Exa-FireFlows: Exascale framework for supporting high-fidelity simulations of multiphase reacting flows in complex geometries

Description

High performance computing (HPC) has transformed scientific research across numerous disciplines by supportingtheory and experiments with numerical simulations. Exascale computing is the next milestone in HPC and is called to play an important role in economic competitiveness, societal challenges and science leadership. Combustion isone of the fields with high strategic importance and potential to fully exploit the future exascale systems. Nowadays,combustion of fossil fuels is the main power source, and some projections indicate that the combustion of liquid fuelswill still dominate transportation and power generation industries for the next 50 years. Further understanding of thephysics and chemistry of the combustion process is fundamental to achieve improvements in fuel efficiency, reducinggreenhouse gas emissions and pollutants, while transitioning to alternative fuels and greener technologies. The use of advanced numerical simulations has enabled to make important contributions for increasing cycle efficiency,reduction of pollutant emissions, and use of alternative fuels in practical applications. The exascale computing will enable the development of high-fidelity turbulent combustion simulations that could not be analyzed before becauseit was too computationally expensive. However, the implementation of the new and future supercomputers require theevolution of multiple and different technologies in a coherent and complimentary way, including hardware, software,and application algorithms. Scientific codes and formulations need to be re-designed and adapted in order to exploit the different levels of parallelism and complex memory hierarchies of the new and future heterogeneous systems. Thegoal of the project is to explore and develop novel co-execution, memory awareness and communication avoidance strategies into a framework that allows the simulation of advance high-fidelity multiphase reacting flows in complex geometries using unstructured grids.

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