Sandia National Laboratories
Overview

SEERI Summer Intern Presentations

Paul Stanfield

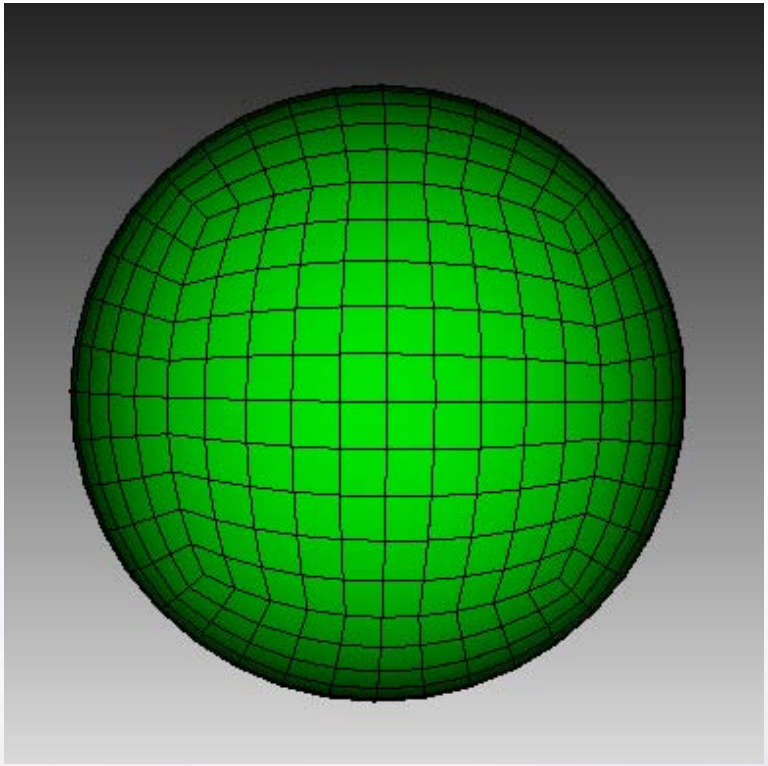
SAND2010-5344C

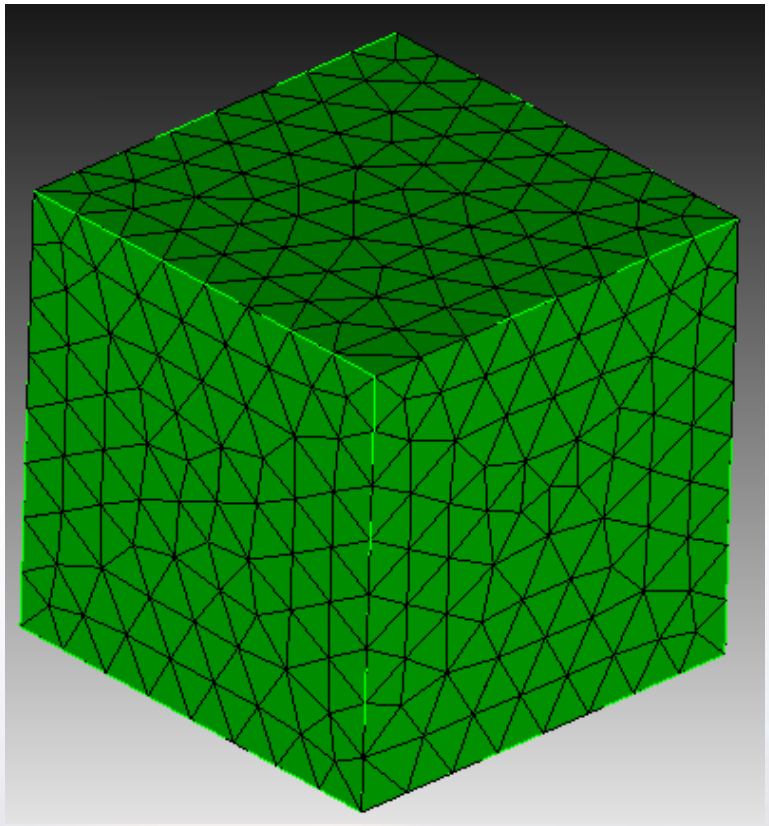
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

LOCKHEED MARTIN

Sandia National Laboratories

Unstructured Mesh Tally for ITS





SAND: 2010-5344C

Goals for my internship

- Increase functionality of ITS code
- Eliminate some post-processing
- While maintaining performance of ITS code

