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An Application of Scalable Massive Model Interaction using Shared-Memory Systems

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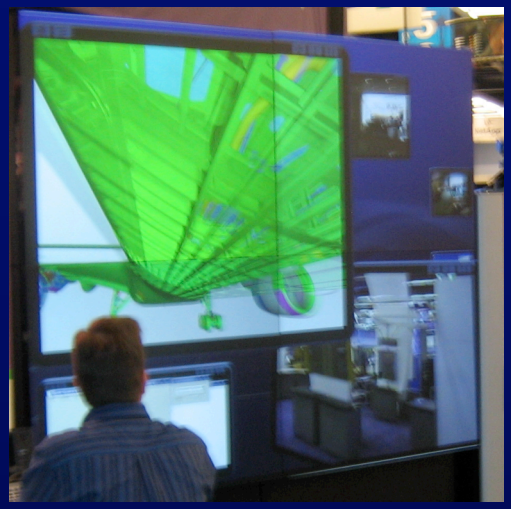
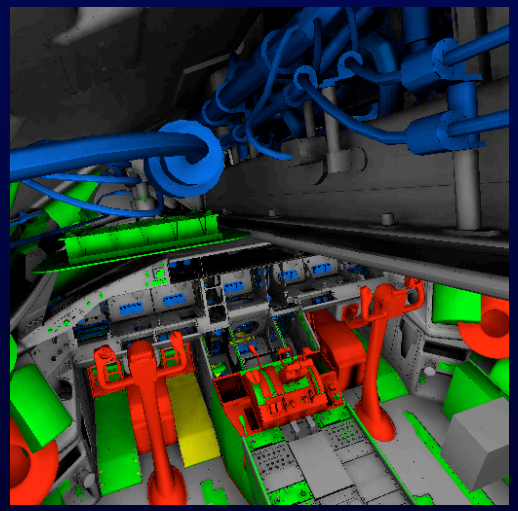
Talk Overview



Feasibility Demonstration:

- Task adopted from real process.
- Rendering one component.
- System demonstrated at SC2005.

