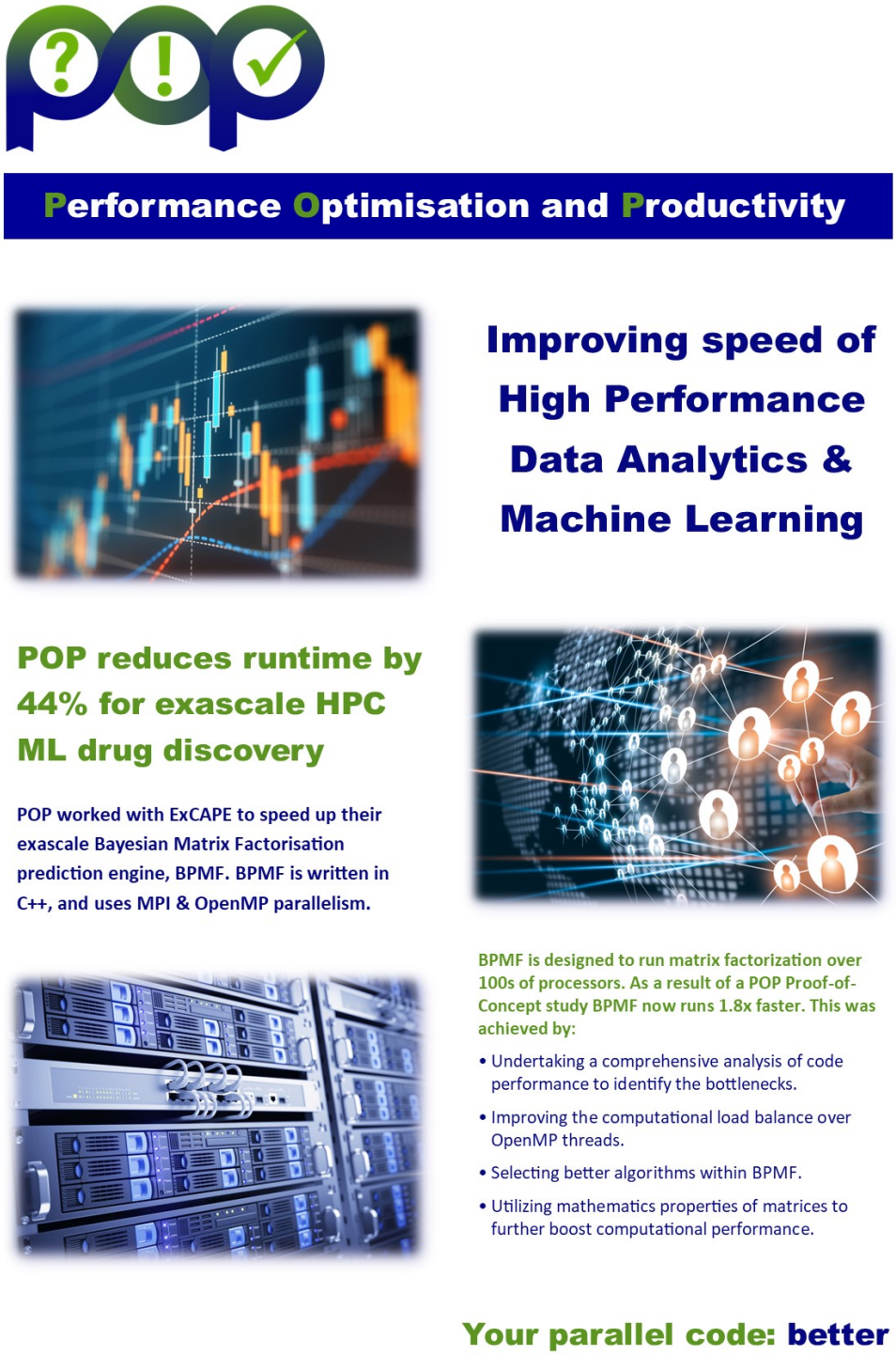
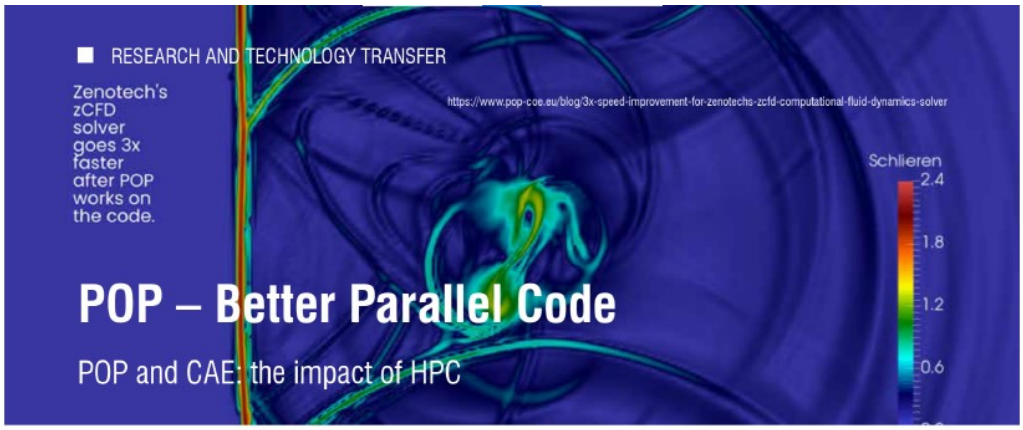


Figure 4: The HPDA Sectoral Flier (front)

8.2.2 Article in ENGINSOFT's Newsletter Magazine



In recent years, HPC facilities have become more widely used where intensive and large-scale simulations are required to control product quality and the production chain. At the International CAE Conference 2020, we were particularly excited to attend the track of talks about commercial software running on HPC machines.

