
INTEL® HPC DEVELOPER CONFERENCE
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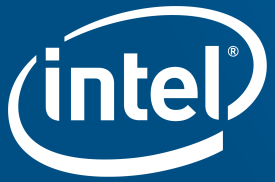
VISUALIZATION TRACK WELCOME AND SDVIS UPDATE

Intel HPC Developer Conference

November 2016

Outline

- The Pendulum of Computing
- State of ~~The Union~~ Software Defined Visualization(SDVis)
  - Quick Refresher – What is SDVis? Why?
  - We are we today? (*Hint: Launched and Active Integrations*)
- Visualization @ HPCDC and SC'16 Overview
- Summary

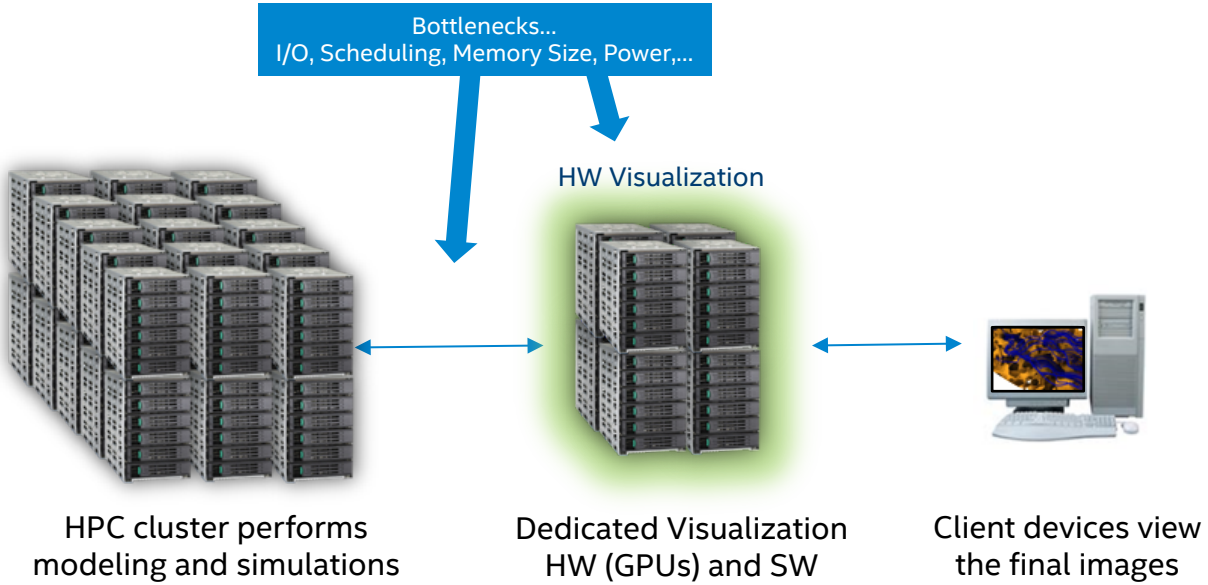


PENDULUM

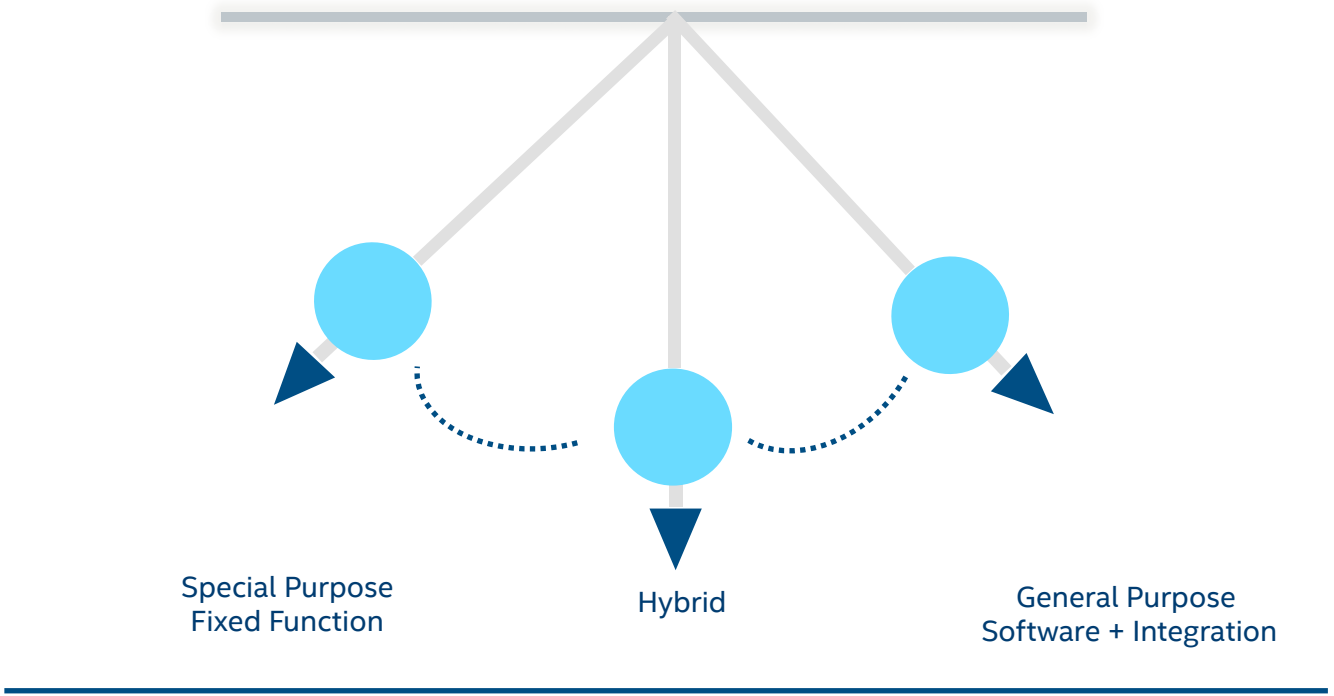
The Challenge with '*Traditional*' Large Scale Visualization

Circa 2010 - 2015

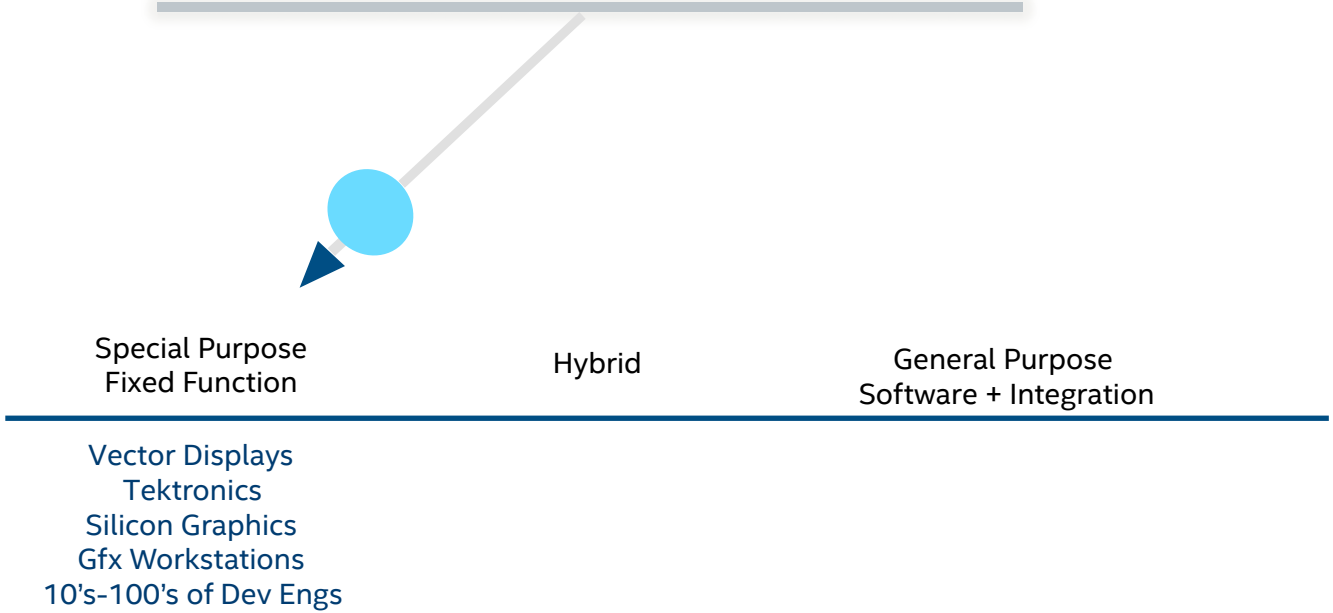
Using Dedicated hardware and specialized software



