



## **HIGH PERFORMANCE COMPUTING ON MASSIVELY PARALLEL ARCHITECTURES**

The Laboratories for Computational Physics and Fluid Dynamics (LCP&FD) of the Naval Research Laboratory (NRL) conducts research and development supporting the national initiative in high performance computing. Advanced algorithms, codes and licensable software are developed for commodity systems and for the newest massively parallel architectures. Research is pursued in the fields of compressible and incompressible fluid dynamics, reactive flows, fluid/structure interaction including submarine and aerospace applications, atmospheric and solar geophysics, magneto-plasma dynamics, fire modeling, engine modeling and molecular dynamics. We are interested in receiving proposals for basic scientific research and development directed toward increasing knowledge or understanding pertaining to our on-going programs in the following topics:

- (1) Novel modeling and simulation of complex combustion systems involving multi-phase fuel (including alternate and synthetic fuels) injection such as droplets, sprays and particulate matter in a gaseous background. Also innovative development, integration and maintenance of an environment for efficient approaches to the massively parallel processing of detailed chemical kinetics mechanisms and the development of simplified chemistry models (for conventional and alternate fuels) for inclusion in multidimensional simulations of flames, fire and detonations.
- (2) Innovative characterization of sound generation and investigation of methods to increase fuel-air mixing, reduce noise and pollution from jet engines burning current and future alternate fuels (including bio-derived and synthetic fuels) using direct and large eddy simulation techniques and supporting data for validation.
- (3) Novel finite difference modeling for large scale studies with general boundary conditions, modeling of local phenomena in multidimensional magnetofluids, innovative many-body simulation models for plasma phenomena.
- (4) New radiation transport and equation of state models for inclusion in highly parallelized and vectorized hydrodynamic simulation codes which address astrophysical and laboratory plasmas, in which the effects of radiation transport and non-ideal equations of state are relevant.

(5) Novel techniques for structured and unstructured grid-based unsteady flow solvers for complex, three-dimensional flows. This research would also address parallel load balancing and adaptive refinement and re-meshing for unsteady flows. CAD interfaces with grid generators and unsteady flow solvers for multiple moving surfaces and bodies in relative motion, bodies in and near a free surface, and bodies in turbulent separating flows are also sought.

(6) Development and application of efficient Flux Corrected Transport (FCT) methods for Graphical Processing Units (GPU) and other computational coprocessors.

(7) Development, validation and application of techniques for complex multi-phase flows and development of innovative techniques for the simulation of low Reynolds number flows through complex geometries.

(8) Innovative modeling of elastic-plastic flows and flow interactions with solid deformable boundaries. This includes shock loading in sand and/or explosive effects on deformable bodies.

(9) Development of innovative and efficient numerical techniques, analysis and experiments for the simulation and validation of the performance and operation of continuous and pulsed detonation engines.

(10) Development, application, validation, and accreditation of numerical simulation models needed to support decisions in protection of buildings, facilities, cities and/or military platforms from the threat of chemical/biological incidents and blasts.

(11) Development and application of scalable methodologies for urban geometry and feature extraction from LIDAR and remote sensing data.

(12) Development and application of numerical simulation models, including visualization techniques, to investigate complex unsteady viscous flows associated with bio-fluidic systems and devices as well as artificial bio-mimetic vehicles and systems.

LCP&FD is interested in receiving proposals for research related to the above research interests. Address White Papers (WP) to [6040WhitePapers@nrl.navy.mil](mailto:6040WhitePapers@nrl.navy.mil). Allow one month before requesting confirmation of receipt of WP, if confirmation is desired. Substantive contact should not take place prior to evaluation of a WP by NRL. If necessary, NRL will initiate substantive contact.