



# Parallel Performance Optimization and Productivity

EU H2020 Centre of Excellence (CoE)



Grant Agreement No 824080

1 December 2018 – 30 November 2021



- One of ten [Centres of Excellence in HPC Applications](#)
  - POP is a CoE in **Performance Optimisation and Productivity**
    - Promoting **best practices in parallel programming**
  - Another is **ESiWACE**, the **Centre of Excellence in Simulation of Weather and Climate in Europe**
- POP provides **FREE** services
  - for (EU) academic and industrial codes and users
  - across all application areas, platforms, scales
- giving users
  - a precise understanding of application and system behaviour
  - suggestions/support on how to refactor code in the most productive way.



# The POP Partners



## • Who?

- BSC, ES (coordinator)
- HLRS, DE
- IT4I, CZ
- JSC, DE
- NAG, UK
- RWTH Aachen, IT Center, DE
- TERATEC, FR
- UVSQ, FR



## A team with

- Excellence in performance tools and tuning
- Excellence in programming models and practices
- A research and development background and a proven commitment to real academic and industrial applications





## Why?

- Complexity of machines and codes
  - ⇒ Frequent lack of quantified understanding of actual behaviour
  - ⇒ Not clear most productive direction of code refactoring
- Important to maximize efficiency (performance, power) of compute intensive applications and productivity of the development efforts

## What?

- Parallel programs, mainly MPI/OpenMP
  - Although also CUDA, OpenCL, OpenACC, Python, ...



# The Process ...



## When?

December 2018 – November 2021

## How?

- Apply
  - Fill in small questionnaire describing application and needs  
<https://pop-coe.eu/request-service-form>
  - Questions? Ask [pop@bsc.es](mailto:pop@bsc.es)
- Selection/assignment process
- Install tools @ your production machine (local, PRACE, ...)
- Interactively: Gather data → Analysis → Report

The screenshot shows the 'Request Service Form' on the Performance Optimisation and Productivity (POP) website. The form is titled 'Request Service Form' and is part of a 'Request Service Form' page. It includes a sidebar with navigation links such as 'News', 'Blog', 'Newsletter', 'Partners', 'Tools', 'Services', 'Request Service Form', 'Target Customers', 'Success Stories', 'Customer Code List', 'Further Information', 'Learning Material', and 'Contact'. The main form area is divided into several sections: 'Contact Details' with fields for 'Applicant's Name', 'Institution', and 'e-mail'; 'Code' with a 'Name of the code' field, a dropdown for 'Scientific/technical area and class of problems it solves', and radio buttons for 'Contribution' (Core developer, Module developer, User) and 'Access to sources' (Yes, No); 'Programming languages' with checkboxes for C, C++, Java, Fortran, Python, and Others; 'Parallel programming models' with checkboxes for MPI, OpenMP, OpenMPs, Pthreads, CUDA, OpenCL, and Others; and 'Performance Service' with a dropdown for 'Service request' and a text area for 'Describe your perception of the performance problem'. A 'Log in' link is visible in the top right corner of the page.



# FREE Services provided by the CoE



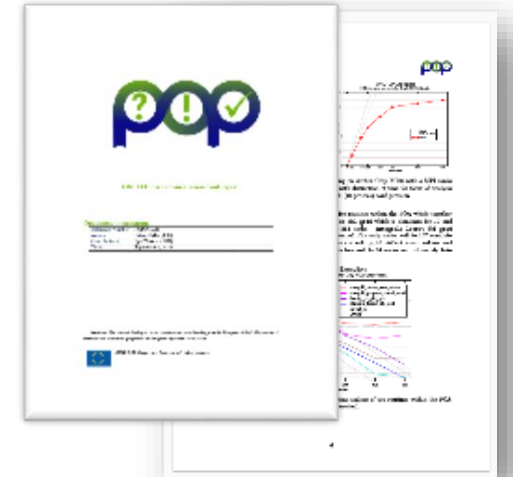
- **Parallel Application Performance Assessment**

- Primary service
- Identifies performance issues of customer code
- If needed, identifies the root causes of the issues found and qualifies and quantifies approaches to address them (recommendations)
- 1-3 months effort

- **Proof-of-Concept**

- Follow-up service
- Experiments and mock-up tests for customer codes
- Kernel extraction, parallelisation, mini-apps experiments to show effect of proposed optimisations
- 3-6 months effort

Note: Effort shared between our experts and customer!



```
<!DOCTYPE html>
<html id="home-layout">
  <head>
    <meta http-equiv="content-type" conte
    <title>Source Code Pro</title>
    <!-- made with <3 and AFDKO -->
    <meta name="keywords" content="sans,
      monospace, open source, coding, for
    <link rel="stylesheet" type="text/css
  </head>
  <body>
    <div id="main">
```



# Some Success Stories



- See [⇒ https://pop-coe.eu/blog/tags/success-stories](https://pop-coe.eu/blog/tags/success-stories)



