Picture This!
Visualization on GPU Accelerated Supercomputers
Peter Messmer, 11/15/2016
Many vis workflows, one GPU accelerated system

Legacy

In transit

In situ
Going beyond post-processing

**MONITORING**
Early termination, progress control

**IN SITU VIS**
Interactive visualization of progressing simulation

**STEERING**
Exploratory simulation
Modifications
In-Situ vis on Titan for improved insight
PyFr simulations, Gordon Bell Finalist

Fluid simulation with PyFR, 113Bn DOF
5000 K20X GPUs
VTK-m + Catalyst + ParaView

F. Witherden, A. Farrington, A Iyer, P. Vincent
Gordon Bell Talk: Wed, 10:30 255EF
Steering a data acquisition system
Enabled by fast reconstruction and visualization

- Investigations of basic principles of bubble flow using electron beam tomography
- Complex reconstruction of acquired data
- GPU accelerated reconstruction
- Operator modification of acquisition parameters (electron beam)

T. Frust, G. Jukeland, A. Bieberle
Leveraging the GPU graphics capabilities

**X SERVER**
- HW accelerated rasterization
- Extra process
- Supported by all vis tools
- Available on all systems

**EGL**
- HW accelerated rasterization
- No extra process
- Supported by major vis tools
- Demonstrated on all systems

**CUDA**
- Software rendering
- No extra process
- Used e.g. for ray-tracers
- Available on all systems
Visualization on GPU accelerated HPC systems
Streamlined GPU accelerated off-screen rendering

- Prior to EGL: X server required for GPU accelerated rendering
- Full OpenGL on EGL announced at SC15
- With EGL: OpenGL without X
- Major enabler for GPU rendering in HPC, incl. Cray systems*
- Quick adoption by vis tool developers
  - * Requires driver version 358.7 or newer required
In situ visualization in the cloud

Obtaining supercomputer on demand

Simulation of Plasma Wakefield Accelerator

P2 instance of Amazon EC2

4xK80, compute and vis

NICE DCV for hardware accelerated streaming

Uses H264 encoders on GPU

Axel Hübl et al.
NVIDIA IndeX: Scalable, interactive volume vis

Large-scale (volume) data visualization
Interactive visualization of TB of data
Stand-alone or coupling into simulation
HW Accelerated remote rendering
Upcoming plugin for ParaView

http://www.nvidia-arc.com/products/nvidia-index.html
In situ visualization and steering

Simulation of drug flow through nasal tract to lungs
50M particles, 18 hrs on 500 CPU nodes
GPU version using OpenACC

Volume visualization using NVIDIA IndeX
Sparse volumes, support for OpenVDB (Houdini)
In situ visualization and steering
NVIDIA IndeX for ParaView plugin

- NVIDIA IndeX rendering in ParaView
- Retain ParaView workflows
- Structured and unstructured meshes

Workstation Edition: Free
Cluster Edition: For Scalable Performance

Learn more: www.nvidia.com/index
Telling a better story, visually
Advanced rendering improves messaging

- Advanced rendering helps visual message
- Interactive ray-tracing via NVIDIA Iray
- Physically accurate renderings via Material Definition Language (MDL)
- Generation of accurate training data
Virtual Reality for Scientific Visualization
A new dimension of exploration

Orientation + Navigation = Exploration

Complex molecular structure of chromatophore
Exploration of groundwater flow

Unreal Engine for rendering
Support for latest generation GPU
Immersive VR Experiences ARE 7x MORE DEMANDING THAN PC Gaming

**PC GAMING = 60 MP/S**
(1920 X 1080 @ MIN 30 FPS)

**VIRTUAL REALITY = 450 MP/S**
(3024 X 1680* @ MIN 90 FPS)

*VR render resolution*
Novel HPC Visualization Workflows with GPU-Accelerated Systems

Novel workflows for new use cases

GPU provide necessary power and flexibility

HPC + interactivity = opportunities

Professional VR enabled by Pascal
OpenGL - The Rendering Workhorse

Obtaining supercomputer on demand

Most visualization tools

GPU acceleration

Runs on Power8, Arm,