



# Performance Optimization and Productivity

EU H2020 Center of Excellence (CoE)



1 October 2015 – 31 March 2018 (30 months)

- **A Center of Excellence**
  - On **Performance Optimization and Productivity**
  - Promoting **best practices in performance analysis and parallel programming**
- **Providing Services**
  - Precise understanding of application and system behavior
  - Suggestion/support on how to refactor code in the most productive way
- **Horizontal**
  - Transversal across application areas, platforms, scales
- **For academic AND industrial codes and users !**



# Partners



- **Who?**

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



- **A team with**

- Excellence in performance tools and tuning
- Excellence in programming models and practices
- Research and development background AND proven commitment in application to real academic and industrial use cases



# Motivation



## Why?

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

## Target

- Parallel programs , mainly MPI /OpenMP ... although can also look at CUDA, OpenCL, Python, ...



# 3 levels of services



## ? Application Performance Audit

- Primary service
- Identify performance issues of customer code (at customer site)
- Small Effort (< 1 month)

## ! Application Performance Plan

- Follow-up on the service
- Identifies the root causes of the issues found and qualifies and quantifies approaches to address the issues
- Longer effort (1-3 months)

## ✓ Proof-of-Concept

- Experiments and mock-up tests for customer codes
- Kernel extraction, parallelization, mini-apps experiments to show effect of proposed optimizations
- 6 months effort

Reports

Software  
demonstrator

Apply @  
<http://www.pop-coe.eu>



# Target customers



- **Code developers**

- Assessment of detailed actual behavior
- Suggestion of more productive directions to refactor code

- **Users**

- Assessment of achieved performance on specific production conditions
- Possible improvements modifying environment setup
- Evidences to interact with code provider

- **Infrastructure operators**

- Assessment of achieved performance in production conditions
- Possible improvements modifying environment setup
- Information for allocation processes
- Training of support staff

- **Vendors**

- Benchmarking
- Customer support
- System dimensioning/design



# Best practices in Performance analysis



- **Powerful tools ...**

- Extrae + Paraver
- Score-P + Scalasca/TAU/Vampir + Cube
- Dimemas, Extra-P
- Other commercial tools

- **... and techniques**

- Clustering, modeling, projection, extrapolation, memory access patterns, ...
- ... with extreme detail ...
- ... and up to extreme scale

- **Unify methodologies**

- Structure
  - Spatio temporal / syntactic
- Metrics
  - Parallel fundamental factors: Efficiency, Load balance, Serialization
  - Programming model related metrics
  - User level code sequential performance
- Hierarchical search
  - From high level fundamental behavior to its causes

- **To deliver insight**

- **To estimate potentials**



# Best practices in parallel programming



- **MPI and OpenMP**

- Active members of OpenMP consortium (RWTH, BSC)
- Active members of MPI Forum (JSC, RWTH)

- **Pushing application as early adopters and co-design drivers**

- **Promoting new features ...**

- **... gathering feedback**

- **Promoting a throughput oriented methodology**

- Task based programming
- Asynchrony, overlap
- Locality
- Malleability, Dynamic Load Balancing
- Nesting, recursion





