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

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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

• 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