The Pendulum of Computing

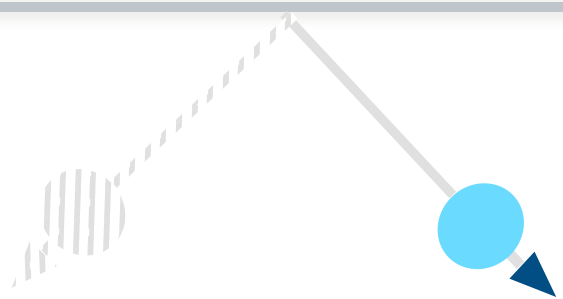


The Pendulum of Computing
Example: Graphics/Visualization – 1970's->80's



Digital Graphics starting to emerge but in the realm of "specialty" uses

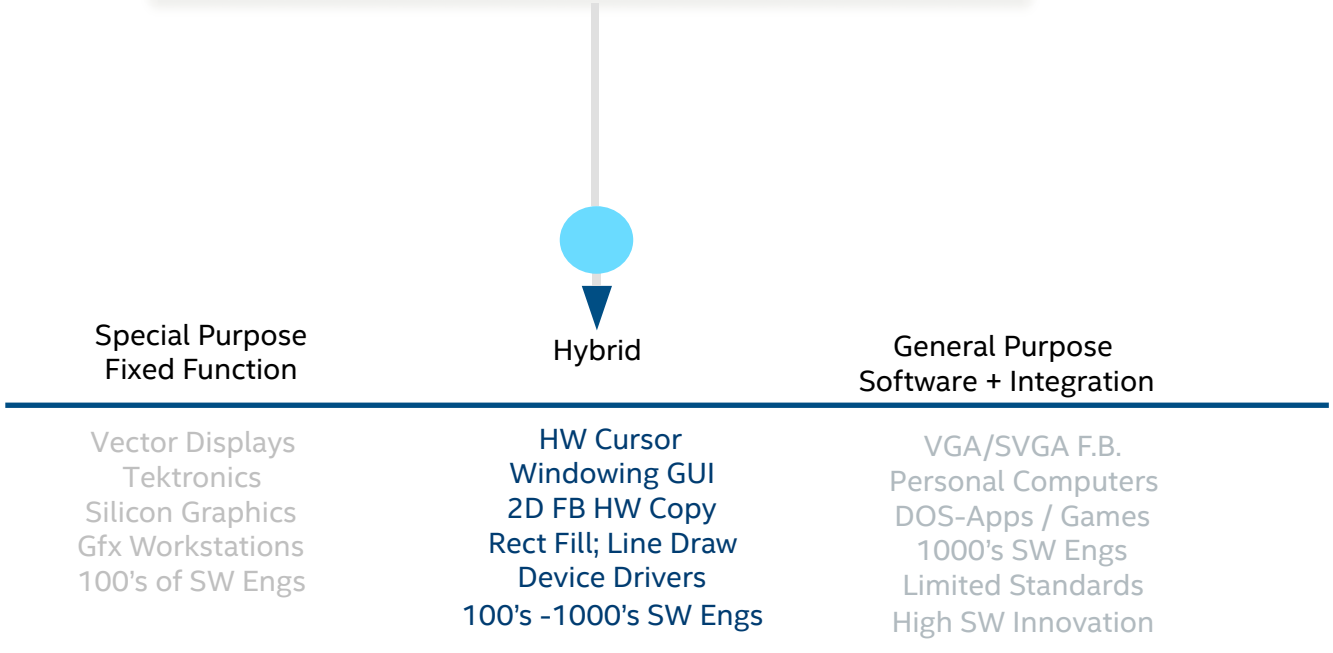
The Pendulum of Computing
Example: Graphics/Visualization – ~1980's-90's



Special Purpose Fixed Function	Hybrid	General Purpose Software + Integration
Vector Displays Tektronics Silicon Graphics Gfx Workstations 100's of SW Engs		VGA/SVGA "Frame Buffers". Personal Computers DOS-Apps / Games 1000's SW Engs Limited Standards High SW Innovation

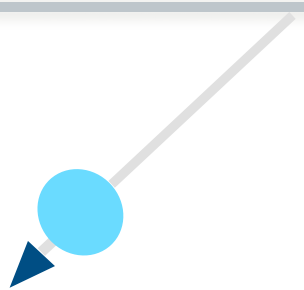
Inflection Point: PCs Democratize Computing and Development

The Pendulum of Computing
Example: Graphics/Visualization – ~1990-'95



Inflection Point: GUI Systems + Standards Emerge - Algo's Mature

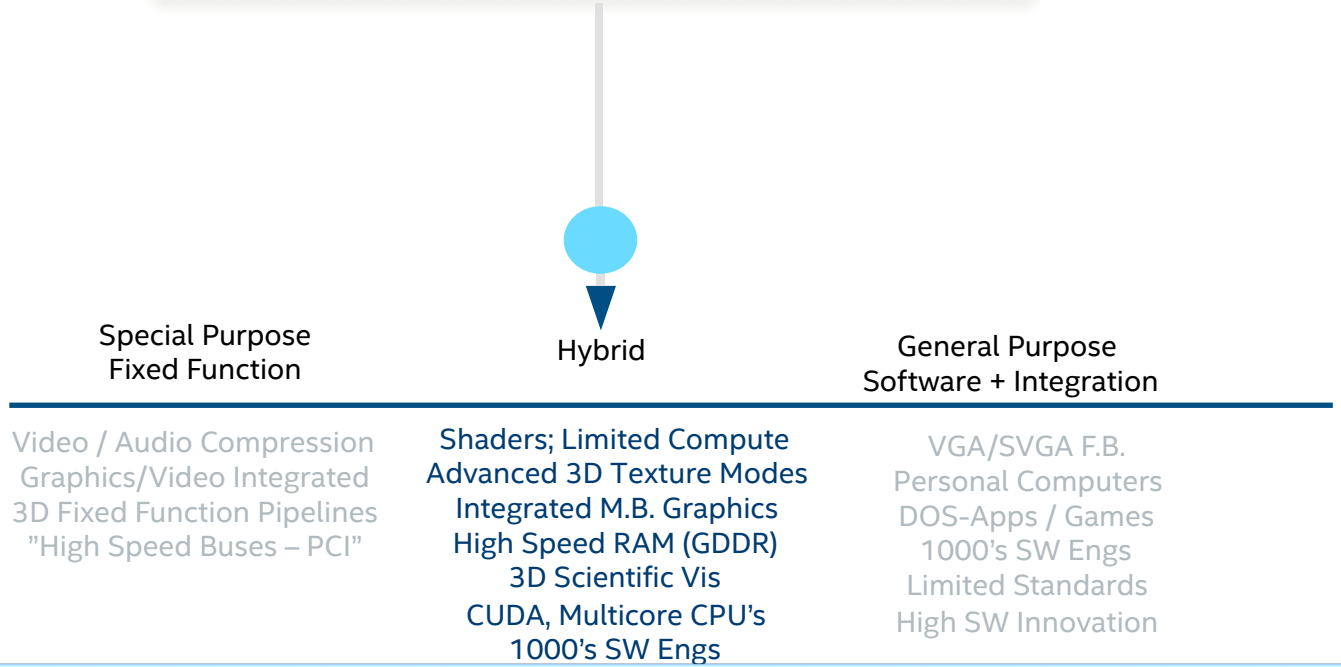
The Pendulum of Computing
Example: Graphics/Visualization – ~1995->2000



Special Purpose Fixed Function	Hybrid	General Purpose Software + Integration
Video / Audio Compression Graphics/Video Integrated 3D Fixed Function Pipelines "High Speed Buses – PCI" 100's SW Engs Limited Software Innovation	HW Cursor Windowing GUI 2D FB HW Copy Rect Fill; Line Draw	VGA/SVGA F.B. Personal Computers DOS-Apps / Games 1000's SW Engs Limited Standards High SW Innovation

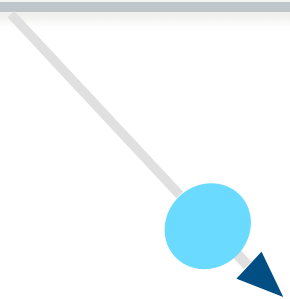
Inflection Point: Windows 95, DirectX/OpenGL, 3D Gaming

The Pendulum of Computing
Example: Graphics/Visualization – ~2000-'14



Inflection Point: 3D Gaming "Realism" drives programmable shaders, improved flexibility
HPC Compute Adjacency + CUDA + Multicore -> Parallel Computing Emerges

The Pendulum of Computing
Example: Graphics/Visualization – 2014 -> ?