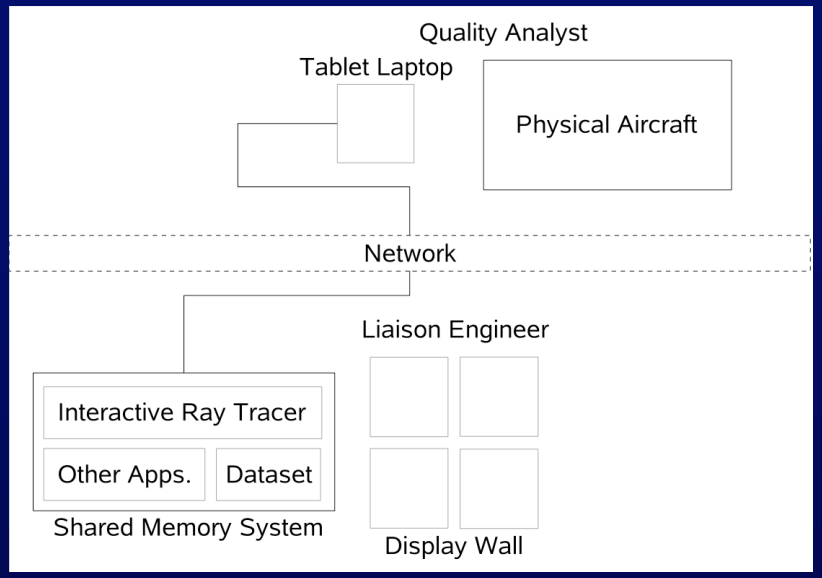


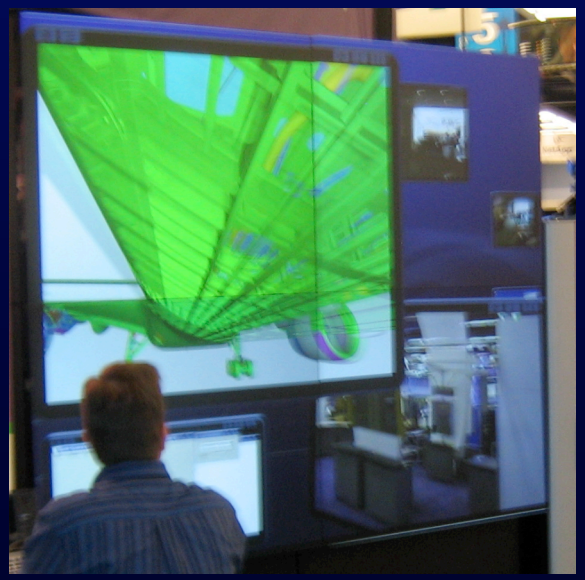
Software Architecture:

- Shared Memory Interactive Ray Tracer.
- Modular, extensible design.
- Transparency and ambient occlusion.

Manta interactiveraytracer

Feasibility Demonstration





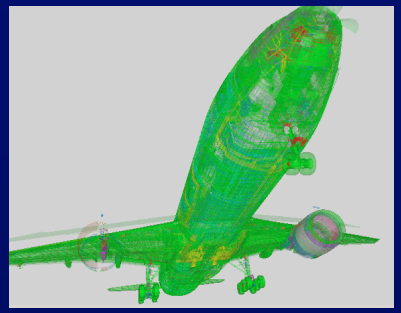
Engineering Task

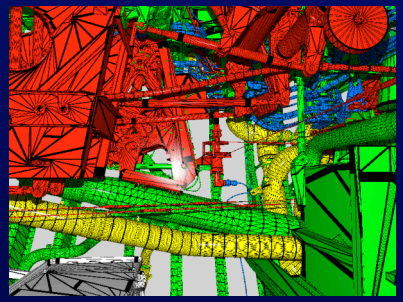
1. Quality Analyst identifies problem with aircraft (in the field).
2. Contacts Liaison Engineer, begins remote collaborative session.
3. Use 3D model to visualize problem.
4. Discuss best course of action using video and desktop sharing tools.

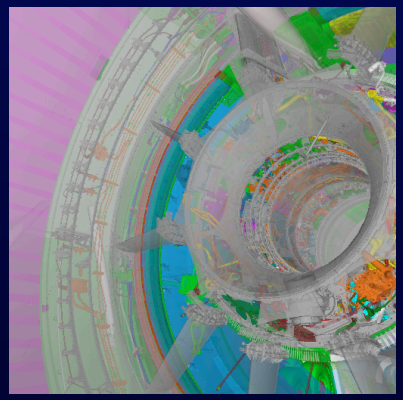
Remote Visualization

- Necessary to share large servers.
- Increases data security.
- Collaborative visualization a byproduct.
- Performance and resolution factor of distance.

Massive Model Rendering







Boeing 777-200 Aircraft

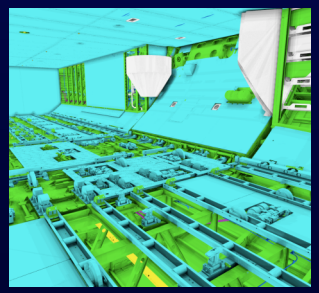
- ~350 M Triangles.

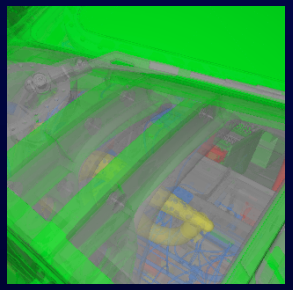
Why Ray Trace?

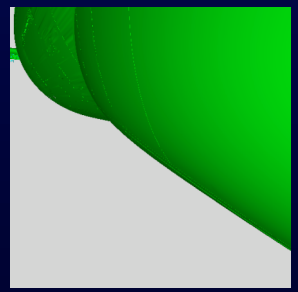
- sub-linear scaling in # triangles.
- Easy transparency, global effects.

