D4.2 Second POP Dissemination and Training Report Version 1.0

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Change Log

Version	Author	Description of Change
V0.1	Bernd Mohr	Initial Draft
V0.2	Bernd Mohr	Further input and corrections from dissemination team
V0.3	Kingshuk Haldar	Internal review
V0.4	Julianna Anguelova	2nd Internal review
V1.0	Bernd Mohr	Incorporated review comments and requests
		(Final Change Log entries reserved for releases to the EC)

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Executive Summary

This report summarizes the dissemination, cooperation and training activities and events for the second 18 months of the second funded phase of the POP Centre of Excellence, POP2, from June 2020 to November 2021.

The project continued the successful POP branding and dissemination plan established by POP1[1]. The dissemination team promoted project activities and results via established dissemination channels, e.g. via 106 blog articles, 12 newsletters, 17 webinars, and numerous social media posts, and participated in key conferences and events including presenting 11 talks and posters. We organized one conference workshop and one mini-symposium. Eighteen technical papers were accepted in peer-reviewed journals or conference proceedings. The frequency of blog articles went up from about two per month on average to three compared to POP1. Followers of our Twitter account increased by 160%, subscribers to our Newsletter by 190%, and offline views of our webinar presentations grew by 3800% (!).

Training activities were also increased compared to POP1: in the reporting period, we organized one POP training event, co-organized another fourteen in cooperation with PRACE, other CoEs, and other organisations; contributed to one training event organized by other organisations, and performed one extensive internal POP analysts trainings. All training events in the past 18 months were virtual based on video conferencing due to the on-going Covid-19 crisis. Finally, we completed our plan to produce various self-study online training modules in the area of performance analysis and tools for beginners in cooperation with POP Work Package 2.

1. Introduction

This report summarizes the activities of the POP CoE Work Package 4 that is in charge of the general public dissemination and training activities for the second 18 months of the project (June 2020 to Nov 2021). The objective is to highlight the demonstrated achievements by the project service activities. In doing so, it will help Work Package 2 (Business Development and Sustainability) in attracting new potential customers.

In particular, the objectives of this Work Package are:

- To continue the successful POP branding established by POP1 by providing and maintaining material and tools for project dissemination, by disseminating project objectives, activities, and results via established and new dissemination channels, and by participating in key conferences and events.

[1] We will use the term POP1 to refer to the first phase of the POP Centre of Excellence, Oct 2015 to March 2018, Grant Agreement No 676553

- To identify and perform training activities in order to engage interested parties in the usage of the offered services and provide appropriate documentation.
- To cooperate with and support other EU H2020 CoEs and Projects to coordinate dissemination and training activities with FocusCoE, to support the governance of High Performance Computing Infrastructures.

In the following sections, we describe the Dissemination, Cooperation, and Training activities in detail.

2. Dissemination

In this area, the project continued the successful POP branding established by POP1 by providing and maintaining material and tools for project dissemination consisting of logo and other branding material, corporate design, public website, and printed material like flyers and brochures. These are documented in the POP1 deliverables D7.1 "POP Promotional Plan" and D7.2 "POP Community Development and Marketing Tools" available on the POP website (https://pop-coe.eu/further-information/deliverables). This enabled us to build on the successful branding and its awareness of POP1.

The dissemination team promoted project objectives, activities, and results via established dissemination channels (like blog articles, newsletter, webinars, and social media posts) and participated in key conferences and events.

The dissemination activities were guided by the original promotional plan defined in POP1. Key dissemination messages in all communication activities were refined using customer advocacy data from Work Package 3. They are summarized in the following table:

Target Audience	Dissemination Message	Dissemination Channels
Industrial HPC Users and Code Developers	• ROI through improved code and amount of savings • Increased competitiveness and market share • Faster time-to-solution	Website (blog), social media, online press, newsletter, events, webinars
Academic HPC Users and Code Developers	• Better code performance or scalability • Ability to better explore parameter space and increase complexity	Website (blog), social media, trainings, webinars
HPC Code Developers	• Importance of performance aware design	Website (blog), social media, webinars, newsletter, publication

HPC Infrastructure and Service Centres	• ROI through improved code performance	Website (blog), social media, online press, newsletter, events, webinars
Standardization Bodies	• Improved code performance	Website (blog), social media, online press, newsletter, events

Table 1: Key Dissemination Messages

2.1 Website

We continued to use and maintain the main project website (https://pop-coe.eu) for overall presentation and dissemination of the project. At this website, interested individuals can find news regarding the progress and outcomes of the project. The website also includes the POP blog (see below) as well as the online archive for project and training material.

Figure 1: POP Main Website Landing Page

In this final phase of the project, the basic layout, which is now well-known to our customers and users, was not changed. It consists of a fixed header and footer and the always-visible menu bar on the left side, which provides quick-access to all parts of the website. It provides the same basic look-and-feel for all pages of the website (for example, compare Figures 1 and 3). The main landing page (shown in Figure 1) displays the overall mission, an introductory video about POP (which changes from time to time), a highlighted blog article, a “latest-news” sticker (in green, top right), links to the social media channels, and the latest tweets from the POP Twitter channel.

The design favors information and function over appearance, i.e., it focuses on quick and easy access to information rather than focusing on looking “nice” avoiding the use of large pictures and video content. This is considered important by the project members because we are a **technical** CoE with a focus on **performance**. Another important aspect of the design was to make it easily accessible for different devices (e.g. desktop computer, laptop, tablet, or smartphone).

The website is based on the Drupal Content Management System. The project coordinator (BSC) is hosting the system and the dissemination team located at Jülich Supercomputing Centre is managing it. A RSS feed system was also set up to inform individuals about the latest updates of web pages.

2.1.1 New sub website for resources for co-design

The biggest change regarding dissemination was the addition of a new website dedicated to resources for co-design early in the reporting period (Summer 2020). It was developed and it is maintained under Work Package 7 (“Co-design activities”). It can be reached via the URL https://co-design.pop-coe.eu but it is also has been completely integrated with our main website (via the “Resources for Co-Design” menu item).

The integration is implemented in the following way: the main site and co-design components are separate websites, however both are using the same basic layout, structure, fonts, colors, and graphics. The difference is in the menu bar on the left: they both show the same high-level (level 1) menu items, but detailed (level 2) menu items are only shown for the parts of the website which belong to the own component (see Figures 1 and 2). Further details can be found in Deliverable D7.4, section 2.1.

Its main purpose is to offer a resource for application developers, performance analysts and system designers (hardware and software) to understand the sort of problems they can encounter when executing on HPC systems. Application developers may find similar problems to those that affect their applications. Performance analysts may find directions on how to interpret metrics and the next steps to take in their analysis. System designers may obtain interesting ideas to guide their future designs: for instance, hardware designers may evaluate the impact of certain characteristics (e.g., the network

bandwidth) on the overall performance, while programming model designers may detect the lack of support of a given feature in their specifications or implementations.

