GPU Photon Mapping

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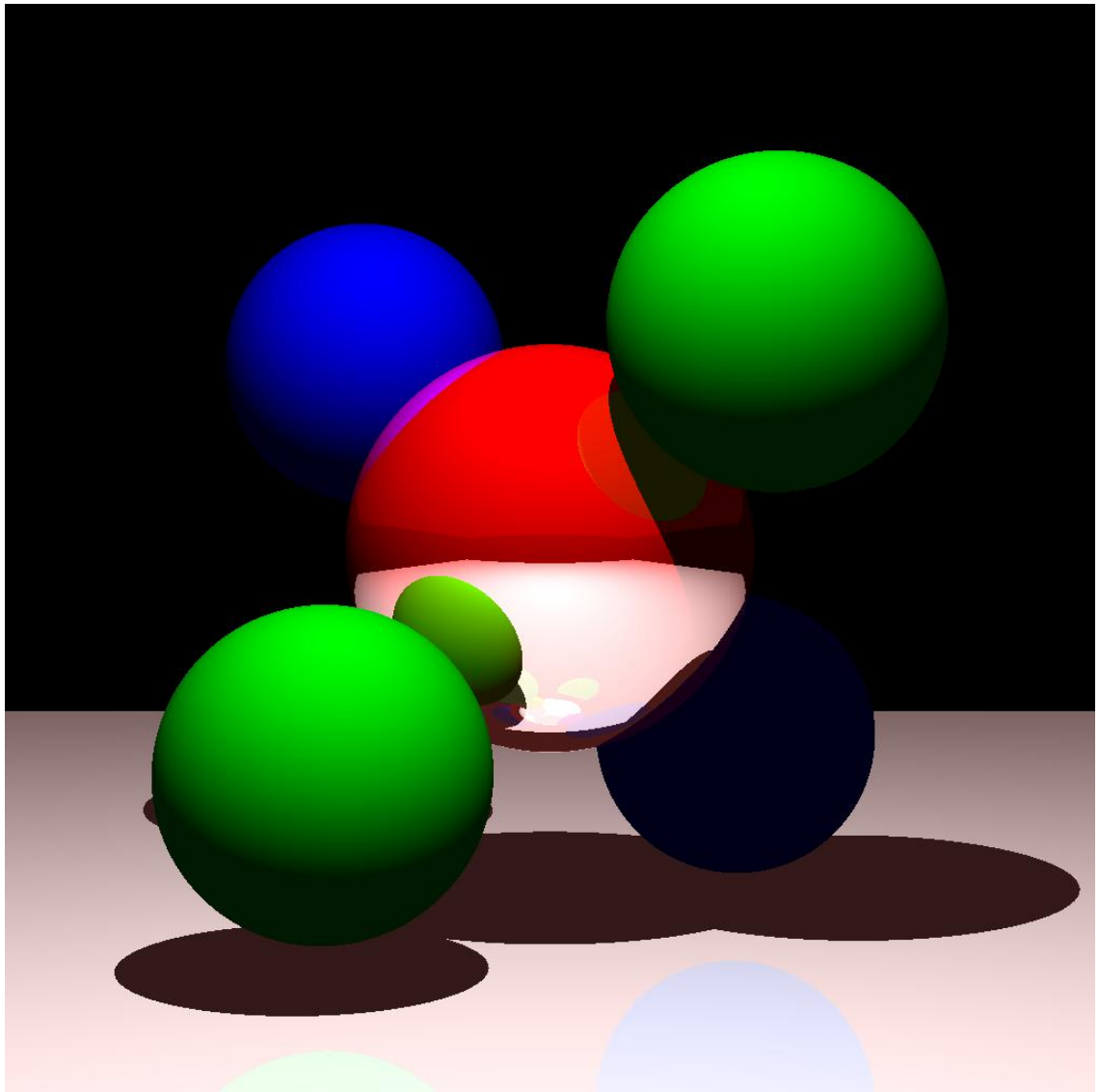
Graphics 101: What is Ray Tracing?

