IXPUG SDVis In-Situ Workshop
Welcome and Intel SDVis Update

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Special Thanks!

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SDVis Quick Recap


Intel supported community effort enabling high performance, high fidelity and in-situ CPU based rendering

- High, interactive performance for even very large (TB+) datasets
- Fully Open Source with liberal Apache 2 and MIT License
- Single Node and Cluster-wide Scalability in 1) Render Time; 2) Render Quality; 3) 3D Model Data Size
- OpenGL and Ray Tracing Support with shadows, ambient occlusion, up to photorealistic quality

Now broadly Integrated and tested with both general and targeted domain applications

Data courtesy Kitware, Visualization, Carson Brownlee, Intel

Data courtesy Hank Childs, U Oregon, Jian Huang and Alok Hota, UTenn

Data courtesy Sean Ahern, CEI and General Motors

Data and Visualization courtesy Cyrille Favreau, EPFL

Data: Salman Habib, Katrin Heitmann, and the HACC team.
Visualization: Joe Insley, Slivio Rizzi, ANL
Mesa/OpenSWR overview

OpenGL compatibility
- Compatibility profile 3.0
- Core profile 3.3
- ES profile 3.0

Drop-in replacement, no code changes or recompilations needed
- Set a couple environment variables (LD_LIBRARY_PATH, GALLIUM_DRIVER) and run!

More info…
- www.mesa3d.org; www.openswr.org ; openswr@googlegroups.com
OpenSWR Releases

Mesa 12.0.0
• 8 July 2016
• Initial officially integrated upstream OpenSWR release

Mesa 13.0.0
• 1 November 2016
• Initial tuning of SWR integration for HPC workloads
• SWR core optimizations

Mesa 17.0.0
• 13 February 2017
• OpenGL conformance fixes

Mesa 17.1.0
• *Just Released 9 May 2017*
• Geometry shader support
• True MSAA available as an experimental feature
Benchmarks

manyspheres.py
67 MiPolys

wavelets.py
11 MiPolys

TimingTests
30 MiTris

GLBenchmarking
30MiTris
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).
Applications

Kitware/VTK/ParaView
• Close collaboration
• ParaView ships with OpenSWR (run with “—mesa-swr”)

VisIt
• OpenSWR works with current version
• Looking forward to them moving to VTK 7.0 or later

Ensight
• OpenSWR works with current version
• Looking forward to their rendering rewrite

VL3 (from Argonne National Laboratory)
• Required implementing point sprites, otherwise OpenSWR dropped in

With our OpenGL compatibility, we’re fairly confident in supporting new customers without heroics
Future development

Features done pending customer/partner requests
MSAA to be finished off and promoted to non-experimental

Build changes
• Improve integration of swr to reduce disk space
• Add KNL and SKX specific swr library builds

Performance, performance, performance
• Dynamically pick the frontend parallelization split based on machine topology
• Widen pipe to 16-wide for AVX512
• Use KNL AVX512ER instructions for shader math
• Add back early rasterization
• Allow early-Z testing to handle z-write shaders (ParaView targeted optimization)
• Optimize MSAA triangle rejection
• Investigate better lane utilization in backend
  • Small triangles (typical HPC visualization workloads) results in tiny triangles = poor lane utilization
  • Quad-packing or pixel-packing triangles (book keeping overhead, render ordering)
test configuration

KNL: Ninja Developer Platform Pedestal, Intel® Xeon Phi™ CPU 7210 @ 1.30GHz, Ubuntu 17.10, 4.10.0-20-generic, gcc 6.3.0
BDW: Intel® Xeon 2699v4 x 2 (44 cores) @ 2.20GHz, Ubuntu 17.10, 4.10.0-19-generic, gcc 6.3.0
Mesa-12: mesa-12.0.6/llvm-3.9.1
Mesa-13: mesa-13.0.6/llvm-4.0
Mesa-17.0: mesa-17.0.4/llvm-4.0
Mesa-17.1: mesa-17.1.0-rc1/llvm-4.0
Development: mesa-master(April 22)/llvm-4.0, -march=knl, patches scheduled to land, KNOB_MAX_DRAWS_IN_FLIGHT=256
pvpython manyspheres.py -s 64 -r 726 -v 1920,1080
pvpython waveletcontour.py -d 256 -v 1920,1080
TimingTests -width 1536 -height 1536 -regex SurfaceColoredWithNormals -nochart -ss 14 -se 14
GLBenchmarking --start 14 --end 14
Ray Tracing Update

Embree and OSPRay
Ray Tracing Foundation: Embree Ray Tracing Kernel Library

Provides highly optimized and scalable ray tracing kernels
• Acceleration structure build and ray traversal
• Single Ray, Ray Packets(4,8,16), Ray Streams(N)

Targets up to photorealistic professional and scientific rendering applications

Highest ray tracing performance on CPUs
• 1.5–6× speedup reported by users

Support for latest CPUs / ISAs
• Intel® Xeon Phi™ Processor (codenamed Knights Landing) – AVX-512
• Intel® Xeon® Processor (codenamed Skylake) - AVX-512 (coming soon!)