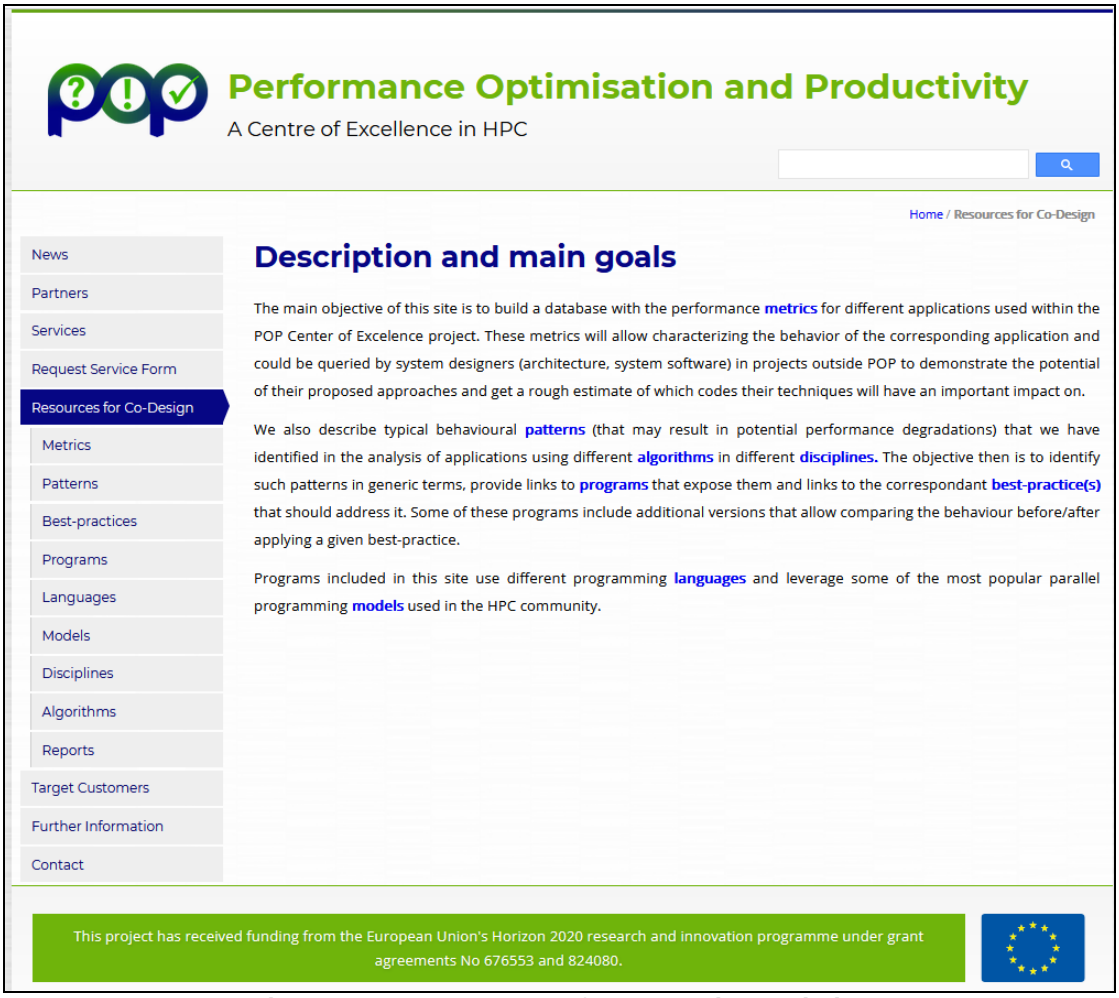

Figure 2: POP Resources for Co-Design Website

The site contents are organized through different collections, each of them populated with stand-alone items that may be connected to various other items in other collections. For instance, the load balance metric is connected to those patterns in which we detect performance degradation in this metric. The site currently offers the following main collections:

- **Metrics** contains the POP metrics used to guide the evaluation of performance.
- **Patterns** describes the typical non-optimal behavioral patterns that we have identified in the analysis of applications.
- **Best-practices** collects a list of recommendations that address the problems exhibited by the patterns.
- **Programs** contains source code programs reproducing the patterns, as well as implementing the best-practices.

- **Reports** includes public POP reports, either analyzing real HPC applications or describing a proof-of-concept implementing a recommendation.

In addition, the site can be navigated through different selection criteria, including programming **languages** and **models**, **disciplines**, and **algorithms**. These additional collections allow the user to easily access program source codes matching their selected option. For example, visitors may choose to select all the codes using the MPI programming model.

2.1.2 Blog

Another pillar for our dissemination is the POP blog (https://pop-coe.eu/blog/) integrated in the main POP website. It features articles about major project results and outcomes, reports from training and dissemination events, and other news items interesting to the HPC community. While the dissemination team writes most of the blog entries (based on the input provided by other project members), it also allows to publish news items and stories related to POP or about POP written by project externals, as blog entries can have a specified (visible) author. Blog articles are typically written in a more personal, sometimes even opinionated, style that is hopefully more attractive to the target audience than formal newsletters and press releases.

The blog also serves as an easily accessible news archive for the project. It allows people to look up specific subsets of articles based on tags via a special URL, e.g., https://pop-coe.eu/blog/tags/sme or via a tag cloud (see Figure 3, top right) or to easily browse them by (publication) time.

The categories **POPCast**, **POP SME**, and **Tool Time** were created for the second project phase. **POPCasts** are interviews conducted by the POP Work Package 2 team that shine a light on what the project does, how it does it, and all the benefits that can be brought to customer codes. **POP SME** are news and information especially targeting SMEs. Finally, **Tool Time** provides tips and hints for users of performance analysis tools.

For the categories **POPCast** and **Webinar**, the blog articles summarize the content of the interview or presentations, and include the recording as embedded video. If available, links to other material (e.g. the slides that were presented) are also included.

The following articles were published in the reporting period:

POPCast (and SME) (1)

- POPCast #4: Why Does Code Matter?

POP SME (1)

- POP and its Role for Materials Modelling

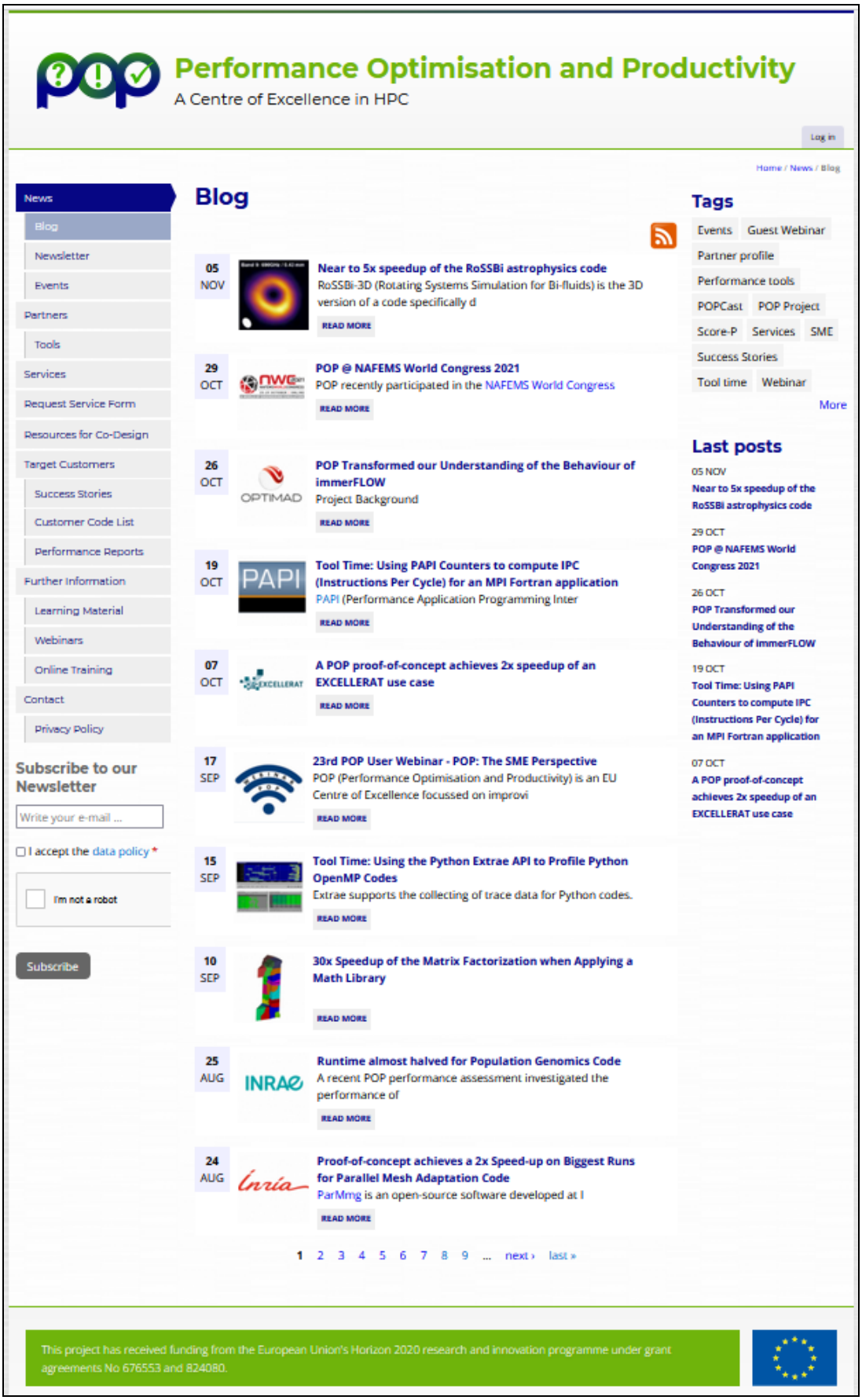

Figure 3: POP Blog

Events (12)