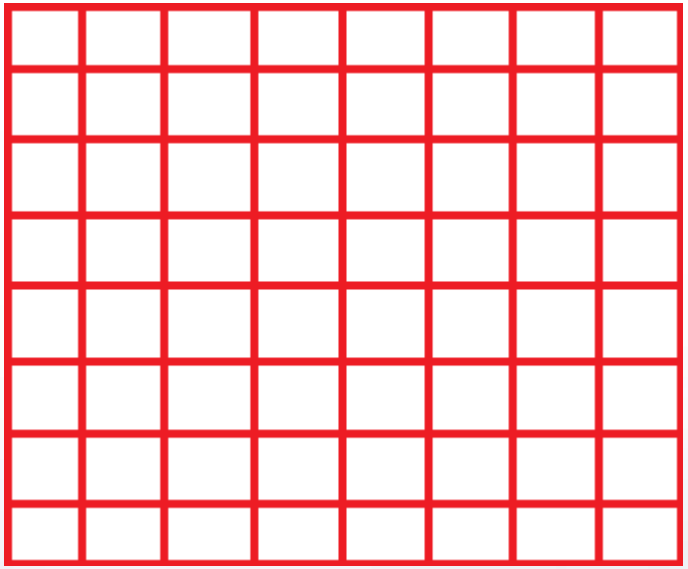
Sandia National Laboratories

ITS

- Integrated Tiger Series radiation transport code
- Coupled Electron/Photon Monte Carlo Codes
- Transports on solid body
- Information is then transferred to a mesh

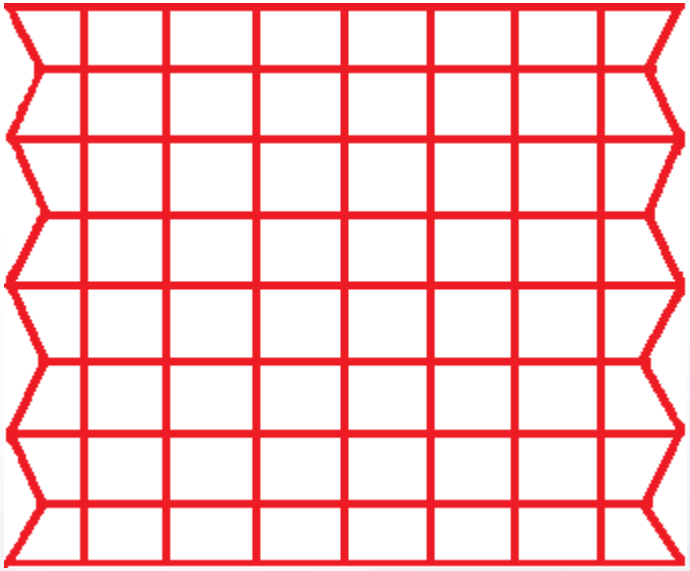
Structured Mesh

- Currently structured meshes are used
- Created by uniformly meshing simple body types
- Only necessary to store and pass a few body parameters



Unstructured Mesh

- **All geometry information is calculated and stored at the beginning**
  - Vertices
  - Connectivity
- **Would allow for a wider variety of shapes to be accurately meshed**

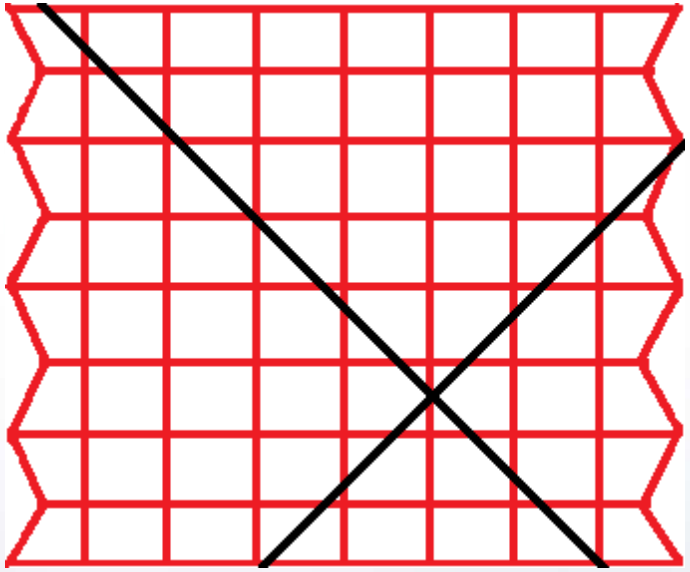


MOAB

- Mesh-Oriented datABase
- Developed at Argonne National Laboratory
- Used to store Unstructured mesh data
- Uses KD Tree to search for points in mesh
- Has the ability to read and write Exodus files which are a common mesh format