- Technique for generating an image
- Idea: shoot rays from light source that hit objects and bounce recursively
- For mathematically inclined: solves the Rendering Equation

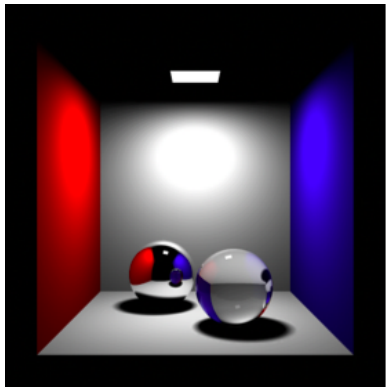
$$L_o(\mathbf{x}, \omega_o, \lambda, t) = L_e(\mathbf{x}, w_o, \lambda, t) + \int_\Omega f_r(\mathbf{x}, \omega_i, \omega_o, \lambda, t) L_i(\mathbf{x}, \omega_i, \lambda, t)(\omega_i \cdot \mathbf{n}) d\omega_i$$

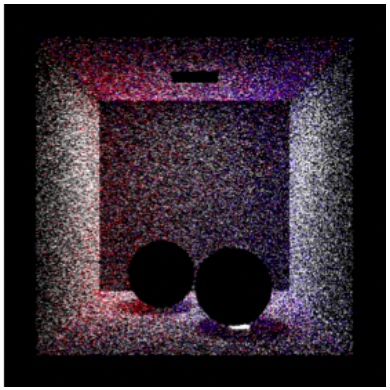
- Can simulate lots of shiny things: reflection, refraction, depth of field
- *Embarrassingly* parallel, but computationally intensive!

Graphics 101: What is Ray Tracing?



Graphics 101: What is Photon Mapping?



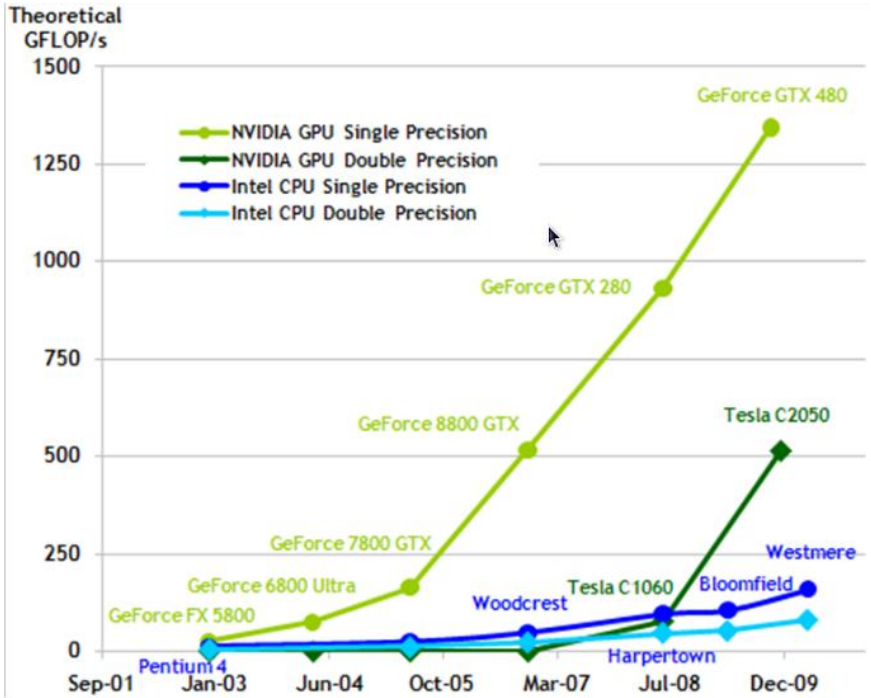


- Two-pass global illumination algorithm by Henrik Wann Jensen that solves Rendering Equation
- Idea: instead of shooting rays, shoot photons, compute radiance of photons and store in photon map, then use photon map to compute shading for image
- Advantages: global illumination is free!
- Still embarrassingly parallel, but even more computationally intensive!

- Instead of using a octree, use a 3D hash table
- Why?
  - Easier to implement on a GPU than octree because of sequential structure.
  - Octree structures contain unused entries in hierarchies and require costly pointer indirections.

The High Performance Component
GPUs to the rescue!