- POP Goes Virtual for 35th VI-HPS Tuning Workshop
- We did it again! POP Goes Virtual for 36th VI-HPS Tuning Workshop
- POP @ NAFEMS20 UK Conference
- Diversifying the HPC community: boosting the uptake of advanced HPC training by women and underrepresented groups
- A one-day POP online training for SURF
- First Workshop on Performance Engineering, Modelling, Analysis and Visualization Strategy (PERMAVOST 2021): Bridging the Stakeholders of Performance Research
- POP Experts Contributed to ISC HPC 2021 Tutorial Program
- PASC'21 minisymposium organised by POP
- Monthly Performance Analysis Workshop Series Successfully Concluded
- POP @ Supercomputing Frontiers Europe 2021
- POP @ NAFEMS World Congress 2021
- POP Experts Contributed to SC 2021 Tutorial Program

Webinars (8)

- [16] [GUEST] Inclusive Leadership and Inspiring Action and Innovation
- [17] [GUEST] Profiling GPU Applications with Nsight Systems
- [18] PyPOP - An Interactive Tool for Performance Assessment
- [19] Identifying Performance Bottlenecks in Hybrid MPI + OpenMP Software
- [20] Debugging Tools for Correctness Analysis of MPI and OpenMP Applications
- [21] The Scalasca Scalable Parallel Performance Analysis Toolset - For POP Assessments and Beyond
- [22] Introduction to Paraver
- [23] [USER] POP: The SME Perspective

Tool Time (7)

- Caliper - A Performance Analysis Toolbox in a Library
- Performance Analysis Study with Vampir
- Analyzing Performance Profiles using Hatchet
- memP - Parallel Heap Profiling
- Observing Application Performance Using the TAU Performance System®
- Using the Python Extrae API to Profile Python OpenMP Codes
- Using PAPI Counters to compute IPC (Instructions Per Cycle) for an MPI Fortran application

Project News (4)

- POP: Half-Time Analysis
- 5th POP2 Project Meeting
- Resources for co-design
- 6th POP2 Project Meeting

Success stories (13)

- 588x and 488x Execution Time Speedups of a Volcanic Hazard Assessment Code
- Performance Improvements by More Than 30% and a Data Race Fixed for CalculiX Code
- POP's OpenMP Metrics: a Case Study
- POP for Astronomy - 40% Reduction in Execution Time for the PIERNIK Code
- Run time halved for OpenMP code
- POP Collaboration with PerMedCoE achieves a 1.45x Speedup in PhysiCell, one of PerMedCoE Core Applications
- Proof-of-concept achieves a 2x Speed-up on Biggest Runs for Parallel Mesh Adaptation Code
- Runtime almost halved for Population Genomics Code
- 30x Speedup of the Matrix Factorization when Applying a Math Library
- A POP proof-of-concept achieves 2x speedup of an EXCELLERAT use case
- POP Transformed our Understanding of the Behaviour of immerFLOW
- Near to 5x speedup of the RoSSBi astrophysics code
- Proof-of-concept Leads to almost 2x Speedup of Atmospheric Physics Code

Services (3)

- Energy Efficiency Analysis of the Multilevel BDDC Solver Library (BDDCML)
- Asynchronous I/O Scheme for openFOAM/ashee
- POP Performance Analysis of TensorFlow: High-Performance Deep Learning

This means that in the second 18 months of the project 49 [BM18: 58] blog articles were published, or 2.97 articles per month on average for POP2 (compared to 2.5 articles per month in POP1).

2.1.3 Other changes and enhancements

Beyond regularly updating the POP website with new material (new blog articles, news and event items, newsletters, success stories), and the integration of the resources for co-design website (see Section 2.1.1), there have been only a few other minor changes to the POP website.

- The page "Learning Material" was re-worked and greatly enhanced. The section on POP Metrics was extended to cover the new POP2 hybrid metrics (developed by Work Package 8). Due to increased interest and higher importance, the metrics section was placed on top of the page, while the section on Documentation about Parallel Programming and Tools moved to the end of the page.
- The list of webinars, which was originally also located under the "Learning Material", was moved to its own separate page and a

corresponding menu item was created, as the list got too long and the interest in our webinars increased considerably in the past 18 months.
- The section “Online Training” was also reworked and enhanced. For more details, see Section 4.5.
- The POP home page (see Figure 3) now uses an animation developed by Work Package 2 (see Deliverable D2.4 section 2.5).

2.2 Social media

Traditional social media channels like LinkedIn or Twitter, and the “News” section on the POP website are mainly used to notify readers and followers about new content published at the POP website or blog. This strategy allows the social media messages and news items to be short, with all details available and easily accessible at the blog site.

Figure 4: POP Twitter Channel

2.2.1 Twitter

Twitter is the established short message service and experience shows that HPC online news sites (like HPCwire and InsideHPC) typically follow HPC project tweets. When using Twitter, we have found that including images into tweets helps increase their reach, as it is more interesting and eye catching as

well as posting mid-week and early in the morning to get the most views. As well as publishing new material related to the POP project, we use it to signal boost other projects, and articles that may be of interest to our markets. Reaching out to people and other projects on Twitter has helped us be more accessible and engaged with our community. Twitter is also a useful way to highlight the impact of the project and reach a wide audience of influencers; however, we have been careful to balance self-promotion with other forms of content to ensure our followers remain.

The POP twitter channel **@POP_HPC** (https://twitter.com/POP_HPC), see Figure 4, currently has 1,111 followers, compared to 420 at the time of the POP1 final review in May 2018. The tweets earned about 12,000 impressions in total on average per month, compared to 8,500 during POP1. Twitter impressions are the number of times a tweet shows up in somebody's timeline. Top tweets get up to 2,000 to 3,500 impressions showing that our tweets reach beyond our own followers.

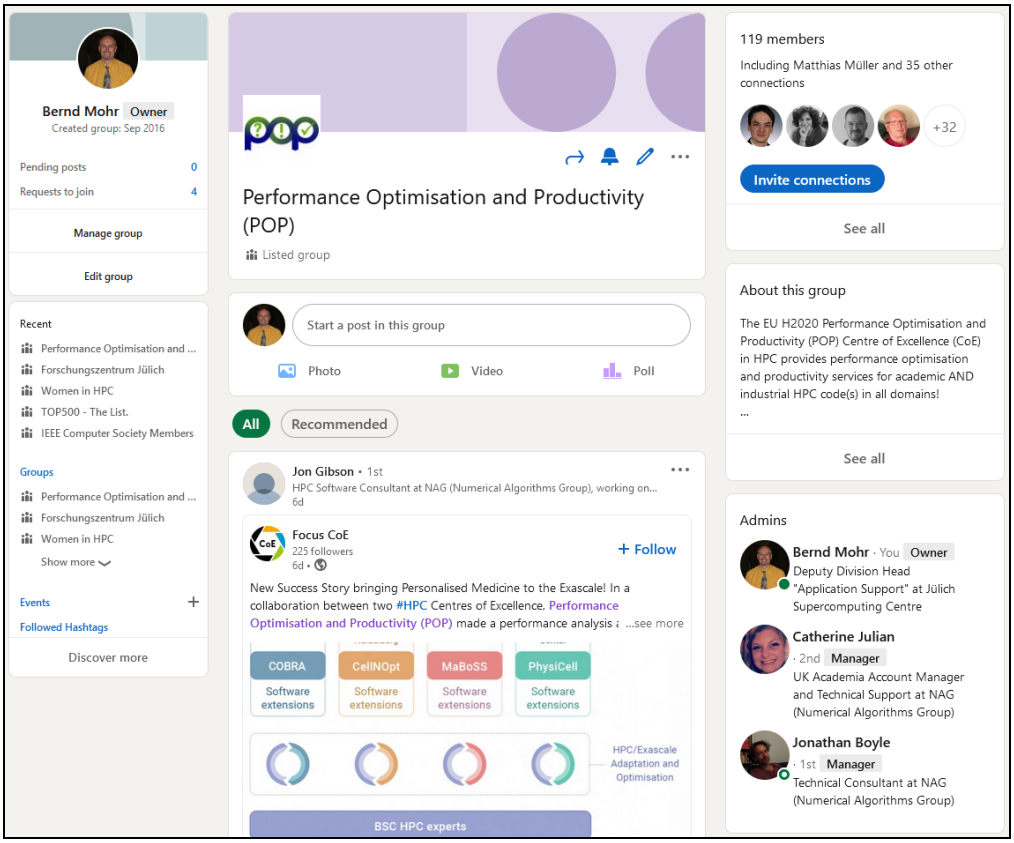

Figure 5: POP LinkedIn Group

2.2.2 Linkedin group

As a second social media channel, we use LinkedIn as it is clearly a professional social media channel compared to Facebook, which typically has a more private and personal news content. Like on twitter, we announce and post links to our webinars, newsletters and training events.