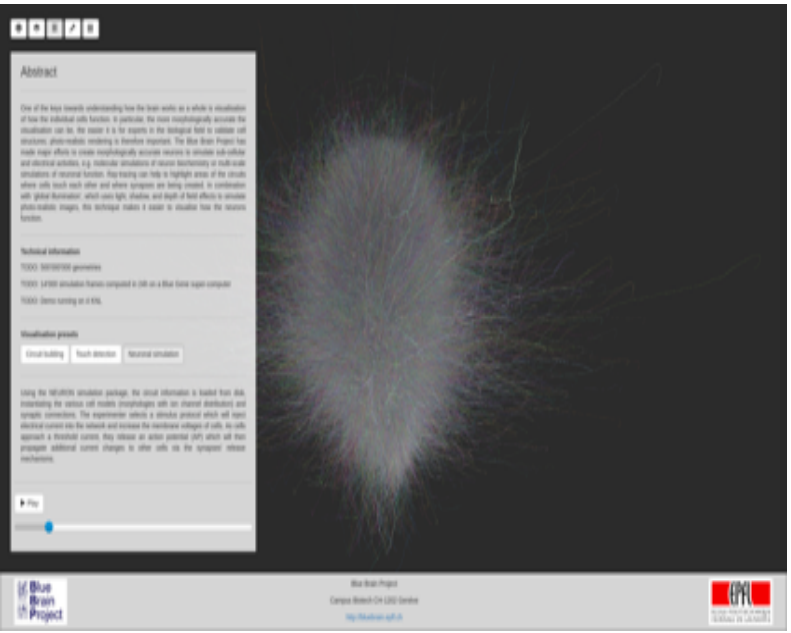
Special Purpose Fixed Function	Hybrid	General Purpose Software + Integration
Video / Audio Compression Graphics/Video Integrated 3D Fixed Function Pipelines "High Speed Buses – PCI"	Shaders; Limited Compute Advanced 3D Texture Modes Integrated M.B. Graphics High Speed RAM (GDDR) 3D Scientific Vis CUDA, Multicore CPU's 1000's SW Engs	Multicore and Many-Core CPU's Integrated CPU Graphics HBW Memory and Caches Big Data High SW innovation (perf+fidelity) SciVis analysis growth 1000's - 10,000's+

A "New" Inflection Point?: Big Data, I/O Bottlenecks, Power, TCO challenges
8+ cores, SIMD CPUs, On-Package High Bandwidth Memory

So what does this mean for Visual Analysis and Workflows?

Example: EPFL Blue Brain Project
"Brayns" + OSPRay
Brain Neuron Growth 3D Visualization

Web-Based GUI

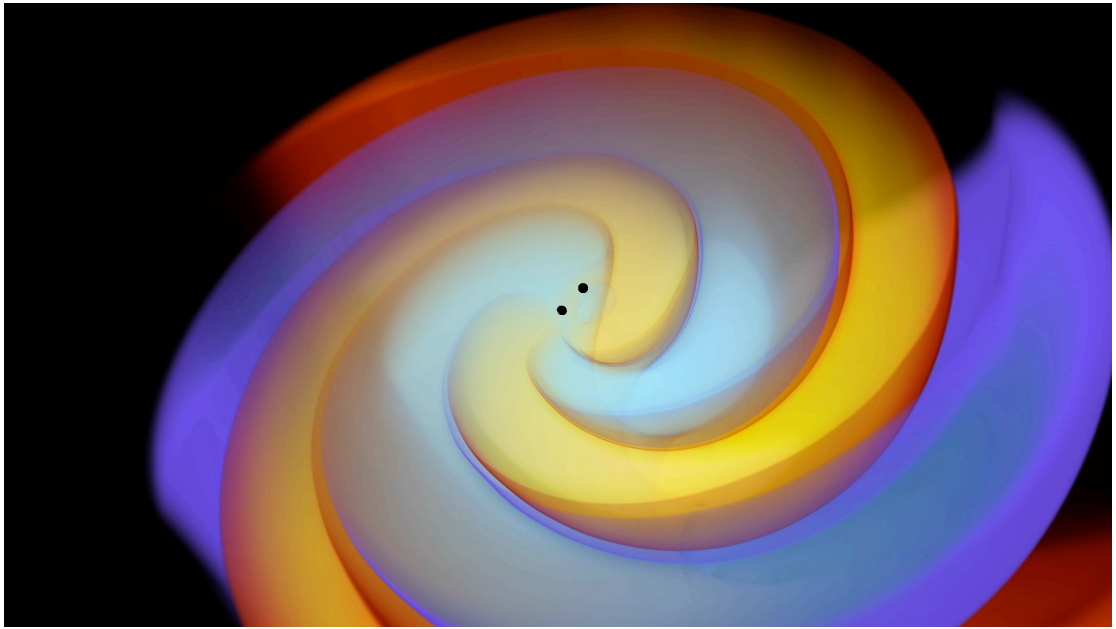


Large Display or Display Wall Output

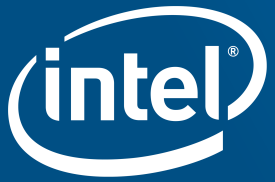
Real-time Simulation of Brain Neuron Formation and Electrical Impulses
~70 GB of Input Data @ 15-20fps; Shown using 4 Knights Landing Processors @ ISC'16 Intel Booth
IMPOSSIBLE FOR A TETHERED GPU WITH LIMITED MEMORY AND Bandwidth!

Example:GR-Chombo Black Hole Collision

Stephen Hawking CTC



LIGO Black Hole Collision simulation and resulting Gravitational Waves
1200 Timesteps over 0.2s – Collide @ 'Speed of Light'
3.6 TB Postprocessed (from 36 TB) Dataset
IMPOSSIBLE FOR A TETHERED GPU WITH LIMITED MEMORY AND Bandwidth!

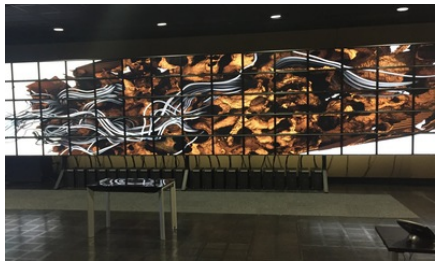


STATE OF SOFTWARE DEFINED VISUALIZATION - 2016

Refresher – Why SDVis and What is it?

Our Vision: Scalable, Flexible Vis Rendering that Runs Anywhere!

Standalone Laptops or Workstations

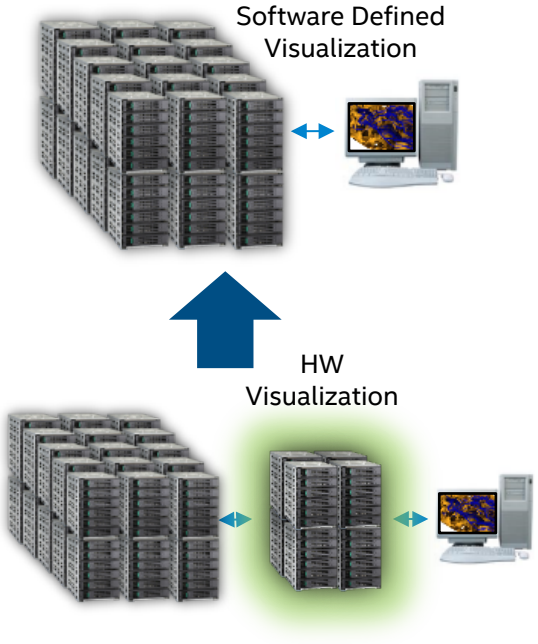


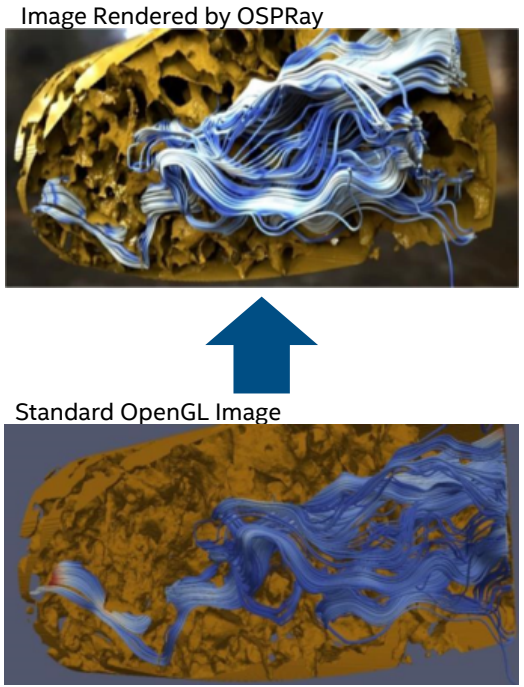
Big Memory Nodes or Rendering Focused Clusters

Large Compute+Vis clusters with Local or Remote Clients

How?