API for easy integration into applications

Free and open source under Apache 2.0 license
• http://embree.github.com
Embree Adoption* - 50+ Studios, Professional Rendering, Gaming Tools, and SIM Apps

*Many other announced users incl.: Pixar, Weta Digital, Activision, Chaos V-Ray, Ready At Dawn, FrostBite, EpicGames UnReal, High Moon, Blue Sky, UBISOFT MP, Framestore, Illumination, ….
Performance: Embree vs. NVIDIA* OptiX*

Frames Per Second (Higher is Better), 1024x1024 image resolution

- **Bentley** (2.3M Tris) - Embree: 40, NVIDIA*: 30
- **Crown** (4.8M Tris) - Embree: 45, NVIDIA*: 35
- **Dragon** (7.4M Tris) - Embree: 50, NVIDIA*: 40
- **Karst Fluid Flow** (8.4M Tris) - Embree: 35, NVIDIA*: 25
- **Power Plant** (12.8M Tris) - Embree: 20, NVIDIA*: 15

**Data and Systems**
- Intel® Xeon® E5-2699 v4 Processor
  - 2 x 22 cores, 2.2 GHz
- Intel® Xeon Phi™ 7250 Processor
  - 68 cores, 1.4 GHz
- NVIDIA Tesla P100 Coprocessor
  - PCIe, 16 GB RAM

**Software**
- Embree 2.16.0-alpha, 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

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OSPRay: A Ray-Tracing based Rendering Engine for High-Fidelity Visualization

- Build on top of Embree; Launched June 2016

- Scalable Visualization targeted features
  - Surfaces (both polygonal and non-polygonal)
  - Volumes, and volume rendering
  - High-Fidelity rendering/shading methods
  - Scalable Cluster Wide Rendering

- Packed it up in an ‘easy-to-use’ rendering library for visualization
  - Same "spirit" as OpenGL, but different API

- 10+ Application adoption in 9 months, more under development!
OSPRAY FEATURES v1.2

What OSPRay can do today:

- Ray tracing based scientific visualization
  - Extendable via in-source ‘modules’ and/or installed SDK
  - Great performance on both Intel® Xeon®, Intel® Xeon Phi™ Processors
    - Embree for very fast ray intersections
    - TBB for great thread scalability
    - Intel® SPMD Program Compiler (ISPC) for rendering/shading good vectorization

- Many ‘built-in’ rendering features
  - Geometry types (+instancing): Cylinders, Spheres, Streamlines, Triangles, Implicit isosurfaces
  - Structured volumes (regular grids) with configurable transfer functions
  - Various cameras, lights, materials, etc
  - Ambient Occlusion, Shadows, Progressive Refinement, …
  - Simple renderers (raycast, AO), to more advanced renderers (scivis, pathtracer)

- Multiple ways to scale rendering compute
  - Local rendering (single application’s CPUs + memory)
  - MPI cluster offload (single application offloading to N worker nodes via MPI)
Future development

OSPRay’s 2017 Feature Roadmap:

- Distributed API for MPI applications (Q2)
  - Built for in-situ rendering of running simulations
  - Both data-distributed geometry and volumes

- AMR “Chombo” volumes (Q2-early Q3)
  - Native rendering support with ParaView integration

- Unstructured volume support (Q3-Q4)
  - Primarily focused on natively rendering Hex and Tet meshes

- Various ongoing feature requests (and of course bug fixes!):
  - Support for instancing volumes
  - Intel® Xeon® Processor (codenamed Skylake) AVX-512 optimization
Whose Here?

Sim + Vis Teams Working Together!
Addressing Data Visualization with Intel® Solutions

Open Source Libraries Optimized by Intel®
- Optimized for parallel processing and latest instruction sets
- OpenSWR, Embree, & OSPRay available today!
- Used by ParaView, VisIt, VMD, CEI EnSight and more…

Intel® Xeon Phi™ Provides Better Performance for Visualization
- Provides up to 72 cores / CPU
- Addresses up to 384GB memory vs 16GB GPUs
- AVX-512 Instruction Optimized

Realize Compelling Value
- Cost of Host vs cost of Host + Card for GPUs
- Plus -> Increased performance for visualization
- Additional use as general purpose compute platform

For in-situ, post-processing, and professional rendering visualization needs
ANNOUNCING…. The Turnkey SDVis Appliance!!

**Installed Software** Intel® HPC Orchestrator, SDVis Libraries (Embree, OSPRay, Mesa/OpenSWR), Open Source Apps (ParaView, VTK, VisIt, VMD), Intel Parallel Studio Cluster Edition, SW Dev. Tools

**Nodes** 8x Intel® Xeon Phi™ 7250 compute nodes, Intel® Xeon ® E5-v4 head node + 6 monitor display card, Intel® Xeon ® E5-v4 storage node

**Storage** 32TB Raid

**Network** 24 port Omni-Path & Ethernet switches

**Targeting Launch Mid-Year**

**Ordering & More Info**
Ordering: sales@colfax-intl.com
Information: http://sdvis.xeonphi.com/

Pre-configured solution for visualization apps and development needs!
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