European High-Performance Scientific Computing: Opportunities and Challenges for Applied Mathematics

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ABSTRACT

High Performance Computing (HPC) is at the core of significant advances in scientific discoveries and innovation in industrial design and society needs, and is therefore a strategic resource for Europe's future. In recent years, European Union (EU) has considerably increased its investments in the HPC ecosystem, making available resources to set up large facilities capable of reaching the peta/exascale rate of computation ($10^{15} - 10^{18}$ floating-point operations per second) and data centers with many exa-bytes of secondary storage, as well as to support the development of a European technology and pursue excellence in application development. Regarding this last objective, the Horizon 2020 program has supported the creation of 10 Centers of Excellence (CoEs) for computing applications, in areas such as environmental science, renewable energies, new materials, bioscience, etc., whose scientific challenges motivate the need for exascale-class computing resources. Predictive simulation capabilities in the different domain science are the main goal of the CoEs, so that computational results can be used not only to increase scientific knowledge and understanding but also for design and decision. In the above context, applied mathematics research is a critical component, indeed Mathematics permeates the activities from the formulation of the problems to the analysis of the results. New models and algorithms to be integrated in new science application codes are required in order to fully exploit the

significant advances in computational capability that will be soon available. This mini-symposium aims to cover some of the most critical research areas of the system of CoEs, highlighting topics such as physical-mathematical modelling, numerical algorithms and scientific libraries, mixed-precision arithmetic for scientific computing, data assimilation and uncertainty quantification, pointing out how CoEs activities and applications result in tangible benefits to address scientific, industrial or societal challenges. The mini-symposium is supported by the EU project FocusCoE, an initiative funded to promote the CoEs services and findings to ever more partners from science and industry, with particular focus on small and medium-sized enterprises (SMEs), and thereby reinforce the positive impact of HPC in all of the areas covered by the CoEs.