Intel® SSF and Intel-Supported Software Defined Visualization (SDVis)!





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+
- Supports ParaView, Visit, VTK, EnSight, VL3
- More at http://mesa3d.org

Addressing Large-scale, High Performance, and High Fidelity Visualization with SDVis

Gain deeper understanding of data impacting science & discovery

High fidelity, more realistic images even as data sets become increasingly larger, and more complex; no need to compromise data resolution

Solve computing + modeling problem together (in-situ vis)

Essential SW development suite that makes concurrent simulation and visualization efficient – users can work interactively and get results quicker

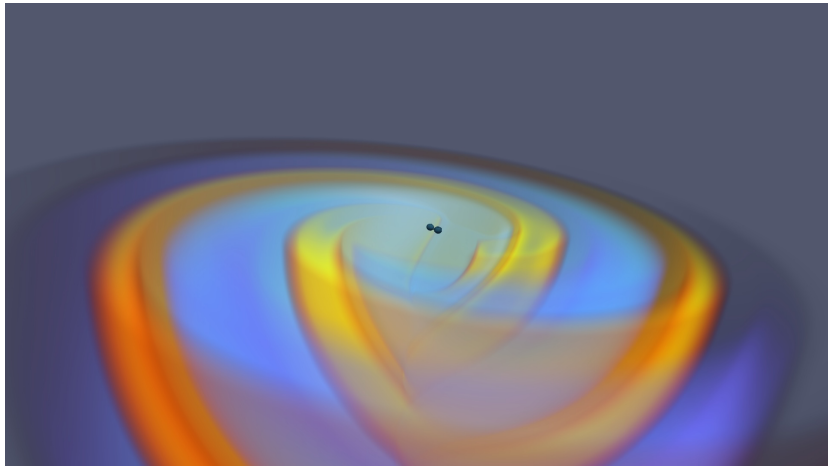
One system

Use same system for both simulation and visualization, avoid data transfer delays and memory size constraints – faster insights for solving toughest problems

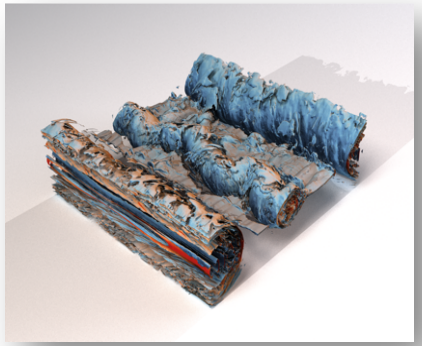
Benefits of SDVis

- Open-sourced technology delivering vivid visualization of complex, enormous data sets
- Innovative software libraries for visualizing results with *high performance* by unlocking the parallelism already in your system
- *High-fidelity* images for gaining deeper insights in science and industry, faster
- Software Only solution *lowers costs* – no card cost, no card maintenance, lower power bills

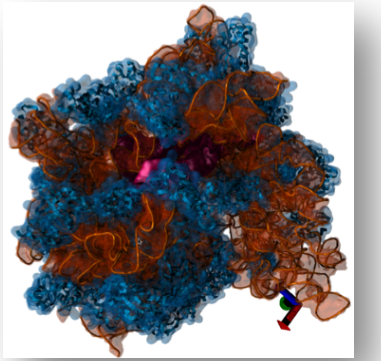
Your Work. No Compromises.



Gravational Waves : GR-Chombo AMR Data, Stephen Hawking CTC, UCambridge; Queens College, London; visualization, Carson Brownlee, Intel, ParaView)



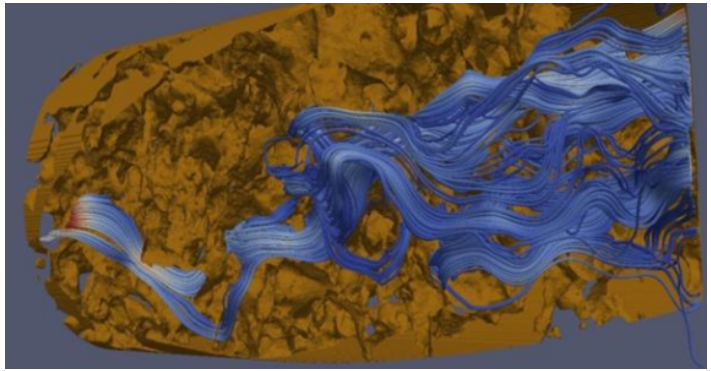
Magnetic Reconnection Model, Courtesy Bill Duaghton(LANL) and Berc Geveci(Kitware)

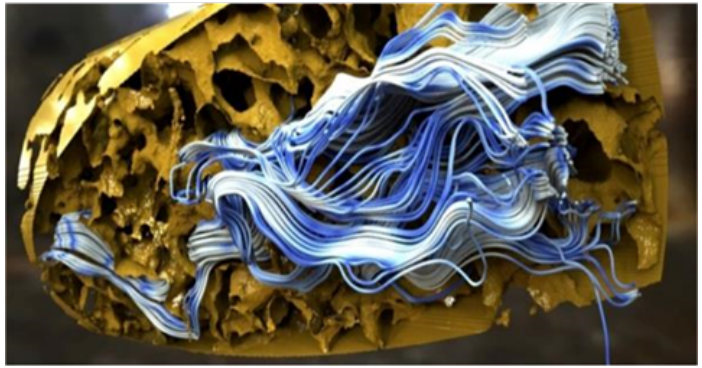


Ribosome: Data: Max-Planck Institute for Biophysical Chemistry

Hi-Fidelity Visualization with…

- … scalable image quality
- … scalable model size
- … scalable in rendering cost





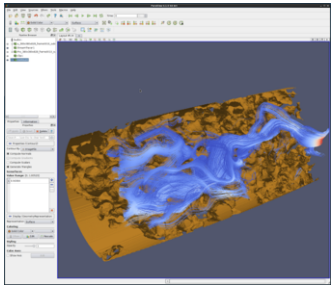
Data set provided by Florida International University

OpenSWR Software Rasterizer

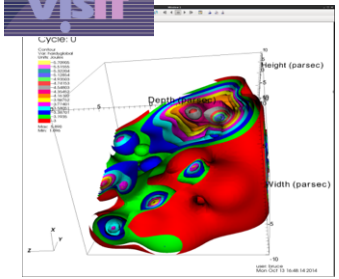
(www.mesa3d.org
www.openswr.org)

- High performance open source software implementation of OpenGL* rasterizer
  - Fully multi-threaded and vectorized for Intel® processors
  - Can access full system memory - highest resolution data
  - Leverages community development effort (MESA)
- Drop in replacement for OpenGL library
- Available since July'16 in Mesa v12.0+ targeting features and performance for leading SciVis Apps