Performance Optimisation and Productivity

Discussions highlighted the benefits of proper design choices and algorithmic selection. EnginSoft's "best practice" initiative is an outstanding example, created to guarantee effective workflows, thus increasing engineering efficiency. The POP Centre of Excellence, funded by the EU under the Horizon 2020 Research and Innovation Programme, complements the existing efforts in the community and fills an existing gap by providing code performance optimization services.

POP puts the world-class HPC expertise of eight commercial and academic partners at your disposal. POP has the tools and expertise to analyze all aspects of parallel performance, from codes running on a small number of cores, to those on tens of thousands of processors. We work with programs written across a plethora of programming languages including C++, Fortran, Python and Julia, not to mention the many parallel paradigms, such as MPI, OpenMP, CUDA, OpenCL and OpenACC. If you are a European firm looking to improve the performance of your parallel software, you are eligible for free services from POP.

The POP workflow is designed to accommodate the constraints of commercial HPC users and be flexible around their individual needs. Your IP is fully protected, and confidentiality is assured.

Our analysis will identify issues such as memory bottlenecks, communication inefficiencies and load imbalances. This enables a better understanding of program efficiency and the identification of target kernels for code refactoring. We can work on these computational kernels and advise on how to roll out improvements to your whole application.

In addition to reducing run-times, greater efficiency can also reduce power consumption and cloud computing costs. After investigating 34 codes used by commercial organizations, we have, on average, reduced their time to solution by more than 50%.

Subscribe to our Newsletter and stay up to date with POP news, developments, events, and live webinars.

For more information:
Fouzhan Hosseini – Numerical Algorithms Group (NAG)
fouzhan.hosseini@nag.co.uk

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Figure 5: Article in ENGINSOFT Newsletter, Spring 2021

8.2.3 Advert in NAFEMS Benchmark Magazine

Figure 6: Advert in NAFEMS Benchmark Magazine

9. Acronyms and Abbreviations

- AI – Artificial Intelligence
- BSC – Barcelona Supercomputing Center
- CAE – Computer-Aided Engineering
- ChEESE – Centre of Excellence for Exascale in Solid Earth
- CoE – Centre of Excellence
- CompBioMed – Computational Biomedicine (CoE)
- CTR – Click-Through Rate
- D – Deliverable
- DIH – Digital Innovation Hub
- DL – Deep Learning
- DoA – Description of Action (Annex 1 of the Grant Agreement)
- EC – European Commission
- EMMC – The European Materials Modelling Council
- EoCoE – The Energy-Oriented Centre of Excellence
- ESiWACE – The Centre of Excellence in Simulation of Weather and Climate in Europe
- EXCELLERAT - The European Center of Excellence for Engineering
- GA – General Assembly / Grant Agreement
- HiDALGO - HPC and Big Data Technologies for Global Systems (CoE)
- HLRS – High Performance Computing Centre (University of Stuttgart)
- HPC – High Performance Computing
- HPDA – High Performance Data Analytics
- IT4I – IT4Innovations (National Supercomputing Centre, VSB-Technical University of Ostrava)
- JSC – Juelich Supercomputing Centre
- KPI – Key Performance Indicator
- M – Month
- MaX – Materials Design at Exascale (CoE)
- ML – Machine Learning
- NAFEMS – The International Association for the Engineering Modelling, Analysis and Simulation Community
- NAG – Numerical Algorithms Group
- Nordita – Nordic Institute for Theoretical Physics
- PM – Person month / Project manager
- PoC – Proof of Concept
- POP – Performance Optimisation and Productivity (CoE)
- PU – Public
- RSE – Research Software Engineering
- RWTH Aachen – Rheinisch-Westfaelische Technische Hochschule Aachen
- SMEs - Small and medium-sized enterprises
- UVSQ - Université de Versailles Saint-Quentin-en-Yvelines
- VI-HPS – Virtual Institute – High Productivity Supercomputing
- WP – Work Package

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[iv] AI Startups webpage https://www.ai-startups.org/
[v] Blog post on HPDL https://pop-coe.eu/blog/pop-performance-analysis-of-tensorflow-high-performance-deep-learning
[vi] Recording of "POP: The SME Perspective" webinar https://youtu.be/WI2xacadU54
[vii] Web page for "POP: The SME Perspective" webinar https://pop-coe.eu/blog/23rd-pop-user-webinar-pop-the-sme-perspective
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[ix] Systematic website https://systematic-paris-region.org/evenement/energy-infrastructure-construction-b2b-forum-in-asean-20-may-2021/
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[xii] Aerospace Valley website https://www.aerospace-valley.com/en
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[xxiv] POP landing page on the NAG website https://www.nag.com/content/pop-eu-project
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[xxxiv] POP Twitter page https://twitter.com/POP_HPC
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[xxxvi] 2nd Workshop on HPC Education and Training for Emerging Technologies (HETET20) @ ISC20 https://sighpceducation.acm.org/events/HETET20.html
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[xxxviii] International Series of Online Research Software Events https://sorse.github.io/
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[xli] 3rd EMMC International Workshop 2021 https://emmc.eu/emmc-2021/