Software Defined [In Situ] Visualization

Jim Jeffers, PE & Director, SW Defined Visualization, Intel Corporation
james.l.jeffers@intel.com; Twitter: @jamesljeffers
**SDVis Quick Recap**

Intel supported community effort for high performance, high fidelity, 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*
Software Defined Visualization (SDVis) OVERVIEW


Embree
- CPU Optimized Ray Tracing Algorithms
- ‘Tool kit’ for Building Ray Tracings Apps
- Broadly Adopted by 3rd Party ISVs
- More at http://embree.github.io

OSPRay
- Rendering Engine Based on Embree
- API Designed to Ease Creation of Visualization Software
- More at http://ospray.org

OpenSWR
- High Performance CPU Vis Rasterization
- Fully Integrated into MESA v12.0+ ParaView, VTK, Visit, EnSight, VL3
- More at http://openswr.org

Data and Vis Courtesy Florida International University and TACC
OPENGL (OpenSWR) 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.
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).
PERFORMANCE TEST

PLATFORMS

Two machines:

• KNL: 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

Four tests:

• manyspheres.py (-s 64 -r 726 -v 1920,1080) – paraview benchmark script
• waveletcontour.py (-d 256 -v 1920,1080) – paraview benchmark script
• TimingTests (-width 1536 -height 1536 -regex SurfaceColoredWithNormals -nochart -ss 14 -se 14) – vtk benchmarking app
• GLBenchmarking (--start 14 --end 14) – vtk benchmarking app
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× typical 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
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)
- **Crown** (4.8M Tris)
- **Dragon** (7.4M Tris)
- **Karst Fluid Flow** (8.4M Tris)
- **Power Plant** (12.8M Tris)

---

**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

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

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).
# Path Tracer Renderer Configuration (slide 11)

## Intel® Xeon Phi™ 7250 Configuration

<table>
<thead>
<tr>
<th>Node count</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Platform</strong></td>
<td></td>
</tr>
<tr>
<td>CPU</td>
<td>Intel® Xeon Phi™ 7250 Processor (16GB MCDRAM, 1.40 GHz, 68 cores)</td>
</tr>
<tr>
<td>RAM</td>
<td>64 GB DDR4 total, 16 GB MCDRAM in quad/cache mode</td>
</tr>
</tbody>
</table>
| BIOS | Vendor: Intel Corporation  
Version: S72C610.86B.01.01.0147.060220162105  
06/02/2016  
BIOS Configuration: default, turbo on, hyper-threading on |
| OS / Kernel | Fedora* Core 23 Server / 4.8.13-100.fc23.x86_64  
Linux Power Scheme: performance governor  
8 GB of pre-allocated 2MB pages |

## Nvidia* Tesla* P100 GPU Accelerator Configuration

<table>
<thead>
<tr>
<th>Node count</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Platform</strong></td>
<td></td>
</tr>
</tbody>
</table>
| CPU | 2 x Intel® Xeon® E5-2697 v4 Processor  
(Dual socket, 2.3GHz, 2 x 18 cores) |
| RAM | 256 GB total |
| BIOS | Vendor: Intel Corporation  
Version:  
Release Date:  
BIOS Configuration: default, turbo on, hyper-threading on |
| NVIDIA Co-Processor | Tesla P100-PCIE-16GB (GP100)  
3584 CUDA Cores  
16GB HBM2 memory  
Software Details:  
Driver Version: 375.20  
CUDA Version 8.0.44  
OptiX* Version 4.0.2 |
| OS / Kernel | Red Hat* Enterprise Linux Server 7.2 / 3.10.0-327.el7.x86_64 |

*Other names and brands may be claimed as the property of others.
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 12 months, more under development!
A TURNKEY SDVIS APPLIANCE SOLUTION

For:

**In Situ Compute+Vis!**; Vis Walls up to 6 UHD Displays; HPC Compute, Vis+HPC SW Development and EVEN Post-Processing Vis 😐
Announcing the Turnkey SDVis Appliance!

Improving Data Visualization with Intel® Solutions

- Optimized for parallel processing and latest instruction sets
  - OpenSWR, Embree, & OSPRay all available
  - Used by ParaView, VisIt, VMD, CEI EnSight, and more…

- Lower cost of host vs cost of host + card for GPUs
  - Single host can address up to 384GB memory
  - Additional use as general purpose compute platform

- 1.58x to 1.91x better performance than GPUs
  - Supports data sets up to 1.5TB
  - Standard configuration price $79,000

For in-situ, post-processing, and professional rendering visualization needs

*Other names and brands may be claimed as the property of others.*

1Software 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 complete information visit [www.intel.com/benchmarks](http://www.intel.com/benchmarks).