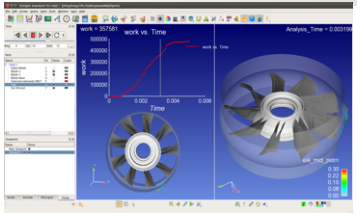
ParaView



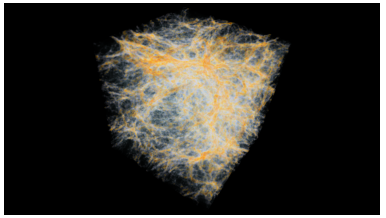
VISIT



CEI EnSight Extreme Visualization Software



Argonne NATIONAL LABORATORY VL3



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

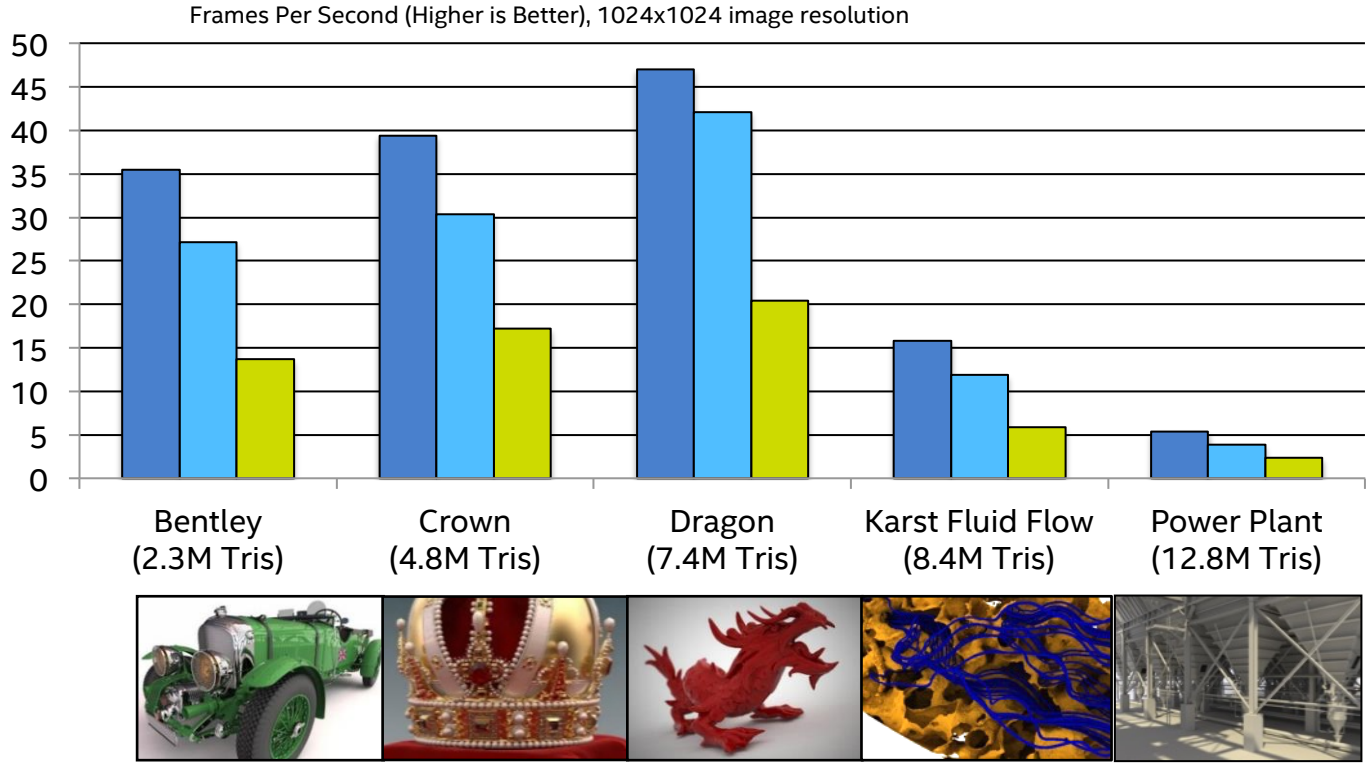
- Intel® Xeon Phi™ Processor (codenamed *Knights Landing*) – AVX-512

API for easy integration into applications

Free and open source under Apache 2.0 license

- http://embree.github.com

Performance: Embree vs. NVIDIA* OptiX* (Pascal)



- Intel® Xeon® Processor E5-2699 v4
  2 x 22 cores, 2.2 GHz
- Intel® Xeon Phi™ Processor 7250
  68 cores, 1.4 GHz
- NVIDIA TITAN X (Pascal) Coprocessor
  12 GB RAM

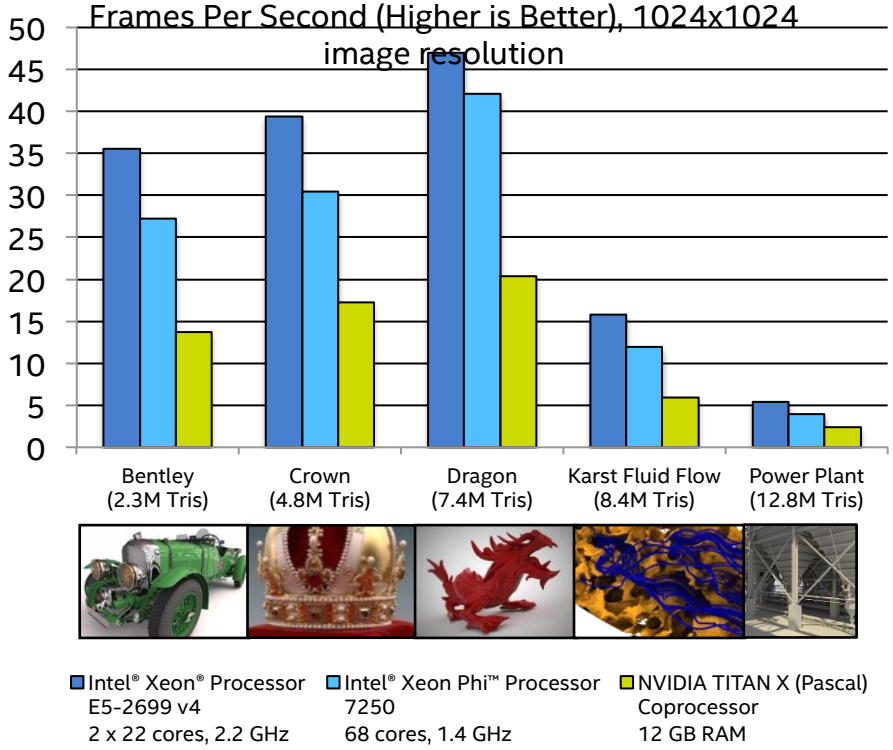
Embree 2.12.0, ICC 2016 Update 1, Intel® SPMD Program Compiler (Intel® ISPC) 1.9.1

NVIDIA* OptiX* 4.0.1, 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.

Intel
Path Tracer Renderer Sample



Application: Path Tracer Renderer using Embree and OptiX* RT Libraries

Description: Path tracing app for use in benchmarking RT libraries

Availability:

- **Code: embree.github.io**
- **Recipe:** *embree.github.io.*

Usage Model:

- TBB, ISPC and Intrinsics

Highlights:

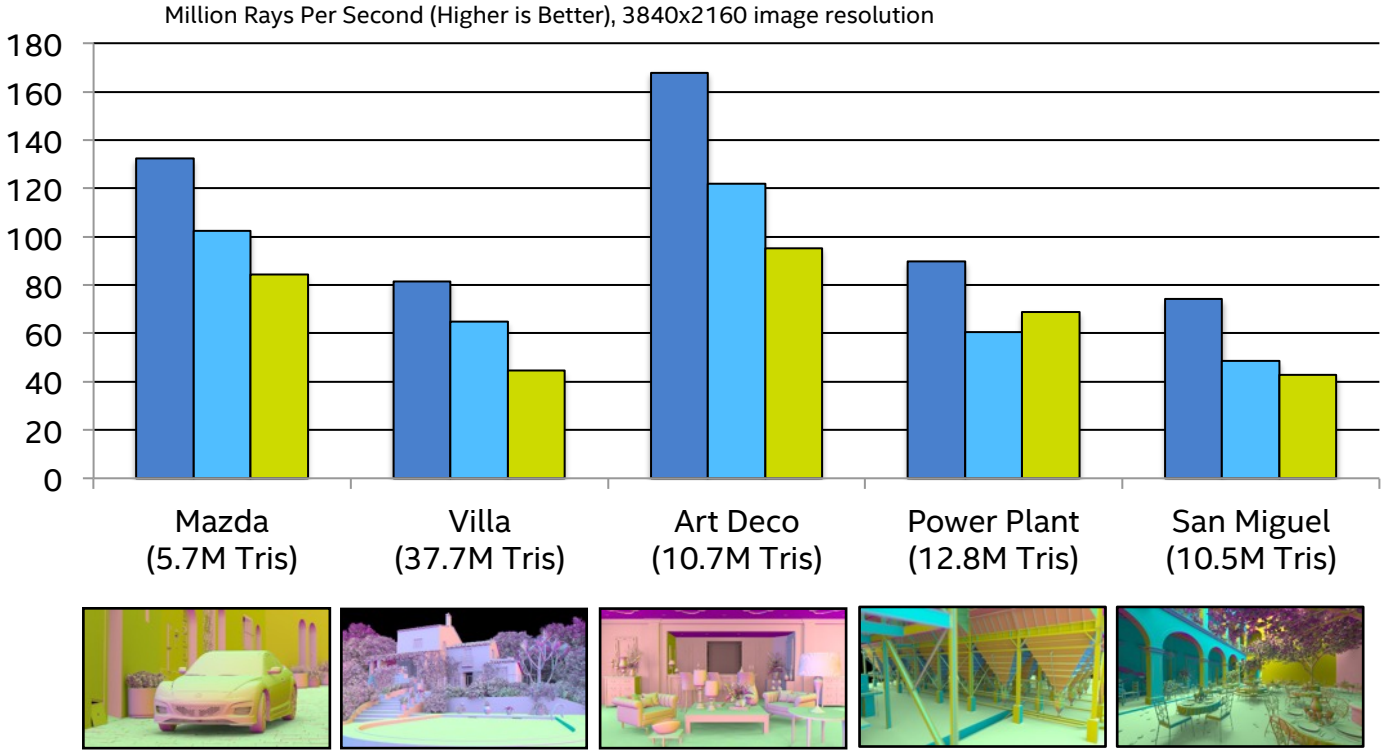
- The code represents a typical ray tracing rendering pipeline used throughout DCC to show comparative performance on different types of hardware with a variety of input 3D data models. It has been optimized for all Intel ISA;s and delivered to the community and available for download from embree.github.io
- End-User benefits: Ability to achieve competitive performance and the flexibility of IA for rendering and render farm applications