Performance Improvements for SCM's ADF Modeling Suite



**3x Speed Improvement** for zCFD Computational Fluid Dynamics Solver



**25% Faster time-to-solution** for Urban Microclimate Simulations



**2x performance improvement** for SCM ADF code



Proof of Concept for BPMF leads to around **40% runtime reduction**



POP audit helps developers **double their code performance**



**10-fold scalability improvement** from POP services



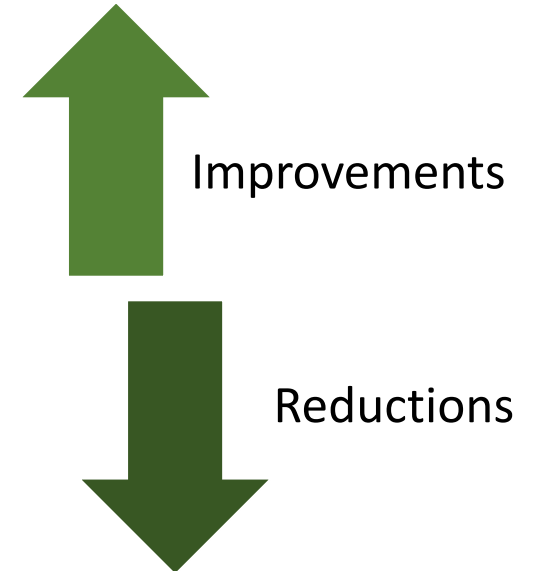
POP performance study improves performance **up to a factor 6**



POP Proof-of-Concept study leads to **nearly 50% higher performance**



POP Proof-of-Concept study leads to **10X performance improvement** for customer





- POP User Portal
- Access to all public information and services

The screenshot shows the POP website homepage. At the top left is the POP logo and the text "Performance Optimisation and Productivity" and "A Centre of Excellence in HPC". A "Log in" button is in the top right. On the left is a navigation menu with categories: News (Blog, Newsletter, Events), Partners (Tools), Services (Request Service Form, Target Customers, Success Stories, Customer Code List), Further Information (Learning Material), and Contact (Privacy Policy). Below the menu is a "Subscribe to our Newsletter" form with an email input field, a checkbox for "I accept the data policy\*", and a "Subscribe" button. The main content area has a "Mission" section with a description of the center's services and a note that services are free of charge. Below is a "Blog Highlights" section with three entries: "POP Project Restarted 1st December 2018" (01 DEC), "Not Only Fortran and MPI: POP's View of HPC Software in Europe" (25 JAN), and "A set of standard metrics for parallel performance analysis" (06 DEC). On the right, there is a "Latest News" section with a social media follow prompt and a "Tweets by @POP\_HPC" widget showing a tweet about the project restart. A red stamp in the top right of the main content area reads "Latest News: POP RESTARTED Dec 1, 2018!". At the bottom right is the European Union flag.



# Follow us on Twitter @POP\_HPC



Home Notifications Messages Search Twitter

POP\_HPC Performance Optimisation and Productivity

TWEETS 26 FOLLOWING 145 FOLLOWERS 54 LIKES 5 MOMENTS 0

**POP\_HPC**  
@POP\_HPC  
EU H2020 funded Centre of Excellence Performance Optimization and Productivity (POP) to boost performance and productivity in HPC applications.  
[pop-coe.eu](http://pop-coe.eu)  
Joined October 2016  
Born on October 1, 2000

**POP\_HPC** @POP\_HPC · Oct 19  
Our aim is to help you optimise your parallel code. Do bigger, better, faster science with POP. [pop-coe.eu](http://pop-coe.eu)

**Who to follow** · Refresh · View all

- EUROfusion** @FusionInCI...  
Follow
- Horizon 2020** @Horizon20...  
Followed by ETP4HPC and ...  
Follow
- martorellBSC** @martorellB...  
Followed by EXDCI and oth...  
Follow



# LinkedIn Group



The screenshot shows the LinkedIn group page for "Performance Optimization and Productivity (POP)". The group is owned by Bernd Mohr and has 80 members. The page features a navigation bar at the top with icons for Home, My Network, Jobs, Messaging, Notifications, and Me. Below the navigation bar, there is a search bar and a banner for an advertisement: "AI and Ethics - 92% of successful AI deployments include ethics training. Learn more".

The group profile section includes the group name, logo, and a description: "The EU H2020 Performance Optimisation and Productivity (POP) Centre of Excellence (CoE) in Computing Applications provides performance optimisation and productivity services for academic AND industrial HPC code(s) in all domains! The services are free of charge to organisations in the EU!". The group owner, Bernd Mohr, is identified as the Deputy Division Head at Jülich Supercomputing Centre. The group manager, Jonathan Boyle, is an HPC Application Analyst at NAG.