1Source: Intel measured or estimated as of May 2017. See slide 7 for performance measurements. Configuration Details: See slide 5.

2Pricing as of June 15, 2017. Pricing is subject to change without notice.
SDVis Appliance Solution

**Installed Software** Intel® HPC Orchestrator, SDVis Software (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, Intel® Xeon® E5-v4 storage node

**Storage** 32TB Raid

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

**Available 4 weeks after ordering**

**Price** $79,000 (1 year SW subscriptions)

**Pre-configured solution for visualization needs**

*Other names and brands may be claimed as the property of others.*

1Pricing as of June 15, 2017. Pricing is subject to change without notice
**SDVis Appliance**

- Includes all the necessary software for visualization and rendering, node management, and software development.
- Address up to 1.5TB data sets using 8 Intel® Xeon Phi™ 7250 68 core compute nodes.
- Intel® Xeon® E5-v4 36 core management node.
- Intel® Xeon® E5-v4 16 core storage node with 32TB RAID storage.
- Features Intel® Omni-Path interconnect fabric.

**14U Rack**

**Software:** SDVis Software (ParaView, VTK, VisIt, VMD), Intel® Parallel Studio XE Cluster Edition, Intel® HPC Orchestrator, SW Dev. Tools.

- 24 port Ethernet Switch
- 24 port Intel® Omni-Path Switch
- Intel® Xeon® Management Node
- 4x Intel® Xeon Phi™ Compute Nodes
- 4x Intel® Xeon Phi™ Compute Nodes
- Intel® Xeon® Storage Node (32TB RAID)
- Power Distribution Unit

**Available Now!**

The SDVis Appliance is more than just a good idea, it is available now from Colfax International. For more information use the links below.

**Product Webpage:**
http://sdvis.xeonphi.com/

**Sales Contact:**
sales@colfax-intl.com

---

**Includes all the necessary software for visualization and rendering, node management, and software development.**

**Address up to 1.5TB data sets using 8 Intel® Xeon Phi™ 7250 68 core compute nodes.**

**Intel® Xeon® E5-v4 36 core management node.**

**Intel® Xeon® E5-v4 16 core storage node with 32TB RAID storage.**

**Features Intel® Omni-Path interconnect fabric.**
Live SDVis Demos @ ISC Intel Booth

DKRZ – German Weather Visualization

TOTAL – Seismic Oil & Gas Discovery Visualization

Los Alamos Nat’l Lab – Asteroid Deep Ocean Impact

EasternGraphics pCon.Planner – "Rendering in the Cloud"
Notices and Disclaimers

Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.

For more complete information about performance and benchmark results, visit www.intel.com/benchmarks.

Intel technologies’ features and benefits depend on system configuration and may require enabled hardware, software or service activation. Learn more at intel.com, or from the OEM or retailer.

The cost reduction scenarios described are intended to enable you to get a better understanding of how the purchase of a given Intel based product, combined with a number of situation-specific variables, might affect future costs and savings. Circumstances will vary and there may be unaccounted-for costs related to the use and deployment of a given product. Nothing in this document should be interpreted as either a promise of or contract for a given level of costs or cost reduction.

Optimization Notice: Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice. Notice Revision #20110804.

No computer system can be absolutely secure.

Intel® Advanced Vector Extensions (Intel® AVX)* provides higher throughput to certain processor operations. Due to varying processor power characteristics, utilizing AVX instructions may cause a) some parts to operate at less than the rated frequency and b) some parts with Intel® Turbo Boost Technology 2.0 to not achieve any or maximum turbo frequencies. Performance varies depending on hardware, software, and system configuration and you can learn more at http://www.intel.com/go/turbo.

Intel processors of the same SKU may vary in frequency or power as a result of natural variability in the production process.

SPEC, SPECfp and SPECint are registered trademarks of the Standard Performance Evaluation Corporation (SPEC).

© 2017 Intel Corporation. Intel, the Intel logo, Xeon, Xeon Phi, Intel Xeon Phi logos and Intel Xeon logos are trademarks of Intel Corporation in the U.S. and/or other countries. *Other names and brands may be claimed as the property of others.