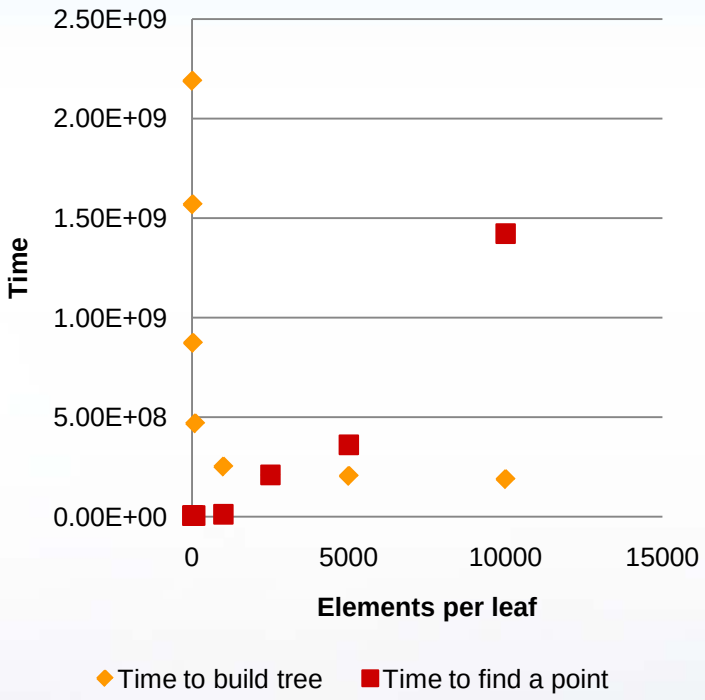
KD Tree

- Spatial-partitioning data structure
- Searches for spatial partition (leaf) containing point
- Then searches elements in the leaf
- Tradeoff: memory vs search time



KD Tree Performance

- Time to build the Tree and Time to find a point in the tree are both functions of the number of elements per leaf
- The number of points being located is very high so time to find a point must be minimal
- The optimum number of elements per leaf is roughly 20



Programming

- This project consisted almost entirely of programming challenges
- I had to familiarize myself with a number of systems I hadn’t used before

Fortran vs C++

- **ITS is written in Fortran**
- **MOAB is written in C++**
- **Problems**
  - All arguments in Fortran are passed by reference
    - C++ must pass Fortran arguments as pointers
  - C++ expects character strings to be null-terminated
    - Character strings from must have the null character appended to them

Make

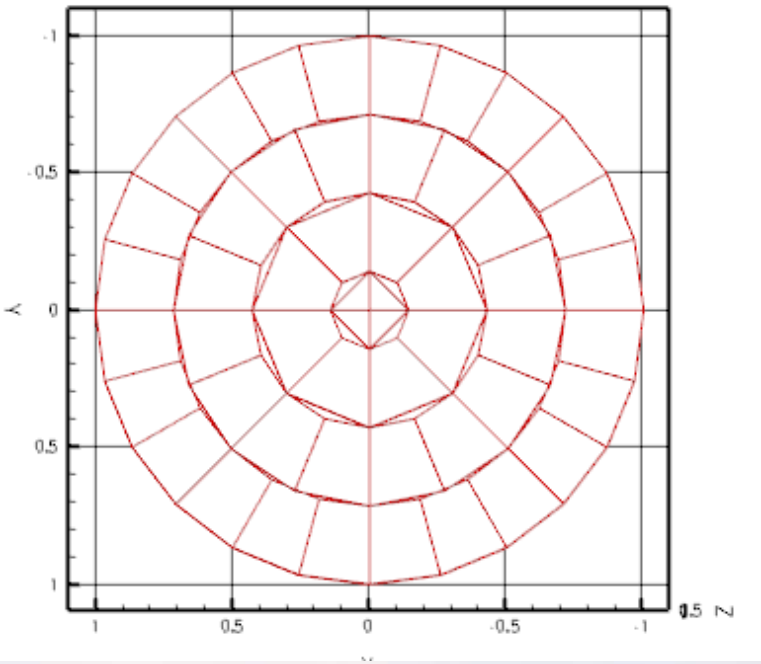
- Used to build executable programs and libraries
- Uses makefiles to specify how to derive the program from the source files
- Cmake is used to help tailor the build system to a given platform using configure shell script

MPI

- Message Passing Interface
- Parallel Computing System used by ITS
- Processes are completely independent
- Data is passed between them in the form of messages

Side Project

- New structured meshing scheme for right circular cylinder
- Equal volume elements for right circular cylinder



Conclusion

- **Still problems to be resolved**
  - Having trouble getting MOAB to write files
  - Haven’t completed interfacing MOAB code with ITS
  - Other various bugs

Question?