The POP LinkedIn group (https://www.linkedin.com/groups/12004488/) currently has 124 members, compared to 79 at the time of the POP1 final review. It serves as a discussion board for people interested in POP.

2.2.3 LinkedIn page

As the content of LinkedIn groups are only accessible to group members, in summer 2020, we also created a POP LinkedIn page to be able to disseminate it to a wider community on LinkedIn. It is accessible via the URL https://www.linkedin.com/company/performance-optimisation-and-productivity-pop/.

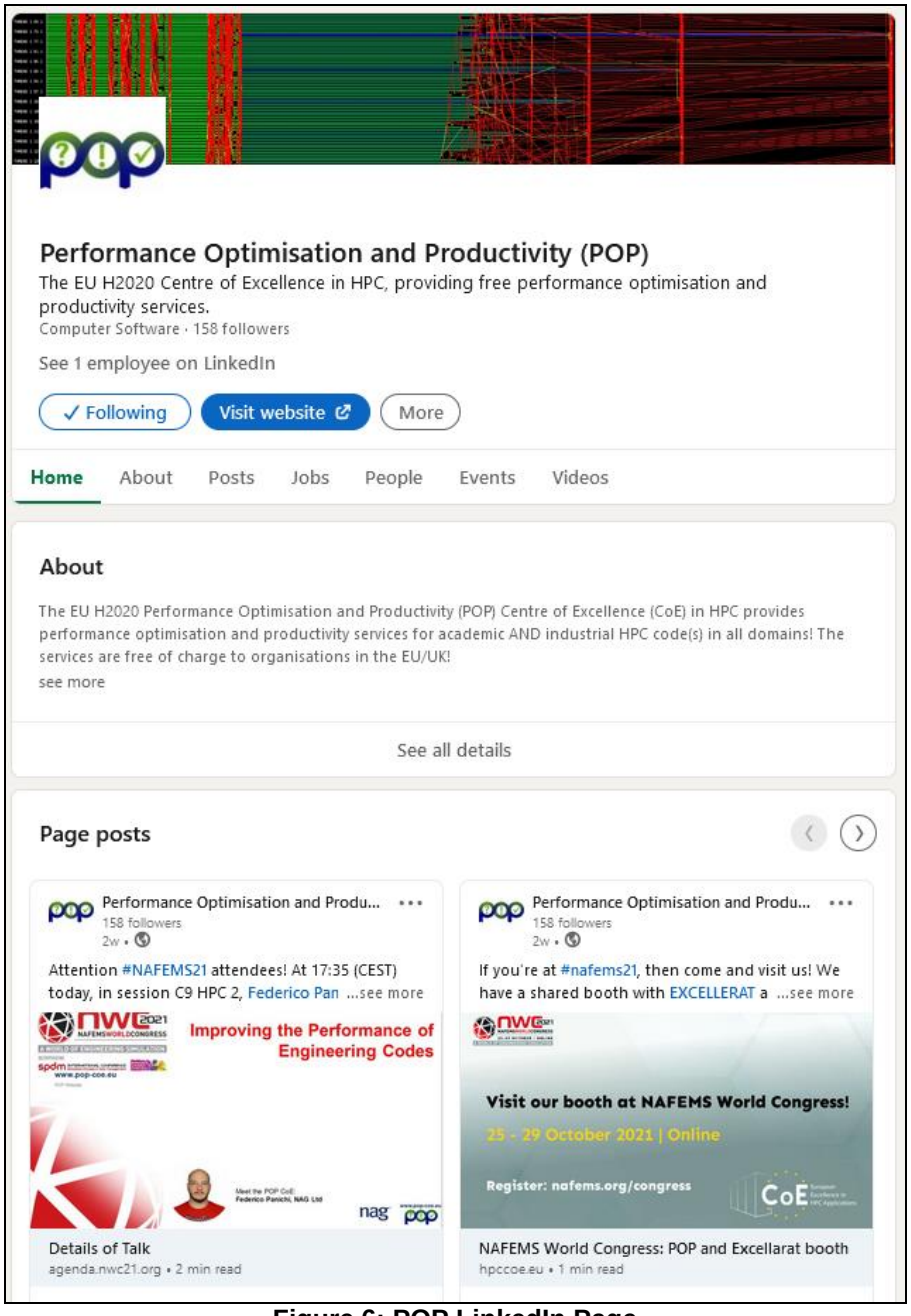

Figure 6: POP LinkedIn Page

Within the past 18 months, the page got already 161 followers. Reader reactions (like Likes, Sharing, and Comments) are on the level of our Twitter tweets, which shows that the community accepted the LinkedIn page much better than our LinkedIn group.

2.2.4 YouTube

All video content produced by POP is made accessible through the POP HPC YouTube channel (https://www.youtube.com/POPHPC). It contains recordings of the POP webinars, the POPCasts, and the POP Online training modules, as well as introduction and overview videos about the POP CoE. The creation of this online content is managed by Work Package 2.

Currently the channel provides 23 webinars (6 from POP1), 4 POPCasts, and 11 Basic and 4 Advanced Online training modules. The webinars currently have 17,392 offline views, compared to 3399 after the first 18 months of POP2 and 445 at the time of the POP1 final review. This translates to about 960 views a month or 30 every single day for the reporting period (past 18 months). The POPCasts got 567 views within 19 months. The Online training modules videos got a total of 2,039 views (1,668 Basic + 371 Advanced) for the past 18 months or about 110 views a month on average.

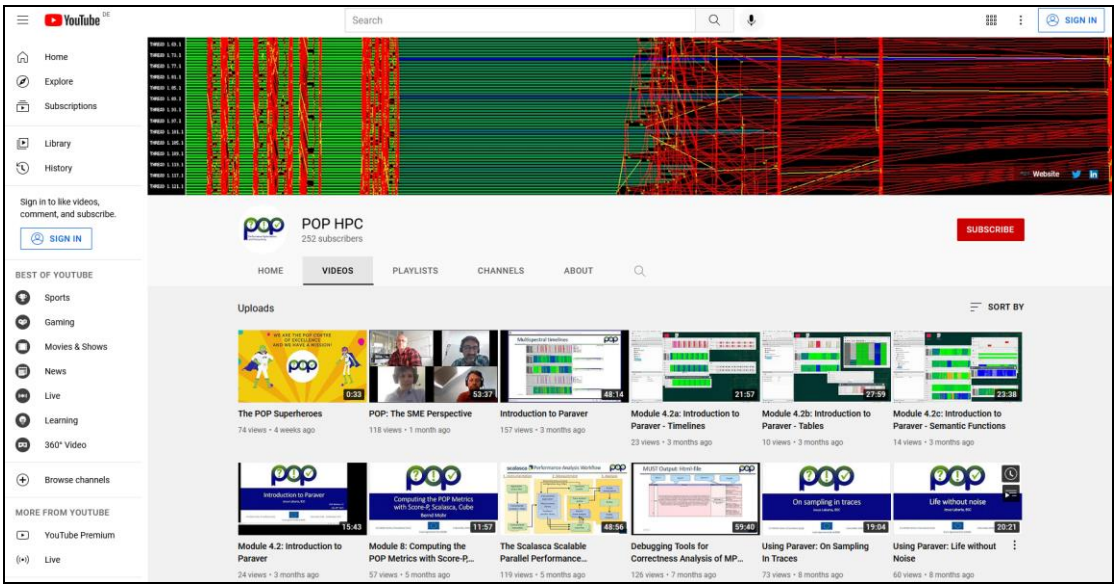

Figure 7: POP YouTube Channel

2.3 Other media

Beyond the POP main project website and the POP social media channels, we use email newsletters, scientific papers, and attending and presenting at events as additional dissemination channels. In addition, we try to position articles and other contributions on other HPC focused websites and in HPC media and related project newsletters.

2.3.1 Newsletter

We also continued the quarterly POP Newsletter started in POP1, which features summaries of the main project activities and results from the past three months as well as announcements of upcoming events and project activities. The newsletter is distributed by HTML email but it is also archived on the project website (https://pop-coe.eu/news/newsletter) in HTML and PDF format.

In the second phase of the POP project, we published 12 newsletters (December 2018 to September 2021). The newsletter subscriber list currently has 1,516 members, compared to 515 at the time of the POP1 final review.

