Updates on Software Defined Visualization

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Why Visualization?

• Analysis & Understanding
  ➔ scale to
    • large data
    • low latency

• Communication
  ➔ high quality renderings
Software Defined Visualization

Application

OpenGL* Renderer

Mesa3D

SWR

OSPRay Renderer

Embree

Intel Xeon\(^1\) / Xeon Phi\(^2\)

\(^1\)Intel® Xeon® processor, \(^2\)Intel® Xeon Phi™ processor
SWR
Software Rasterizer
SWR Update

• Fully integrated into Mesa Open Source Project
  • Use SWR driver with GALLIUM_DRV=swr
• Maturity: 100% pass rate for VTK tests
• Support MSAA (Multi-Sample Anti-Aliasing)
• Continued performance improvements
  • Support for AVX-512
SWR Performance

M polys/sec (higher is better)

- **many spheres** (67 MPolys)
- **wavelet contour** (11 MPolys)
- **Timing Tests** (30 MTris)
- **GL Benchmarking** (30 MTris)

- **Intel® Xeon® Platinum 8180 Processor**
- **llvmpipe**
- **Intel® Xeon Phi™ 7210 Processor**
- **SWR Mesa 17.1**
- **Intel® Xeon Phi™ 7210 Processor**
- **SWR Mesa 18.0**
- **Intel® Xeon® Platinum 8180 Processor**
- **SWR Mesa 18.0**

Source: Intel

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark* and MobileMark*, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to [http://www.intel.com/performance](http://www.intel.com/performance).
SWR Upcoming

• Mesa v18.0 release imminent
• Finish AVX-512 optimizations
• Support OpenGL* 3.3
• Ongoing maintenance and new processor support
Embree
Ray Tracing Kernels
Embree Update

• v3.0
  • Streamlined API
  • Better instancing
• Bézier & B-spline curves / hair
• Memory usage down 50% (compact mode)
• Performance
  • Ray streams about 30% / 70%
  • Ray packets up to 25% / 50%
  • BVH build up to 10% (hair 2x)
Embree Performance

Frames/sec (higher is better), 1024x1024 image resolution

- **Bentley** (2.3M Tris)
- **Crown** (4.8M Tris)
- **Dragon** (7.4M Tris)
- **Karst Fluid Flow** (8.4M Tris)
- **Power Plant** (12.8M Tris)

| NVIDIA Tesla P100 Coprocessor | PCIe, 16 GB RAM |
| Intel® Xeon Phi™ 7250 Processor | 68 cores, 1.4 GHz |
| Intel® Xeon® Platinum 8180 Processor | 2 x 28 cores, 2.5 GHz |

Embree 2.16.1, Intel® C++ Compiler 17.0.2, Intel® SPMD Program Compiler (Intel® ISPC) 1.9.1

NVIDIA OptiX 4.0.2, CUDA 8.0.44

Source: Intel
Different Code Paths SKX vs. KNL

• Both AVX-512
  • But different subsets
  • ...and different micro-architecture / implementation

• Different memory subsystems (does not matter much)
SKX vs. KNL, Areas

- Prefetching
- Mixed-width vector ops (4-wide/8-wide)
  - AVX-512VL instead of masked AVX-512F
- Much more 8-wide (because of AVX-512 frequency drop)
- min/max
Embree Upcoming

• Continued optimization
  • performance
  • memory consumption
• New geometry primitives
• Denoiser
OSPRay
Ray Tracing Based Rendering Engine
Unstructured Volume Data Types

Unstructured tetrahedral and hexahedral meshes

Adaptive Mesh Refinement (AMR)

"Colliding Black Holes" courtesy Juha Jaikka and Paul Shellard, The Stephen Hawking Centre for Computational Cosmology

"Landing Gear" data courtesy Pat Moran, Cetin Kiris, Mike Barad, Tim Sandstrom, and many others, NASA AMES
Streamlines with Smoothing, per-vertex Radii
Photo-realistic Path Tracer

Available in upcoming ParaView v5.5!
New Materials (Path Tracer)
New Principled Material (Path Tracer)

- Generic & flexible Uber material
- Based on Disney’s Principled BSDF

- SC’17 demo: The new Bentley* Continental GT
- Rendered @ 60-100 fps
- Multiple nodes of Intel Xeon Platinum 8160 processors

* (*required for use in commercial applications)
Load Balancing (MPI)

- Image split into tiles
- Previously: static mapping tile → node/rank (round robin)
- But: some tiles cheaper to compute (esp. path tracing)
Dynamic Load Balancing

• Now: rank 0 tracks finished tiles, other ranks ask for next tile

• Hide fabric latencies by prefetching tiles (multiple in flight)

⇒ Better scalability
   2x-3x higher performance
MPI distributed device

- First support for in-situ, data-parallel cluster applications
OSPRay Upcoming

• Volume rendering also in path tracer
• Optimize data-parallel rendering
• Re-architecture for streaming computations
  • Better SIMD efficiency
  • Pure C++, drop ISPC
Wrap Up
Summary

• Software Defined Visualization
  • High(er) fidelity images
  • High(er) performance for interactive vis

• Take advantage
  • Directly → [www.SDVis.org](http://www.SDVis.org)
  • Using Vis tools: ParaView*, VisIt, VMD*, ...

• Collaboration, feature requests
Thank You
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