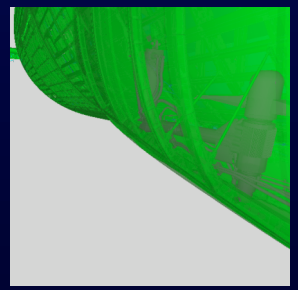
Acceleration Structure

- kd-tree acceleration structure.
- Size and quality depend on build time.
- Memory use not a concern.
- 29 GB kd-tree.



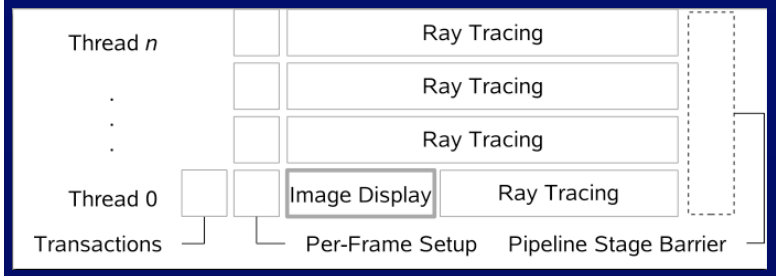






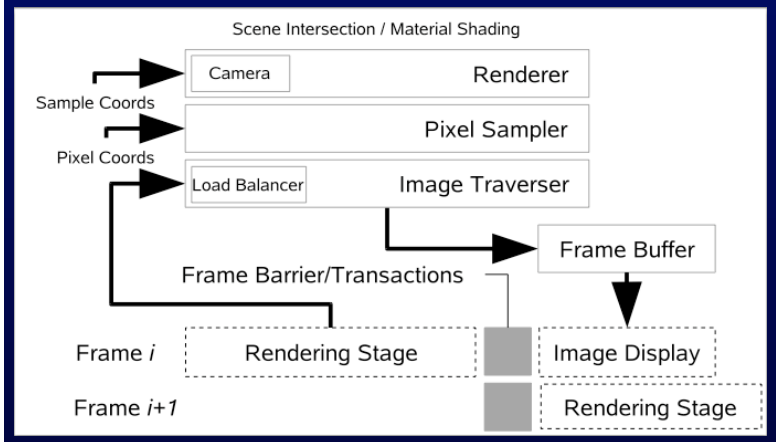
Boeing 777-200 model provided by The Boeing Company

Manta Software Architecture



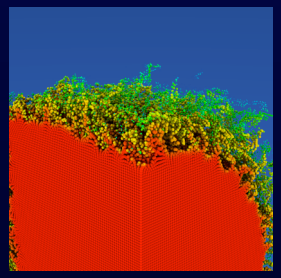
Manta Pipeline

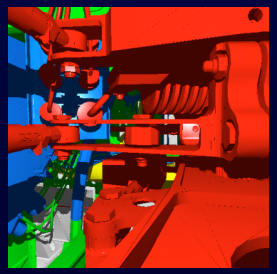
- Display followed by rendering.
- Modular and extensible components.
- Transaction state changes applied each stage.
- Barrier synchronization between stages.



Rendering Stack

- Modular call stack invoked by rendering stage.
- Scene intersection and shading performed by *Renderer* component.



