Advanced Meshing Methods for Complex Multiphysics Applications

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Abstract:

Multiphysics scientific and engineering applications have added a new dimension to the challenges of computational complexities associated with geometry, mesh, and field manipulation tasks. While many research issues still remain in meshing methods for single-physics applications, multiphysics simulation adds additional complications that arise from the need to incorporate requirements from many, possibly tightly-coupled phenomena into the meshing process. Unfortunately, requirements for different equations systems may be orthogonal, necessitating the use of different meshes for each physics model and the need for accurate transfer of data between these meshes. The advent of supercomputing creates new opportunities for the representation of the entire fully-integrated designs via meshing at an unprecedented fidelity, particularly as computer architectures move toward the petascale/exascale.The premise of this talk is to present an overview of the challenges in meshing, geometry, and intermesh data transfer for multiphysics simulation and presents methodologies of tackling some of the issues that arise. In addition, we will present ongoing research in the development of adaptive mesh refinement tailored to application areas and highlight its use in several different simulation fields; e.g., climate modeling, astrophysics simulation, Neutron Science and reactor modeling, and materials science. The adaptive meshing approach and its underlying methods are attractive to many application areas when solving three-dimensional, multi-physics, multi-scale, and time-dependent problems.