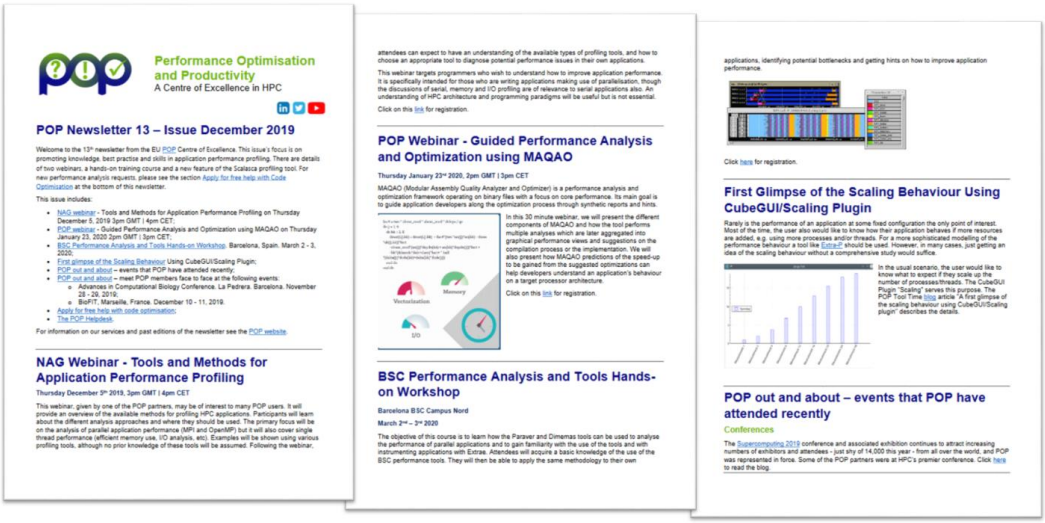

Figure 8: POP Newsletter

2.3.2 Scientific papers

Although POP is a service-oriented EU Centre of Excellence and not a research and innovation action, we still try to publish important results, procedures, methodologies, or insights in peer-reviewed scientific/technical papers. In the reporting period, we were able to get 18 papers published[2]:

1. B. Wang, C. Terboven, M. Müller, *Dynamic Runtime and Energy Optimization for Power-Capped HPC Applications*, In: Advances in Parallel Computing, Volume 36: Parallel Computing: Technology Trends, IOS Press, pp. 441 – 452, doi:10.3233/APC200070.

2. B. Wang, J. Klinkenberg, D. Ellsworth, C. Terboven and M. Müller, *Performance Prediction for Power-Capped Applications based on Machine Learning Algorithms*, 2019 International Conference on High Performance Computing & Simulation (HPCS), 2019, pp. 842-849, doi:10.1109/HPCS48598.2019.9188144.

[2] This information has also been uploaded into the "Publication" tab of the reporting module of the EU project portal.

3. F. Mantovani, M. Garcia-Gasulla, J. Gracia, E. Stafford, F. Banchelli, M. Josep-Fabrego, J. Criado-Ledesma, M. Nachtmann, *Performance and energy consumption of HPC workloads on a cluster based on Arm ThunderX2 CPU*, FGCS, Vol. 112, 2020, pp. 800-818, doi:10.1016/j.future.2020.06.033.

4. M. Knobloch, P. Saviankou, M. Schlütter, A. Visser, B. Mohr B., *A Picture Is Worth a Thousand Numbers—Enhancing Cube's Analysis Capabilities with Plugins*. In: Tools for High Performance Computing 2018 / 2019. Springer, doi:0.1007/978-3-030-66057-4_13.

5. F. Orland, C. Terboven. *A Case Study on Addressing Complex Load Imbalance in OpenMP*. In: OpenMP: Portable Multi-Level Parallelism on Modern Systems, Proceedings of IWOMP 2020. LNCS 12295, Springer, doi:10.1007/978-3-030-58144-2_9.

6. F. Banchelli, M. Garcia-Gasulla, G. Houzeaux, F. Mantovani, *Benchmarking of state-of-the-art HPC Clusters with a Production CFD Code*, In: PASC '20: Proceedings of the Platform for Advanced Scientific Computing Conference, June 2020 pp. 1-11, doi:10.1145/3394277.3401847.

7. H. Zhou, J. Gracia, N. Zhou, R. Schneider, *Collectives in hybrid MPI+MPI code: Design, practice and performance*, In: Parallel Computing, Vol. 99, 2020, doi:10.1016/j.parco.2020.102669.

8. J. W. S. McCullough, R. A. Richardson, A. Patronis, R. Halver, R. Marshall, M. Ruefenacht, B. Wylie, T. Odaker, M. Wiedemann B. Lloyd, E. Neufeld, G. Sutmann, A. Skjellum, D. Kranzlmüller, P.V. Coveney, *Towards blood flow in the virtual human: efficient self-coupling of HemeLB*, In: Interface Focus, Vol. 11, Issue 1, 2021, doi:10.1098/rsfs.2019.0119.

9. J. Protze, M.-A. Hermanns, A. Demiralp, M. Müller, T. Kuhlen, *MPI Detach - Asynchronous Local Completion*, In: EuroMPI/USA '20: 27th European MPI Users' Group Meeting, 2020 pp. 71-80, doi:10.1145/3416315.3416323.

10. L. Yu, J. Protze, O. Hernandez, V. Sarkar, *A Study of Memory Anomalies in OpenMP Applications*, In: OpenMP: Portable Multi-Level Parallelism on Modern Systems, Proceedings of IWOMP 2020, LNCS 12295, Springer, doi:10.1007/978-3-030-58144-2_21.

11. B. J. N. Wylie, *Exascale potholes for HPC: Execution performance and variability analysis of the flagship application code HemeLB*, IEEE/ACM Intl. Workshop on HPC User Support Tools (HUST) and Workshop on Programming and Performance Visualization Tools (ProTools), 2020, pp. 59-70, doi:10.1109/HUSTProtools51951.2020.00014.

12. A. Hück, J. Protze, J. -P. Lehr, C. Terboven, C. Bischof and M. S. Müller, *Towards compiler-aided correctness checking of adjoint MPI applications*, In: IEEE/ACM 4th Intl. Workshop on Software Correctness for HPC Applications (Correctness), 2020, pp. 40-48, doi:10.1109/Correctness51934.2020.00010.

13. M. Garcia-Gasulla, F. Banchelli, K. Peiro, G. Ramirez-Gargallo, G. Houzeaux, I. Ben Hassan Saïdi, C. Tenaud, I. Spisso, F. Mantovani, *A Generic Performance Analysis Technique Applied to Different CFD Methods for HPC*, In: Intl. Journal of Computational Fluid Dynamics, 34:7-8, pp. 508-528, 2020, doi:10.1080/10618562.2020.1778168.

14. J. Giménez, E. Mercadal, G. Llort and S. Mendez, *Analyzing the Efficiency of Hybrid Codes*, IN: 19th Intl. Symposium on Parallel and Distributed Computing (ISPDC), 2020, pp. 29-36, doi:10.1109/ISPDC51135.2020.00014.

15. R. Speck, M. Knobloch, S. Lührs, A. Gocht A., *Using Performance Analysis Tools for a Parallel-in-Time Integrator*. In: Parallel-in-Time Integration Methods. PinT 2020, Springer Proceedings in Mathematics & Statistics, Vol. 356. Springer, doi:10.1007/978-3-030-75933-9_3.

16. V. Lopez, G. Ramirez Miranda, M. Garcia-Gasulla. *TALP: A Lightweight Tool to Unveil Parallel Efficiency of Large-scale Executions*, In: Proceedings of the 2021 Workshop on Performance EngineeRing, Modelling, Analysis, and VisualizatiOn STrategy (PERMAVOST '21). ACM, pp. 3–10. doi:10.1145/3452412.3462753

17. H. Schulz, G.B. Gadeschi, O. Rudyy, T. Weinzierl T., *Task Inefficiency Patterns for a Wave Equation Solver*. In: OpenMP: Enabling Massive Node-Level Parallelism, IWOMP 2021. LNCS 12870, Springer, doi:10.1007/978-3-030-85262-7_8.

18. F. Banchelli et al., *Cluster of emerging technology: evaluation of a production HPC system based on A64FX*, 2021 IEEE International Conference on Cluster Computing (CLUSTER), 2021, pp. 741–750, doi:10.1109/Cluster48925.2021.00110.

2.3.3 Other websites and newsletters

Besides publishing on the POP website, blog and social media channels, we also try to place important POP news and results in media channels operated by our customers, collaborators, and general HPC online news sites.