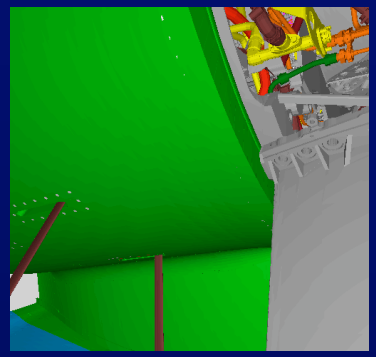


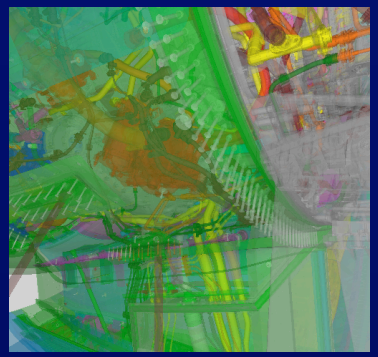
Modular Design

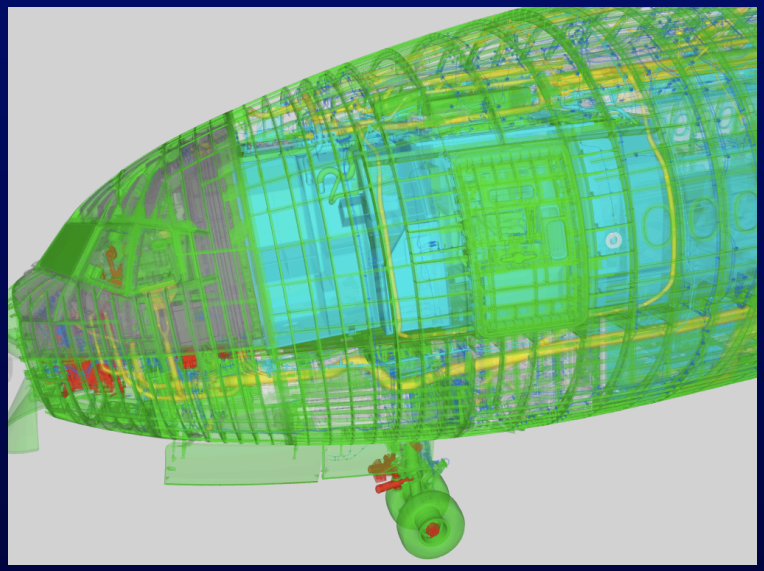
- Allows Manta to be embedded in other programs.
- Supports multiple primitives:
  - Massive triangle models.
  - Massive volumes.
  - Sphere glyph (MPM) rendering.

MIT Licensed, Open Source Software.

Transparency







Transparent rendering reveals intricate details while preserving the context of the model.

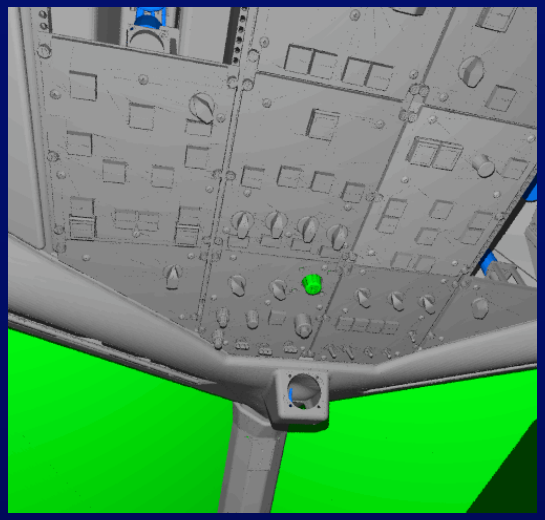
kd-tree traversal modified

- Continues until ray attenuates.
- Intersections are stored in an array.
- Array is sorted and each intersection color blended.

Simplifications:

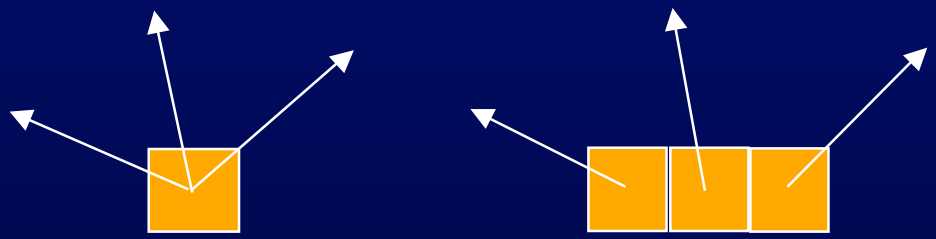
- No solid objects, blend surfaces only.
- Fixed number of intersections for constant alpha.