# Activities

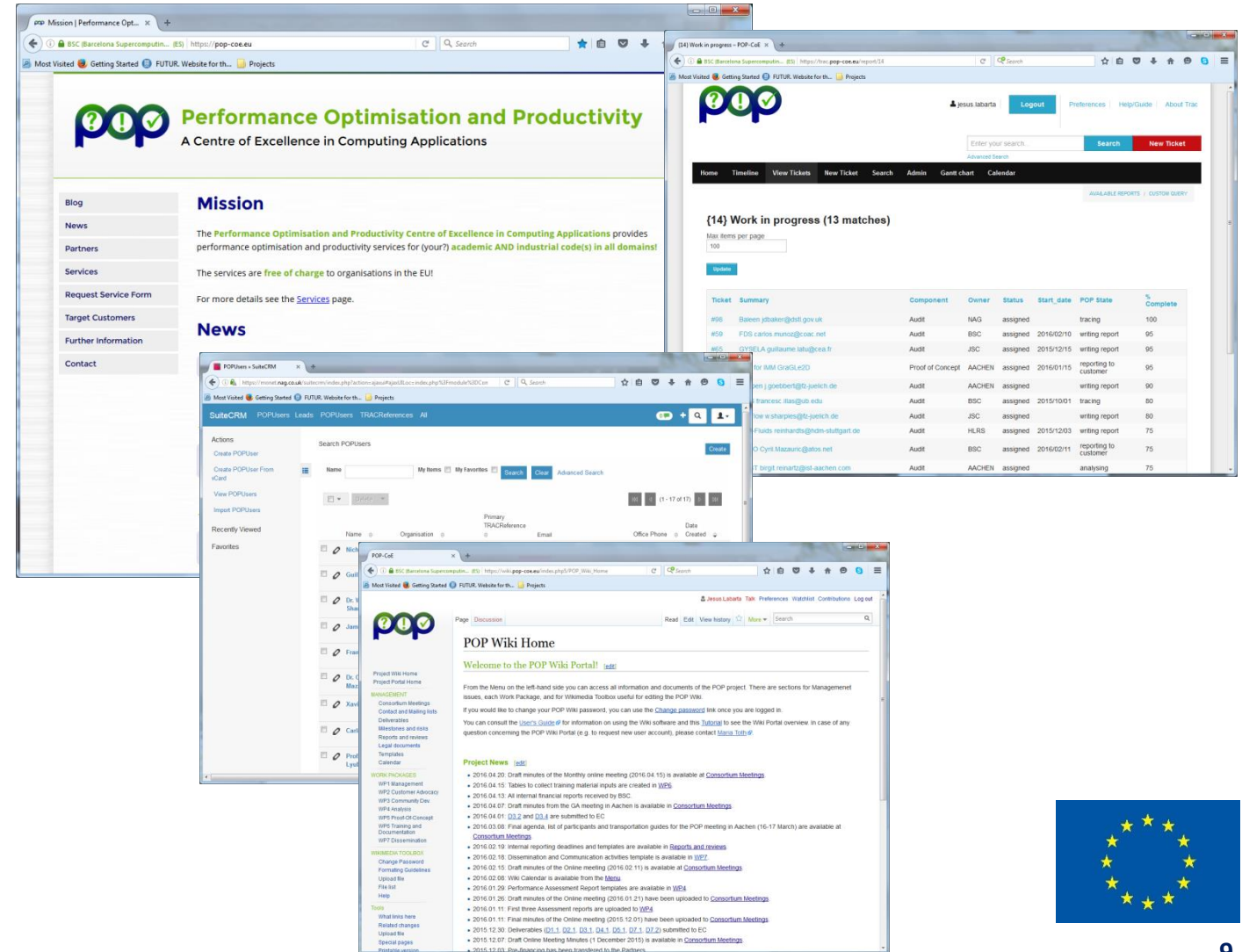


- **External access**

- WEB (www.pop-coe.eu)
  - Request form
  - Feedback questionnaires
  - News and blog

