Parallel Unstructured Mesh Infrastructure

The PUMI toolkit supports massively parallel adaptive unstructured mesh applications. It also supports in-memory integration of adaptive mesh control through APIs. Current in-memory integration with PHASTA, Proteus, Nektar++, and FUN3D for fluid flow analysis, ACE3P for electromagnetics analysis, M3D-C1 for MHD analysis of fusion plasmas, and Albany for multiphysics analysis.

Support for PPPL Fusion Codes

- PUMI supporting
- Mesh infrastructure for M3D-C1
- Mesh generation needs of XGC and M3D-C1
- Mesh adaptation needs of M3D-C1

Curved Meshes for High-order Methods for SLAC

Complex curved geometry can be better approximated by high-order shape functions for surface faces. With proper corrections to maintain a positive Jacobian. Meshes by SLAC ACE3P code.

APF is the interface to PUMI. It allows dynamic adding and removing of scalar, vector, and tensor fields.

AFP also has an extensible shape function system. Built-in functions include Lagrange, Bezier, and Hierarchic. General shape function queries enable correct high-order solution transfer. Supports operations on fields.

APF is designed to integrate with solvers. It associates material and boundary conditions to a CAD model, lays out field data for solvers, and simplifies linear system assembly by providing scalable numbering and node sharing tools.

Mesh and fields can be output for visualization to Paraview.

Performance Portability & Scaling

- PUMI scales well on machines like the BlueGene/Q, and can use threads if they communicate
- For example, we generated a 92 billion element mesh for PHASTA on ALCF Mira using 256K MPI ranks and 8 threads per rank

Accelerator Machines

PUMI scales well on TACC Stampede (Intel Xeon Phis), but thread communication and file I/O currently not well supported by hardware partitioning tools.

Research continues into mesh modification with OpenMP & CUDA parallelism for accelerator systems.

Performance is possible, but portability unlikely due to different models between MPI and OpenMP.

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More Information: http://github.com/SCOREC/core or contact Dan Ibanez, RPI, ibaned@rpi.edu