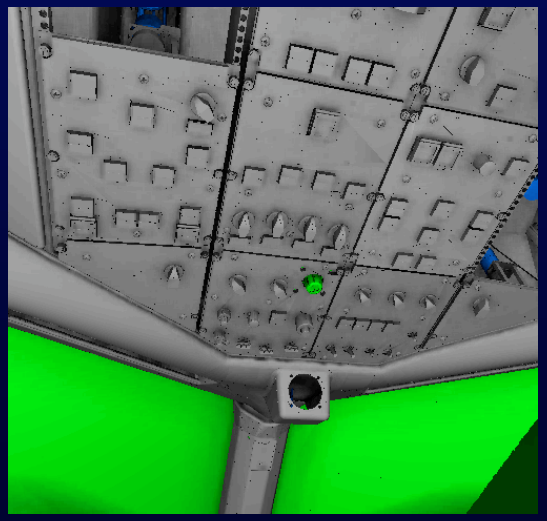
Ambient Occlusion



Adapted Instant Global Illumination

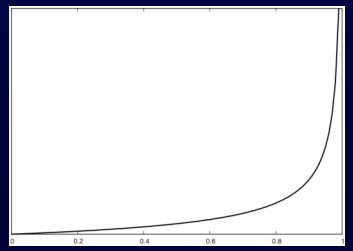
- Interleaved sampling of secondary rays based on *NxN* pixel neighborhood.
- Filter truncates based on distance threshold.
- Sensitive to normal between neighbors.

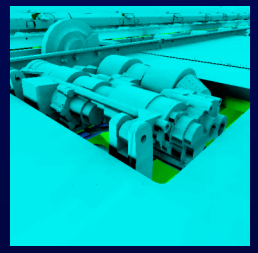


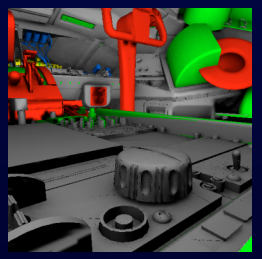


Compute Weights

Filter

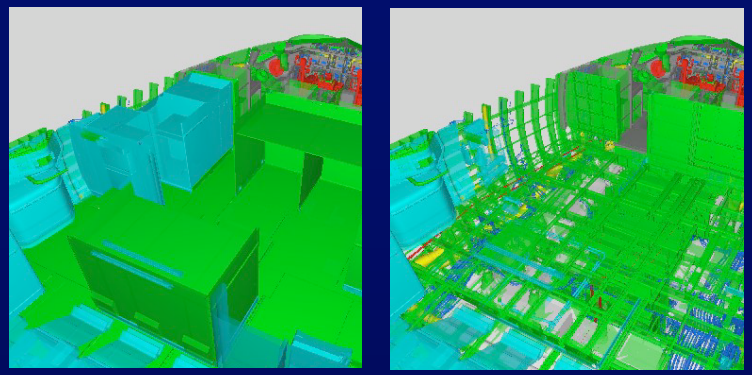




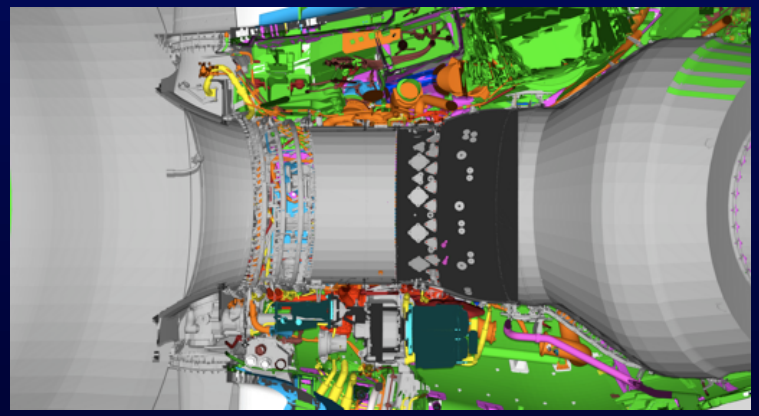


Filter Kernel based on dot product between normals.