- **Internal organization**

- CRM
- TRAC ticketing system
- Wiki



# Activities



## • Services

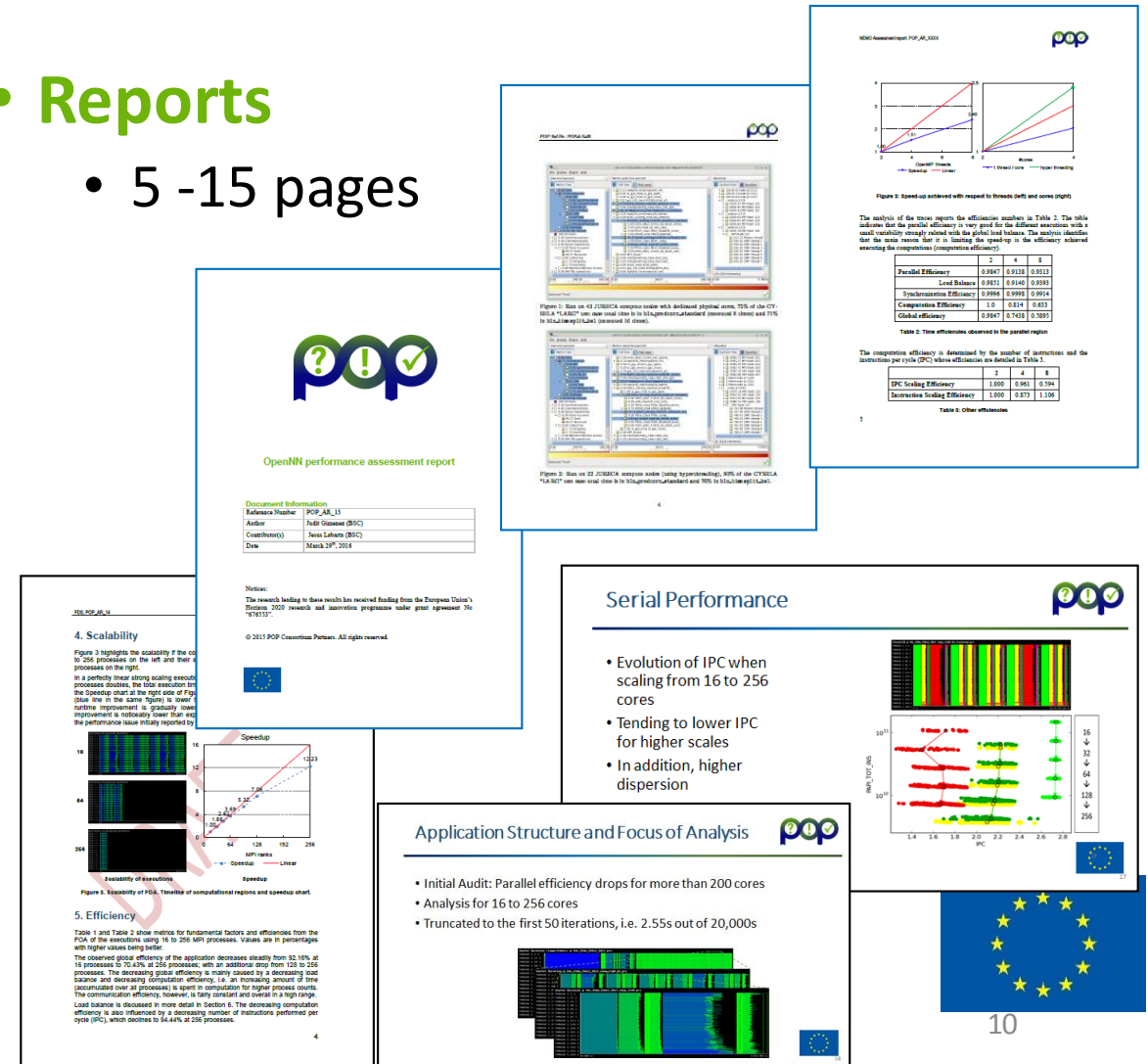
- Completed/reporting: 15
- Codes being analyzed: 6
- Waiting user input: 13
- Cancelled: 1

## • By type

- Audits: 31
- Plan: 2
- Proof of concept: 2

## • Reports

- 5 -15 pages



# Other activities



- **Promotion and dissemination**
  - Market and community development
  - Dissemination material and events
- **Customer advocacy**
  - Gather customers feedback, ensure satisfaction, steer activities
- **Sustainability**
  - Explore business models
- **Training**
  - Best practices on the use of the tools and programming models (MPI + OpenMP)
    - Lot of interest ... customers want to learn how to do it themselves



# Answer to Questions



- **Presented what we offer, what we are doing**
- **Requests by EC**
  - Women participation: BSC: 4/6, HLRS: 1/3, RWTH: 1/3, NAG: 1/3, JSC: 0/3
  - Interaction between CoEs: Training EoCoE, Events (EsiWACE, ...). Assessments to other CoEs
- **International cooperation**
  - we do have many activities (JLESC, VI-HPS,...) as individual partners.
  - Not at project level
- **PRACE scientific case, SRA, other FETHPC projects**
  - Involved on SRA at individual partners level
  - Have customers from other CoE and FETHPC projects. Our tools technologies are also used and partially developed in them



# Conclusion

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- We have established our internal operation infrastructure and procedures
- We have already performed 15 assessments and 19 are in the pipeline
- We believe the effort to unify our methodologies can become the core of best practices in performance analysis and programming practices that expand at international level
- We consider the POP CoE is progressing at a fairly good pace and results are already showing up.





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THANKS