- GPUs are not only for games!
- Cost effective for parallel numerical tasks

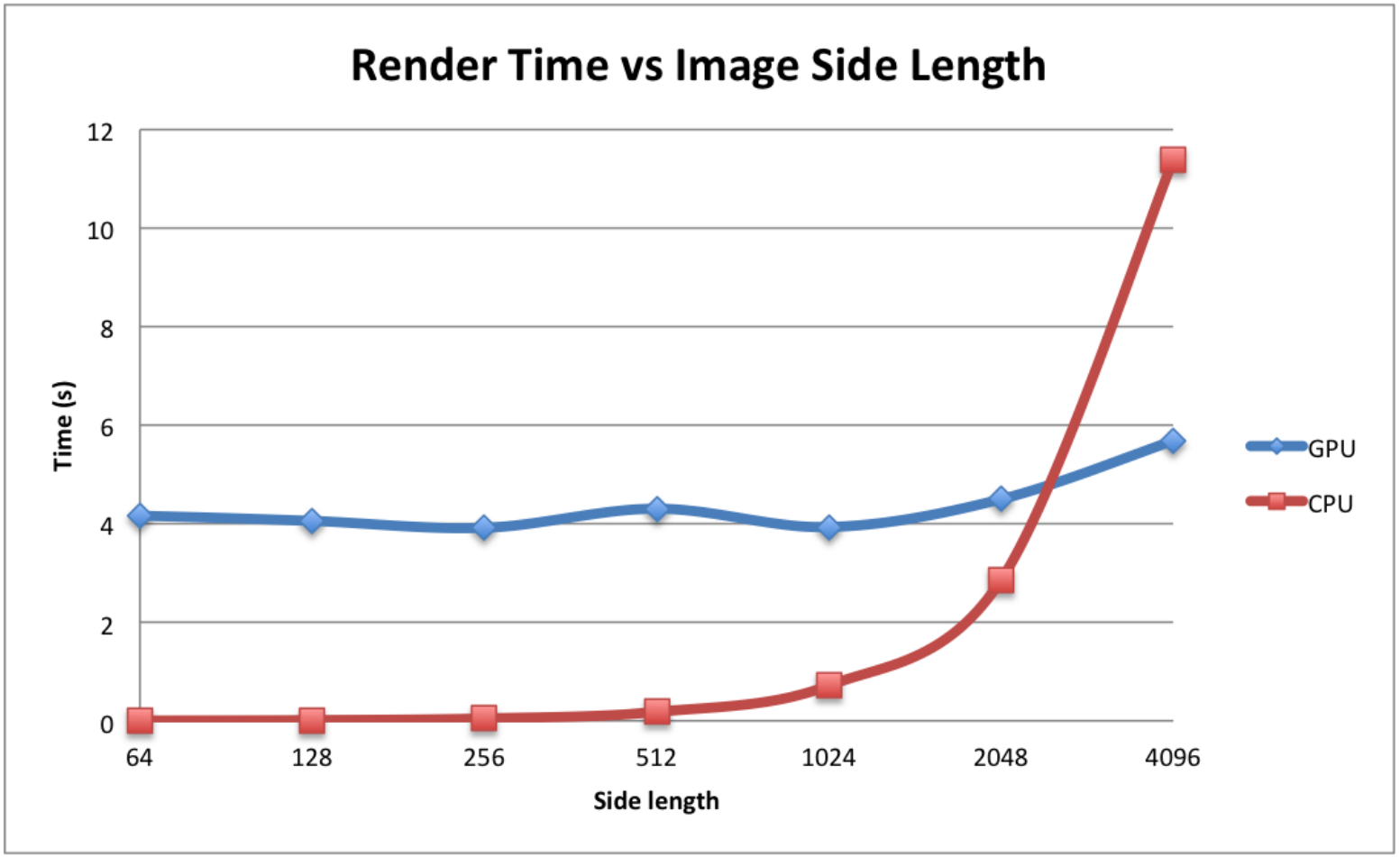


GPUs: When things get ugly

- What's a print statement?
- No recursion!
- Issues with Nvidia GNU/Linux driver and X will cause long-running jobs to get killed
- Distributing jobs over multiple GPUs with `cudaSetDevice`
- Blocks? Grids? Wha?

Preliminary Benchmark

- Rudimentarily parallelized
- GPU runs out of memory for $N = 8192$ (but who needs 64MP ray traced images???)



Questions?