Exploring the Model



Hiding Objects

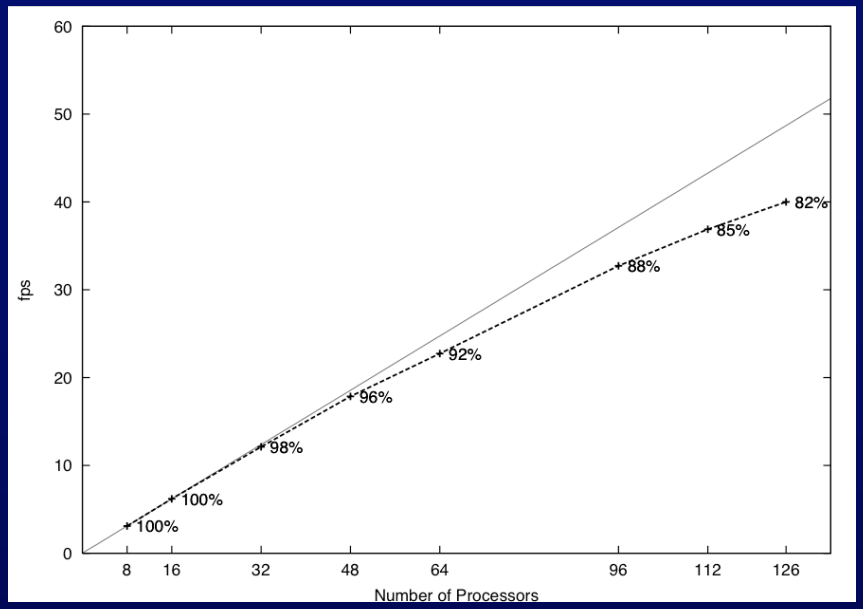


Cutting Planes

Object Hiding & Cutting Planes

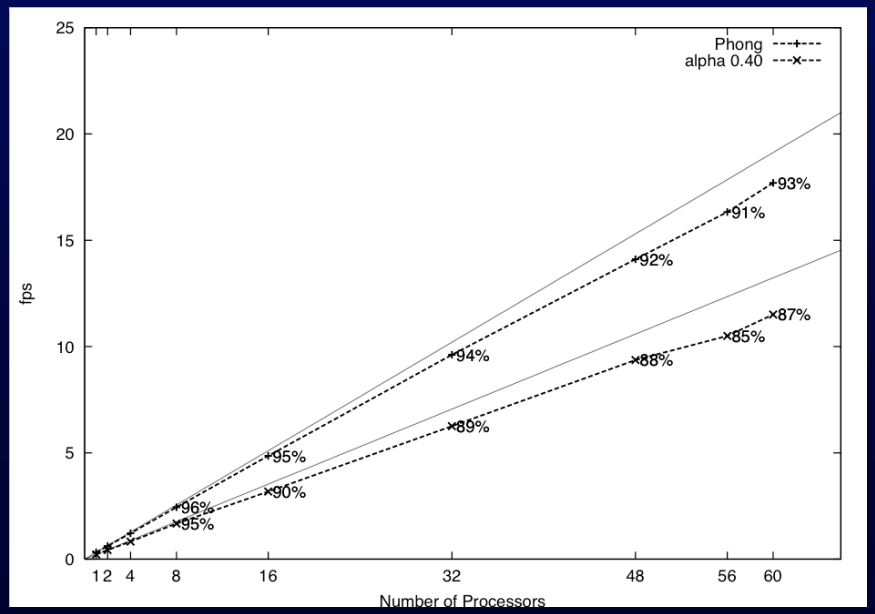
Users employed cutting planes and object hiding to locate a certain region of the model, then adjusted opacity to examine fine details and occluded structures.