- POP and ChEESE work together to improve Probabilistic Volcanic Hazard Assessment pilot demonstrator, ChEESE CoE News, 9. Nov 2020
- Newsletter article "POP – Better Parallel Code, POP and CAE: the impact of HPC", EnginSoft Magazine, Year 18 no. 1, page 52, Spring 2021.

- Blog article "POP and PerMed Centers of Excellence are Getting Cell-Level Simulations Ready for Exascale", https://www.hpccoe.eu/, 28. Oct 2021
- Blog article "Profiling of the XXT Coarse grid solver", ENCCS, 29. Oct 2021

2.3.4 Events

Another important dissemination channel is attendance and presentations at high-level peer-reviewed conferences in the fields of HPC, supercomputing, computational science, parallel computing, etc. and European events like HiPEAC or PRACE events or the European HPC Summit Week. Presenting the latest updates and success stories of the project at such events, tutorials, meetings, or workshops is an effective means of involving industry leaders in standards discussions early on. Unfortunately, all events in the reporting period were virtual due to the ongoing Covid-19 pandemic, which allowed us to participate in more events, however the resulting interaction with the audience was limited.

These activities largely overlap with Work Package 2, as of course these events also serve as business development. For a full description, we refer to the WP2 deliverable D2.4 ("Final Business Development and Sustainability Review"), Section 8.1. A short list of the events POP participated in can be found in section 2.2.1 of this document under the category "Events".
At large events that offer an exhibition in addition to a technical program, such as SC in the USA and ISC-HPC in Germany, BSC, HLRS, IT4I, JUELICH, and NAG typically have exhibition booths showcasing their latest technology, including live-demos of visualizations of tools to attract visitors. However, ISC 2019, SC 2020, and ISC 2021 were virtual. Some partners organized virtual booths for some of these events with very limited success. SC 2021 was hybrid, but only NAG had an on-site booth.

2.3.4.1 PASC'21 mini-symposium organised by POP

The 2021 edition of the Platform for Advanced Scientific Computing (PASC) conference was held 5 to 9 July as a virtual digital event. It featured 45 distinct mini-symposia, several comprising multiple parts, including some carried over from the cancelled 2020 incarnation. POP organized a two-part mini-symposium "Performance Optimisation and Productivity for EU HPC Centres of Excellence (and other European parallel application developers preparing for exascale)" where sectorial HPC Centres of Excellence were invited to report on their experience collaborating with POP and using POP services as part of preparing their flagship application codes for forthcoming exascale computer systems.

The first part on Wednesday 7 July opened with an introduction to POP and a review of best practice for efficient and scalable application performance by Marta Garcia-Gasulla (BSC), which was also the topic of a virtual poster. The outcome of performance evaluation workshops jointly organized with the

Energy-oriented CoE (EoCoE) was then reported by Mathieu Haefele (Universite de Pau). This was followed by an in-depth look at the performance of the SeisSol code for earthquake simulations that was part of a campaign of assessments for the ChEESE CoE focused on Solid Earth, given by Ravil Dorozhinskii (TU Munich). Closing the first session, Peter Coveney (UCL) reviewed work that was done with two of the CompBioMed CoE for computational biomedicine, where the HemeLB and SCEMa simulation codes are being prepared for exascale with the assistance of E-CAM and POP.

On Thursday 8 July the mini-symposium continued with a second session. Ricard Borrell (BSC) summarized the collaboration with POP on the versatile Alya computational mechanics code used by six HPC Centres of Excellence. Sebastien Masson (Sorbonne Universite LOCEAN-IPSL) reviewed POP collaboration to improve execution efficiency of the NEMO ocean modelling framework that features in the ESiWACE weather and climate CoE. And in the final talk, Andrea Ferretti (CNR Nano) presented the work of the MaX CoE on materials design where electronic structure community codes have been ported to GPUs after POP performance audits.

A concluding panel discussion with the presenters from both parts discussed their HPC CoE and flagship application preparations for a range of potential exascale computer systems and remaining challenges.

2.3.4.2 1st Workshop on Performance Engineering, Modelling, Analysis, and Visualization Strategy (PERMAVOST) 2021

On June 25th 2021, POP partners (RWTH Aachen University, Barcelona Supercomputing Center), together with the University of Arizona and the Federal University of Rio Grande do Sul, organized a virtual workshop PERMAVOST.

This workshop was created to foster collaborations with stakeholders in performance research, analysis and engineering ecosystems. Modern software engineering is getting increasingly complicated, especially in the HPC field, where the complication not only comes from working with cutting-edge technology and novel problems, but also from the scale of the problem and from the team itself. We are increasingly working with stakeholders of various backgrounds and varying degrees of expertise in HPC performance analysis. Bridging these diverse stakeholders and creating a robust feedback loop can be a way to prepare for future challenges in performance modelling, analysis, engineering and visualization.

The workshop gathered more than twenty attendees, from as far away as the US west coast and Japan. The workshop's call for papers attracted submissions from Barcelona Supercomputing Center, Chiba Institute of Technology and the Technical University of Munich. Besides the paper presentations, there was a keynote speech from Dr. Andreas Herten from Juelich Supercomputing Center (JSC). Dr. Herten shared his experience managing JUWELS Boosters Early Access Program. JUWELS Booster is a

recently installed Tier-0/1 system at JSC and is currently the seventh fastest supercomputer in the world and the fastest in Europe. In this talk, participants gained insights into the state of the art in the performance analysis and modelling of GPUs from JUWELS Booster Early Access Program.

The last event of the workshop was a discussion panel, with panelists from industry (Dr. Max Katz from NVIDIA), academia (Dr. Lucas M. Schnorr from the Federal University of Rio Grande do Sul), and research institutions (Dr. Guido Juckeland from Helmholtz-Zentrum Dresden-Rossendorf and Dr. Olga Pearce from Lawrence Livermore National Laboratory). The discussion covered topics related to the future of performance analysis techniques and tools, with specific regard to how GPUs and Cloud Computing applications are changing a lot of approaches in performance analysis and engineering.
The workshop proceedings are available in the ACM digital library: https://dl.acm.org/doi/proceedings/10.1145/3452412.

2.3.4.3 Other Conferences or Workshops

In addition, we contributed to various scientific conferences and workshop by presenting regular and invited talks or posters:

- Talk "The Performance Optimisation and Productivity Centre of Excellence: From Improving Parallel Codes to HPC training and education", 2nd Workshop on HPC Education and Training for Emerging Technologies (HETET20)@ISC20, 25. Jun 2020
- Talk How to understand and improve the performance of your parallel applications using the POP Methodology, N8 Centre of Excellence in Computationally Intensive Research Training Event, 26. Jun 2020
- Talk "Promoting HPC Best Practices With the POP Methodology", Third Workshop on Strategies for Enhancing HPC Education and Training (SEHET20)@PEARC20, 27. Jul 2020
- Talk "Future HPC systems made in Europe", ESiWACE2 Virtual Workshop on Emerging Technologies for Weather and Climate Modelling, 30. Jun 2020
- Talk **"**Exascale potholes for HPC applications", 11th JLESC Workshop, 9. Sep 2020
- POP presentation, NAFEMS 2020 France, 24. Nov 2020
- Talk "Exascale Potholes for HPC: Execution Performance and Variability Analysis of the Flagship Application Code HemeLB", ProTools Workshop at SC 2020, 12 Nov 2020
- Customer Presentation "Performance Analysis and Benchmarking for a space-time parallel Python code", 12th JLESC Workshop, 24. Feb 2021
- Presentation POP CoE, BMBF CoE Future Meeting, 5. Jul 2021
- Presentation "How to make HPC applications scalable", EU-ASEAN High-Performance Computing (HPC) Virtual School, 6. Jul 2021
- Presentation "Performance analysis and hybrid programming in HPC", ACM Europe Summer School on HPC Computer Architectures for AI and Dedicated Applications, 1. Sep 2021

2.3.4.4 Invited Webinar presentation

Finally, we got invited to present our POP activities in webinars (or similar online talks) organized by other institutions:

- Talk "POP: towards insight on program behavior", CECAM webinar, 25. Jun 2020
- Talk "How to understand and improve the performance of your parallel applications using the POP Methodology, International Series of Online Research Software Events, 16. Oct 2020
- Presentation "How to Understand and Improve the Performance of Your Parallel Applications Using the POP Methodology", FocusCoE: Webinar with Industries "Opportunities and Challenges for Industrial Applications", 4. Feb 2021
- e Seminar 15: Performance Optimisation and Productivity POP services for HPC application developers, CompBioMed e-seminar #15, 13. Apr 2021
- POP: Un centre HPC pour la performance et l'optimisation des applications parallèles, Teratec Webinar, 11. May 2021
- Presentation "POP CoE: Free Performance Assessments for the HPC Community", PRACE Virtual Booth @ Teratec Forum 2021, 22. Jun 2021
- Presentation "POP CoE: Free Performance Assessments for the HPC Community", PRACE Virtual Booth @ Teratec Forum 2021, 1. Jul 2021
- Presentation POP CoE and its achievements, TerTec Webinar, 9. Jul 2021

3. Cooperation

Besides POP dissemination and training activities, Work Package 4 is also responsible to **coordinate dissemination and training activities** with PRACE and the FocusCoE CSA. A summary of the work in this area is reported below. In addition, there is also a cooperation between POP and FocusCoE regarding sustainability of CoEs and business development (which is reported in the deliverable of Work Package 2 Deliverable D2.4 Section 3.1); and cooperation between POP and other CoEs as well as EU FET projects to organize formal periodic campaigns (which is reported in the deliverable D5.2 of Work Package 5).

