TUG 2008
Meshes, Geometry and Load Balancing Capability Area

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SAND2008-7552C
Motivation: Generation, management and manipulation of mesh-based data play key roles in many scientific simulations.

- *Finite difference, volume, and element methods* require efficient mesh generation and management.
- *Adaptive mesh refinement methods* require even more sophisticated mesh management, along with the ability to modify, manipulate, and redistribute mesh and geometry data.

Goal: Provide tools and common interfaces for creating, accessing and manipulating mesh and matrix data within applications.
Capabilities in Trilinos

• New and Improved in Trilinos v9.0:
  – PhDMesh
  – PAMGEN
  – Zoltan
  – Isorropia

• Planned for Trilinos v10++:
  – ABMesh
  – TUCASA
  – STKMesh
  – ITAPS
phdMesh
Unstructured Mesh Database

• POC: Carter Edwards
• History: Mesh kernel for Mantevo project.
• Capabilities:
  – Compact, flexible software component for managing parallel, heterogeneous and dynamic unstructured meshes.
  – Mesh specified as application-defined parts, fields, entities and connections.
  – Blocking data into contiguous memory provides high computational efficiency.
• Brag: phdMesh provides an API and implementation that is an order of magnitude simpler/smaller than SIERRA Framework.
PAMGEN
In-Line Meshing Library

• POC: David Hensinger
• History: Spin-off from ALEGRA.
• Capabilities:
  – On-the-fly parallel generation of simple meshes.
  – C interface to local mesh geometry and topology as well as inter-processor connections.
• Brag: PAMGEN has been used to generate meshes with more than 1.1B elements on 17,576 processors.
Zoltan
Dynamic Load Balancing Toolkit

• POC: Karen Devine
• History: Spin-off from MPSalsa.
• Capabilities:
  – Suite of partitioning and load-balancing methods for many applications (meshes, particles, circuits, matrices, …).
  – Graph coloring, graph ordering, distributed data directories, unstructured communication.
• Brag: Zoltan is used by over a dozen Sandia applications, as well as the SciDAC, lab, and academic communities.
Isorropia Matrix
Partitioning, Coloring & Ordering

• POC: Erik Boman
• History: First released in Trilinos v8.
• Capabilities:
  – Epetra interfaces to Zoltan; connects Zoltan to the rest of Trilinos.
  – Matrix redistribution tools.
  – Development platform for advanced matrix partitioning and ordering algorithms.
• Brag: Isorropia in Trilinos v9 contains new matrix ordering and coloring interfaces.
  (POC: Cedric Chevalier)
Future Tools in Capability Area

• **ABMesh**: Array-based mesh database.
  – POC: Rich Drake

• **TUCASA**: Parallel mesh file reader and initial partitioner.
  – POC: Rich Drake

• **STK Mesh**: Sierra Toolkit Mesh component.
  – POC: Carter Edwards and Mike Glass

• **ITAPS**: Interoperable parallel mesh interfaces.
  – POC: Vitus Leung and Karen Devine