Results:

- Embree on dual socket (44 cores total) Intel® Xeon® E5-2699 v4 Processor performs 20% - 30% faster than Intel® Xeon Phi™ 7250 Processor
  - Path tracing causes low SIMD utilization (better for Xeon)

- Embree on dual socket (44 cores total) Intel® Xeon® E5-2699 v4 Processor more than 2x faster than OptiX on NVIDIA TITAN X (Pascal) GPU.
  - Path tracing causes low SIMD utilization (better for Xeon)
  - Large path tracing kernel requires many registers (thus fewer threads executed on GPU)

Diffuse Path Tracing Performance: Embree vs. NVIDIA* OptiX* Prime



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- Intel® Xeon Phi™ Processor 7250
  68 cores, 1.4 GHz
- NVIDIA TITAN X (Pascal) Coprocessor
  12 GB RAM

Embree 2.12.0, Intel® C++ Compiler 17.0

NVIDIA* OptiX* Prime 4.0.1, CUDA* 8.0.44

Source: Intel

Embree Adoption*

DreamWorks

UBISOFT MOTION PICTURES

AUTODESK.

EasternGraphics visualize your business

SURVICE ENGINEERING COMPANY

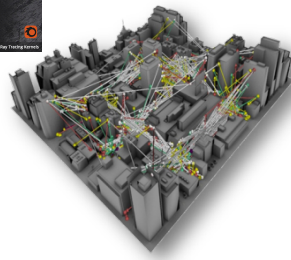
FluidRay RT Physically Based Renderer

corona

Simlab Soft Bringing Art closer

3DEXCITE

Courtesy of Jeff Patton, Rendered with Corona Renderer



Rendered with StingRay, SURVICE Engineering

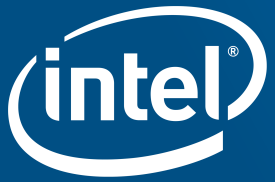
Image rendered with FluidRay RT

pCon.planner rendered courtesty EasternGraphics

*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,....

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

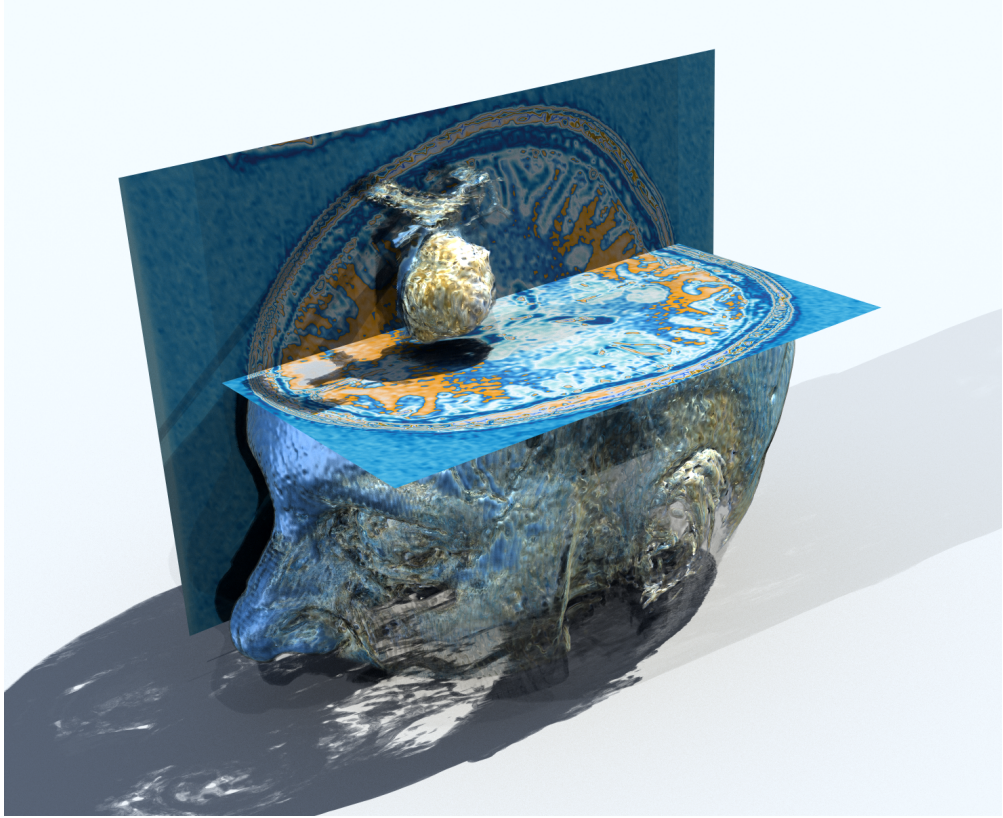


WHERE ARE WE TODAY?
WHAT IS BEING DONE WITH SDVIS?

ParaView v5.2 with integrated OSPRay and OpenSWR

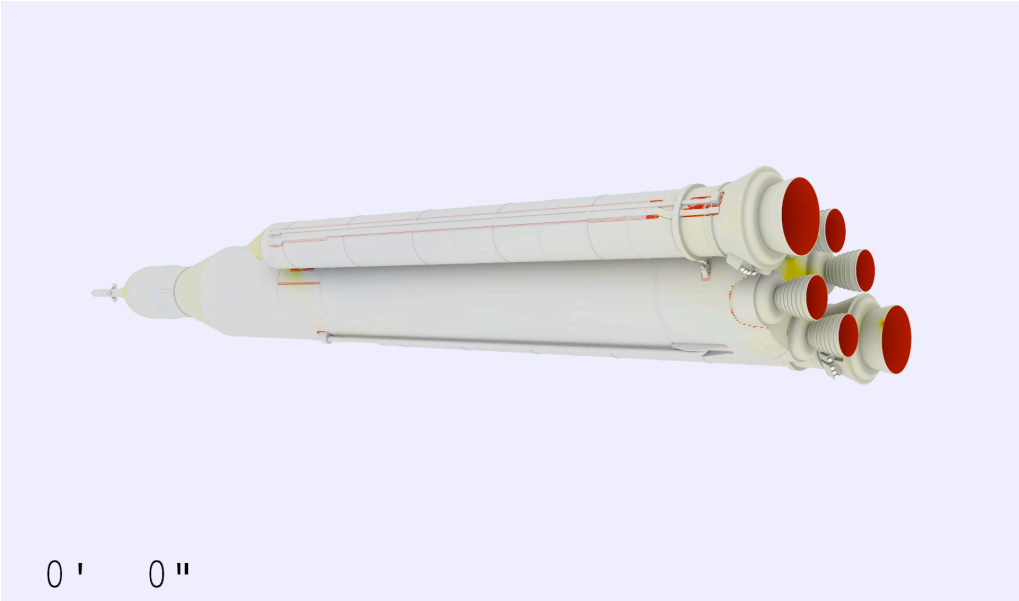
- Brain Tumor monitoring and treatment
- 3D interactive @ 10-20fps
- Intel® Xeon Phi™ processor cluster
- Ambient occlusion plus shadows
- Stop by the Intel SC'16 booth to see it live!