Due to the ongoing Covid-19 pandemic, no face-to-face meetings have been organized by the FocusCoE CSA. In the past 18 months, we participated in all monthly video conferences as well as the bi-monthly video conferences of the Dissemination Work Package of FocusCoE. We contributed content for the https://hpccoe.eu website and FocusCoE brochures.

Finally, on 23. Nov 2021, we participated and introduced the POP CoE in a virtual meeting with the EuroHPC National Competence Centers (NCC) on the topic “Code optimization” organized by FocusCoE.

4. Training

In this area we improved, and enhanced the online training material and documentation on standard parallel programming models and performance analysis tools and processes, which were created during POP1. We also performed tutorial and workshop events for POP customers in various forms. In order to gain international visibility to the POP training activities, we contributed to selected tutorials, workshops at key conferences with high visibility (i.e. ACM/IEEE SC, ISC High-Performance), VI-HPS events, and Bring-your-own-code activities with staffing and material.

4.1 Types of POP Training Activities

The project partners have a long record of organising and contributing to training events where they teach the effective use of their tools for performance assessments. The spectrum of activities ranges from half- or one-day conference tutorials to tuning workshops lasting up to a week. POP partners BSC, HLRS, IT4I, JUELICH and UVSQ are part of their national PRACE (Advanced) Training Centres. In addition, the project partners BSC, HLRS, JUELICH, RWTH, and UVSQ bundle their training activities in the framework of the Virtual Institute – High Productivity Supercomputing (VIHPS, https://www.vi-hps.org), which offers effective advertisement channels, including a website, a mailing list, a “VI-HPS Tools Guide”, and flyers. VI-HPS is an initiative of currently fourteen HPC tool builders in Europe and the USA, including universities, national labs, and companies. Next to the development of state-of-the-art productivity tools for high performance computing, VI-HPS also provides training in the efficient use of these tools.

Workshops and tutorials were orchestrated in close collaboration with the host organisation to fit the individual need of the audience. Training events can be a tuning workshop, a special bespoke workshop, or a tutorial conducted in collaboration with an HPC-related conference. VI-HPS Tuning Workshops are the major training vehicle where approximately 15 to 30 participants receive instruction and guidance applying VI-HPS tools to their own parallel application codes, along with advice for potential optimisations. Feedback to tools developers also helps direct tools development to user needs, as well as improve tool documentation and ease of use. So far, VI-HPS has organised over 40 Tuning Workshops since 2008 all over the world and will continue to organise these workshops of three to five days at HPC centres two to three times per year. These were complemented with additional courses and tutorials at conferences (e.g., SC and ISC HPC), seasonal schools, and other invited training events (e.g., PATC courses). Coordinated tools training material is available with emphasis on hands-on exercises using VI-HPS tools individually and inter-operably.

As can be seen from the tables below, the current Covid-19 crisis quickly affected the POP training schedule. In the past 18 months, we investigated

and experimented with how our training activities could be continued **online** based on video conference technology. This can be done for some part of the training with reasonable effort, especially the part where we introduce the topic, methods, and tools, and demonstrate their use. However, we still struggle with how to implement the most valuable part of our training strategy, where users try to apply the methods and tools they just learned to their own application codes under the supervision of our experts. In a physical event, one POP expert can support three to five code teams by going from table to table, however this cannot be done easily in the virtual world. The obvious solution to team up a POP expert and a code developer team in a separate virtual room does not scale. As can be seen from the tables below, we organized and conducted several virtual Tuning Workshops in the reporting period, however they all required a larger numbers of trainers/helpers, though not all simultaneously, and that as a result there has been more of a trend towards comparable numbers of trainers/helpers and trainees getting hands-on support. One advantage of these events was that we were able to create video recordings of some , which are now available on our website for the HPC community (see also Section 4.6).

4.1.1 Special Training Event: Monthly Performance Analysis Workshop Series

From January through July 2021, members of POP contributed to a series of seven workshops on application performance analysis and optimisation organized for the UK's ExCALIBUR programme by Durham University, the DiRAC consortium and N8 CIR. The series addressed inter-node, intra-node and core-level runtime efficiency as well as correctness of MPI and OpenMP/multithreaded application codes, featuring invited presentations of a variety of tools from JSC, RWTH Aachen and UVSQ plus others.

In contrast to established training workshops for individual participants held over several days all in the same week, a series of full-day virtual workshop sessions took place once per month for teams of application developers and analysts. In the mornings one or two new tools were introduced with plenary presentations and demonstrated in hands-on exercises with small example codes, with the afternoon using breakout rooms for the teams to be assisted applying the tools to their own applications. Along with access to Slack for collaboration, Durham provided participants priority access to their DINE cluster with 16 dual 16-core AMD EPYC 7302 compute nodes for the duration of the workshop series, where the presented tools were installed ready to use.

Almost 80 registered participants formed 13 teams around different scientific research codes, with typically 20 or so actively engaged in each session. Teams who were working with applications that they hadn't themselves developed most valued tools providing a high-level overview of execution performance and visualization.

Those who had developed their own application code had a preference for tools that provided more detailed insight into CPU, OpenMP and MPI

performance. Some tools were praised for better support for performance analysis of Python (which was used extensively in a few cases), or struggled with highly C++ templated code and parallel programming models based on OpenMP tasks and MPI used concurrently by multiple threads. While the comprehensive performance information obtainable from the tools was generally welcomed, managing its volume via event selection/filtering and annotating/recording important phases were often a challenge with the different tools.

At the start of each session teams were encouraged to informally share their significant insights and performance improvements. In one case, Scalasca/Vampir analyses identified copious small MPI messages degrading performance that could be improved by their consolidation into fewer, larger messages and MPI_Waitall replacing individual waits. Another case used MAQAO to identify a few loops in an expensive data initialization phase that could be reordered and simplified to deliver an 11-fold speed-up. Correctness checks provided by MUST and Archer fortunately only uncovered minor issues with the participants' application codes.

Participant feedback collected throughout and at the end of the workshop series showed that it was greatly appreciated, and that the format worked well. The extended workshop sessions and periods to follow-up between sessions facilitated deeper interactions and more advanced analyses than typically possible in compact training events, while reducing overload on participants. Having teams with application code of common interest encouraged everyone to work together and share the benefits during the workshop, and set them up to continue using their preferred tools in their ongoing development activities.

Almost all participants would like to see the workshop series repeated and there were also lots of suggestions for improving our tools and for additional topics for workshops which will be investigated.

An experience report produced by the organizers covering the key outcomes, findings and impressions of the workshop series is available from https://zenodo.org/record/5155503. Recordings of the workshop presentations and associated slides are available on the workshop page at https://tinyurl.com/performanceanalysis2021.

4.1.2 Special Training Event: Diversifying the HPC community: boosting the uptake of advanced HPC training by women and underrepresented groups

HPC training is a crucial step in encouraging and building a diverse and inclusive workforce for our community. It is essential to ensure that all underrepresented groups advance equitably in their careers. While striving to achieve this goal will be a multifaceted campaign in any workplace, facilitating development of the HPC skills among underrepresented groups can be a

community effort. In response to this, over the last couple of years, we have seen an increasing number of activities including workshops, tutorials and fellowship programs that aim to close the gap in the HPC community, e.g., Women in HPC workshops at SC and ISC conferences since 2014.