The main content area displays two posts. The first post is a webinar announcement: "POP webinar - Large-scale Application Execution Performance Assessment" held on Thursday 7 June 2018 at 14:00hrs BST. The second post is a performance assessment report titled "7th POP Webinar - Large-Scale Application Execution Performance Assessment" by Wadud Miah, a Computational Scientist at Numerical Algorithms Group. The report highlights improvements in Shearwater Reveal seismic processing code, showing a speed-up of up to 44% runtime reduction. A line graph compares five different scaling scenarios: Linear (CPU scaling), 80% of linear (CPU scaling), PoC code - dynamic, PoC code - I/O and alloc/dealloc removed, and original code - static. The graph shows that the PoC code - I/O and alloc/dealloc removed scenario achieves the highest speed-up, reaching approximately 11.5 at the highest data point.

Speed-up	Linear (CPU scaling)	80% of linear (CPU scaling)	PoC code - dynamic	PoC code - I/O and alloc/dealloc removed	original code - static
2	2.0	2.0	2.0	2.0	2.0
4	4.0	4.0	4.0	4.0	4.0
6	6.0	6.0	6.0	6.0	6.0
8	8.0	8.0	8.0	8.0	8.0
10	10.0	10.0	10.0	10.0	10.0
12	12.0	12.0	12.0	12.0	12.0

The bottom of the page shows an advertisement for Etihad Airways, promoting flights to Abu Dhabi for €499.

- Important announcements
- Also serves as a user forum



# Quarterly Email Newsletter



- Subscribe on the POP website
- Newsletter archive: <https://pop-coe.eu/news/newsletter>

The screenshot shows the homepage of the POP Newsletter. It features the POP logo and the text 'Performance Optimisation and Productivity - A Centre of Excellence in Computing Applications'. The main content area is titled 'POP Newsletter 1 -- Issue June 2016' and includes a table of contents with sections like 'POP Newsletter 1 -- Issue June 2016', 'News', 'Topics', 'Articles', 'Request Services Form', 'Target Customers', 'Business Startups', 'Customer Code of Conduct', 'Further Information', 'Learning Material', and 'Contact'. A sidebar on the left contains navigation links and a search bar.


The screenshot displays the 'POP Partner Profiles' section. It features three main articles: 'The Numerical Algorithms Group (NAG)', 'The HPC Group at RWTH Aachen', and 'POP's Performance Analysis Tools'. Each article includes a brief description of the partner's work and a photograph of the team. The 'NAG' article mentions their expertise in numerical software and their work on the 'Numerical Algorithms Group'. The 'RWTH Aachen' article highlights their focus on high-performance computing and their work on the 'HPC Group'. The 'Performance Analysis Tools' article describes the development of tools for analyzing application performance.

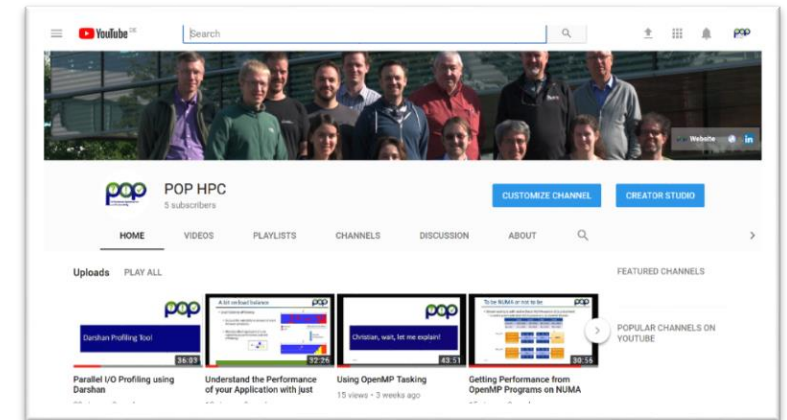
The screenshot shows a news article titled 'New story just - AIA improvement for OpenMP code'. The article discusses a performance improvement on 132 core BDP hardware after a POP performance analysis. It includes a 'Breakdown of our users' codes' section with four pie charts showing the distribution of users by discipline, country, language, and parallelization scheme. The 'Meet POP CoE partners at some upcoming events' section lists several events, including 'POP @ ISC 2016', 'POP @ ISC 2017', 'POP @ TeraGrid Forum', 'POP @ European Research Gateway', and 'POP @ HPCFS 2016'. The bottom of the page features logos for Jülich, RWTH Aachen, and NAG, along with the URL 'https://pop-coe.eu' and the European Union flag.



# Webinars / YouTube



- See [⇒ https://pop-coe.eu/blog/tags/webinar](https://pop-coe.eu/blog/tags/webinar)
- Or our  [YouTube Channel](#)
- Already available:
  - How to Improve the Performance of Parallel Codes
  - Getting Performance from OpenMP Programs on NUMA Architectures
  - Understand the Performance of your Application with just Three Numbers
  - Using OpenMP Tasking
  - Parallel I/O Profiling Using Darshan
  - The Impact of Sequential Performance on Parallel Codes
  - Large-scale Application Execution Performance Assessment
  - POP Case Study: 3x Speed Improvement for Zenotech's zCFD Solver





# Performance Optimisation and Productivity

A Centre of Excellence in HPC

Contact:

<https://www.pop-coe.eu>

<mailto:pop@bsc.es>

 @POP\_HPC