Rendering Performance



128 p 1.6 Ghz Itanium2

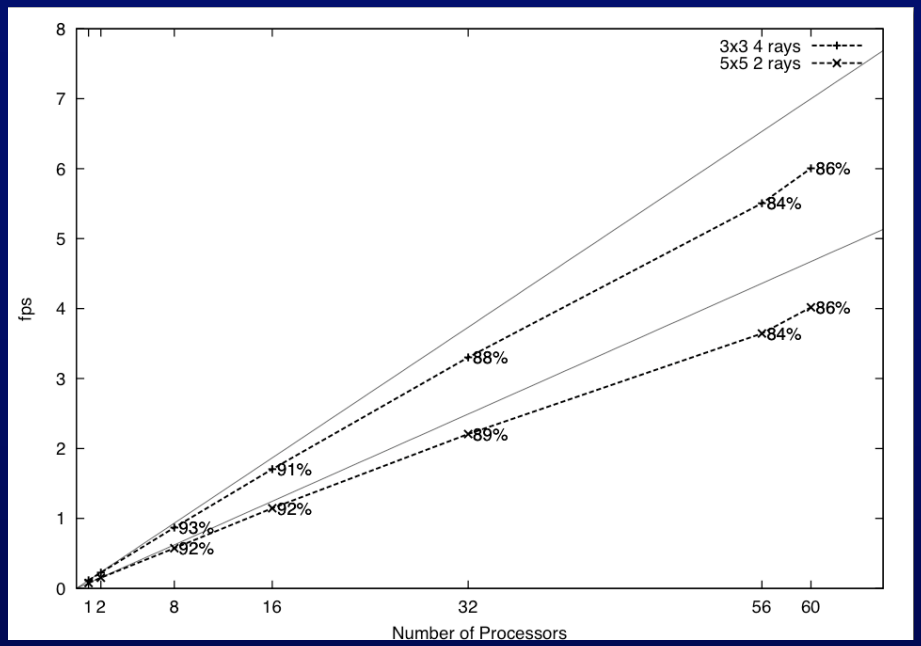
- 92% linear at 64p 82% at 126p
- Resolution 1024x768
- Demonstration system



62 p 1.4 Ghz Itanium2

- Resolution 800x600

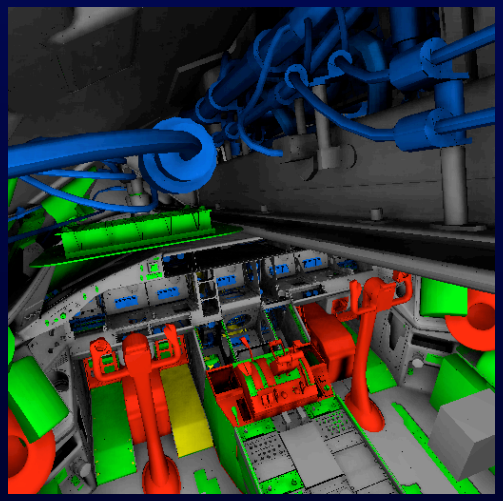
Rendering Performance Cont'd



Ambient Occlusion

62 p 1.5 Ghz

- Resolution 512x512
- 3-5 fps depending on quality.
- Not fast enough to be useful during feasibility demonstration.



Acknowledgments

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All 3D model data was provided by the Boeing Company.

Manta is open source software and contains contributions from many individuals. SGI has been, and continues to be, a principle contributor.

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- Intel Corporation
- The Boeing Company

Questions?