On 19 to 21 April 2021, the POP project members Fouzhan Hosseini (NAG Ltd), Marta Garcia-Gasulla (Barcelona Supercomputing Center) and Radita Liem (RWTH Aachen University), came together to run a performance optimization workshop aimed at women and underrepresented groups. This workshop was organized and taught by an all-female team. The event was supported by POP CoE in collaboration with the NAG Women in HPC (WHPC) chapter and VI-HPS.

The workshop was held online using the Zoom and Slack platforms. There were lectures and demo sessions in the morning and hands-on sessions in the afternoon, in which attendees could either work on their own application or on the examples and benchmarks provided, with the assistance of experts.

This workshop had thirty-five participants in total. However, the number changed during the event, as the agenda and the online format provided attendees with the flexibility to skip some sessions if needed. The workshop was primarily aimed at women and underrepresented groups in the HPC community, and this was reflected in the demographic of our attendees.

The attendees were at different stages of their education or career, with the majority being post-doctoral researchers (30.8%) or PhD students (23.1%), followed by MSc Students (15.4%) and HPC support staff (15.4%). The majority of attendees were based in European countries.

Training team

- Marta Garcia-Gasulla (Barcelona Supercomputing Center)
- Judit Gimenez (Barcelona Supercomputing Center)
- Sandra Mendez (Barcelona Supercomputing Center)
- Fouzhan Hosseini (Numerical Algorithms Group)
- Christina Mühlbach (TU Dresden)
- Anara Kozhokanova (RWTH Aachen University)
- Anke Visser (Jülich Supercomputing Center)
- Radita Liem (RWTH Aachen University)

This workshop was a great success! We asked attendees to share what was the most important takeaway; 91% of responses (12 in total) where in line with the learning objectives of the workshop, including learning the fundamentals of HPC performance analysis and being able to use the POP methodology and tools to better understand the behavior of their code.

4.2 POP Training Events

POP training events are organized, sponsored, and hosted by POP partners. The only such event in the reporting period was a training at surf which is part of a business-building activity of Work Package 2 to build a long-term relationship with SURF (see deliverable D2.4 section 3.2.1).

Date	Location	Event
2021-05-17	Online	SURF POP Training

Table 2: POP Training Events

4.3 Training events in cooperation with POP

POP training events in cooperation with POP are co-organized and co-sponsored in cooperation between POP partners with other EU projects or organizations, mostly the PRACE (Advanced) Training Centres, the VI-HPS, and other CoEs. This is our preferred type of training activities because it shows the effective cooperation of organizations in the EU HPC ecosystem, and it re-uses rather than re-invents existing infrastructures.

Date	Location	Event	Co-Sponsor
2020-07-28 – 07-30	Online	34th VI-HPS Tuning Workshop Development Workshop	EPCC
2020-09-14 – 09-18	Online	35th VI-HPS Tuning Workshop	HLRS
2020-09-30 – 10-02	Online	36th VI-HPS Tuning Workshop	CINECA
2020-11-09 – 11-10	Online	Tutorial "Advanced OpenMP"	SC20
2020-11-09	Online	Tutorial "Practical Hybrid Parallel Application Performance Engineering"	SC20
2020-12-07 – 21-11	Online	37th VI-HPS Tuning Workshop	HKHLR
2021-03-01 – 03-03	Online	38th VI-HPS Tuning Workshop	FAU RRZE
2021-04-19 – 04-21	Online	39th VI-HPS Tuning Workshop (for women/underrepresented groups)	BSC
2021-06-14 – 06-18	Online	40th VI-HPS Tuning Workshop	LRZ
2021-06-24	Online	Tutorial "Determining Parallel Application Execution Efficiency and Scaling using the POP Methodology"	ISC 2021
2021-06-24	Online	Tutorial "Mastering Tasking with OpenMP"	ISC 2021
2021-06-24	Online	Tutorial "Hands-on Practical Hybrid Parallel Application Performance Engineering"	ISC 2021
2021-06-25	Online	Tutorial Introduction to HPC: Applications, Systems, and Programming Models"	ISC 2021

2021-01-21 – 05-20	Online	ExCALIBUR code performance tuning workshop series • Jan: Introduction / Baseline measurements • Feb: Parallel Profiling • Mar: Trace Collection • Apr: Tracing analysis with Scalasca • May: MPI and multithreaded correctness • Jun: MAQAO	DIRAC
2021-11-14	Online	Tutorial Hands-on Practical Hybrid Parallel Application Performance Engineering	SC21
2021-11-14	Online	Tutorial Mastering Tasking with OpenMP	SC21
2021-11-15	Online	Tutorial Advanced OpenMP: Host Performance and 5.1 Features	SC21

Table 3: Training Events in cooperation with POP

4.4 Training events with POP contributions

Training events with POP contributions are events organized, sponsored, and hosted by other organizations where POP experts were invited to contribute to parts of the program.

Date	Location	Event	Sponsor
2021-01-20 – 01-26	Online	JUWELS Booster Porting Workshop	JSC

Table 4: Training Events with POP contributions

4.5 Internal training for POP analysts

Internal training for POP analysts is training targeting performance analysts working in the POP CoE and close collaborators. It is organized to get new members of the POP staff up-to-speed quickly and for skill enhancement of the existing POP experts.

Date	Location	Event	Sponsor
2020-10-20	Online	Energy-efficiency assessments	JSC

Table 5: Internal training for POP analysts

4.6 Online Training

This new activity, started in summer 2020 in cooperation with Work Package 2, produced various self-study online training modules in the area of performance analysis and tools (see also deliverable D4.2 section 2.6).

Figure 9: Available POP Online Training Modules

The main target audience are beginners and code developers with little experience in methods and tools for performance analysis of HPC applications. Although the Online training modules videos are only online for the past 18 months, they are very popular. They got already a total of 2,039 views (1,668 Basic + 371 Advanced) or about 110 views a month on average.

Each Online Training Module (for an example see Figure 10) describes (1) the topic of the module, (2) the necessary prerequisites, (3) the actual training in form of a YouTube video, as well as (4) additional material, references and documentation.

Figure 10: Example POP Online Training Module

All online training modules are available under https://pop-coe.eu/further-information/online-training.

5. Conclusion

The project continued the successful POP branding and dissemination plan established by POP1. POP news, outcomes, and results were successfully disseminated through the POP blog on the POP website and our social media channels. The quarterly E-mail Newsletter as well as the POP webinar series was continued. New forms of communication, introduced in the first 18 months of POP2 (e.g. POPCast video interviews, POP SME and Tool Time blog articles, and self-study online training modules for beginners) were continued and optimized. The new sub website for resources for co-design, developed by Work Package 7, was successfully integrated into the main POP website. Dissemination concentrated on the project outcomes and results as they became available: we published eighteen scientific papers (compared to four the first 18 months) and thirteen success-story blog articles (compared to one).

Training activities also greatly increased compared to POP1. Due to the Covid-19 crisis, all training events were successfully changed to online trainings based on video conference tools in the last 18 months of the project. New training formats like tuning workshops spread over a half year instead of a week or more inclusive, women-only training events were designed, organized and successfully conducted.

Finally, the project milestone 8 (MS8) at month 36 which promised four trainings and eight webinars organized by the project was exceeded, as we organized 17 webinars and 27 trainings.

Acronyms and Abbreviations

- BSC – Barcelona Supercomputing Center
- CA – Consortium Agreement
- CAdv – Customer Advocate
- CSA – Coordination & Support Action
- D – Deliverable
- DoA – Description of Action (Annex 1 of the Grant Agreement)
- EC – European Commission
- GA – General Assembly / Grant Agreement
- HLRS – High Performance Computing Centre (University of Stuttgart)
- HPC – High Performance Computing
- IPR – Intellectual Property Right
- IT4I - IT4Innovations National Supercomputing Centre, Vysoka Skola Banska - Technicka Univerzita Ostrava
- Juelich – Forschungszentrum Juelich GmbH
- KPI – Key Performance Indicator
- M – Month
- MS – Milestones
- NAG – Numerical Algorithms Group Ltd
- PEB – Project Executive Board
- PM – Person month / Project manager
- POP – Performance Optimization and Productivity
- R – Risk
- RV – Review
- RWTH Aachen – Rheinisch-Westfaelische Technische Hochschule Aachen
- USTUTT (HLRS) – University of Stuttgart
- UVSQ - Université de Versailles Saint-Quentin-en-Yvelines
- VI-HPS – Virtual Institute – High Productivity Supercomputing
- WP – Work Package
- WPL – Work Package Leader

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