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Meshes, Geometry and Load Balancing Capability Area

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NNSA National Nuclear Security Administration

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Meshes, Geometry and Load Balancing Capability Area

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- **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.**

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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

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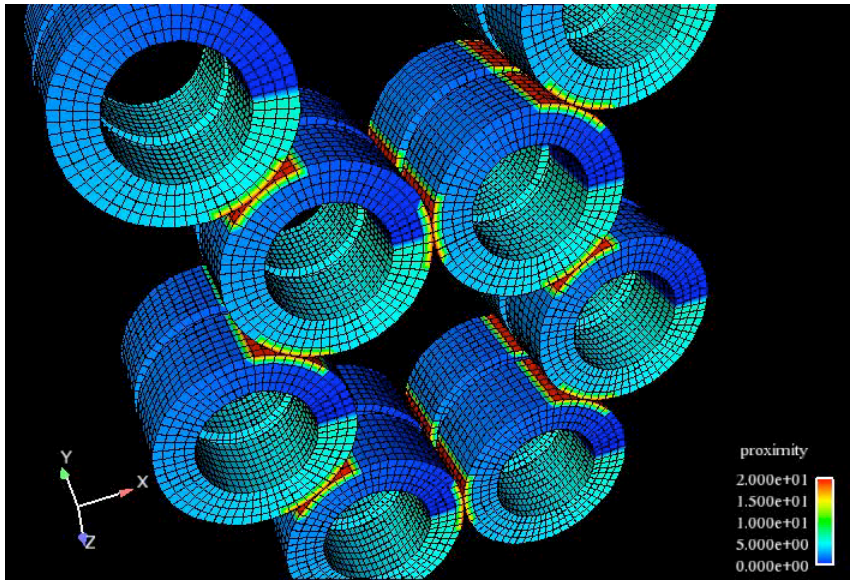
- POC: Carter Edwards
- History: Mesh kernel for Mantevo project.
- Capabilities:
  - Compact, flexible software component for managing parallel, heterogeneous and dynamic unstructured meshes.
  - Mesh specified as application-defined parts, fields, entities and connections.
  - Blocking data into contiguous 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

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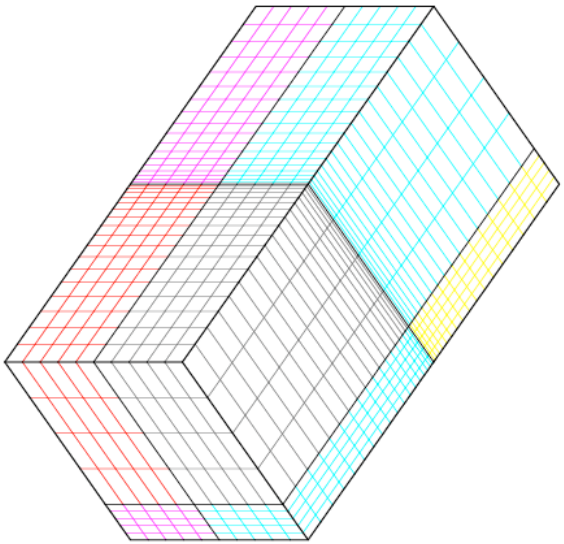
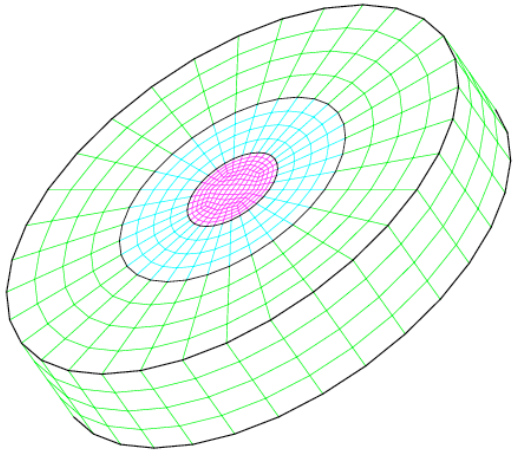
- POC: David Hensinger
- History: Spin-off from ALEGRA.
- Capabilities:
  - On-the-fly parallel generation of simple meshes.
  - C interface to local mesh geometry and topology as well as inter-processor connections.
- Brag: PAMGEN has been used to generate meshes with more than 1.1B elements on 17,576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





Zoltan
Dynamic Load Balancing Toolkit

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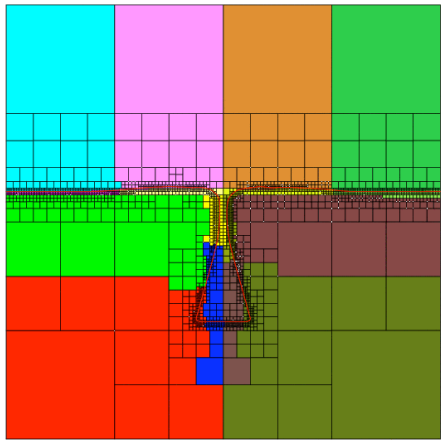
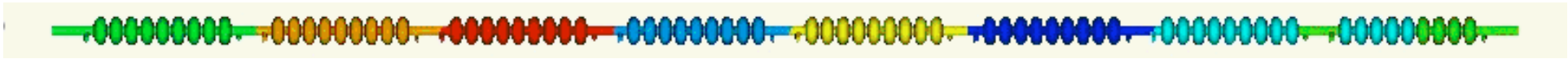
- POC: Karen Devine
- History: Spin-off from MPSalsa.
- Capabilities:
  - Suite of partitioning and load-balancing methods for many applications (meshes, particles, circuits, matrices, …).
  - Graph coloring, graph ordering, distributed data directories, unstructured communication.
- Brag: Zoltan is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





Isorropia Matrix Partitioning, Coloring & Ordering

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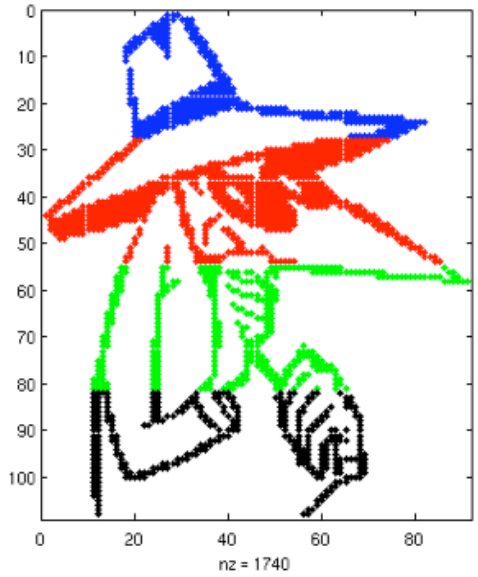
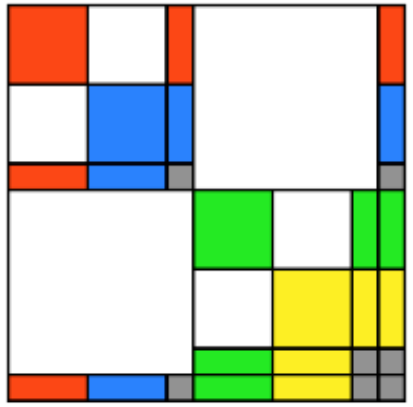
- POC: Erik Boman
- History: First released in Trilinos v8.
- Capabilities:
  - Epetra interfaces to Zoltan; connects Zoltan to the rest of Trilinos.
  - Matrix redistribution tools.
  - Development platform for advanced matrix partitioning and ordering algorithms.
- Brag: Isorropia in Trilinos v9 contains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





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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**