- Data courtesy Kitware. Visualization, Carson Brownlee, Intel



NASA – Custom OSPRay App

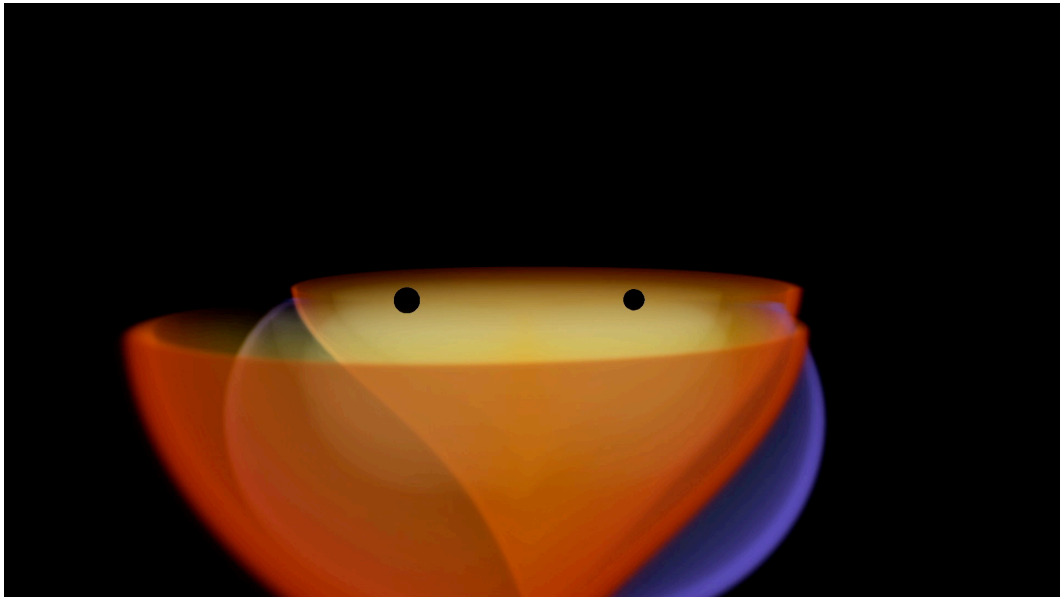
- Simulated on Pleiades supercomputer
- Rendered on attached ‘hyperwall’ cluster
- Dataset: SRB booster separation from SLS



Simulation: Jeff Onufer and Tom Pulliam, NASA Ames
Visualization: Tim Sandstrom and Pat Moran, NASA Ames

Stephen Hawking Centre for Theoretical Cosmology – ParaView / VTK with OSPRay

- 600 GB Memory Footprint
- 36 TB Simulation Data Set
- 4 Intel® Xeon Phi™ 7230 Processors
- 1 Intel® Xeon® E5 v4 Dual Socket node
- Intel® Omni-Path Fabric
- ~10 fps
- See a demo in the SC'16 Intel "Discovery Zone"



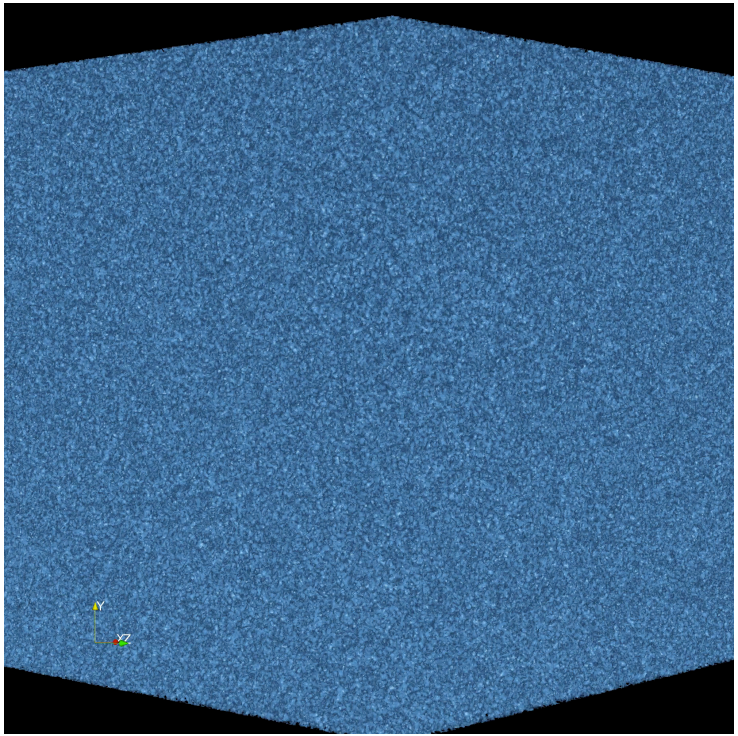
Gravational Waves : GR-Chombo AMR Data, Stephen Hawking CTC, UCambridge; Queens College, London; visualization, Carson Brownlee, Intel)

Stephen Hawking Centre for Theoretical Cosmology – ‘Walls’ in situ with OSPRay Rendering

- 10 TB Memory Footprint
- SGI UV-300 16TB SMP
- >1000 Shared memory Intel® Xeon® E5 v3 processors
- ~15 fps

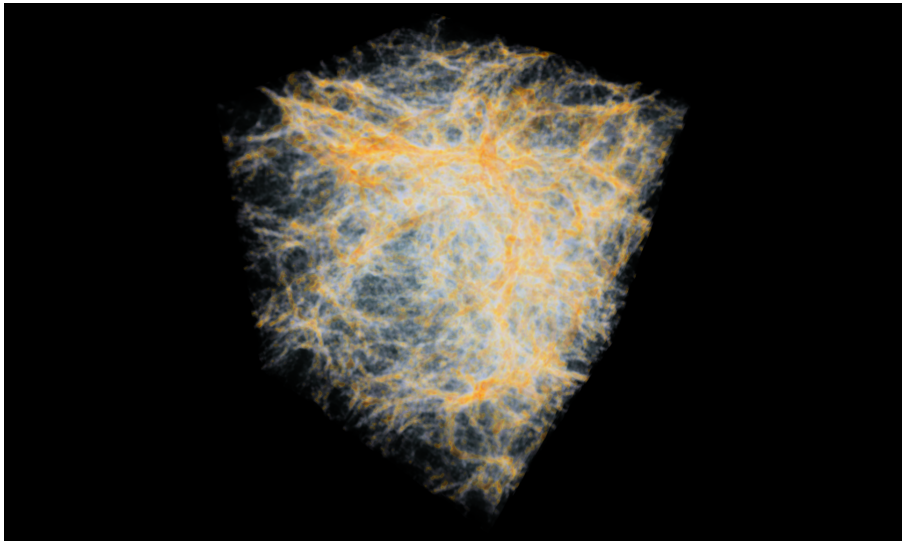
- Domain Wall formation in the universe from Big Bang to today (13.8 billion years)

- Simulation code by Shellard et al, Visualizaiton by Johannes Gunther (Intel)

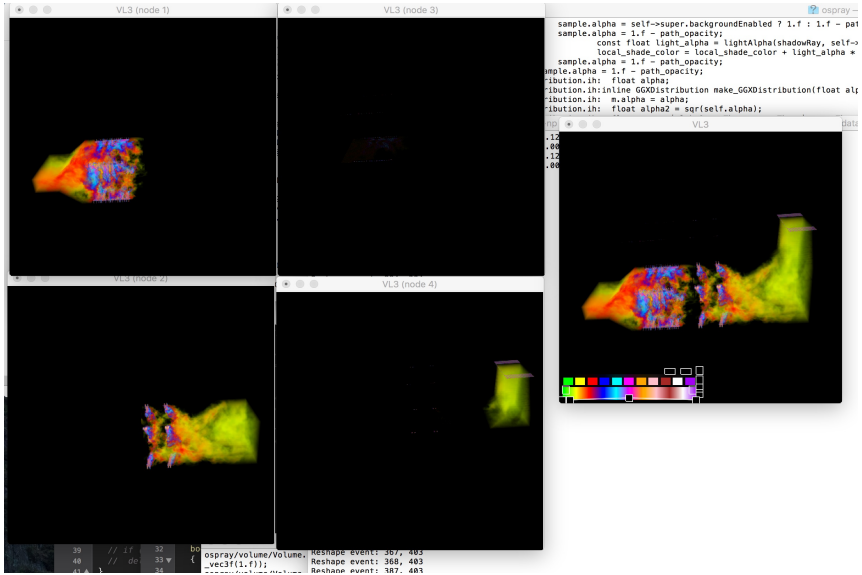


Argonne VL3 Distributed Volume Renderer

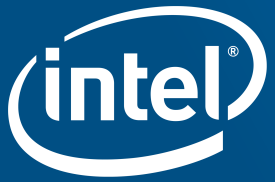
VL3 with Mesa v13.0 with OpenSWR



VL3 Compositing with OSPRay



Visualizations: Silvio Rizzi, Joe Insley: Argonne; Aaron Knoll: SCI @ UUtah



VISUALIZATION @ HPCDC AND SC'16 OVERVIEW

SDVis Track Schedule (SATURDAY)

Technical Sessions		**SW Visualization (Powder Mountain)**	Lab Sessions		**Lab Room 3 (Capacity 50)**
Start	End	Technical Sessions	Start	End	Hands On Lab
12:00 PM	1:00 PM	Registration Opens			
1:00 PM	1:50 PM	Welcome Kick Off			
1:50 PM	2:05 PM	Break			
2:05 PM	2:55 PM	Talk 1 - SDVis Update (Jim Jeffers) Talk 2 – OpenSWR Update (Jeff Amstutz)	2:05 PM	3:30 PM	
2:55 PM	3:10 PM	Break			
3:10 PM	4:00 PM	Talk 1 - OSPRay 1.0 and Beyond (Jeff A, Intel) Talk 2 - MPI Data-Parallel Rendering w/OSPRay (Carson B, Intel)			
			3:30 PM	3:40PM	Break
4:00 PM	4:15 PM	Break	3:40PM	4:30PM	Software Defined Visualization : Getting the most out of ParaView OSPRay (Paul A. Navrátil & David E. DeMarle, Kitware)
4:15 PM	5:05 PM	Talk 1 - Realizing Multi-Hit Ray Tracing in Embree and OSPRay (Christiaan Gribble, Intel/SURVICE) Talk 2 - Visualization w/Visit on Knights Landing (Jian Huang & Hank Childs, UOregon / UTennessee)	4:30PM	5:05PM	

SDVis Track Schedule (SUNDAY)

Technical Sessions		SW Visualization (Powder Mountain)	Lab Sessions		Lab Room 2 (Capacity 25)
7:00 AM	9:00 AM	Registration andBreakfast			
8:45 AM	9:30 AM	Keynote			
9:30 AM	9:45 AM	Break			
9:45 AM	10:35 AM	**Talk 1 - SDVis Efforts @ Intel® PCC Aaron Knoll, Unv. Of Utah) Talk 2 - OSPRay Integration into Pcon-Planner (Caglar Özgür & Frank Wicht, Eastern Graphics)**	9:45 AM	10:35 AM	**Software Defined Visualization : Getting the most out of ParaView OSPRay (Kitware)**
10:35 AM	10:50 AM	**Break**	10:35 AM	11:25AM	
10:50 AM	11:40 AM	**Bio-Molecular Vis on Knight Landing (John Stone, UIUC)**			
			11:25 AM	11:40AM	Break
11:40 AM	1:00 PM	**Lunch time Panel**	11:40 AM	1:00 PM	Lunch time Panel
1:00 PM	1:50 PM	**Paraview & VTK w/OSPRay and OpenSWR (David DeMarle, Kitware)**	1:00 PM	2:00PM	
1:50 PM	2:05 PM	**Break**			
2:05 PM	2:55PM	**SDVIs and In-Situ Visualization on TACC's Stampede (Paul Navratil)**	2:00PM	2:40 AM	
			2:40AM	2:50PM	Break
2:55 PM	3:10 PM	**Break**	2:50PM	4:00 PM	
3:10 PM	4:00 PM	**Live Demos and Open Discussion on Software Defined Visualization (All Vis Track Presenters)**			
4:00 PM	4:15 PM	Break			
4:15 PM	4:45 PM	Closing Keynote			
7:00 PM	10:00 PM	Intel® Networking Reception			

SC'16 Software Defined Visualization Demos

Intel Main Booth (#1819):

Intel® SSF Cluster (Intel® Xeon Phi™ Processors, Intel Xeon® v4 Processors, Intel® Omni-Path Fabric, Intel® HPC Orchestrator, Intel® Lustre

- 1) ParaView v5.2 w/OSPRay&OpenSWR: Brain Tumor Analysis
- 2) VMD v1.9.x w/OSPRay: Cryo-EM Reconstruction with ROME
- 3) VMD v1.9.x w/OSPRay: LAMMPS for Cancer Research

Intel Discover Zone (#2121) – Intel® Xeon Phi™ Processor DAPs

- Argonne VL3 w/OSPRay: HACC Dark Matter Analysis
- ParaView v5.2 w/OSPRay: Stephen Hawking CTC – Ligo based Black Hole collision

Partner Booths

- Dell, SuperMicro, Kitware, NASA, Univ of Utah, NCSA, …

SCI-X Open House
Univ. of Utah

Weds Nov. 16
1:00 p.m. - 7:00 p.m.

1-5 p.m.: Open House: Cont. Buses between the Salt Palace and the University (10 minutes each way).

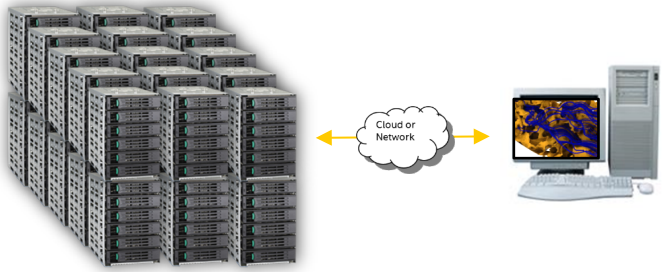
5 p.m.: Keynote presentation by Jim Clark - Warnock Engineering Building L104 (overflow - WEB 2230)

6:00 p.m. - Reception - Catmull Gallery

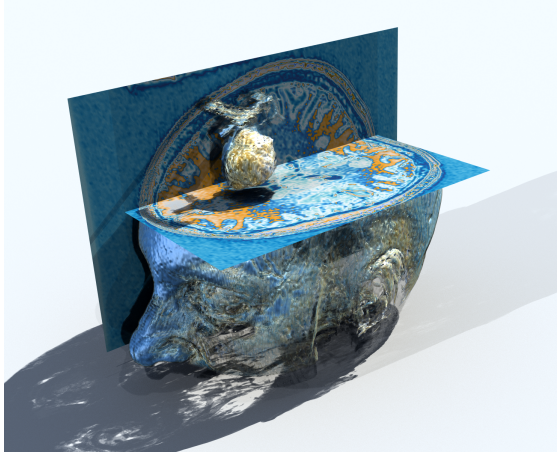
Summary:

Software Defined Visualization

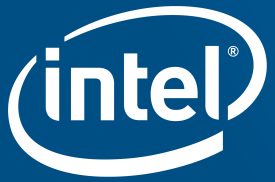
www.sdvis.org



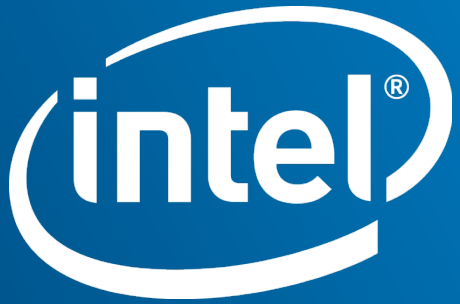
- Addresses ever-growing HPC challenges for data size, flexibility, reliability and maintainability
- OpenSWR, OSPRay and Embree rendering libraries optimize use of CPUs and main memory
- Integrating into prominent Vis tools, ParaView*, VisIt, EnSight*, VMD, Brayns, VL3, and more ….
- All freely available (Open Source), developed and maintained by Intel



SDVis = *Performance, Fidelity and Lower Cost!!*



QUESTIONS?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experience
what's inside™

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